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Education is the manifestation of the perfection already in man". These are the words of the great philosopher and educator Swami Vivekananda. The contributions of the great people who devoted their life for the cause of education and youth have always inspired the promoters and, therefore, following the preaching of Swami Vivekananda, the promoters established VIT Campus, comprising of Vivekananda Institute of Technology and Vivekananda Institute of Technology (East), in 2008, to usher in technology revolution by using modern management techniques and harnessing potential of India. Another feather in the crown of Vivekananda Group of Institutions is Vivekananda Global University, established in the year 2012. Vivekananda Global University, Jaipur has been formed keeping in mind his teaching and mentoring ideals. The overall development of the techno-managers with a seeking spirit towards education is VGU's vision for its students. It Promises to develop as an institution with a commitment to excellence in education, research and consultancy and promote human advancement. Swami Vivekananda advocated the concept of 'total development' which includes physical, mental and spiritual. He also advocated incorporation of science and technology in curricula and laid emphasis on technical education that will develop industries. Our core values are inspired by Swami Vivekananda philosophy, and our institution is founded on his thoughts and ideas. To meet these ends, Vivekananda Global University encourage development of student's physical, mental, emotional, secular and spiritual faculties.

Thue guidance is like a small torch in a dark forest. It doesnt show everything once. But gives enough light for the next step to be safe.

Swami Vivekananda

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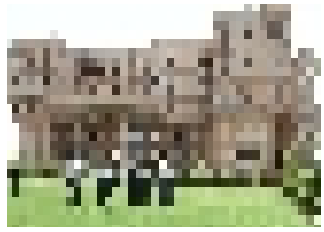

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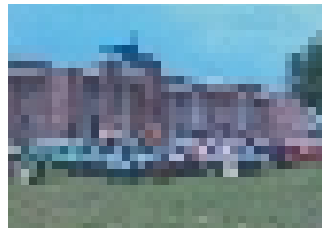

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CONTENTS

Power Sector Restructuring Experiences in United Kingdom

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Abstract : Over the past 20 years, there has been a worldwide trend to change the way in which electricity industries are organised, from an integrated monopoly, often owned by central government, to a de-integrated structure, usually privately-owned and operated, where possible, within a competitive market.
This paper focuses on the experiences of these changes, reforms/restructuring in power sector of United Kingdom. The concept of Reforms, Motivation for the Reforms in United Kingdom and Restructuring of Power Sector in United Kingdom are the main components which taken in the study.

Key words : Privatization, British or United Kingdom Model, CEGB, NGC, REC, NETA.

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Introduction

A particular problem in discussing changes to the electricity industry is terminology. These changes are variously described as: 'reforms'; 'privatisation'; 'liberalisation'; 'deregulation'; and even 'modernisation'. More importantly, they do not accurately describe the changes that have taken place. Most changes have required a major strengthening of the regulatory regime so deregulation is certainly not appropriate. None of the terms describes a change from a monopoly to a competitive market, arguably the most important justification advanced for making these changes. In this paper, either 'change', 're-structuring' or're-organisation' unless the meaning is more specific, e.g., privatisation.

1.0 Concept of Reforms

The 'British Model' is now well known throughout the world as the model for the introduction of competition to the electricity industry. The main elements are:

- Introduction of a wholesale electricity market;
- Introduction of retail competition for final consumers of electricity;

- Restructuring of the industry into four corporately separate sectors, generation, transmission, distribution and retail supply;
- Regulation of monopoly activities by an independent regulatory body using incentive regulation;
- Privatisation of publicly owned companies.

For practical reasons it was impossible to implement the British Model in Britain in 1990 when the industry was privatised and since then, while in some respects, the British electricity industry has moved closer to the ideals of the British model, in other respects, it has moved away from them (Surrey, J., 1996).

1.1 The wholesale electricity market

The Power Pool is the wholesale market. Experience with the Pool was poor and in 1998, it was decided to replace it with the New Electricity Trading Arrangements (NETA). These are immensely complex, but they can be seen more significantly less competitive than the Power Pool should have been. About 98% of power is expected to be bought and sold under confidential bilateral contracts.

1.2 Retail competition

Retail competition was phased in 1999 andafter that all final consumers have been able to choose their electricity supplier.

1.3 Restructuring

In 1990, the generation sector was separated from the other three sectors. Three generation companies were created; two privatised companies and one nationally owned nuclear generation company. This structure was too concentrated to produce competition and required substantial intervention by the Regulator through forced sell-offs of plants and encouragements to enter the sector to produce a more competitive structure. Now, there are about 12 significant size generators, enough in theory, to produce a competitive market. Distribution and retail supply were not separated and 12 regional distribution and retail companies (RECs) were privatised intact. In 1999, the Regulator required the RECs to make a full separation of the two businesses (although they could be under the same owners). Since then, there has been major take-over activity. The 12 supply businesses have been taken over by six of the generation companies, some of which now own three regions. The distribution businesses are also beginning to merge. The transmission business was transferred to a new company, initially owned jointly by the RECs, but now fully independent.

1.4 Regulation

A single person Regulator, the Director General of Electricity Supply was appointed in 1990, assisted by a regulatory staff, the Office of Electricity Regulation (OFFER). In the period 1998-2001, changes were made to this structure, with the gas and electricity regulatory system merging and decision-making being taken over by a ‘board’ of five executive and five non-executive directors, the Gas and Electricity Markets Authority.

1.5 Privatisation

The companies were created on April 1 1990 and shares sold off progressively. In 1996, the publicly owned nuclear generation company was split again into a company that was privatised and one, containing the older nuclear plants that remained in public ownership.

2.0 Motivation for the British reforms

There was little apparent need for reform in 1987. Service was reliable, prices were in line with European countries, the industry was profitable and investment needs could be readily financed. However, there were three strong non-sector objectives that influenced the decision: generation of government revenues; widening of share ownership; and breaking trade union power.

2.1 Generation of government revenues

When the privatisation programme was launched around 1980, Britain was in deep recession. Revenues from privatisation allowed government spending to be maintained. When electricity privatisation was mooted, the British economy had recovered, but the political value of income that could reduce income tax was large. The Treasury's objective was to generate about £5bn per year from privatisation in 1987. The sale of the electricity companies was spread over several years with a total yield of about £15bn, far more than any previous privatisation.

2.2 Wideningof Share Ownership

The public flotation of the utility industries, such as telecoms (Littlechild, S. 1983), gas (1986) and water (1989), included sale of some of the shares to the public. The public assumed that the shares would be profitable and the flotation was over-subscribed several times over. The use of public flotation in such a way, which make risk towards minimise to investors. The difference between the flotation price and the price on the first day of trading ranged from 20 per cent for the power generators to 86 per cent for British Telecom [Wright and Thompson 1994: 55]. The government ensured the companies would be profitable by limiting the extent of competition and by setting easy regulatory targets. However, by 1987, the public backlash against companies seen as privatised monopolies meant that the British electricity industry had to have the appearance of a competitive industry but transitional measures limited the scope for competition for eight years after privatisation.

2.3 Breaking Trade Union Power

Much of the power of the trade union movement lay in large publicly owned utilities. These had monopoly powers over public services, so strike action would quickly have an impact. Breaking up these large companies and introducing competition was bound to reduce union power. Support from the workforce for strikes that could harm a company operating in a competitive market would be difficult to gain. If the companies were split up on privatisation this would fragment

union power. In addition, private owners could impose conditions on the work force that it would have been politically difficult for publicly owned companies to impose.

3.0 Re-structuring of Power Sector in United Kingdom

The ideal British Model structure would have required the industry to be split into two competitive activities, generation and retail supply both with a number of competing companies; and two monopoly activities, high voltage transmission and low voltage distribution. A number of factors meant that it was impossible in 1990 to introduce this ideal structure:

- The unfamiliarity to investors of some activities making the companies difficult to value and sell;
- The difficulties of setting up a large number of new companies;
- The problems of introducing retail competition; and
- The need to introduce transitional protection for the British nuclear and coal industries.

The CEGB (Newbery, D. and M. Pollitt, 1996) was split into two privatised generators, National Power and Powergen, a publicly owned nuclear generator, Nuclear Electric, and a transmission company, National Grid Company (NGC). The 12 regional distribution/retail companies became Regional Electricity Companies (RECs).

3.1 Generation

The government's commitment to nuclear power prevented the creation of a competitive field of generators. The government believed that Britain's nuclear plants, then providing 15 per cent of electricity, could be privatised if they were 'sheltered' in a large company owning two thirds of the capacity. To provide countervailing power, the rest of the plants would be placed in one other company. In the event, the shelter of a large company was insufficient to make the nuclear plants attractive to investors.The fossil fuel plants were allocated so National Power had 30GW, Powergen had 20GW and Nuclear Electric was had 8GW.About half Nuclear Electric's income came from a subsidy and the generation market was therefore effectively a duopoly.

The RECs were allowed to acquire up to 15 per cent of their power from their own plant. In the 'Dash for Gas' from 1990-92, they bought about 10GW of plant. This allowed the RECs to diversify their businesses and reduced their dependence on the duopoly. The principle of separating retail and generation was compromised further by the decision to allow National Power and Powergen to supply power to final consumers in the competitive part of the market.

The Regulator has intervened continually to increase competition in generation, twice, requiring the 'duopoly' to sell plant. In 1996, National Power and Powergen had to sell 6GW of their plants [Offer 1995] but at the expense of compromise to the principle of separation of generation and retail, the plant being sold to a REC, Eastern Electricity. However, when National Power and Powergen tried to take over

RECs in 1996, they were blocked by the government [Department of Trade and Industry Press Release 1996]. In 1998, the government allowed them to take over retail businesses on the condition that they both sold 4GW of their plant. How far this reversal was a pragmatic decision based on recognition that the principle of de-integration had already been lost and how far it represented a decision to allow the market to integrate is not clear. One explanation is that the separation of distribution and retail would have left the retail sector vulnerable. A retail business has few assets other than customer loyalty and if the retail businesses were forced to operate as separate entities, they might have proved too unstable. If they could not be integrated with distribution, integrating with generation was the only viable option.

The two regions of Scotland are now part of a British market and the 14 retail regions of Britain are owned by five companies. National Power got into financial difficulties and in 2000, was split into a UK business, Innogy (trading as Npower), and an independent power producer, International Power. Innogy and Powergen were taken over by German companies, RWE and E.ON, in 2001. EDF entered the market taking over RECs and buying some of the capacity released by the duopoly. TXU, a US utility that built an integrated business around its ownership of the Eastern REC and the purchase of generating plant, made poor power purchase deals, got into severe financial difficulties in 2002, and was taken over by E.ON. Centrica has about 24 per cent of the household electricity market but only a small share of the market for large electricity consumers [Ofgem 2003].

Nuclear Electric doubled the output of the newer nuclear plants. A government review [Department of Trade and Industry and the Scottish Office 1995] recommended that the newer nuclear plants (9GW) be privatised and the nuclear subsidy be removed. In 1996, British Energy was privatised. The older plants were left in public ownership in a new company, Magnox Electric, later absorbed into the nationally owned nuclear fuel cycle company BNFL. British Energy prospered initially, but by 2000, falls in the wholesale electricity price had eroded profits and by autumn 2002, it had to receive a government loan of £650m to stay in business. The Magnox plants are a small part of BNFL's overall operations. BNFL is also insolvent and the Magnox plants lost £159m in fiscal year 2002/03.

Table 1 Ownership of generating capacity: 1990 and 2004

1990 (Capacity GW)		**2004 (Capacity GW)**	
National Power	30	British Energy(nuclear: insolvent)	9.6
Powergen	20	*Innogy (RWE)	8.0
Nuclear Electric	8	*Powergen (E.ON)	8.3
Scottish & Southern	5.3	*Scottish Power	4.7
*EDF	4.7	BNFL (nuclear: insolvent)	2.7
*Centrica	2.2	Others	9.2
Plant repossessed by banks etc	7.9	Plant for sale	6.3
TOTAL	**68.9**		

Source: *www.statisticsauthority.gov.uk*

The generation market appeared competitive by 2004 (Table 1). Eight companies had more than 3 per cent of the market and no company had more than 15 per cent. However, 40 per cent of capacity is owned by companies that are financially

distressed or has been repossessed by banks.EDF, E.ON and RWE are doing very well in the British market making a significant proportion of their profits there.

3.2 Retail supply, distribution and transmission

The RECs had to make an accounting separation between distribution and retail and were protected from takeover by golden shares for five years. When the golden share expired, all except one was taken over. In 1997, the Regulator became concerned about the scope for cross-subsidy between distribution and retail. A significant proportion of staff and systems were common to both businesses. The Regulator feared that companies would cross-subsidise retail from distribution choking off competition. He required a legal separation of the businesses although they could remain under common ownership [Offer 1998a]. Distribution and retail have little in common in terms of skills – retail requires buying and selling a commodity while distribution requires the maintenance of a network. As a result, many of the owners chose to split the businesses. By 2004, the distribution businesses of half of the regions of England, Wales & Scotland were owned by companies other than the owner of the retail business. EDF, Scottish Power, Powergen and Scottish & Southern operate in both distribution and retail. Innogy has not bought distribution, while PPL, Mid-American Energy Holding, and United Utilities have sold their retail businesses.

A priority for the government in 1990 was to ensure that transmission was not owned by a generator, as this would have led to fears that access to the network would not be fair. The National Grid Co was owned by the RECs, with limitations on how far they could influence its policy. In 1995, they were required to sell their shares. In 2003, NGC merged with its gas industry equivalent, Transco, to form National Grid Transco (NGT). The strong regulatory requirement for de-integration of retail and distribution and the independence of NGT mean that all generators and retailers have equal access to networks on non-discriminatory terms.

Conclusions

The decisions to allow integration of generation and retail and to allow concentration mean the structure is not competitive and there seem few policy options to improve it. There is little independent power to give liquidity to the wholesale market. Of the six integrated companies, the parents of the three foreign owned companies are much larger than the three British-owned companies who could prove vulnerable to takeover. The one success with the structure has been the separation of the network from the competitive activities. However, given the uncompetitive structure of generation and retail, this is a hollow victory.

Notes: Companies with generation and retail supply are marked *.

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A Review of Voltage Control Technique of Grid Connected Distributed Generation

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Abstract : Voltage is an important parameter for the control of electrical power systems. The Distribution Network Operators (DNO) have the responsibility to regulate the voltage supplied to consumer within statutory limits. Traditionally, the On-Load Tap Changer (OLTC) transformer equipped with automatic voltage control (AVC) relays is the most popular and effective voltage control device. STATCOM, power factor generator are also the useful technique to control the voltage in distribution system. Connecting Distributed Generation (DG) to the network inherently affects the feeder voltage profiles and influences the voltage control in distribution systems. In recent years, the number of DGs connected to the distribution networks is continuing to grow. Their impact on the network is therefore demanding proper attention and is affecting the design of new voltage technique scheme. The potential for using Smart Grids also promises to have a major influence on schemes for voltage control in the power systems. This paper presents an overview of existing voltage control schemes which are used to control the voltage in distribution networks. It includes a discussion of new techniques which have been introduced and those being proposed to improve voltage control for networks containing various levels of DG. It also examines the potential opportunities for OLTC voltage control schemes offered by the use of Smart Grids

Keywords : distribution generation, OLTC, STATCOM, AVR relay, PFC, distribution system, voltage control

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Introduction

Now a day, the electrical power transmission and distribution system normally operated at multiple voltage level. Voltage is one of the most important parameter for the control of power system when connected to DG. The

connection of DG in distribution system has created a challenge for distribution network operator to change their usual passive approach to an active system. The conventional distribution networks are designed based on the assumption of unidirectional power flow with the increasing connection DG. The network has become more dynamic with bidirectional power flow. It is known as active distribution network.

An active distribution network is defined as distribution network with system in place to control a combination of distributed energy resource comprising of generator and storage. Voltage controls in active distribution system have been decomposing into three hierarchical level i.e. primary, secondary and tertiary levels. The primary control is performed by AVR (Automatic Voltage Regulator), the secondary control is performed by on load tap changer (OLTCs) meanwhile tertiary control is a short operation planning is developed to coordinate the action of primary &secondary control device according to secured operation and economic criteria based on load and generation forecast.

On the other hand voltage control in distribution system is normally achieved by in cooperating on load tap changer (OLTCs) and switched shunt capacitor only in most distribution system

The voltage and reactive power equipment in distribution system are mostly operated based on and assumption that the voltage decreases along the feeder on the other connection of distribution generation will fundamentally alters the feeder voltage profile which will obviously effect the voltage control in distribution system .The modernization of electricity distribution system now a day coordinated voltage control developed into distribution system. Different method of short term operation planning for distribution system voltage control have been proposed .This paper present a review of different voltage control method in distribution system in the presence of DG.

The distribution networks become more complex and the number of distributed generation (DG) is continuing to grow, conventional OLTC voltage control schemes are going to be less effective. Whenever there is reverse power flow caused by the integration of distributed generation, there are complications for the operation of the AVC. Meanwhile, the potential use of Smart Grids also indicates to have a significant influence on schemes for voltage control in the power systems. To deal with the voltage control problems together with the increasing penetration of the DGs as well as the use of Smart Grid, DNOs need more stable and effective OLTC voltage control schemes and also the other voltage schemes.

Votage Control In Electrical Distribution System

The voltage variation ∆V across the line can be represented by the following equation.

Where ∆V indicates voltage variation P and Q represents active and reactive power output of DG, X and R are reactance and resistance of line connecting to DG. V is the nominal voltage at the terminal of DG.

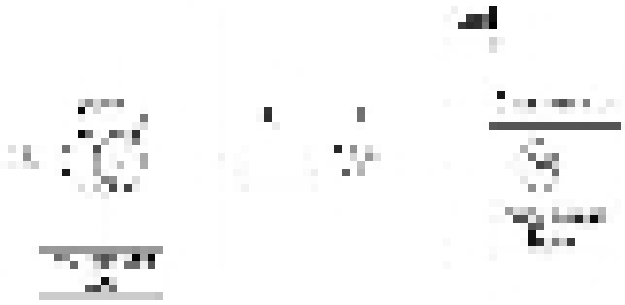

Fig.1: Simple Radial Feeder with Connected DG

A simple radial feeder is connected with DG is shown on figure. On Load Tap Changer transformer load a reactive power compensator, automatic voltage controller, line drop compensator, energy storage device is also connected on the system.

Generally the **X/R** ratio of distribution system is relatively low than that of transmission line. According to equation 1 , power generated by DG will result in voltage rise or drop on the distribution network , feeder with high impedance . The voltage variation would also depend on several factor including DG size , location and method of voltage regulation

A. Generator power factor control

The uses of AVC relay with DGs synchronous generator are implemented to adjust their reactive power output of bus bar voltage. This operation could result in several severe problem including high current and over current protection and disconnecting the generator from the network. For ensuring network safety DGs are not allowed to use AVC to adjust their voltage. So power factor control has been implemented with DG.

In power factor control P/Q is maintained constant. According to equation , P is directly proportional to voltage variation. If Q can be compensated for voltage variation generated by P by adjusting in opposite direction. So voltage variation can be maintained within the limit. For voltage increment situation the more leading power factor at where the DG is connected. Wallace and Kiprakis (2002) proposed a voltage control method for DG which assumed a more flexible directive from DNOs in terms of voltage control by DG. The voltage control technique is able to keep DG online during light heavy load condition by combining AVC and PFC. This technique was also able to improve steady state and slow transient profile.

B. Static Synchronous Compensator

A STATCOM is a flexible AC transmission system (FACTS) device it is a voltage source converter based device which a DC input voltage into an AC output voltage in order to compensate the reactive power of the system . Usually the reactive power output of a STATCOM is regulated to maintain the minimum AC voltage at the bus to which STATCOM is connected .It can provide control in both transmission as well as distribution system with a fast response control.

Due to the fast response of STATCOM modern control strategy such as linear quadratic regulator (LQR) can be provided for voltage control. Rao et al.(2003) implemented PI ,pole –placement and LQR controller on the STATCOM respectively .the performance were compared in terms of response profile and control effort.

C. On-Load Tap Changer

There are various control characteristics associated with OLTC such as Line Drop Compensation (LDC), time grading for accommodating operation in series of transformers, as well as a variety of circulating current compensation techniques for operation of parallel transformers.

Fig 2: AVC relay scheme with LDC

LDC monitors the voltage at the secondary side of the transformer and then using a measure of the secondary current to simulate the voltage drop across the feeder that exists between the transformer and the load . This voltage drop along the feeder impedance is used to boost the voltage regulated at the transformer terminal therefore ensuring the correct voltage level maintains at the load where it is required. The LDC provides voltage control at a nominal load point rather than at transformer terminals as shown in Figure 2.

There are multiple voltage levels used for generation, transmission and distribution in most power supply networks. In each area, On-Load Tap Changer

transformer will be used between these different voltage levels as shown in Figure 3.

Fig3 : Different OLTCs operated in series

Due to the uncoordinated control schemes between the upstream and down-stream controller, the OLTC transformer can become unstable. The grading time (GT) is introduced as an additional delay to ensure the upstream transformer has finished its operation before the down-stream transformer restores the voltage level [3]. The GT is set as the worst case voltage correction time.

1) Communications assisted voltage control schemes

A communications unit can be used to replace the need For GT delay. When the up-stream transformer starts the operation, a blocking signal is issued to stop the operation of down-stream transformer. The blocking signal is removed when the up-stream transformer has done its correction .Hence, the time delay is reduced from worst case correction time to up-stream operation time.

2) Operation in parallel

With the growing customer demand for the higher security and reliability of supply, it is common practice for the DNOs to parallel transformers on one site or across the network in order to meet the engineering recommendation as shown in Figure 4.

In this situation, the main aim of the AVC scheme is to maintain the voltage within statutory limits, at the same time, to minimise circulating current between parallel transformers. There are some factors might affect the AVC schemes such as power factor, DG integration or varying load.

The Standard voltage control schemes for paralleled transformers are as follows.

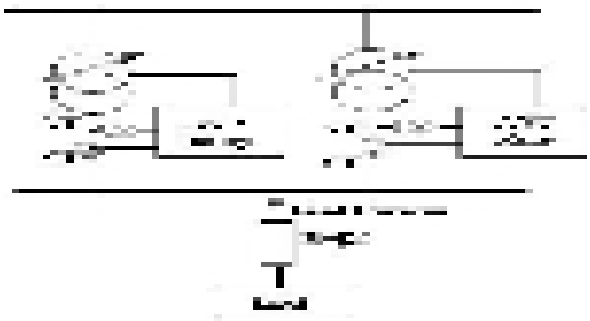

Fig.4: OLTC in parallel.

a) Master-Follower

A simple and extensively used AVC scheme is the master follower scheme. One OLTC transformer is designed as the "Master" and all other OLTC transformers in parallel with it as "Followers". In this scheme the master transformer monitors the required voltage and alters the tap position to regulate the voltage to desirable level. The other OLTC transformers replicate the same actions to make all paralleled transformers kept on the same tap position. The master follower scheme can be used with LDC and operates under varying power factor, reverse power flow and DG integration.

The disadvantage of this scheme is that the circulating current will flow between transformers if the paralleled transformers are not the same type. Additionally, the parallel transformers must be on the same site. It is impossible to use this scheme across a network due to the connection between the AVC relays.

b) True Circulating Current

The True Circulating Current scheme is considered to use essentially identical transformers as the master-follower scheme. This scheme regulates the voltage as well as reduces circulating current between paralleled transformers. The different tap positions of the transformers will result in a circulating current. This current is calculated by the interconnection between controllers to create a voltage bias. The biasing in opposite polarities is used to correct the OLTC to adjust the relay setting voltage therefore the circulating current is minimised. It can also work with LDC and operates under varying power factor, reverse power flow and DG integration. The backward is that it is difficult to parallel transformers which are not in the same site.

c) Negative Reactance Compounding

The negative reactance compounding (NRC) method is one of the common AVC schemes used in the distribution networks. The negative value of reactance with LDC settings is used to make the tap positions of paralleled OLTC transformers to be similar. The following formulas show the relationship between LDC settings and negative reactance compounding (NRC) setting:

ZLDC = RLDC + jXLDC
ZNRC = RLDC – Jxldc

The tap position of transformer T1 is much higher than of transformer T2 in this situation. A circulating current occurs and flows between the two paralleled transformers. The individual transformer current IT1 is shifted clockwise and current IT2 anti-clockwise by the circulating current. A voltage drop IT·ZNRC is created to modify the target voltage from VVT to VAVC and used by AVC relay to correct the tap position. The effective measured voltage VAVC1 is seen by AVC relay of T1 higher than the target voltage VVT and as a result the tap change is down. A similar action is done by AVC of T2 but the tap change is up. When the circulating current is eliminated and target voltage is achieved, the action stops with a similar tap position of both the parallel transformers.
The paralleling transformers with the negative reactance compounding scheme can operate with transformers at different positions in the networks and it is unnecessary to be identical anymore due to the independently action of each transformers. However, the NRC scheme is not accurate without unity power factor thus is susceptible to the varying power factor. The voltage error is increased due to the power factor deviation . The performance of LDC is reduced due to the negative value of XLDC setting and an increased value of RLDC is necessary to keep the same boost.

d) Transformer Automatic Paralleling Package

The Transformer Automatic Paralleling Package (TAPP) scheme, based on the NRC scheme, reduces the circulating current between the paralleled transformers by dividing the measured current into load transformer current and circulating current. TAPP scheme uses techniques based on the target power factor, to evaluate circulating current by comparing the measured transformer load current (ITR) with the target power factor (pftarg) as shown in Figure. Two separate circuits, one for LDC and one for compounding, are introduced into TAPP scheme to eliminate the LDC degradation with NRC. However, the disadvantage of TAPP scheme is that the load power factor deviation will result in an error in the controlled voltage due to knowledge of the load current being considered as circulating current. The specified power factor is the necessary factor to make the voltage control to be satisfactory.

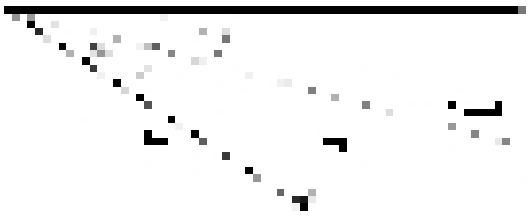

Fig.5 . Principle of TAPP scheme

Influence of the dgs integration

Due to a variety of reasons, more and more distributed resources are connected to provide local power supplies to solve the constraints of the transmission or distribution networks, reduce the transportation cost from power supply stations to consumers and to exploit renewable energy. Therefore, the capacity of Distributed Generation (DG) connected to distribution networks has grown and is continuing to grow. The presence of DG considerably influences the voltage regulation of distribution network. This situation demands much more attention to improve voltage control techniques to accommodate the increasing number of DGs in distribution networks as shown in Figure 6

Fig.6 Diagram of a distribution network with DG

The voltage drop across the feeder is compensated by the compounding setting with traditional AVC relay schemes. However, the presence of DGs including wind turbines connected to distribution networks affects the AVC relay performance and results in voltage regulation problems due to the interference. The DG integration changes the power flow and sometimes results in reverse power flow as well as a voltage increase occur at the point of connection. Thus the feeder currents measured by traditional AVC relay are no longer proportional to load currents. The measured voltage is shifted upwards or downwards depending on the power factor of transformer current and direction of power flow to the DG and load. Improved voltage control schemes are the topic of ongoing research to accommodate the presence of the
DGs connected to distribution networks.

Future Development Of Voltage Control With Smart Gird

With the growing power demand and increasing use of renewable energy, the traditional power grid is improved to Smart Grid in the future.

a) Concept of Smart Grid

The Smart Grid uses intelligent devices and a digital communication upgraded power system to enhance the performance of transmission and distribution grids.

This can assess its health in real-time, accommodate new environments, control distributed resource integrations and optimise the response of smart appliances of end users. The efficiency and reliability can be improved and active roles from end users are involved in Smart Grid in order to save consumers' money. The basic concept of Smart Grid is to have monitoring capability with data integration, advanced analysis to support system control, enhanced power security and effective communication to meet the power demand as well as reduce the energy consumption and costs. It should also facilitate a generator led control rather than one centred on demand.

b) Influence of the Smart Grid

Smart Grids are more consumer-interactive in order to make the grid truly intelligent. There are many challenges and problems need to be addressed with the use of Smart Grids. The renewable energy resources are used more and more such as wind, solar and hydrogen to result in the consumer integration inevitable to aid the grid performance. Therefore, a high degree of DG penetration will occur due to the high efficiency and low environmental impact of these preferred DG sources. The presence of high level DGs integration has considerable impact on voltage regulation of the existing
OLTC voltage control system due to their complex nonlinear characteristics. Since the end users are expected to play a more dynamic role to develop voltage control in Smart Grid, the short-term voltage control is required. This is considered not to be adequately supported by the existing OLTC control systems.

c) Opportunity for new OLTC voltage control scheme

The voltage control method may well be changed in the future as the control needs to be more flexible and smarter. The solid state devices using power electronics provide new opportunities to operate coordination control with OLTC to control the voltage in Smart Grid.

The Static Synchronous Compensator (STATCOM) is a Flexible AC Transmission Systems (FACTS) device. STATCOM provides reactive compensation to control power flow for power systems. Since the dynamic voltage control is needed in Smart Grid, STATCOM can be used due to the fast response time in distribution networks. The energy storage is always come with the renewable energy sources, thus the STATCOM can operated in all four power quadrants to accommodate the situation. When both STATCOM and OLTC are used to control system voltage, the coordination controller is introduced. The use of STATCOM is helpful for the control scheme to couple with power grid with Wide spread use of digital communication. The proposed arrangement of the new control scheme is as follows as shown in Figure 7

The new control scheme for voltage regulation, centred on the control of OLTC transformers, is aimed at meeting both the demands of the existing power system and future developments of Smart Grid

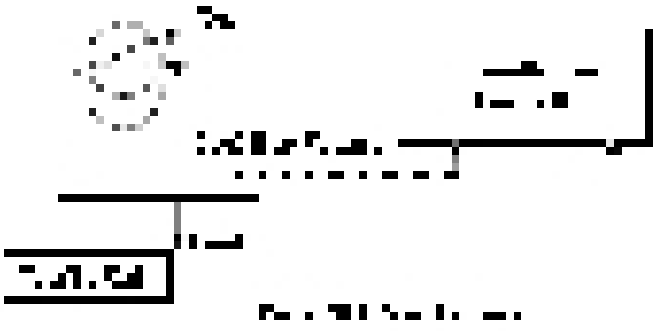

Fig. 7. Proposed controller scheme

CONCLUSION

This paper has shown the review of the existing voltage control of different control technique which are used to regulate the voltage level (i.e.) on-load tap changer transformer with their features are operated in series and in parallel. Distributed generation integration has impacts on the OLTC control scheme. The discussion of new techniques of the Enhanced Automatic Paralleling Package and SuperTAPP n+ relay schemes have been introduced. These schemes are proposed to improve voltage control for networks containing various levels of DG.STATCOM give the harmonics free voltage control in distribution system.

The influence due to the concept of Smart Grid has many potential opportunities for the OLTC control schemes. Naturally, these schemes build on the previous techniques that are used for OLTC control and will have a significant influence on the development of voltage regulation in distribution networks**.** The STATCOM is a possible device to operate co-ordinately with OLTC to meet the requirement offered by use of Smart Grids.

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Distributed Generation System

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Abstract : Any technology that produces electric power outside from the utility grid is Distributed Generation. Distributed energy resources systems are decentralized, modular and more flexible technologies, which are located within the electric distribution system at or near to the load having capacity of 3MW to 50MW.Distributed energy resources are basically renewable energy sources including solar power, wind power, which can be use for the production of the useful electric energy so these are abbreviated as back-up generators, or on-site power system. A grid connected equipment for energy storing and increment in the energy quality can be treated as distributed energy storage system (DESS).

By means of the allegation, distributed energy resources can be control with a smart grid. Distributed generation and storage enables collection of the energy from various sources which is to be supply to the load. This paper includes the basic information regarding the renewable energy resources, distributed generation, various applications of the distributed resources for the improvement of the conventional electric power system.

DG encompasses various power generating technologies, which can vary by size, application and efficiency. Some of the techniques are micro turbine, UPS system, photovoltaic system, wind system.

Keywords : smart grid, distributed generation

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Introduction

The demand of power is increasing rapidly in today's technological world. This has emphasized for the creation of more energy supplier, increment in the power quality, and reduction in various losses. One advance way for the completion this task is distributed generation. Distributed generation uses a low power rating generator which is activated in the electrical distribution system. The rating of the distributed generation is lying between 3MW to 50MW.It is basically an active power generating unit which is connected in the distribution networks.

Distributed generation can be define as

IEEE defines the production of electricity by services sufficiently minor than fundamental plants, usually 10 MW or less, so as to permit interconnection at nearly any point in the power coordination, as Distributed assets.

- The International Council on Large Electricity Systems (CIGRE) defines DG as generation that is not centrally designed, centrally dispatched at current, usually associated to the delivery network, and smaller than 50-100 MW.
- Electric Power Research Institute (EPRI) these energy providers are distributed all through the power system nearer to the loads, for this effort these are abbreviated as on-site generators.
- The block diagram represents the energy flow criteria between energy generation system and energy consuming system.

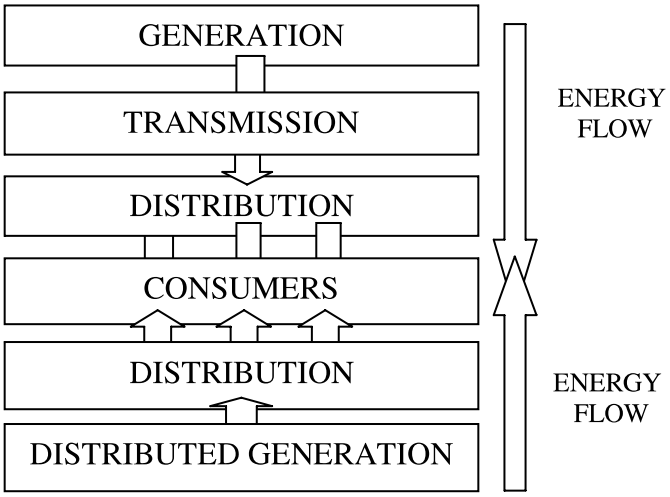

Fig.1 New concept for electric energy supply

Understanding DG

Distributed generation mainly encompasses different power generating techniques which utilizes the distributed energy resources (DES) which are basically renewable energy resources like sunlight, wind, geothermal, biomass, biogas, hydro act for the production of the useful electric energy which is to be feed to the loads. By various means renewable resource energy is converted into the electric energy, as solar power plant having the object of conversion sunlight into electric energy by means of a solar cell.

Distributed generation can convey electrical energy straight to the power distribution network or where it is consumed, rather than via transmission system. It provide lesser domain of facilities as compared to the central plant, can be operated remotely, and support a wide range of application.

The active network between the parameter of the conventional power system and various distributed generation technologies as shown with various type of loads.

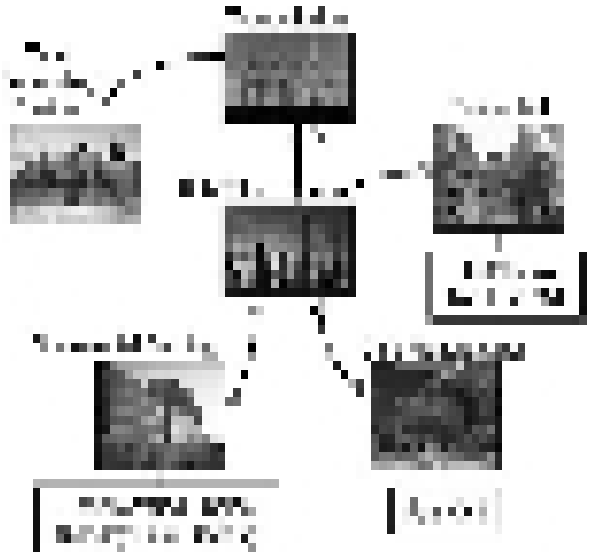

Fig.2 representing the collaboration of conventional power system with distributed generation.

Merits of Distributed Generation

There are various merits of the distributed generation which are as follows

- Reduction in the transmission losses as transmission line length is absent or reduced.
- Decrease in the complexness of the power system.
- Avoid effect of breakdown of the main grid.
- Environment friendly, increment in system efficiency and reliability.
- Preservation of environment as there is reduction in carbon emission.
- Diminution in loading effect as load is collective.
- Economical electrical energy can be provided to consumer.

DG Technologies

Distributed energy resources are use to a substitute or an improvement of the conventional electric power system. DER is characterized by the high installing cost, having a supplementary device used for the storage of the generated electric energy which is termed as the distributed energy storage system. The various technologies are:

- Hybrid power system (power system collaborating with solar or wind power plant)
- Photovoltaic systems
- Micro combined heat and power
- Micro turbines
- Combine heat power

- Fuel cell
- Reciprocating engines
- Or the combination of above

A. Hybrid Power System

This type of the power system is basically a composition of the centralized and non-centralized power generating units. Hybrid electric power system combines solar and wind electric technologies which offer several advantages over the conventional power system. Here combination of other renewable resources can be adopted. Many hybrid systems are stand-alone system which operates off-grid that is isolated from the main grid. Here decentralized generation also contain the supplementary appliances which can be used for the storeroom of the electric power. This type of system is introduced in the smart grid which has the property of two way communications and decentralized generation of the electrical power. The efficiency of the hybrid power system is higher than the conventional or centralized power generating grids.

B. Photovoltaic System

A solar PV power system or photovoltaic system is a renewable power system having a aim of conversion of sunlight energy to the useful electric energy by means of photovoltaic .This system consists of solar panels which are used to convert solar energy into electric energy, an inverter for modulation of produced DC energy to applicable AC energy, mounting and cabling. Its efficiency can be improved by the application of the solar tracking system.

C. Micro Combined Heat and Power

Micro combined heat and power (CHP) are the system which is energized by natural gas for the production of heat and electricity. It is a small heat engine driving a alternator which generates electric power and heat for the loads or sinks. The principal of operation of CHP is cogeneration. The efficiency of the CHP is 33% to 67% which is function of the components connected in the system.

D. Micro Turbines

Micro turbines are new emerging distributed generation system which is being used of the stationary energy generation applications. These uses fuel combust energy for the generation of electrical and thermal energy. Micro turbines consists of a compressor, combustor, turbine, alternator, recuperates, and generator. The efficiency of the turbines varies from 25% to 85% which is a function of the turbines energy utilizing components.

E. Cogeneration or Combine Heat and Power

Cogeneration is the utilization of power station for the creation of constructive thermal and electrical energy. Combined heat and power refers to concurrent generation of heat and electricity from the combustion of fuel or solar heat collector.

By the concurrent access to various energy developers the raw material or the waste material can be applied to other for the generation of the energy. This results in overall increment in the efficiency combined energy generating units. One example of cogeneration is combination of desalination plant with gas turbine having the effectiveness range from 40% to 80%.

F. Fuel cell

It is a device which translates chemical energy into electric energy through the chemical reaction of the fuels. These required a continuous supply of fuel and oxygen to sustain the chemical reactions so these can produce electricity for as much as long time till the chemicals and oxygen are supplied to it.

G. Reciprocating engines

Reciprocating or piston engine posses the objective of conversion of pressure into rotational motion. In this engine the piston is double actuating which results in addition of the system output.

H. Other composite approach

By the combination of two or more than two techniques a new advance methodology can be implemented of increment in power quality and growth of system reliability. For example, hybrid photovoltaic, CHP and battery system can provide full electric power without extreme storage expenses.

Impact of Distributed Generation on Power System

The output of the distributed generation system is function of the active local load. By the use of the distributed generation the efficiency of the power system is increased as ongoing losses are reduced which lead to a more consistent electrical power system. Distributed generation implement by two way communication which provides economical electrical energy to the consumer.

Decentralized Generation In Asia

In Asia there are various way used for the production of useful electric energy employing renewable and nonrenewable resources which is explained as in the given block diagram.

Fig.3 Various ways of generation of electricity

Total Renewable Energy Installed Capacity

TABLE I. IN INDIA THE TOTAL DISTRIBUTED GENERATING UNIT INSTALLED TILL (31 NOV.)

Source	**Total Installed Capacity (MW)**
Biomass Power(Biomass & Gasification and Biogases Cogeneration	4,550.55
Small Hydro Power	4,161.90
Solar Power (SPV)	4,684.74
Wind power	24759.32
Waste to Power	127.08
Total	38,283.59

Conclusion

By the use of various distributed energy resources the reliability of the conventional electric power system can be improved. As these are renewable resources having higher efficiency and lower environmental impact, so these can be adopted commercially.

These renewable resources can improved in the smart grid, and can be control remotely. In this paper various types of distributed generation techniques are explained which will provide a fruitful result after implementation.

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Model order reduction using evolutionary Algorithms and design of controller

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Abstract : In order to obtain models of lower complexity than the original discrete-time higher order model Evolutionary techniques of Particle Swarm Optimization (PSO) and Differential Evolution (DE) is used by minimizing the Integral of Square Error (ISE) as objective function. Then a PID Controller is designed for the reduced discrete-time model by using the same optimization technique of PSO and DE and then finally the assessment of the performance using this controller with the PID controller of original higher order model.

Keywords : Discrete-time system, Model order reduction, PSO, DE, ISE, and PID Controller.

Introduction

Model Order Reduction is an area of control system theory, which studies properties of dynamical systems in application for reducing their complexity, while preserving their input-output behavior. Modeling physical systems usually results in system of higher order whose order is greater than two. Design of controllers for the working system becomes tedious when the system order is high. Thus the purpose of Model Order Reduction (MOR) is to replace a large system of equations by a smaller one, which preserves the essential properties of the original model. This smaller system must be an approximation of the larger system, in a sense that the input-output behavior of this system is comparable to the original, within certain accuracy. Mathematical models can quickly become very complex, when for a realistic prediction a large number of details or subsystems need to be included in the model. This can make the simulation or the analysis of a model difficult. This is the motivation for deriving less complex reduced model from a complex model, where a reduced model is supposed to approximate the original behavior sufficiently well for a given application. Therefore the reduced model should have a lower number of dynamic states than the original model because this is a key requirement for a reduced model to reduce the complexity of mathematical model. These mathematical models are used to simulate the behavior of the system when certain variables of the system are manipulated. This way, the

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system can be controlled in a desired way. The required changes of the manipulated variables can be found in an optimization procedure using multiple simulations and an objective function that evaluates the behavior of the system. The values of the manipulated variables are determined such that they minimize this objective function. The focus of MOR is therefore to remove this unnecessary information by simplifying the equations to describe only those properties that are interesting regarding the simulation.

Evolutionary algorithms (EAs) are search methods that take their inspiration from natural selection and survival of the fittest in the biological world. EAs differ from more traditional optimization techniques in that they involve a search from a "population" of solutions, not from a single point. Each iteration of an EA involves a competitive selection that weeds out poor solutions. Based on fitness, some of the better candidates are chosen to seed the next generation by applying recombination and/or mutation to them. Recombination is an operator applied to two or more selected candidates (called the parents) and results one or more new candidates (the children). Mutation is applied to one candidate and results in one new candidate. Executing recombination and mutation leads to a set of new candidates (the offspring) that compete based on their fitness (and possibly age) with the old ones for a place in the next generation. This process can be iterated until a candidate with sufficient quality (a solution) is found.

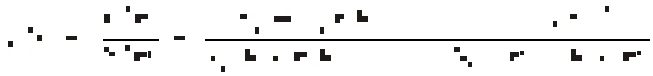
Particle Swarm optimization (PSO) is a stochastic search technique with reduced memory requirement, computationally effective and easier to implement compared to other evolutionary algorithms (EAs). Also *PSO* has very fast converging characteristics among the EAs. Its basic idea was inspired by natural flocking and swarm behavior of birds and ants.

Differential evolution (DE) is a branch of evolutionary algorithms developed by Rainer Stron and Kenneth Price in 1995 for optimization problems. It is a population-based direct search algorithm for global optimization capable of handling non-differentiable, nonlinear and multi-modal objective functions, with few, easily chosen, control parameters. DE differs from other evolutionary algorithms (EA) in the mutation and recombination phases. DE uses weighted differences between solution vectors to change the population whereas in other stochastic techniques such as genetic algorithm (GA) and expert systems (ES), perturbation occurs in accordance with a random quantity. DE employs a greedy selection process with inherent elitist features. Also it has a minimum number of EA control parameters, which can be tuned effectively.
Model order reduction employing differential algorithm for the controller design of discrete time control system is used in [1]. The PID controllers have been used for achieving the desired response of the closed loop system.

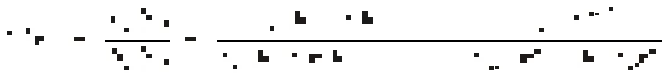
Problem Statement

1. Model order reduction of discrete-time higher order system by using Evolutionary techniques of PSO and DE by employing Integral of Square Error (ISE) as objective function.

Given a higher order descrete time system of order 'n' that is described by the transfer function:



The objective is to find a reduced order model that has transfer function (r < n):



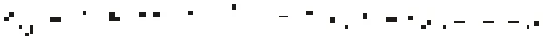
The R(z) approximates in some sense and retain the important characteristics of and the time response of R(z) should be as close as possible to that of for similar inputs.

2. To design the PID Controllers using PSO and DE for the reduced discrete-time model by employing the ISE as an objective function and assessment of the performance using this controller with the original higher order model.

Differential Evolution

***A*. Initialization**

The first step is to initialize the population. In general, every member of the population is selected uniformly within a given box. Most problems are considered to be box constrained since the variables are subject to boundary constraints. This leaves us with the following simple initialization formula [2] for each component:



where, *rand* [0, 1] is a uniformly distributed random value generated for each j and u^j and are the respective upper and lower limits for the j^{th} variable or component.

***B*. Mutation**

Mutation allows the introduction of new genetic material. The primary aim of a mutation operator is to ensure that a full range of genetic material is available to the search mechanism. Some possible mutation schemes for the i^{th} target point are given below:

where F and are scaling parameters and x_b is the best point in the current population. and are randomly chosen points such that (1) (2)

$(3) \neq i$ i.e. all points are unique and none of these points corresponds to the target point $_{i>g}$.

C. Crossover

The target or parent point $_{i,g}$ together with the new mutated point $_{i,g}$ are recombined to create the trial point $y_{i,g}$. There are two popular types of crossover methods used with the DE algorithm, namely binomial and exponential. Binomial recombination starts at the first component of the vector and generates a random number $r^j \in [0,1]$ for each component. If $r^j \leq c_r$ then the j^{th} component of $y_{i,g}$ is taken from ^{j}, otherwise if $r^j > c_r$ then the component is taken from $_{i,g}$. The trial vector can contain components from $_{i,g}$ at multiple, separated points. Binomial recombination can be mathematically formulated as [3]:

D. Parameter Selection

In the original paper that introduces the DE algorithm, the suggested value for the scaling parameter F was in the range [0, 2] [4]. However empirical testing has shown that for most problems the optimal value for F is in the range [0.4,1] [5].The crossover parameter $c_r \in [0,1]$ is used to control the diversity of the trial vector. Higher values of c_r results in faster convergence. In general $c_r = 0.5$ is suggested as a good choice for most unconstrained problems. The population size, N, is often determined by the dimension of the problem. A popular setting for N is N = 10 x n, where n is the dimension of the problem. However values smaller than 10 x n may be used when the dimension of the problem is very high.

E. Acceptance

At each iteration the DE algorithm attempts to replace each point in S with a better point. Therefore at each generation g, N competitions are held to determine the members of S for the next iteration. The i^{th} competition is held to replace $_{i,g}$ in S. This is done by comparing the function values of the trial points $y_{i,g}$ to those of $_{i,g}$, the target points. If $f(y_{i,g}) < f(_{i,g})$ then $y_{i,g}$ replaces $_{i,g}$ in S, otherwise S retains the original $_{i,g}$. This can be written mathematically as:

The DE algorithm maintains a greedy selection scheme that ensures that the current generation is equal to or better than the previous generation.

The selection operator may provide an opportunity for the better candidate solutions to reside in the population and the poorer ones to be removed. Selection techniques

exist as either *explicit* or *implicit* fitness remapping. Explicit fitness remapping uses the normalization of the fitness value between the values of 0 and 1.

$$P_i = \frac{F_i}{\sum_{n=1}^{N} F_i}$$

where i represents an individual in the population and F_i is its fitness.

Particle Swarm Optimization

A. Parameters of PSO Technique

The swarm is manipulated according to the following two equations [6]:

where $d = 1, 2, \ldots, D$; $i = 1, 2, \ldots, N$.

N is the size of the swarm, c_1 and c_2 are positive constant called *acceleration constants*, , are random numbers, uniformly distributed in [0, 1] and $n = 1, 2, \ldots$, determines the iteration number.

In the latest versions of the PSO [7], Equations (3.1) and (3.2) are changed to

(3.3)

(3.4)

where w is called *inertia weight*; , are two positive constants, called *cognitive* and *social* parameter respectively, is a *constriction factor*, which is used, alternatively to w to limit velocity.

The parameters c_1 and c_2 in equation (3.3) are not critical for PSO's convergence. However, proper fine-tuning may result in faster convergence and alleviation of local minima. As default values, $c_1 = c_2 = 2$ were proposed [8], but experimental results indicate that $c_1 = c_2 = 0.5$ might provide even better results. It might be even better to choose a larger cognitive parameter c_1 than a social parameter c_2 but with $c_1 + c_2$ 4.

The parameters r_1 and r_2 are used to maintain the diversity of the population, and they are uniformly distributed in the range [0, 1]. The constriction factor controls on the magnitude of the velocities [37], in a way similar to the V_{max} parameter resulting in a variant of PSO, different from the one with the inertia weight.

The current position x_i can be considered as a set of coordinates describing a point in space. On each iteration of the algorithm, the current position is evaluated as a problem solution. If that position is better than any that has been found then the coordinates are stored in the second vector p_i. The value of the best function result so far is stored in a variable that can be called $pbest_i$ (for "previous best") for comparison on later iterations. The objective is to keep finding better positions and

updating *pi* and $pbest_i$ .New points are chosen by adding v_i coordinates to x_i, and the algorithm operates by adjusting v_i, which can effectively be seen as a step size.

In the particle swarm optimization process, the velocity of each particle is iteratively adjusted so that the particle stochastically oscillates around p_i and p_g locations. Suitable selection of inertia weight '*w*' provides a balance between global and local explorations, thus requiring less iteration on average to find a sufficiently optimal solution. The parameter V_{max} determines the resolution, or fitness, with which regions are to be searched between the present position and the target position. If V_{max} is too high, particles may fly past good solutions. If V_{min} is too small, particles may not explore sufficiently beyond local solutions. The constants $c_1$and c_2 pull each particle towards *pbest* and *gbest* positions.

In general, the inertia weight *w* is set according to the following equation,

(3.5)

Where, *w* is the inertia weighting factor

w_{max} - maximum value of weighting factor

w_{min} - minimum value of weighting factor

$ITER_{max}$ - maximum number of iterations

ITER - current number of iteration

The role of the *inertia weight w* in Equation (3.5) is considered critical for the PSO's convergence behavior. The inertia weight is employed to control the impact of the previous history of velocities on the current one. The parameter *w* regulates the trade-off between the global and local exploration abilities of the swarm. A large inertia weight facilitates global exploration, while a small one tends to facilitate local exploration i.e. fine-tuning the current search area. A suitable value for the inertia weight *w* usually provides balance between global and local exploration abilities and consequently results in a reduction of the number of iterations required to locate the optimum solution.

PID Controller

A discrete PID controller will read the error, calculate and output the control input at a given time interval, at the sample period T. The sample time should be less than the shortest time constant in the system. To implement a continuous time control law, such as a PID controller in a digital computer, it is necessary to approximate the derivatives and the integral that appear in the control law. A few different ways to do this are presented below.

Proportional Action (P): The proportional term is:

(2.13)

This term is implemented simply by replacing the continuous variables with their sampled versions. Hence,

(2.14)

where, {*tk*} denotes the sampling instants, i.e., the times when the computer reads the analog input.

Integral Action (I): The integral term is given by

(2.15)

It follows that

Method	Reduced Model	ISE
PSO algorithm		0.000741
DE algorithm		0.000839

(2.16)

The derivative is approximated by a forward difference gives

(2.17)

This leads to the following recursive equation for the integral term

(2.18)

Derivative Action (D): The derivative term is given by

(2.19)

This equation can be approximated in the same way as the integral term. In this case we approximate the derivatives by a backward difference.

(2.20)

This can be rewritten as

(2.21)

The advantage by using a backward difference is that the parameter is in the range of 0 to 1 for all values of the parameters. This guarantees that the difference equation is stable.

Integral of Square Error (ISE)

The integral of squared-error (ISE) is a performance criterion which has often been used for control system design since the integral involved can be evaluated analytically in the frequency domain is given by

(2.24)

The calculation of this performance index is based on Parseval's theorem

(2.25)

where *E(s)* is the Laplace transform of e(t) and is assumed to be a fractional rational function.

(2.26)

If all the poles of *E(s)* are located in the left-hand side (LHS) of the complex *s*-plane, then Eq. (2.23) converges and can be solved by partial-fraction expansion. It is possible to obtain transfer function of system dynamics in integral form such as

Simulation Results

Firstly, discrete-time model of 8th order is taken which is reduced to 2nd order by using optimization techniques PSO and DE. Then a PID controller is designed for the reduced order model by using same optimization techniques and Integral Square Error (ISE) is used as the objective function. The same PID controller is then used for the original higher order model with the same structure and same controller parameters.

Consider the transfer function of the plant from [13] as:

The objective is to find out the 2nd order reduced model by using PSO and DE of the form:

To reduce the higher order model in to a lower order model firstly PSO is employed. The objective function *J* defined as an integral squared error of difference between the responses given by the equation (4.3) is minimized by firstly PSO.

(4.3)

where

yo(t) is the step response of the original plant

yr(t) is the step response of the reduced plant

TABLE 4.1
TRANSFER FUNCTION OF DISCRETE-TIME REDUCED PLANT

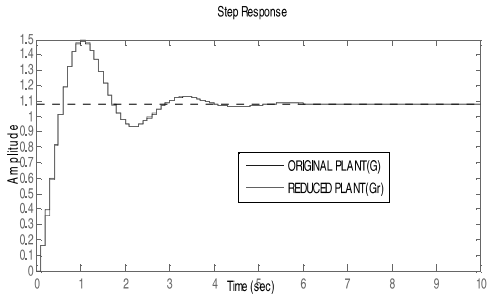


Fig 4.1 Step response of the original and reduced plant using PSO

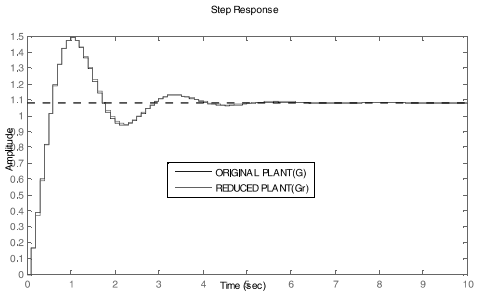


Fig 4.2 Step response of the original and reduced plant using DE

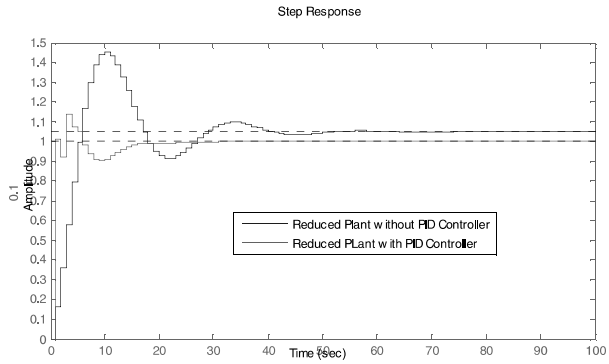
Design of PID Controller for the Reduced Plant

In the second step a PID controller is designed for the reduced order system. The parameters of the PID controller are optimized using the same error minimization technique employing PSO and DE.

The parameters of the PID controller optimized by PSO and DE are given in Table 4.2. The step responses of the reduced plant with and without PID controller designed using PSO and DE are shown in Figs. 4.3 and 4.4, respectively.

TABLE 4.2
PARAMETERS OF PID CONTROLLER

Controller	K_p	K_i	K_d
PID (PSO)	2.7674	0.636	2.7133
PID (DE)	2.901	0.6289	2.6196



4.3 Step response of the reduced plant with and without PID using PSO

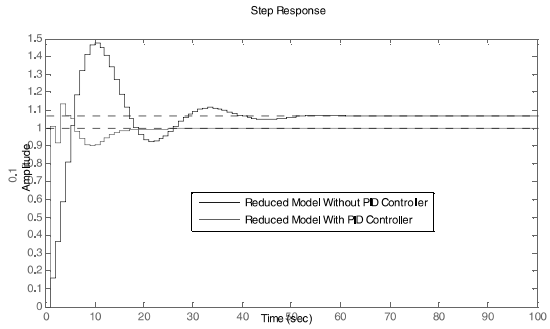
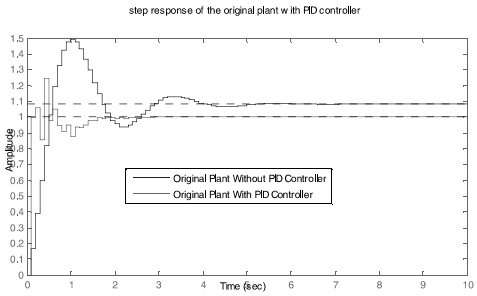


Fig 4.4 Step response of the reduced plant with and without PID using DE

PID Controller for the Original Plant

In this step the same PID controller as designed for the reduced model is used with the original higher order model. Step responses of the higher order model with and without PID controller designed using PSO and DE are shown in the Figs. 4.5 and 4.6, respectively.



4.5 Step response of the original plant with and without PID controller using PSO

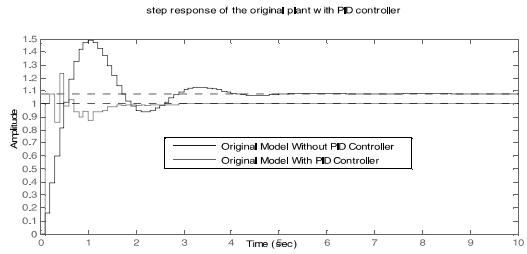


Fig 4.6 Step response of the original plant with and without PID controller using DE

Conclusions

In the first part of the study proposed model reduction methods uses the modern optimization techniques in its procedure to derive the stable reduced order model for the discrete system. The algorithm has also been extended to the design of controller for the original discrete system. The matching of the step responses of the original higher order model and reduced order model is assured reasonably well in this proposed method. The optimization techniques of PSO and DE preserve more stability and avoid any error between the initial or final values of the responses of original and reduced model. This approach minimizes the complexity involved in direct design of PID Controller. The values for PID Controller are optimized using the reduced model and to meet the required performance specifications. The optimized values of the PID controller parameters are tested with the original system and its closed loop response for a unit step input is found to be satisfactory with the response of reduced order model.

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Power Loss Minimization & Voltage Regulation Improvement: A Practical Approach

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Abstract : This paper examines the effect of poor voltage regulation and power loss on the overall health of power system and also describes how to improve voltage regulation and minimize power loss. As load varies continuously the current and voltage also vary. The variation in voltage should be within permissible limit at all buses/nodes, if voltage regulation is beyond the permissible limit, then it will degrade the power system and will impose a threat on stability, efficiency and economy of the power system.

Keywords : Voltage regulation, Permissible limit, Power loss

Introduction

The electricity is a form of energy. This is most convenient form of energy as almost all activities of our life depends on electricity. Our industries, agriculture, education, commercial and domestic activities, transportation etc. all depends on electricity. It is also convenient because of its unique property that it can be generated in bulk quantity at a suitable location& it can be transmitted over long distances very economically. Hence electricity is a necessity now days. It is no more a status symbol as it was before.

The purpose of electric power system is to generate, transmit and distribute electricity to its consumers at a minimum possible cost with full reliability& continuity. The power system has been represented by three distinct components: The generation system, the transmission system & the distribution system. The system voltages of all the three components are different due to number of technical, economical, & number of other reasons.

The economic growth and development of a nation depends heavily on the reliability, continuity and quality of electric power supply. The per capita consumption of electricity of a nation signifies the economic and social development of the nation.

One of the most important factor which effects the efficiency and economy of

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electric power system is power loss. According to an estimate, transmission loss in India is about 6-11%and distribution loss is about 35%. In India the power loss is about 45%.

Generally, rigorous planning is done for the addition of power generation and transmission network. Whereas, the distribution system were expended particularly in last three decades in an unplanned and haphazard manner keeping minimum expenses in view. Hence degradation of distribution network was not given due importance which led to the worst condition of the distribution system. Also as stated above, distribution power loss is about 35% in distribution network alone which is about 80% of total power loss in the whole power system. Hence minimization of distribution power loss is the biggest headache for electricity utilities.

A. There are two types of distribution power losses

Technical loss and Non- Technical loss:

The Non-Technical losses are more dominant in lower level load distribution system. They include unauthorized line tapping, meter tempering, in accurate meter readings, unmetered public lighting, subsidies given to special class of consumers etc. The technical losses are the losses in distribution system due to flow of electric current .There are number of factors responsible for technical losses in distribution system. The transformer capacity, line parameters, phase balancing, ratio of LT to HT, power factor, network topology according to load, devices used to control line parameters etc are the major factor responsible for distribution power loss.

In power system, measures are taken to maintain voltage within permissible limits. As load changes, the terminal voltage at receiving end also varies. This variation in voltage magnitude should not exceed the permissible limit. The voltage regulation (V.R) is derived in percentage. The voltage regulation in LT lines (440\220v) must be within ±6% and ±8% and ±12% is the permissible limit in 11KV and 33KV lines respectively.

Mathematically, it is expressed as

$$\%V.R.=\frac{\text{-- Hy-}}{\text{-- Hy-}}\times 100$$

Where-

V*nl*=voltage at no load

V*fl*=voltage at full load

The percentage change at receiving end from no load to full load is called percentage voltage regulation. If the voltage at consumer end is as required then the devices will operate smoothly and efficiently. But if, too high voltages or too low voltages are applied then devices may be damaged and their output will not be as desired. Hence, voltage at all levels in power system should be within permissible limit.

Methodologies to minimize distribution power loss

As far as non technical losses in distribution network are concerned, these losses can be reduced by political will, maintaining strict discipline, proper monitoring, creating awareness, installing accurate metering devices etc. Thus non technical loss reduction is essentially related to policy making. Apart from policy making, non-technical losses can be reduced by preventing theft of electricity. The theft of electricity can be prevented up to a large extent by providing small single phase transformers for domestic and non-domestic services at consumer end. Also by replacing overhead LT lines by ABC cables, by replacing existing service lines of consumers by armored PVC/ XLPE cables. There are number of methods to reduce distribution technical power loss.

The technical loss in distribution network can be reduced by augmenting the distribution lines and proper selection of transformers. The transformer capacity in the system should be optimal. Because an overloaded transformer has lower efficiency and power loss is more & chances of transformer failure are more. If the transformer is under loaded, then efficiency is less as well as extra expenditure incurred in placing higher capacity transformer for low load causes financial loss. Transformer optimal unit commitment may be adopted to reduce losses if several transformers are operating in parallel at a substation.

The electric distribution power loss also increases if there is unbalanced loading among the three phases of the distribution network. Unbalanced loading among the three phases causes current to flow in the neutral. Neutral wire also has finite resistance per unit length causes I^2R loss. Therefore unbalanced loading should be avoided to reduce power loss. If there is 10% unbalancing of load in the three phases then losses are increased by 2.66%. The loss increases to 10.66% if 20% unbalancing in load is there in the distribution network. If unbalancing is 50%, then power loss increases to 66.6%.

The ratio of LT lines (440/220V) to HT lines (33KV, 11KV) in electric power distribution system is also a factor responsible for electric power loss. This ratio should be less. If ratio of LT lines & HT lines in a particular distribution network is 4, then power loss is almost 28%. If this ratio is reduced to 2, then power losses reduces to 7% only. Hence ratio of LT to HT lines plays a very important role in the distribution network. If this LT to HT lines ratio is reduced, non technical losses such as theft can be reduced. Because, theft of electricity cannot be done by HT lines. Theft can be done by LT lines (440/220 V) only. Hence, more HT lines, less chances of theft. Due to this reason, government is heading towards LT less system in the distribution network. Number of schemes and policies are going on to make the distribution system LT less.

Distribution power loss is also reduced by compensation of reactive power in the distribution network. The reactive power in distribution network is reduced by placing capacitor banks at substations as well as by placing capacitor in distribution lines & at consumer end. Capacitors of suitable size at a suitable location compensate reactive power thereby reducing power loss.

Apart from above ways, power loss in distribution network can be further reduced by operating distribution network in the optimal configuration. The feeder

configuration can be changed as and when required as per change in load demand on the feeder by operating pair of sectionalizing/tie switches. For different load levels, there may be different optimal feeder configuration which reduces power loss.

Voltage Regulation improvement

In present competitive business environment the electric utilities are forced to supply good quality of electricity to the consumers. To provide good quality of electricity the system should operate at normal frequency and normal voltage. To have normal voltage in the distribution network, voltage regulation must be within permissible limit.

If the voltage is high, than failure of insulation is possible. If the voltage is low then different types of load will respond differently. Such as for every 1% drop in voltage, there will be 1.6% reduction in voltage of filament lamps, fluorescent lamps and resistive loads. Also at low voltage, induction motors which contribute about 80% of total load draw more current resulting in over-heating and reduction in life of motor. Insulation of motor winding may be weakened due to over-heating which may cause short circuit and burning of motors. At low voltage, line losses will be high due to increase in current. This will further increase the voltage drop in the line.

The devices used to maintain the voltage level within permissible limits are mentioned below.

(i) A load tap changer (LTC) at the sub-station transformer which changes the turn ratio in response to load current and therefore adjust the voltage supplied at the sending end of the feeder.

(ii) Voltage regulators, which are essentially transforms with tap changers to adjust the voltage along the feeder so as to compensate for the voltage drop over distance.

(iii) Capacitors which reduce the voltage drop along the feeder by reducing current flow to loads consuming reactive power and some technologies for reactive power compensation.

Conclusion

Electricity which is lifeline of present day is very precious and essential just like oxygen, water and food etc. Our lives as well as all developments worldwide are not possible without electricity. Hence electricity should be used very economically, efficiently and it also should be available to its consumers at a cheapest possible rate. These goals can be achieved only if we follow the policies, practices and methodologies as detailed in the previous section to minimize technical as well as non-technical electric power losses in distribution network.

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Review Paper on Improved the Efficiency of Solar Power Generation

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Abstract : The feasible, effective and better utilization of solar energy is way to solution of shortage energy and make environment pollution free. In order to improve power factor and cost reducing problem, We have reviewed several ways to improve the efficiency of solar power, conducted survey and analysis that; improving tracking accuracy of solar concentrating photovoltaic power generation system and improve overall light focusing efficiency by one or two dimensional auto tracking control system suitable for different conditions and in this paper also analysis and study about technical aspects of the conversion efficiency of solar panels.

Keywords : Solar energy; Photovoltaic power generation; Efficiency; Power factor

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Introduction

Consumption of electrical energy in the world is constantly growing. Most of used and produced electrical energy is obtained by combustion of fossil fuels or by nuclear processes. Thermal power plants and nuclear power plants are natural polluters of environment. Alternative energy sources that we are surrounded with, on the other hand are pure ecological energy sources. The main alternative energy sources include solar energy, geothermal energy, wind energy, wave energy, and bio-energy and hydrogen technologies. One of particularly important sources of energy is solar energy. Solar energy can play a very important role in providing most of the heating, cooling and electricity needs of the world and also has the potential to solve our environmental problems. The sun is infinite and clean energy source and it sends to earth about 10,000 times as much energy of the world's energy consumption. So, solar energy has attracted a great interest during the last two decades. Converting solar radiation energy into electrical energy and usage of this method of production of the necessary energy becomes an important condition for further development and progress of the plane. The daily and seasonal variation of solar radiation is a significant problem in solar energy. Direct usage of solar

energy is limited with sunny hours so direct usage of solar energy is not continuous. Therefore, the utilization of solar energy has the limitation of practicality due to high cost and low efficiency. To solve these problems, many researchers have studied about effectively practical methods of solar energy. One of methods is solar tracking system. In this method, the direction of solar panel changes according to sunlight position during the course of a day. Thus, solar tracking systems are designed in different ways with the aim to utilize a high rate from solar radiation. Solar tracking systems provide an annual basis up to 35% increase in efficiency of energy production. In continuous increasing efficiency we use different types of solar panels like Mono-crystalline solar cell(15-24%), Polycrystalline Solar Cells (13-18%), Amorphous solar Cells (7-9%) energy efficient .The benefits include simple wiring and. That you can use thinner wires within your solar PV system, so less copper is used which makes the system cheaper. One of the basic components is inverter which changes the DC to AC, allowing the individual to sell the electricity back to the grid (in grid tie systems) or to be used easily in the homes. Grid Tie Inverters differ slightly from your regular inverters in that the AC pure sine wave signal has to be perfectly coordinated with the waveform from the grid. For measurement of solar panels energy, the measurement of kWh refers to the amount of energy produced by the panel. This measurement is represented as kWh per square meter of panel surface. We can use solar net metering or Measure the voltage across the different Power Resistors and Digital multi-meter.

Review Process Adopted

A literature review is necessary to know about the research area and what problem in that area has been solved and need to be solved in future. This review process approach was divided into five stages in order to make the process simple and adaptable. The stages were:-

a) Stage 0: Get a “feel”
   This stage provides the details to be checked while starting literature survey with a broader domain and classifying them according to requirements.
b) Stage 1: Get the “big picture”
   The groups of research papers are prepared according to common issues & application sub areas. It is necessary to find out the answers to certain questions by reading the title, abstract, introduction, conclusion and section and sub section headings.
c) Stage 2: Get the “details”
   Stage 2 deals with going in depth of each research paper and understand the details of methodology used to justify the problem, justification to significance & novelty of the solution approach, precise question addressed, major contribution, scope & limitations of the work presented.
d) Stage 3: “Evaluate the details”
   This stage evaluates the details in relation to significance of the problem, Novelty of the problem, significance of the solution, novelty in approach, validity of claims etc.

Fig.1 Review Process Adopted

e) Stage 3+: "Synthesize the detail"
Stage 3+ deals with evaluation of the details presented and generalization to some extent. This stage deals with synthesis of the data, concept & the results presented by the authors.

Various Issues In The Area

After reviewed 15 research papers on 'Improve the efficiency and cost reduce technique of solar (PV) power generation' we analysis that to intensification the total efficiency of solar energy we want work on some issues , which has to be a addressed, while the designing and implementation of solar power generation these issues are:

- Tracking System
- Solar Panel
- Measuring of Photovoltaic Energy
- Inverters Systems

Issue Wise Discussion

Issue1:- Tracking System

Advances in the algorithms of sun tracking systems have enabled the development of many solar thermal and photovoltaic system for a diverse variety of application in recent years Compared to their traditional fixed position counterparts. Solar system which track the changes in the sun traditional over the course of the day collect a far greater amount of solar energy. And therefore generate a significantly higher output power Taking into consideration of all the reviewed sun-tracking methods, sun trackers can be grouped into one-axis and two axis tracking devices. For one-axis sun tracker, the tracking system drives the collector about an axis of rotation until the sun central ray and the aperture normal are coplanar. Broadly

speaking, there are three types of one-axis sun tracker: 1. Horizontal-Axis Tracker – The tracking axis is to remain parallel to the surface of the earth and it is always oriented along East-West or North-South direction. 2. Tilted-Axis Tracker – The tracking axis is tilted from the horizon by an angle oriented along North-South direction, e.g. Latitude-tilted-axis sun tracker. 3. Vertical-Axis Tracker – The tracking axis is collinear with the zenith axis and it is known as azimuth sun tracker.

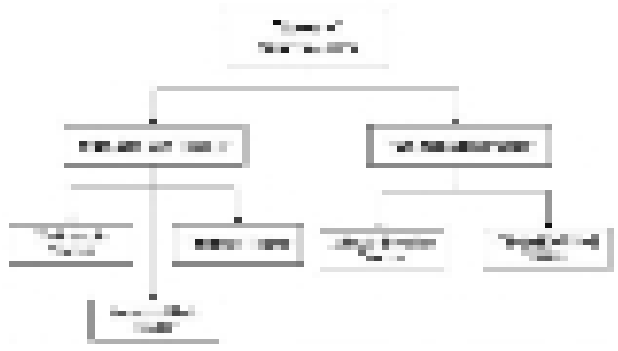
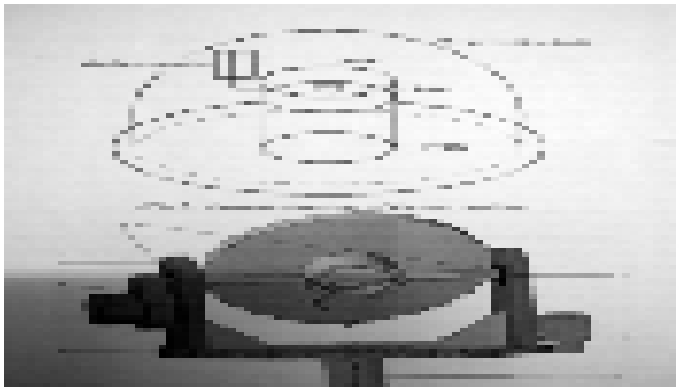


Fig. 2 Types of Sun Trackers

In contrast, the two-axis sun tracker, such as azimuth elevation and tilt-roll sun trackers, tracks the sun in two axes such that the sun vector is normal to the aperture as to attain 100% energy collection efficiency. In the azimuth-elevation sun-tracking system, the solar collector must be free to rotate about the azimuth and the elevation axes Alternatively, tilt-roll (or polar) tracking system adopts an idea of driving the collector to follow the sun-rising in the east and sun-setting in the west from morning to evening as well as changing the tilting angle of the collector due to the yearly change of sun path. The method of tracking analysis on review use for rise efficiency of solar energy is first an omnidirectional photoelectric sensor and a PSD is designed, the PSD is based on the principal of horizontal photoelectrical effect. PSD is a larger area of the PN junction sensor, with the electrodes around the PN junction. when the PSD sensitive area is radiated by the local non-uniform beam, the location of the relevant parallel to the sensitive side of the horizontal will be established in the sensitive spot. If the light continuous exposure, the PSD has an external electrodes on the circuit, it can produce current. Because the relation of the current size and location of the spot. We can calculate the position of the light spot. The whole tracking system include photoelectric detection tracking machinery sun position measurement device including PSD, lens azimuth adjustment device, stepper motor etc. by this technique we can improve up to more than 30% from constant tracking panel the system adopt the combination of the PSD position sensor and the sun trajectory position advantages such as suit of all weathers condition, fully automated, easy to installed disadvantages is costly.



Second is based on microcontroller or LDR (light dependent resistor), are used for sensing the positional change of the sun. This sensor continuously absorber solar radiation and data transfer to stepper motor via microcontroller. The motor moves the panel where the intensity of the light is Maximum. For sensing mechanism LDR's are put in perpendicular tube. The Advantages of this technique generally we use two motor in dual axis solar tracker but in this not used two stepper motor simultaneously

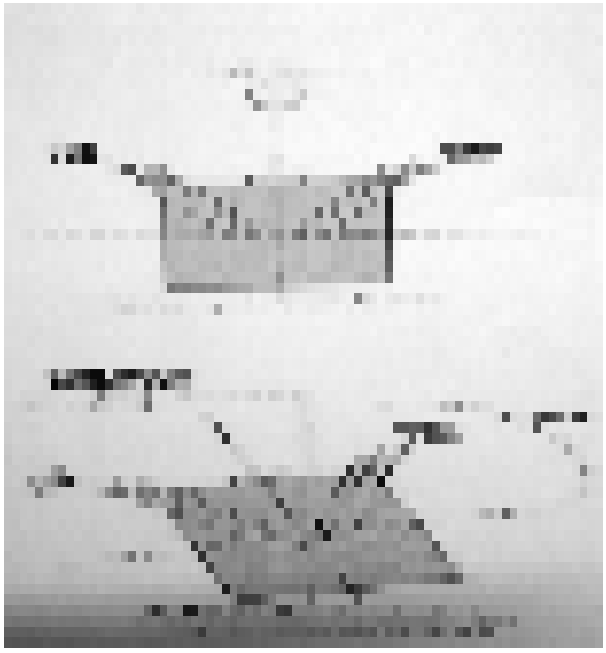


Fig. 4 Light sensing at different positions

In this line another method is flexible combination of 'light sensation tracking' and 'time tracking' make up each other deficiencies. Time tracking refers to calculating solar azimuths according to time and geographical position and time tracking calculation method include horizontal coordinate tracking method and polar axis tracking method, And the Light sensation tracking refers to measuring solar azimuths according to light sensation components. but in some error conditions are comes like time tracking method has error accumulated in long term running and run in different weather conditions so that's wastes of energy. and in light sensation tracking method has a error or can't work in cloudy days. So combination of both tracking method bring the advantages and improve the precision of solar tracking and reduce the energy consumption of the system.

Issue 2:- Solar Panel

The second major issue is solar panels. The term solar panels will be used to describe photovoltaic solar panels (the type that generates electricity), not solar thermal collectors. In my analysis mostly four types of solar panels are covers present and past, and which is use for increasing the efficiency of solar energy, panels are following as: A. Crystalline Silicon Solar Cell (c-Si) B. Mono-crystalline Silicon Solar Cell C. Polycrystalline Silicon Solar Cell D. Thin Film Solar Cell (TFSC) Crystalline Silicon Solar Cell- In 2011, about 95% of all shipments by U.S. manufacturers to the residential sector were crystalline silicon solar panels The silicon used in PV takes many forms. The main difference is the purity of the silicon. Purity really mean the more perfectly aligned the silicon molecules are, the better the solar cell will be at converting solar energy into electricity. Crystalline silicon forms the basis of mono and polycrystalline silicon solar cells Mono-crystalline Silicon Solar Cell- Solar cells made of mono-crystalline silicon (monoSi), also called single crystalline silicon. Mono-crystalline solar cells are made out of silicon ingots, which are cylindrical in shape. To optimize performance and lower costs of a single mono-crystalline solar cell, four sides are cut out of the cylindrical ingots to make silicon wafers. Advantages are highest efficient rates, space efficient, live longer life and tend to perfume batter then similarly rated polycrystalline solar panels at low-light conditions. Disadvantages are most expensive, significant amount of the silicon ends up waste. Efficiency 15-24% Polycrystalline Silicon Solar Cell- The first solar panels based on polycrystalline silicon, which also is known as poly-silicon (pSi) and multi crystalline silicon (mcSi). Polycrystalline solar panels do not require the Czochralski process. Raw silicon is melted and poured into a square mold, which is cooled and cut into perfectly square wafers. Advantages are simpler and costless compared to mono-crystalline and slightly lower heat tolerance then mono-crystalline panels. Disadvantages are Efficiency 13-16% , lower space-efficiency.

Thin Film Solar Cell- Depositing one or several thin layers of photovoltaic material onto a substrate is the basic gist of thin film solar cells are manufactured. Thin film module prototypes have reached efficiencies between 7–13% and production modules operate at about 9%. Future module efficiencies are expected to climb close to the about 10–16%. One of best example of thin film solar is Amorphous

silicon (a-si) solar cell have traditionally only been used for small scale application such as in pocket calculators. Efficiency rate 6 to 8%.

Issue 3:-Measurement of Photovoltaic Energy

Another issue is measuring solar energy. For solar panels, the measurement of kWh refers to the amount of energy produced by the panel. This measurement is represented as kWh per square meter of panel surface. If provider may install two meters, with on monitoring power drawn from the grid, and another recording extra electricity generated by our system that is fed back into the grid. In this case, we pay the retail price for electricity drawn from the grid, while our excess power is bought at avoided cost. However, most often, excess power is forfeited to the utility, as in the case of the net metering system is use Solar Net Metering involves one bidirectional meter. The meter spins forward when drawing electricity and backward when your system provides power to the grid.

Fig.5. Solar net metering

Issue 4:- Inverter System

A solar Inverter or PV inverter converts the variable direct current output of a photovoltaic solar panel into a utility frequency alternating current that can be fed into a commercial electrical grid or used by a local, off grid electrical network. it is a critical component in photovoltaic system, allowing equipment. Solar inverters have special function adapted for use with photovoltaic array , including maximum power point tracking and anti-islanding protection.

Conclusion

This paper has presented a review of the major parts of solar system which enhanced the solar power generation. It has been shown that various methods for advance tracking system can be briefly classified as omnidirectional photoelectric sensor and a PSD is designed, by LDR technique and by light sensing tracking and

time tracking. The above analysis evinces that the proposed tracking system increases the output of PV cell with compare to fixed tracking system and its reduces the power dissipation of the power generation system. From the analysis the type of panels are also effects on solar generation. It's depends upon area, cost and efficiency. We feel that for most installations polycrystalline cells are most suitable as they are value for money still also bring relative efficient. Another factor the new concept of measurement PV energy by net metering. So if we are able to generate sufficient power of solar, we can serve two purpose; we can meet the total residential demand and contribute surplus power to national grid. Thus the conceptions of establishing of solar system make sense.

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Global Material Science and Engineering for Society

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The material science is changing life style of every one. The importance of material science teaching is essential in all higher education courses and bring them in practice by all human beings and all sphere of social system in order to save earth for future.

All the human being on mother earth are connected through material available to them for their survival, environment around them, connectivity with each other possible exchange of material, means and mind(thoughts and information).10 Most Abundant Elements in the Earth's Crust (Source: CRC Handbook of Chemistry and Physics, 77th Edition) as given in Figure-1.

Element	**Abundance** percent by weight
Oxygen	46.1%
Silicon	28.2%
Aluminum	8.23%
Iron	5.63%
Calcium	4.15%
Sodium	2.36%
Magnesium	2.33%
Potassium	2.09%
Titanium	0.565%
Hydrogen	0.14%

Figure-1

The evolution on earth has been believed to be due to the fundamental interaction of sun light on the available materials as described in Figure-2. Long time has passed in evolution of our society in the present form.

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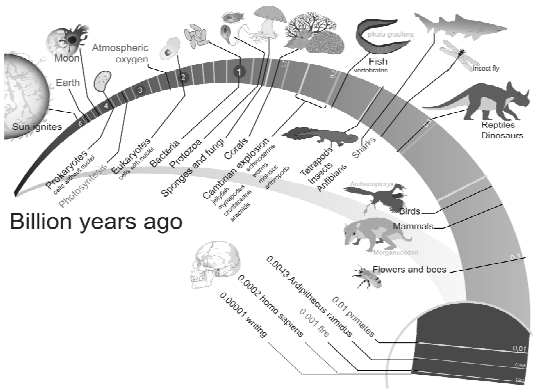


Figure-2

Much significant impact of global science and technology development is visible with in this century as Global Scientific Discoveries are affecting our life. The quality of life has improved globally due to global connectivity and economic interest. However, we are bound to take mandatory steps to save the environment and ecology on our Mother Earth. We need to develop and optimize the use of appropriate Materials for Energy Harvest and development of the society:

- Energy Efficient Conversion
- Low Cost
- Ease of Processing
- Abundance on Mother Earth
- Environment Friendly
- Renewable/ Recycle able
- Global

Stone Age to Carbon Age

.

Figure- 3

Apart from the available material on mother earth for everyone, their conversion, cyclic uses and conservation for future generation is very important for the growing society. From the stone age to silicon age and now the future of the society looks towards the carbon age. Polymer and Composites of Polymer, is being considered as Materials of the future. The major criteria for the choice of Material has been the density and the strength as summarized in Figure-4. The properties of polymers could be varied in large range from transparent to opaque, insulating to conducting, and flexible to hard.

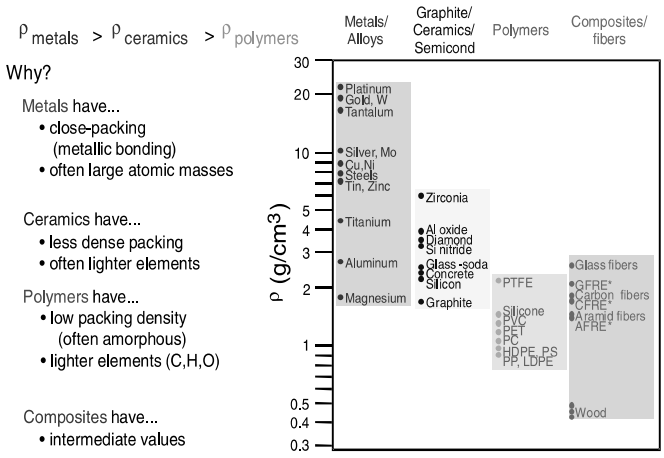


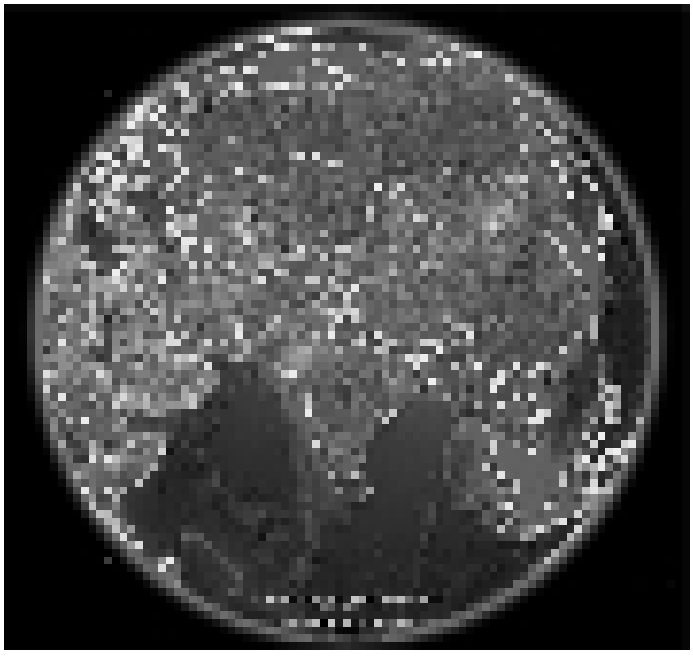
Figure-4

Future of Global Material Science

- **Miniaturization :** "Nanostructured" materials, with microstructure that has length scales between 1 and 100 nanometers with unusual properties. Electronic components, materials for quantum computing.
- **Smart materials:** airplane wings that deice themselves, buildings that stabilize themselves in earthquakes…
- **Environment-friendly materials:** biodegradable or photodegradable plastics, advances in nuclear waste processing, etc.
- **Learning from Nature:** shells and biological hard tissue can be as strong as the most advanced laboratory-produced ceramics, mollusks produce biocompatible adhesives that we do not know how to reproduce…
- **Hightech Materials:** Materials for lightweight batteries with high storage densities, for turbine blades that can operate at 2500°C, room-temperature superconductors?

- **Materials for Solar Energy harvest**
- **Materials for Carbon dioxide adsorption**
- **Materials with hard coating and diamond like material.**

Therefore basic studies related to Material Science and Engineering is globally essential for every human being on the globe and learn to Optimize: Needs, Energy & Materials to SAVE MOTHER EARTH for better future of Society.



Astronomers have a way to track objects that don't emit light: Discovery of Gravitational waves

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Abstract : Gravitational waves travel outward from their source at the speed of light, slightly distorting space as they pass through it. In this paper a quick overview of what gravitational waves are, and why the discovery is one of the biggest scientific breakthroughs seen in the last century is given. How can you be certain that outside effects (such as vibration) aren't impacting the results? This question is addressed in this paper. What is it a big deal that we found gravitational waves? The detection of gravitational waves gives us more evidence that black holes, the details of which have long puzzled astronomers, are real. This discovery would open a new window on the universe and its most violent phenomena. Many people outside of the scientific community ask how it will affect them, answer is provided here.

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Introduction

Over the years physicists have used increasingly complex instruments in hopes of finding gravitational waves. People around the world cheered on February 11, 2016, when scientists from the Massachusetts Institute of Technology and the Laser Interferometer Gravitational-Wave Observatory (LIGO) — announced that they finally detected ripples in the fabric of space-time whose existence was first proposed by Albert Einstein in 1916, known as "**gravitational waves**" The signal related to Gravitational waves was detected at LIGO lab that's been hunting these waves for years. LIGO detected gravitational waves coming from the collision and merging of two black holes. This discovery means that an entirely new era of astronomy is upon us. Astronomers finally have a way to track all the objects in the universe that don't emit any kind of visible light, like black holes and neutron stars and perhaps objects that physicists haven't yet dreamed up or discovered yet. We finally have a concrete way to study these mysterious cosmic objects that we know very little about. Gravitational waves are going to paint a completely new picture of the universe.

The waves came from two black holes circling each other, closer and closer, until they finally collided. The recently upgraded Laser Interferometer Gravitational Wave Observatory (LIGO) captured the signal on Sept. 14, 2015. Not every

Astronomers have a way to track objects that don't emit light: Discovery of Gravitational waves

scientific discovery gets this kind of reception, so what exactly is all the hype about, and what's next for LIGO now that it has spotted these elusive waves?

Detecting two colliding black holes is thrilling by itself, no one till date, knew for sure if black holes actually merged together to create even more-massive black holes, but now there's physical proof. And there's the joy of finally having direct evidence for a phenomenon that was first predicted 100 years ago, using an instrument that was proposed 40 years ago. But what is truly monumental about this detection is that it gives humanity the ability to see *the universe* in a totally new way. The ability to directly detect gravitational waves, which are generated by the acceleration or deceleration of massive objects in space, has been compared to a deaf person suddenly gaining the ability to hear sound. An entirely new realm of information is now available.

We are opening our eyes, our ears to a new set of signals from the universe that our previous technologies did not allow us to receive study and learn from. Up until now, we've been deaf to gravitational waves. With this new sensory view of the universe, here are some of the new things scientists hope to discover.

Light is often blocked by dust and gas, gravitational waves come right out of the supernova, boldly unimpeded, As a consequence, one really find out what's going on inside of these things.

Neutron Stars, which are mind-bogglingly dense, burned-out stellar corpses scientists hope to study with gravitational waves. A teaspoon of neutron-star material would weigh about a billion tons on Earth. Scientists aren't sure what happens to regular matter under such extreme conditions, but gravitational waves could provide extremely helpful clues, because these waves should carry information about the interior of the neutron star all the way to Earth.

Einstein and Gravitational Waves

One hundred years ago; Einstein wouldn’t have dreamed that gravitational waves would be detectable, but here they are. This discovery is historic. General relativity was is one of the most profound scientific and philosophical realizations of the 20th Century and it forms the basis of some of our most intellectual investigations into reality itself. Astronomically, the applications of general relativity are clear; from gravitational lensing to measuring the expansion of the universe. But much of today’s technology uses lessons from general relativity for everyday applications and things are taken for granted. For example, global positioning satellites: wouldn’t be the precise if simple corrections for time dilation, based on general relativity prediction, weren’t considered there. It’s clear that general relativity has real-world applications, but when Einstein presented his new theory in 1916, it’s highly doubtful that any application would have seemed obvious.

Data from pairs of black holes will be like lighthouses scattered through the universe. One will be able to measure the rate the universe is expanding, or how much dark energy there is in the universe to precision, far greater than one can do today. One might combine observations of astrophysical phenomena with the electromagnetic signals to add more dimensions to our understanding of our universe.

When announcements are made of complex scientific discoveries, many people outside of the scientific community ask how it affects them. Trying to explain why gravitational waves discovery are so important is almost as complex as the equations that describe them, but finding them not only strengthens Einstein's already robust theories as to the nature of space-time; we now have a tool that can probe into new astrophysical phenomena, a layer of the universe that was once invisible to us.

Discovery will open up for technological revolution

The view of Author can be seen by consider this: When X-rays were revealed by Roentgen in 1895 during his experiments, few would have known that in a few years these high-energy electromagnetic waves would become a key component in everyday medicine from diagnosis to treatment. Similarly, the first experimental production of radio waves in 1887 by Hertz confirmed predictions by Maxwell's electromagnetic equations. Just few years later, in the 1890 s, a series of demonstrations by Marconi, who set up radio transmitters and receivers, proved they had a practical use. Take another example, Schrodinger's equations describing the unfathomable world of quantum dynamics are finding an application *right now* in the development of super-fast quantum computing.

Computer simulation showing emission of gravitational waves during a black-hole collision. ***Credit: MPI for Gravitational Physics/W.Benger***

Gravitational waves travel outward from their source at the speed of light, a prediction confirmed by the new discovery, *slightly* distorting space as they pass through it. The changes predicted to occur as gravitational waves pass by are so small that Einstein himself doubted that these waves ever be detect on earth. But advances in science and technology proved Einstein wrong, since they have now been observed with the detectors known as LIGO, short for *Laser Interferometer Gravitational-Wave Observatory*.

Astronomers have a way to track objects that don't emit light: Discovery of Gravitational waves

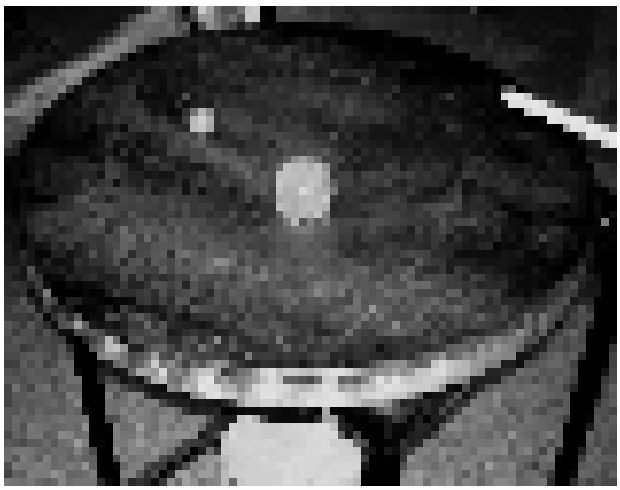
Newton's laws defined how gravity works, but silence about what it is. Einstein's theories showed how gravity warps space-time, but gravity has always been "spooky action at a distance. That gravity propagates in waves form, gives room for thousands of new physical hypotheses to be tested, verified, and integrated into existing theories of the universe.

Einstein's theory of relativity tells us that space and time are intertwined as a four-dimensional *space-time*. Space-time has a structure that can vary from place to place (and time to time), much as a two-dimensional surface — like a rubber sheet or the surface of a pond — can have varying bumps, dips, and ripples. The structure of space-time is shaped by the gravity of the objects within it, so if these objects undergo certain types of movement or change, they can cause a change in the structure of space-time around them. According to general relativity, this change then propagates outward through the universe like ripples on a pond, and it is these space-time ripples that we call gravitational waves.

Gravitational waves are tiny distortions of space-time caused by some of the most violent cosmic events such as colliding black holes. The observation of these 'ripples of space-time' requires exquisitely sophisticated technology.

A popular way of imagining gravitational waves is if you were to place a heavy object on a stretched rubber sheet. The stretched sheet would bend because of the weight of the object. A lighter object placed on the same stretched rubber sheet would roll towards the heavier one. An even heavier object would further bend the stretched rubber sheet, pulling both other objects towards it.

Visualizing distortion:

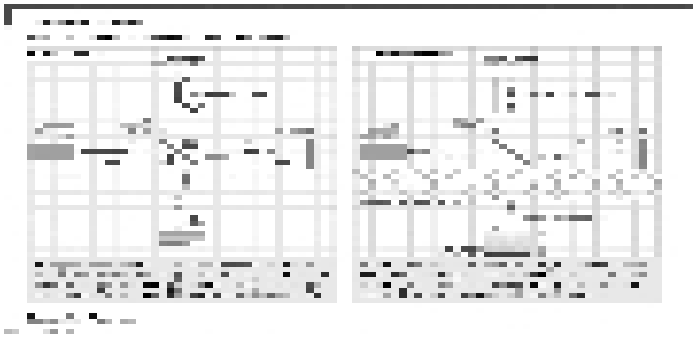


Model of stretched rubber sheet in the form hyperboloid surface representing space-time depressed surface due to heavy mass: two black holes model.
Credit: Prof. Y.K.Vijay, Innovation Hub, VGU, Jaipur

A group of scientists were sure that gravitational waves exist, but they have never been detected. This is because by the time that gravitational waves reach Earth, the amount of space-time movement they generate is extremely small – thousands of times smaller than an atomic nucleus. This makes recording and measuring them very difficult.

Ligo Interfrometer

LIGO — a huge, L-shaped, laser-powered detector — has been looking for gravitational waves since it opened in 2002. A more powerful, advanced LIGO went online in September 2015, and when these gravitational ripples passed by Earth, it picked up the disturbances due to its new, highly-sensitive laser and mirror setup. They detected the waves coming from two merging black holes. The LIGO project aims is to find physical evidence of gravitational waves. Using LIGO's Interferometer, scientists are looking to detect these tiny measurements. As the gravitational wave passes, it should stretch space in one direction and shrink it in the other.

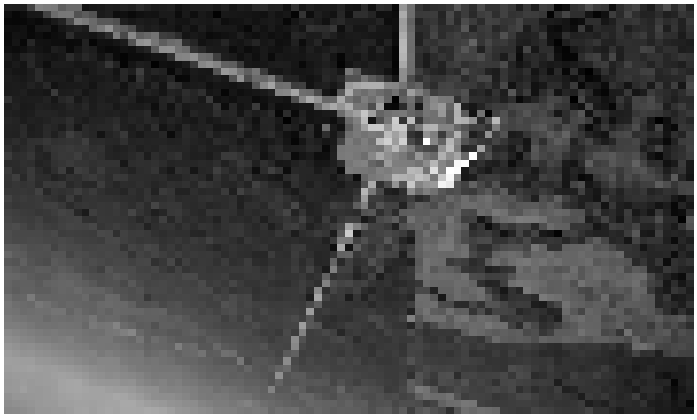


The Interferometer looks out for these changes by splitting a single laser beam in two and sending these beams from two distant locations. If the beams travelled the same distance when they return, then they have not been distorted in any way. However, if they do not align when they return, something has disrupted them in the process – one potential culprit being gravitational waves.

Gravitational waves cause space itself to stretch in one direction and get squeezed in a perpendicular direction. In the wake of a gravitational wave, one arm of an interferometer lengthens while the other shrinks, then vice versa. The arms will change lengths in this way for as long as it takes the wave to pass. When objects with mass accelerate, such as when two black holes spiral towards each other, they send waves along the curved space-time around them at the speed of light, like ripples on a pond.

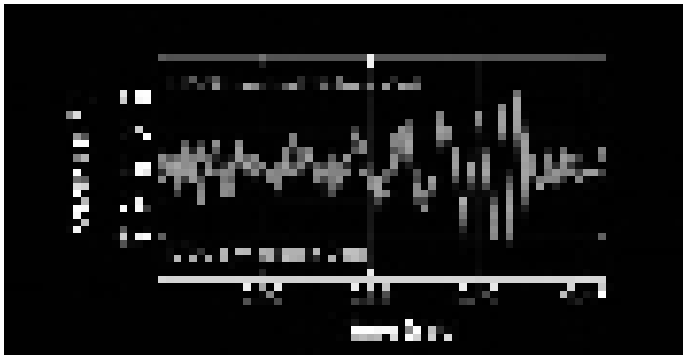
Ultimately, the detection of gravitational waves is a triumph for humanity that will continue to teach us new things about our universe for generations to come. This is

most definitely a golden age for science, where historic discoveries are commonplace. These discoveries drive our culture forward, making us all richer and more aware that our universe is a beautiful and complex place. And we know we have the intellectual capability to create models of how we think the universe works and then perform experiments to prove we are right. This seems fairly straightforward – but it isn't because of how tiny the changes would be. The Interferometer is able to detect these miniscule changes, down to around 1/10,000th the width of a proton. But other things could also cause disruption, such as earthquakes or road traffic, so these must be discounted before physical evidence can be found.



This is an aerial photograph of the LIGO Livingston Observatory in Louisiana.

The discovery is profound in 3 ways, he argues. First, we now know that gravitational waves exist and we know how to detect them. Second, the signal detected by the LIGO stations on Sept. 14, 2015, is the strongest evidence yet of the existence of a binary black hole system — each black hole "weighing in" at a few tens of solar masses. The signal is exactly what we'd expect to see during the violent merger of two black holes, one 29 times the mass of our sun and the other 36 solar masses. Thirdly, and possibly even more important, "short of sending someone to a black hole," this is the strongest direct evidence of the existence of black holes.
There are two LIGO detectors, one in Louisiana and the other in Washington State. Each consists of an L-shaped pair of four-kilometer-long arms with mirrors at their ends. (Yes, you read correctly: four kilometers long! These are large scientific instruments.) In essence, LIGO measured very slight changes in the lengths of the arms as the gravitational waves passed through. However, the changes in length are smaller than the size of an atomic nucleus, so they cannot be measured with rulers. Instead, they are measured with what physicists call an *interferometer* (the '"I" in LIGO); the LIGO interferometers use lasers in a way that allows the detectors to notice when lengths change even by incredibly tiny amounts.



To confirm the propagation of gravitational waves, LIGO is comprised of 2 observing stations, one in Louisiana and the other in Washington. To rule out false positives, a candidate gravitational wave signal needs to be detected by both stations. And the Sept. 14 event was detected first in Louisiana and then 7 milliseconds later in Washington. The signals matched and, through triangulation, physicists were able to learn that it originated in Southern Hemisphere skies.

There are also many other tests a detection candidate must pass before we consider it to be a valid detection, but these are the basics.

Gravitational waves are expected to travel at the speed of light. This is the speed that is implied by general relativity. However, experiments like LIGO will get to test this. It is possible that they could travel slower but very near the speed of light. If that is the case, then the theoretical particle associated with gravity (and what gravitational waves are made up of) called the graviton would have a mass. Since gravity acts between masses, this would add complications into the theory. The complications don't make it impossible, just improbable. This is a great example of the use of Occam's razor: the simplest explanation is usually the correct one.

Light is often blocked by dust and gas, gravitational waves come right out of the supernova, boldly unimpeded, As a consequence, one really find out what's going on inside of these things.

Summary and indian contribution to come:

Gravitational waves are one of the most interesting predictions of general relativity, and provide an unprecedented probe of extreme gravity environments in the Universe.

There are many potential sources of gravitational waves for our detectors, ranging from binary star systems to super-massive black hole mergers to cosmic string cusps. We are now able to detect these waves using Advanced LIGO. Once gravitational wave detections become routine, we stand to learn a great deal about systems that are inaccessible to electromagnetic telescopes.

At present three detectors are being used for gravitational waves detection namely two units in USA already referred above and third one is VIRGO of European Gravitational Observatory in Italy. To improve ability to pinpoint source in the sky, LIGO plan to set a laboratory in India. Fourth detector to be the LIGO – VIRGO

net work, a world class gravitational detector is to be set in India. Indian government has in principle approved an expenditure of 146 million US dollar for this proposed project.

Astronomers have a way to track objects that don't emit light: Discovery of Gravitational waves

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Preparation of CNT By Arc Discharge Method in Deionised Water

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Abstract
Carbon nanotubes are allotropes of carbon. These cylindrical carbon molecules have interesting properties that make them potentially useful in many applications in nanotechnology, electronics, optics and other fields of materials science, as well as potential uses in architectural fields. They exhibit extraordinary strength and unique electrical properties, and are efficient conductors of heat. In the Physics Department an apparatus was developed, based on arc discharge method in demonized water, to synthesis CNTs and described here. CNTs prepared by this apparatus are characterized and results are presented.

Introduction

Carbon is capable of forming many allotropes due to its valiancy. Well-known forms of carbon include diamond and graphite. In recent decades many more allotropes and forms of carbon have been discovered and researched including ball shapes such as Buckminster fullerene and sheets such as graphene. Larger scale structures of carbon include nanotubes, nano-buds and nano-ribbons. Other unusual forms of carbon exist at very high temperature or extreme pressure.

Fullerenes are the three dimensional cage-like structure of carbon, composed of honeycomb type lattices of hexagon and pentagon. In 1996, Harry Kroto, Robert Curl, and Richard Smalley were awarded the Nobel Prize in Chemistry for the discovery of a spherical molecule composed entirely of carbon atoms. Important fullerenes materials include "BUCKEYBALL" C60 and CNT.

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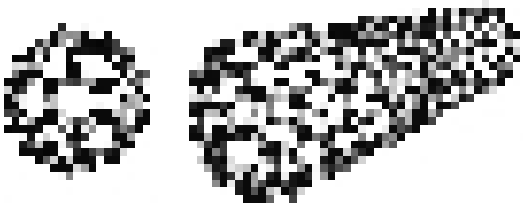

Figure 1. Molecular models representing a C60 fullerene (left) and a single-walled carbon Nano-tube (CNT) caped on one end (right).

Fullerenes are closed-cage clusters relatively stable in gas phase, whereas nanotubes are elongated structures that can nowadays reach several micrometers in length but still have very small diameters (in the few nanometers order). The end cap of the nanotube can be thought as an incomplete fullerene.

Carbon nanotubes (CNTs) are allotropes of carbon. These cylindrical carbon molecules have interesting properties that make them potentially useful in many applications in nanotechnology, electronics, optics and other fields of materials science, as well as potential uses in architectural fields. They exhibit extraordinary strength and unique electrical properties, and are efficient conductors of heat.

In 1991 Iijima, presented transmission electron microscopy observations of elongated and concentric layered microtubules made of carbon atoms, This propelled the research related to one of the most actively investigated structures of the last century: nowadays called the carbon nanotubes (CNTs) and his work catapulted carbon nanotubes onto the global scientific stage.

Different Methords for Preparation of CNT:

There are various methods of production of carbon nanotubes such as production of nanotubes by arc discharge, chemical vapor deposition, laser ablation, flame synthesis, high pressure carbon monoxide , electrolysis, pyrolysis etc. But they can be mainly classified into following groups.

1) Physical Processes
2) Chemical Processes
3) Miscellaneous Processes

Experimental Setup for arc Discharge Method:

Arc Discharge method is one of the oldest methods of carbon nanotube production. Iijima [1] in 1991, utilized arc discharge method at NEC's Fundamental Research Laboratory to produce new type of finite carbon structures consisting of needle-like tubes. The tubes were produced using an arc discharge evaporation method similar to that used for the fullerene synthesis. The carbon needles, ranging from 4 to 30 nm in diameter and up to 1 mm in length, were grown on the negative end of the carbon electrode used for the direct current (DC) arc-discharge evaporation of carbon. During the process Iijima used a pressurized chamber filled with a gas mixture of 10 Torr methane and 40 Torr argon.

The setup used by the author's for the synthesis of CNT by arc discharge basically consist of four parts namely.

1. Water tank made of ordinary glass
2. Transformer (step-down) with rectifying circuit compiled with it
3. Two graphite rods fixed on tank with help of aluminum rod.
4. Inductor coil

For the production of CNT, we should provide enough energy to the graphite so that the graphene sheet could be separated and also enough cooling so that it can form fullerenes material like CNT.

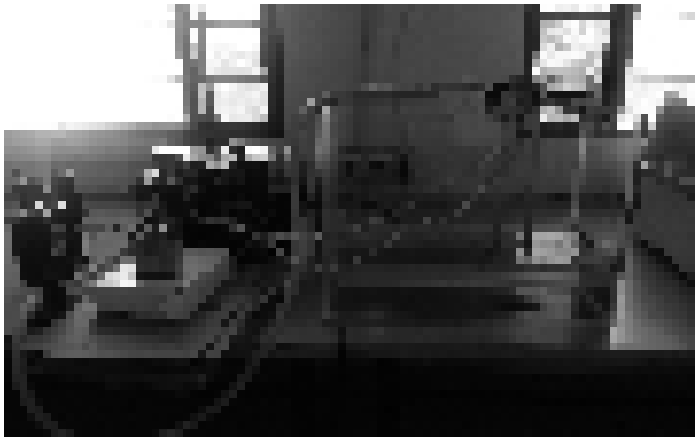

Figure 2. Experimental set up used for the production of CNT in the author's laboratory.

Heating of the graphite rod is done by constantly bombardment of electron from one graphite rod to other rod by arc discharge. In this method the graphite rod are kept at distance of ~1mm.When high current is passed through the circuit then, electron tunnels through one rod in to the another rod. it produces very large amount of heating. This causes the graphene sheet to breakdown.since the arcing is done inside the water, it provide a compatible ambient for graphene sheet to cool down.
The brief description of apparatus used for the arc-discharge is described below

Water Tank Made Up Of Transparent Ordinary Glass
There is no restriction on using the shape /size of the tank . An ordinary glass sheet of thickness~3mm was bought and was cut using a diamond cutter. The glass sheet was stick by using silicon adhesive. The tank which I used was of dimension 30cm*21cm*41cm.There is no restriction on using the shape /size of the tank.

Transformer (Step-Down) With Rectifying Circuit Compiled With It
For arc-discharge, we need high current and a constant DC supply. To achieve high current, a step-down transformer is used and to get the constant DC supply, AC mains signal is converted in to DC supply by using the rectifying circuit.
The wielding transformer is used. The transformer has three level of operation. When the AC input of 244 volt is applied at the input then we get following voltage at the output.

Level	At open loop (volts)	At closed loop (volts)
1	42.1	20
2	45.7	20
3	48.4	20

Rectifying Circuit

The basic circuit of the rectifying unit is shown in the figure. It consist of four diode RUTTON SH8 HM 120 connected in full rectifier pattern. Capacitor ALCON FF06 47N/1000V is connected parallel with each of the diodes. The output obtained is shown in the figure below.

Level	AC INPUT WHEN		DC INPUT WHEN	
	Loop is open (volt)	Loop is closed (volt)	Loop is open (volt)	Loop is closed (volt)
1	42.1	20	65.9	29.8
2	45.7	20	68.05	30.5
3	48.4	20	72.9	31.2

Graphite Rod

Two graphite rod is attached at the end of an aluminum rod and it is fixed at the top of water tank .The two rod are placed closed to each other. One of the rod is adjustable and can be moved in forward and backward direction with respect to other rod. One of the graphite rod has pointed tip and is connected to the negative terminal and another rod is connected to the positive terminal.

Inductor Coil

An inductor coil is put in the circuit to control the flow of heavy current when the circuit is switched on. This reduces the chance of any damage made to the rectifying circuit.

EXPERIMENTAL DETAILS

Synthesis of CNT

The carbon arc experiment has been performed between two cylindrical graphite electrodes in a reaction vessel which is made of thick glass and was filled with deionized water. The electric arc was initiated by contacting the pure graphitic anode (4 mm tip diameter) with a cathode (9 mm diameter) of similar purity submerged to a depth of 5 cm under deionized water. The rod length was of the order of 3 cm. The electrodes were aligned horizontally and during the arc ignition distance between the electrodes were manually controlled by a screw unit so that they always remain at a separation of approximately 1 mm to obtain a continuous arc. The excitation between anode and cathode is carried out under deionized water by applying a DC potential of ~20 V. As the roads are brought close together a discharge occurs resulting in formation of plasma. At the time of arc discharge between two electrodes black colored soot sputtered in all the directions below the water in the reaction container. The current was roughly stable in the range 50-60 Ampere. The arc discharge in water was found to be stable and could be run at the interval of 1 minute, for so long as a sufficient amount of graphite rod (cathode) was

consumed and arc discharge was over, a large number of black particles appeared at the bottom of the reaction container. Then the carbon soot was wiped out from the bottom of the container and was dried .Then it was taken for further analysis.

Characterization

Characterization of the soot obtained by arc- discharge was done by using optical microscope. Soot was placed under the optical microscope and its images were analyzed.

RESULT AND DISCUSSION

Soot obtained by the arc-discharge method was characterized under optical microscope. When soot was analyzed under optical microscope following images were obtained.

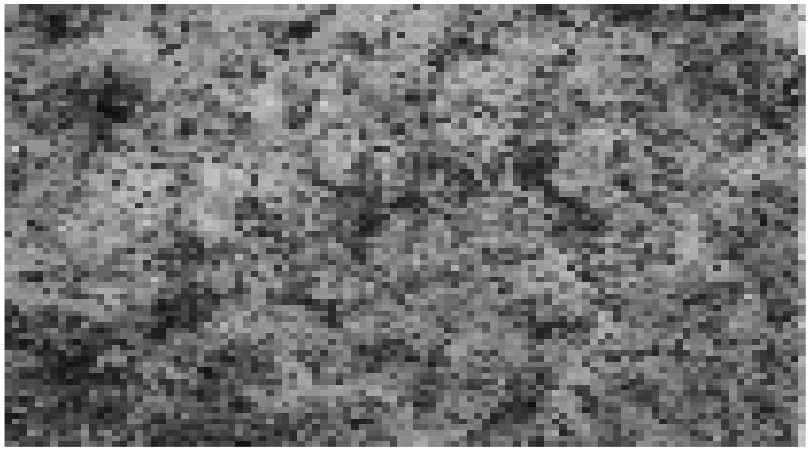

Figure 3. Optical images of the soot obtained by arc- discharge methord. It is mixture of graphene sheet, CNT and other Fullerenes materials. The cluster consists of CNT.

Soot obtained is mixture of fullerenes materials. It consists of graphene sheets, CNT and other compounds of carbon.

The thickness of the materials of soot can be easily analyzed by comparing its thickness with that of the hair. The thickness of the hair is of the order of few microns. Image below shows the comparison of soot with a single hair. The dark line is the image of the hair. Clearly the image of soot is very small in comparison with the hair.

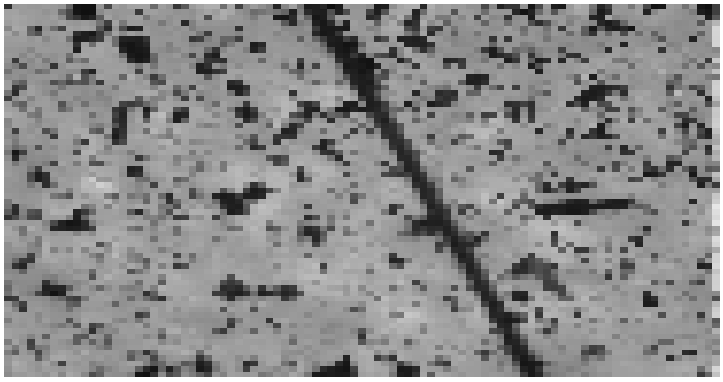

Figure 4.Image of soot under optical microscope. The dark line is the image of the hair. Clusters are of the size comparable with hair. These clusters consist of CNT. When these clusters of carbons are observed in SEM and TEM following images are obtained.

(a) **(b)**
(b) **(d)**

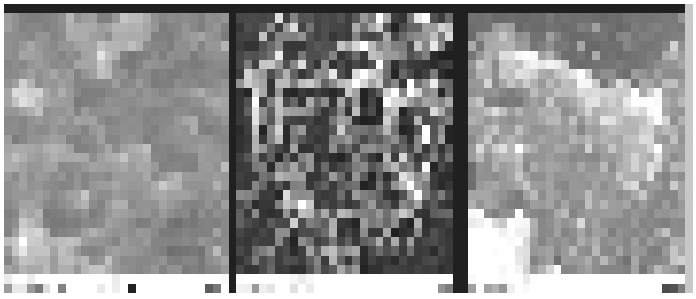

Figure 5. SEM images of (a) SWNT (b) MWNT and (c) Powder from arc discharge. These images are taken from American Science Publication vol. 2, 2014.[3]

Conclusion

This method is a successful technique for CNTs production. A powder consisting of a large quantity of CNTs was generated. The procedure used here is a low cost, and a simple method for CNTs synthesis.

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Microcontroller based Servo Controlled Voltage Stabilizer & its Parameter Estimation

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Abstract : DC drives are widely used in measurement of online parameters since olden days [1-3].But now a day electric drives plays an important role in industrial as well as agricultural applications. With recent advancement & developments in the semiconductor technology microprocessor, microcontroller & computer based applications are developed to reduce power, size & cost requirements. In the desert area single phase induction motors are widely used for pumping water from well. During summer there is large variation in the water level is observed. Due to water level variation the current requirement by the motor also drastically changes. The continuous use of motor in such condition results in heating of motor windings due to variation in voltage. This in turn may leads to power shut due to overloading. The present investigation deals with the design of servo mechanism stabilizer in the input stage of supply. It maintains the constant voltage for the induction motor irrespective of variations in the load. This is possible using the microcontroller based feedback system to control the servo mechanism. If load increases the feedback is taken by the microcontroller and the servo mechanism will allow to increase the voltage using the servo stabilizer. By doing this constant output voltage is maintained.

Keywords - Microcontroller, Servomechanism, Induction motor.

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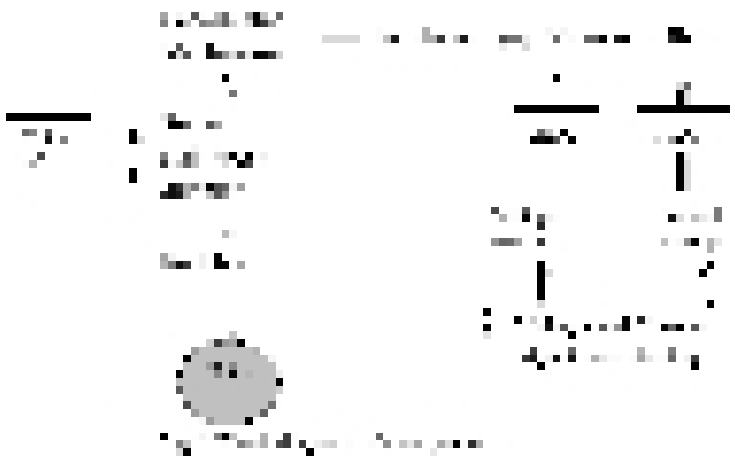
Introduction

DC drives were initially used for the industrial applications but not suitable for high voltage and heavy duty applications. Therefore, AC drives with new advance techniques provided better solution in the latter half of the 20th century. The AC drives have ability to work in any adverse conditions and control technique is also easier [5-8]. These days high performance control strategies are developed using the PC, Microprocessor, Microcontroller and PLC, which boosted the control technique. Use of these devices plays significant role in the controlling techniques of the induction motor. There are some particular industrial and agriculture applications to run the system continuously the voltage or current must be constant .But in many applications we find that the either of them parameter varies. Usually the voltage

drops below the expected value results in withdrawal of more current rather than expected. So due to excess current the cabling and the internal winding may damage and due to heating wastage of power will takes place. To avoid this constant voltage is provided by using the servo techniques using the feedback from the drive with the help of microcontroller. Input voltage to the motor is kept constant with the help of servo stabilizer mechanism that will keep the current constant throughout the process constant.

System Design Details

The control system consists of the servo mechanism for the maintaining the constant voltage. Even though the load changes (water level) during the pumping out of the water from well or bore well. The microcontroller based system will note the feedback instantaneously & send noted parameter to the servo mechanism to provide voltage to the motor. The abrupt transient changes in the system are avoided using snubber circuit. Signal conditioning circuits are used for Voltage & current sensing respectively. Overall block diagram of the system is shown in Fig. 1.



As soon as system is switched ON there will be abrupt change in the current occurs which is avoided by using the snubber circuit. The snubber consists of simply inductor, diode and capacitor. The motor will turn ON. As the level of the water goes down or load increases the current requirement also increases. It draws more current from the transformer .In order to provide constant current the output of servo stabilizer is used which is controlled by microcontroller.

The feedback of the motor current and voltage through signal conditioning is provided to microcontroller. It compare the incoming data and through software the corrective action is taken by rotating servo mechanism. If current requirement increases then servo mechanism will provide more voltage to compensate the

current requirement by stepping up and vice versa for other condition. Hence providing servomechanism it is possible to reduce the rise in current avoiding heating and loss of power.

Signal Conditioning

Signal conditioning is required in order to provide proper signal as per desired requirements.

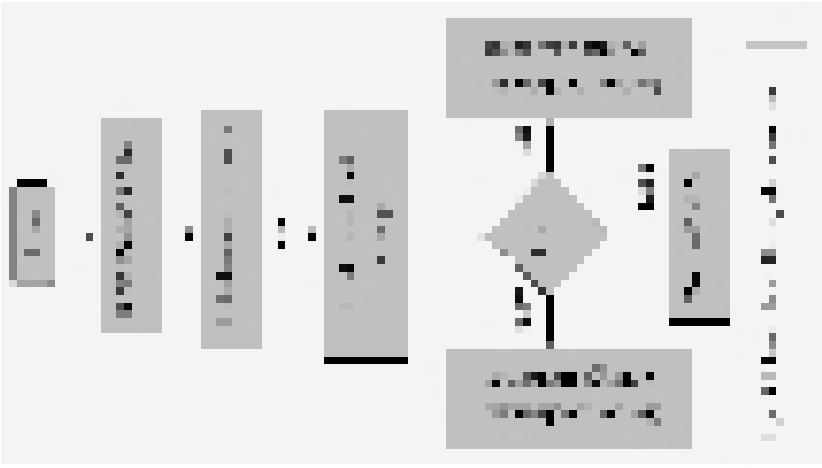
AC Voltage Sensing

Peak detector circuit is used for AC voltage measurement. The variation in the voltage of the peak detector according to the line voltage changes applied to one of the ADC channel and further converted to actual voltage by scaling the output voltage through software. The calibration is essential for measurement of sensed voltage. The correction factor obtained through the software used to get the correct result.

Current Sensing

The current sensing circuit consists of step up transformer whose primary is short-circuited by the shunt wire and the current through the shunt is given to the motor. The voltage drop across the shunt wire is proportional to the current passing through it. In other words secondary voltage is proportional to the motor current. The output voltage varies from 0 to 5 volt for variation of current from 0 to 5 ampere. There is linear relationship between input current and output voltage.

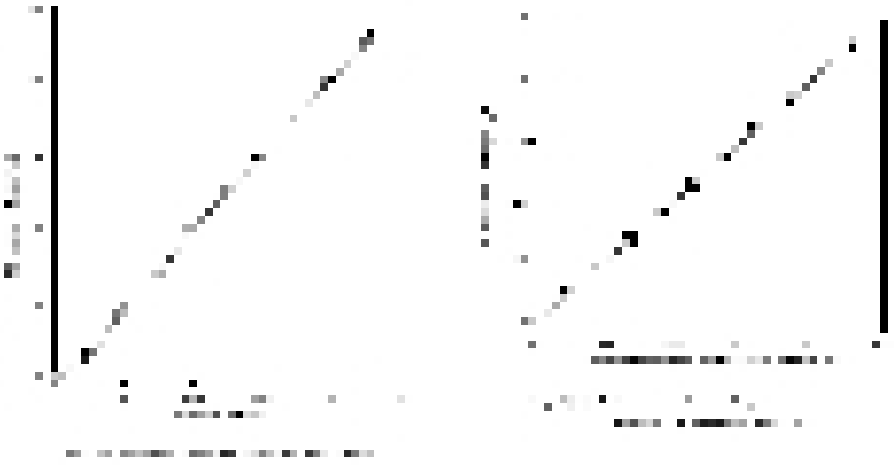
Flowchart of Developed Software



Calibration of System

Calibration of the system is very essential to maintain the accuracy of the system because, while sensing instrumental, human or environmental error may occur

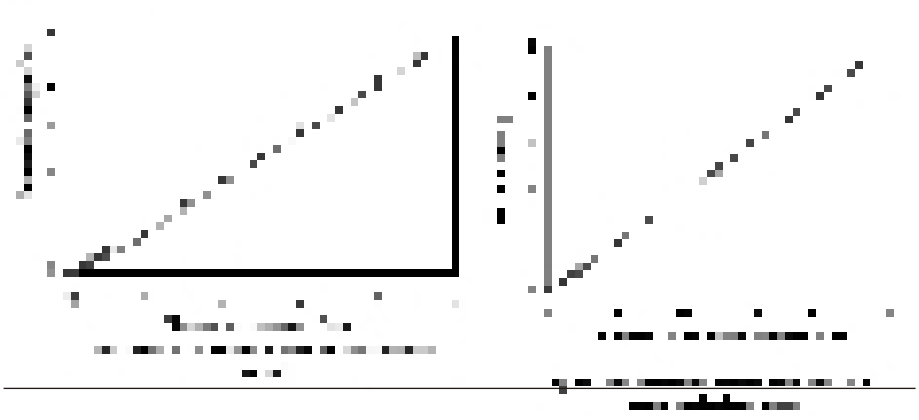
which may lead to deviation from the actual value. Therefore, it is necessary to have a precision meters and a stable noise free DC voltage source. In the present system current and voltage calibration is carried out by standard meters and required correction factor is applied through software.



Voltage Calibration

Figure 5(a) shows the variation of measured voltage verses input voltage. It is observed that the output voltage varies linearly with input voltage however; initially the output is slightly deviated with respect to input. This creates the error while reading the input voltage. To read the actual value of the input voltage, some correction factor must be introduced and it is introduced through software [2]. After applying the correction factor the output is measured. The plot of corrected voltage versus measured input voltage is shown in Fig 5 (b) indicating that corrected voltage displayed by the computer varies linearly with the measured voltage with standard voltmeter.

Current Calibration



Current measurement in case of induction motor under working condition is very important. The output voltage of the amplifier is proportional to the current. The calibration for the current measurement is done at different current ranges, to get the correct result. One such current calibration plot of the variation of sensed voltage (proportional to the current) versus measured current is shown in Fig. 6(a). After applying the calibration for current through software, output readings are recorded. Fig. 6(b) shows the plot of corrected current versus measured current. From the plot it is observed that both actual current and measured current are equal. However, there is little non-linearity in the graph at lower currents. So correction in measurement at lower current level is required. Presently the following relation is used to determine the exact current value with correction [2].

Conclusion

For agriculture operation in the desert areas the induction motors are used for pumping the water from well as well as tube well. With increase in load on the motor due to variation in the water level the current requirement increases and the motor draws more current which is compensated by implementing servo control voltage mechanism. The servo mechanism maintains the voltage requirement with change in load. The using the microcontroller based feedback system which will controls the servo mechanism.

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Robust Decentralized Fast Output Sampling Technique via reduced order models based Power System Stabilizer for Multimachine Power System

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Abstract : Power System Stabilizers (PSSs) are added to excitation systems to enhance the damping during low frequency oscillations. In this paper, the design of decentralized PSSs for 10 machines with 39 buses using fast output sampling feedback via reduced order model is proposed.
In multi-machine power system the order of the states matrix is very large. The main objectives of order reduction is to design a controller of lower order which can effectively control the original high order system so that the overall system is of lower order and easy to understand. The state space matrices of the reduced order system are chosen such that the dominant eigenvalues of the full order system are unchanged. The other system parameters are chosen using the PSO with objective function to minimize the mean squared errors between the outputs of the full order system and the outputs of the reduced order model when the inputs are unit step. Design of fast output sampling feedback controllers via reduced order model using PSO method is proposed for good damping enhancement for various operating points of multi-machine power systems. This paper also presents a comparatively study of design of fast output sampling feedback controllers via reduced order model *using Particle PSO method, and Davison method technique* for multi-machine system**.** Particle swarm optimization (PSO) order reduction method based fast output sampling feedback controller gives very good results, less complexity and also economic in designing of PSSs comparatively Davison method and balance truncation technique.

Keywords : Decentralized control, fast output sampling feedback, multimachine system, nonlinear simulation, power system stabilizer, reduced order model,particle swarm optimization, balance truncation, Davison method, simulink, MATLAB.

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Introduction

The dynamic stability of power systems is an important factor for secure system operation. Low- frequency oscillation modes have been observed when power systems are interconnected by weak tie lines. The low-frequency oscillation mode, which has poor damping in a power system, is also called the electromechanical oscillation mode and usually occurs in the frequency range of 0.1–2.0 Hz. The power system stabilizer (PSS) has been widely used for mitigating the effects of low- frequency oscillation modes.

The construct and parameters of PSS have been discussed in many studies. Currently, many plants prefer to employ conventional lead-lag structure PSSs, due to the ease of online tuning and reliability. The widely used conventional power system stabilizers (CPSS) are designed using the theory of phase compensation in the frequency domain and are introduced as a lead-lag compensator. The parameters of CPSS are determined based on the linearized model of the power system. In order to provide perfect damping over a wide operation range, the CPSS parameters should be fine tuned in response to both types of oscillations. Since power systems are highly nonlinear systems, with configurations and parameters which alter through time, the CPSS design based on the linearized model of the power system cannot guarantee its performance in a practical operating environment.

PSS have been used for over 20 years in Western systems of United States of America and in Ontario Hydro. In United Kingdom, PSS have used in Scotland to damp oscillations in tie lines connecting Scotland and England. It can be generally said that need for PSS will be felt in situations where power is required to be transmitted over long distances with weak AC tie lines. Even when PSS may not be required under normal operating conditions, they allow satisfactory operation under unusual or abnormal conditions which may be encountered at times. Thus PSS has become a standard option with modern static Exciters and it is essential for power engineers to use it effectively. Retrofitting of existing excitation system with PSS may also be required to improve system stability.[1]

Power System Stabilizers are added to excitation systems to enhance the damping of electric power system during low frequency oscillations. Several methods are used for the design of PSSs. Tuning of supplementary excitation controls for stabilizing system modes of oscillation has been the subject of much research during the past 35 years. Two basic tuning techniques have been successfully utilized with power system stabilizer applications: phase compensation method and the root locus method. A commonly used approach is based around the conventional PSS structure which is composed of a wash out circuit and a cascade of two-phase lead networks. A number of PSS input signals, such as terminal voltage, rotor speed, accelerating power, electric power etc., and linear combinations of these have been extensively investigated and recommendations regarding their use have been reported in the literature. Phase compensation consists of adjusting the stabilizer to compensate for the phase lags through the generator, excitation system and power system, such that, the stabilizer path provides torque changes which are in phase with the speed changes [2] . This is the most straightforward approach, easily understood and

implemented in the field and is most widely used. The design of such PSSs requires the determination (or tuning) of few parameters for each machine viz. the overall dc gain, the wash out circuit time constant, and the various constants for the two lead networks. A number of sequential and simultaneous approaches for tuning of these parameters have been reported in literature [22] . Although the above approaches have been used and have produced satisfactory results regarding the damping of local modes of oscillation, their outcome may not be considered the best possible. This is because of the restrictive assumptions made and the intuitive nature of the design process. Synthesis by root locus involves the shifting of eigenvalues associated with power system modes of oscillation, by adjusting the stabilizer pole and zero locations in the s-plane [17]. This approach gives an additional insight to the performance, by working directly with the closed-loop characteristics of the systems, as opposed to the open loop nature of the phase compensation technique. But it is more complicated to apply, particularly in the field. Moreover, the performance of these stabilizers considerably degrades with the changes in the operating condition during normal operation. It is also known that for a multimachine system, eigenvalue assignment is often too involved and complex for simultaneous stabilization of multivariable systems and may not provide satisfactory results for Sequential multivariable systems applied as SISO systems. Not much attempts have been made for designing the power system stabilizers for multimachine power system using multivariable control theory. The complexity stems from the fact that insufficient degree of freedom is available to the designer in assigning Eigen structure by fixed gain output feedback method. Moreover, even if a sufficient degree is available or a dynamic output feedback stabilizer is sought, numerical problems often arise regarding the solution of sets of high dimensional nonlinear algebraic equations, for which a solution may or may not exist. It is also well known that, in application of multivariable Nyquist array methods to multimachine power system, many difficulties arrive for the attainment of necessary diagonal dominance condition [18].

Since eigenvalue assignment and Nyquist array approaches have proved to be cumbersome, modern control methods have been used by several researchers to take advantage of the optimal control techniques. These methods utilize a state space representation of power system model and calculate a gain matrix which when applied as a state feedback control will minimize a prescribed objective function. Successful application of the optimal control to power system stabilizers requires that the constraints imposed by power system nonlinearities be used effectively and that a limited number of feedback signals be included [19]. The reason is that all the states may not be available for measurement or may be difficult to measure. In this case, the optimal control law requires to design the state observer. This increases the implementation cost and reduces the reliability of control system. Another disadvantage of the observer based control system is that, even slight variations of the model parameters from their nominal values may result into significant degradation of the closed loop performance. Hence, it is desirable to go for an output feedback design method.

In recent years there have been several attempts at designing power system stabilizer using H based robust control techniques [8]. In this approach, the uncertainty in the chosen system is modeled in terms of bounds on frequency response. A H optimal controller is then synthesized which guarantees robust stability of the closed loop system. Other performance specifications such as disturbance attenuation criteria are also imposed on the system. However, it should be noted that the main objective of using a PSS is to provide a good transient behavior. Guaranteed robust stability of the closed loop, though necessary, is not adequate as a specification in this application. In addition to this, the problem of the poorly damped pole-zero cancellations and the choice of weighting functions used in design, limit the usefulness of this technique for PSS design. H design, being essentially a frequency domain technique does not provide much control over transient behavior and closed loop pole location. It would be more desirable to have a robust stabilizer which, in addition guarantees an acceptable level of small signal transient performance. Moreover, this will lead to dynamic output feedback, which may
be feasible but leads to a higher order feedback system [9].
The static output feedback problem is one of the most investigated problems in control theory. The complete pole assignment and guaranteed closed loop stability is still not obtained by using static output feedback. Another approach to pole placement problem is to consider the potential of time-varying periodic output feedback. It was shown by Chammas and Leondes [7] that a controllable and observable plant was discrete time pole assignable by periodically time-varying piecewise constant output feedback. Since the feedback gains are piecewise constant, their method could be easily implemented and indicate a new possibility. Such a control law can stabilize a much larger class of systems than the static output feedback
Due to the geographically distributed nature of power systems, a decentralized control scheme may be more feasible than a centralized control scheme. In the decentralized power system stabilizer, the control input for each machine should be a function of the output of that machine alone. This can be achieved by designing a decentralized PSS using periodic output feedback technique in which the gain matrix should have all off diagonal terms zero or are very small compare to the diagonal terms. In a decentralized PSS, to activate the proposed controller at same instant, a proper synchronization signal is required to be sent to all machines. All PSSs can be applied simultaneously to the respective machines. So the decentralized stabilizer design problem can be translated into a problem of diagonal gain matrix design for multi-machine power system [23-31].

Power system stabilizers

Small-signal stability is the ability of the power system to remain in synchronism under normal operating condition and regain an acceptable state of equilibrium when subjected to small disturbances. Since the disturbance is considered to be small, the equations that describe the resulting dynamics of the system may be linearized. Instability that may result is of two types:

1. Steady increase in generator rotor angle due to lack of synchronizing torque;
2. Rotor oscillations of increasing amplitude due to lack of sufficient damping torque.

In today's practical power systems, the small-signal stability problem is usually one of insufficient damping of system oscillations.
For the analysis of small-signal stability, linearized models are generally considered to be adequate for representation of the power system and its various components.

2.1 Basic concept

The basic function of a power system stabilizer is to extend the stability limits by modulating generator excitation, to provide damping to the oscillation of synchronous machine rotors relative to one another. The oscillations of concern typically occur in the frequency range of approximately 0.2 to 3.0 Hz, and insufficient damping of these oscillations may limit the ability to transmit the power. To provide damping, the stabilizer must produce a component of motor slip which is in phase with reference voltage variations. For input signal, the transfer function of the stabilizer must compensate for the gain and phase of excitation system, the generator and the power system, which collectively determine the transfer function from the stabilizer output to the component of mechanical speed. This can be modulated via excitation system [1].

2.2 Performance objectives

Power system stabilizers can extend power transfer stability limits which are characterized by lightly damped or spontaneously growing oscillations in the 0.2 to 3.0 Hz frequency range. This is accomplished via excitation control to contribute damping to the system modes of oscillations. Consequently, it is the stabilizer's ability to enhance damping under the least stable conditions, i.e., “the performance conditions", which is important. Additional damping is primarily required under the conditions of weak transmission and heavy load as occurs, for example, when attempting to transmit the power over long transmission lines from the remote generating plants or relatively weak tie between systems. Contingencies, such as line outage, often precipitate such conditions. Hence, system normally having adequate damping can often benefit from stabilizers during such conditions.

Figure 1: Block diagram of PSS [1].

2.3 Classical stabilizer implementation procedure

It is important to realize that the stabilizer is intended to provide damping for small excursions about a steady-state operating point, and not to enhance transient

stability, i.e., the ability to recover from a severe disturbance. In fact, the stabilizer will often have deleterious effect on transient stability by attempting to pull the generator field out of ceiling too early in response to a fault. The stabilizer output is generally limited to prevent serious impact on transient stability, but stabilizer tuning also has a significant impact upon the system performance following a large disturbance [2].

The block diagram used in industry is shown in Fig. 2.1[4]. It consists of a washout circuit, dynamic compensator, torsional filter and limiter. The washout circuit is provided to eliminate steady-state bias in the output of PSS which will modify the generator terminal voltage. The PSS is expected to respond only to transient variations in the input signal (rotor slip) and not to the dc offset in the signal. The washout circuit acts essentially as a high pass filter and it must pass all frequencies that are of interest.

Implementation of a power system stabilizer implies adjustment of its frequency characteristic and gain to produce the desired damping of the system oscillations in the frequency range of 0.2 to 3.0 Hz. The transfer function of a generic power system stabilizer having washout circuit and a dynamic compensator may be expressed as

$$H(s) = K_s \frac{sT_w(1+sT_1)(1+sT_3)}{(1+sT_w)(1+sT_2)(1+sT_4)} \qquad (2.1)$$

where, K_s represent stabilizer gain.

The stabilizer frequency characteristic is adjusted by varying the time constant T_w, T_1, T_2, T_3 and T_4. The output of PSS must be limited to prevent the PSS acting to counter the action of AVR.

A number of sequential and simultaneous approaches for the tuning of these parameters have been reported in literature although these approaches have been usedand produce satisfactory results regarding the damping of local modes of oscillation; theiroutcome may not be the optimal. This is due to the restrictive assumption made and theintuitive nature of the design process.A power system stabilizer can be made more effective if it is designed and applied withthe knowledge of associated power system characteristics. Power system stabilizer must provide adequate damping for a range of frequencies of the power system oscillation modes. To begin with, simple analytical models, such as that of a single machine connected to an infinite bus system, can be useful in determining the frequencies of local mode oscillations. Power system stabilizer should also be designed to provide stable operation for the weak power system conditions and associated loading. A designed stabilizer must ensure for the robust performance and satisfactory operation with an external system reactance ranging from 20% to 80% on the unit rating [5].

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Multi-machine power system analysis

Analysis of practical power system involves the simultaneous solution of equations consisting of synchronous machines and the associated excitation system and prime movers, interconnecting transmission network, static and dynamic load (motor loads), and other devices such as HVDC converters, static var compensators. The dynamics of the machine rotor circuits, excitation systems, prime mover and other devices are represented by differential equations. The result is that the complete system model consists of large number of ordinary differential and algebraic equations.

Model 1.0 is assumed for synchronous machines by neglecting the damper windings. In addition, the following assumptions are made for simplicity [4].

1. The loads are represented by constant impedances.
2. Transients saliency is ignored by considering $x_q = x'_d$.
3. Mechanical power is assumed to be constant.
4. E_{fd} is single time constant AVR.

3.1 State space model of 10 Machine and 39 bus power system (Machine model 1.0): Generator equations

The machine equations (for k^{th} machine) are

$$pE'_{qk} = \frac{1}{T'_{d0k}}\left[-E'_{qk} + (x_{dk} - x'_{dk})i_{dk} + E_{fdk}\right],$$

$$p\delta_k = w_B(S_{mk} - S_{mk0}),$$

$$pS_{mk} = \frac{1}{2H}\left[-D_k(S_{mk} - S_{mk0}) + P_{mk} - P_{ek}\right]$$

The state space model of a 10-machine 39 bus system as shown in Fig. 2.5 can be obtained using machine data, line data and load flow data as given in [1] as

$$\dot{x} = [\overline{A}]x + [\overline{B}](\Delta\overline{V}_{ref} + \Delta\overline{V_s}),$$

$$y = [\overline{C}]x,$$

Where

$$x = [x_1, x_2, ..., x_{10}]^T, \text{ and } y = [y_1, y_2, ..., y_{10}]^T.$$

x_k (k=1,10) denotes the states of k^{th} machine, and y_k (k=1,10) denotes the output of the k^{th} machine.

The elements (sub matrices of 10×10) of A matrix depend on the machine and network parameters. Thus we have

$$\overline{A} = \begin{bmatrix} a_{00} & a_{01} & a_{02} & a_{03} & a_{04} & a_{05} & a_{06} & a_{07} & a_{08} & a_{09} \\ a_{10} & a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} & a_{17} & a_{18} & a_{19} \\ a_{20} & a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} & a_{27} & a_{28} & a_{29} \\ a_{30} & a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} & a_{37} & a_{38} & a_{39} \\ a_{40} & a_{41} & a_{42} & a_{43} & a_{44} & a_{45} & a_{46} & a_{47} & a_{48} & a_{49} \\ a_{50} & a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} & a_{57} & a_{58} & a_{59} \\ a_{60} & a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & a_{67} & a_{68} & a_{69} \\ a_{70} & a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & a_{78} & a_{79} \\ a_{80} & a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} & a_{89} \\ a_{90} & a_{91} & a_{92} & a_{93} & a_{94} & a_{95} & a_{96} & a_{97} & a_{98} & a_{99} \end{bmatrix}$$

$$\overline{B} = \begin{bmatrix} B_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & B_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & B_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & B_4 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & B_5 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & B_6 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & B_7 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & B_8 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & B_9 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & B_{10} \end{bmatrix}$$

$$\overline{C} = \begin{bmatrix} C_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & C_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 00 \\ 0 & 0 & C_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & C_4 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & C_5 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & C_6 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & C_7 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & C_8 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & C_9 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & C_{10} \end{bmatrix}$$

$$\Delta\overline{V}_{ref} + \Delta\overline{V_s} = \begin{vmatrix} \Delta V_{ref\,1} + \Delta V_{s1} \\ \Delta V_{ref\,2} + \Delta V_{s2} \\ \Delta V_{ref\,3} + \Delta V_{s3} \\ \Delta V_{ref\,4} + \Delta V_{s4} \\ \Delta V_{ref\,5} + \Delta V_{s5} \\ \Delta V_{ref\,6} + \Delta V_{s6} \\ \Delta V_{ref\,7} + \Delta V_{s7} \\ \Delta V_{ref\,8} + \Delta V_{s8} \\ \Delta V_{ref\,9} + \Delta V_{s9} \\ \Delta V_{ref\,10} + \Delta V_{s10} \end{vmatrix}$$

Figure 2: Single line diagram of 10 machines and 39 bus System [1].

Review on Fast Output sampling Method

For large scale power systems comprising of many interconnected machines, the PSS parameter tuning is a complex exercise due to the presence of several poorly damped modes of oscillation. The problem is further being complicated by continuous variation in power system operating conditions. In the simultaneous tuning approach, exhaustive computational tools are required to obtain optimum parameter settings for the PSS, while in the case of sequential

tuning, although the computational load is fewer, evaluating the tuning sequence is an additional requirement. There is a further problem of eigenvalue drift.
With Fast output sampling approach, it is possible to simultaneously realize a given state feedback gain for a family of linear, observable models. This approach requires increasing the low rank of the measurement matrix of an associated discretized system, which can be achieved by sampling the output several times during one input sampling interval, and constructing the control signal from these output samples. Such a control law can stabilize a much larger class of systems than the static output feedback. In fast output sampling feedback technique gain matrix is generally full. This results in the control input of each machine being a function of outputs of all machines.

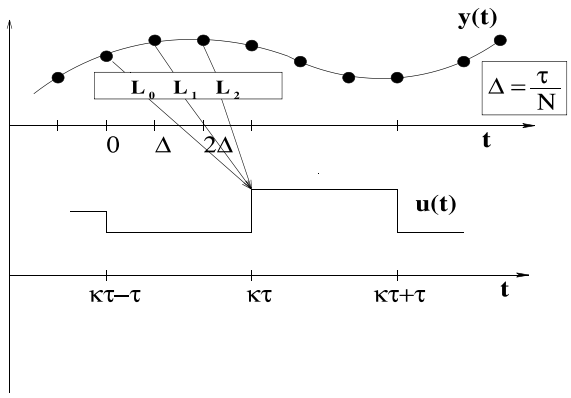

Figure 3: Fast Output Sampling Method.

The problem of pole assignment by fast output sampling was studied by Werner and Furuta [48]. It was shown that fast output sampling feedback technique has the features of static output feedback and makes it possible to arbitrarily assign the system poles.
In this technique an output feedback law is used to realize a discrete state feedback gain by multirate observations of the output signal. The control signal is held constant during each sampling interval τ. Let (Φ, Γ, C) be the system [42] sampled at rate $1/\Delta$ where $\Delta = \tau/N$. Output measurements are taken at time instants $t = l\Delta, l = 0,1,.....,N-1$. The control signal u(t), which is applied during the interval, $k\tau \le t < (k+1)\tau$ is then constructed as a linear combination of the last N output observations [66-67].

Consider a plant described by a linear model

$$\begin{aligned} x &= Ax + Bu \\ y &= Cx \end{aligned} \quad (4.1)$$

with (A,B) controllable and (C,A) observable. Assume the plant is to be controlled by a digital controller, with sampling time τ and zero order hold, and that a sampled data state feedback design has been carried out to find a state feedback gain F such that the closed loop system

$$x(k\tau+\tau) = (\Phi_\tau + \Gamma_\tau F)x(k\tau) \quad (4.2)$$

has desired properties. Hence $\Phi_\tau = e^{A\tau}$ and $\Gamma_\tau = \int_0^\tau e^{As}ds B$. Instead of using a state observer, the following sampled data control can be used to realize the effect of the state feedback gain F by output feedback. Let $\Delta = \tau/N$ and consider

$$u(t) = [L_0, L_1, \ldots, L_{N-1}] \begin{bmatrix} y(k\tau) \\ y(k\tau+\Delta) \\ \vdots \\ y(k\tau+(N-1)\Delta) \end{bmatrix} = Ly_k \quad (4.3)$$

For $k\tau \le t < (k+1)\tau$, where the matrix blocks L_i represent output feedback gains, and the notation L, y_k has been introduced for convenience. Note that $1/\tau$ is the rate at which the loop is closed, whereas output samples are taken at the N-times faster rate $1/\Delta$. This control law is illustrated in fig. 2.6.

To show how a fast output sampling controller eqn. (2.28) can be designed to realize the given sampled-data state feedback gain, we construct a fictitious, lifted system for which eqn. (2.28) can be interpreted as static output feedback. Let (Φ, Γ, C) denote the system eqn. (2.27) at the rate $1/\Delta$ where $\Delta = \tau/N$.

Consider the discrete-time system having at time $t = k\tau$ the input $u_k = u(k\tau)$, state $x_k = x(k\tau)$ and output y_k as

$$x(k+1) = \Phi_\Delta x_k + \Gamma_\Delta u_k, \quad (4.4)$$

$$y(k+1) = C_0 x_k + D_0 u_k. \quad (4.5)$$

where C_0 and D_0 are defined as

$$C_0 = \begin{bmatrix} C \\ C\Phi \\ \vdots \\ C\Phi^{N-1} \end{bmatrix}, \qquad D_0 = \begin{bmatrix} 0 \\ C\Gamma \\ \vdots \\ C\sum_{j=0}^{N-2}\Phi^j\Gamma \end{bmatrix}$$

Let F be an initial state feedback gains such that the closed loop system matrix $(\Phi_\tau + \Gamma_\tau F)$ has no eigenvalues at the origin. Then one can define a fictitious measurement matrix,

$$C(F,N) = (C_0 + D_0 F)(\Phi_\tau + \Gamma_\tau F)^{-1} \qquad (4.6)$$

which satisfies the fictitious measurement equation

$$y(k) = Cx(k) \qquad (4.7)$$

Let ▪ denote the observability index of (Φ, C). N is chosen to be greater than or equal to ▪. So that any state feedback gain can be realized by a fast output sampling gain L.

The control law is of form

$$u_k = Ly_k \qquad (4.8)$$

For the output feedback gain L to realize the effect of F it must satisfy

$$x_{k+1} = (\Phi_\tau + \Gamma_\tau F)x_k = (\Phi_\tau + \Gamma_\tau LC)x_k \qquad (4.9)$$

i.e. $LC = F \qquad (4.10)$

The controller obtained from the above equation will give desired behavior, but might require excessive control action. To reduce this effect we relax the condition that Lexactly satisfy the above linear equation and include a constraint on the L

$$\|L\| < \alpha_1$$
$$\|LD_0 - F\blacksquare\| < \alpha_2 \qquad (4.11)$$
$$\|LC - F\| < \alpha_3$$

LMI Formulation [67] of above eqns. is

$$\begin{bmatrix} -\alpha_1^2 I & L \\ L^T & -I \end{bmatrix} < 0$$

$$\begin{bmatrix} -\alpha_2^2 I & (LD_0 - F\blacksquare) \\ (LD_0 - F\blacksquare)^T & -I \end{bmatrix} < 0 \qquad (4.12)$$

$$\begin{bmatrix} -\alpha_3^2 I & (LC-F) \\ (LC-F) & -I \end{bmatrix} < 0$$

If the initial state is unknown, there will be an error $u_k = u_k - Fx_k$ in constructing the control signal under state feedback. One can verify that the closed loop dynamics are governed by

$$\begin{bmatrix} x_{k+1} \\ \Delta u_{k+1} \end{bmatrix} = \begin{bmatrix} \Phi_\tau + \Gamma_\tau F & \Gamma_\tau \\ 0 & LD_0 - F\Gamma_\tau \end{bmatrix} \begin{bmatrix} x_k \\ \Delta u_k \end{bmatrix} \qquad (4.13)$$

To see this, apply the coordinate transformation

$$T = \begin{bmatrix} I & 0 \\ F & I \end{bmatrix} \qquad (4.14)$$

to the equation

$$\begin{bmatrix} x_{k+1} \\ \Delta u_{k+1} \end{bmatrix} = \begin{bmatrix} \Phi_\tau & \Gamma_\tau \\ LC_0 & LD_0 \end{bmatrix} \begin{bmatrix} x_k \\ \Delta u_k \end{bmatrix} \qquad (4.15)$$

and use eqn. (2.31). Thus, one can say that the eigenvalues of the closed loop system under a fast output sampling control law eqn. (2.28) are those of $(\Phi_\tau + \Gamma_\tau F)$ together with those of $(LD_0 - F\Gamma_\tau)$.

One feature of fast output sampling control that makes it attractive for robust controller design is the fact that a result similar to the above can be shown to hold when the same state feedback is applied simultaneously to a family of models representing different operating conditions of the plant.

Multi Model Synthesis

For multi-model representation of a plant, it is necessary to design controller which will robustly stabilize the multi-model system. Multi-model representation of plants can arise in several ways. When a nonlinear system has to be stabilized at different operating points, linear models are sought to be obtained at those operating points. Even for parametric uncertain linear systems, different linear models can be obtained for extreme points of the parameters. The models are used for stabilization of the uncertain systems [42,67].

Let us consider a family of plant $S = \{ A_i, B_i, C_i \}$, defined by [1,43-45]

$$\dot{x} = A_i x + B_i u$$
$$y = C_i x \qquad i=1,.....M \qquad (5.1)$$

By sampling at the rate of $1/\tau$, we get a family of discrete systems $\{\Phi_i, \Gamma_i, C_i\}$

Augmented system defined below

$$\tilde{\Phi} = \begin{bmatrix} \Phi_1 & 0 & . & 0 \\ 0 & \Phi_2 & . & . \\ . & . & . & . \\ . & . & . & \Phi_M \end{bmatrix}, \quad \tilde{\Gamma} = \begin{bmatrix} \Gamma_1 & 0 & . & 0 \\ 0 & \Gamma_2 & . & . \\ . & . & . & . \\ . & . & . & \Gamma_M \end{bmatrix}, \qquad (5.2)$$

$$\tilde{C} = [\, C_1 \quad C_2 \quad . \quad C_M \,]$$

Let $\{\Phi_i, \Gamma_i, C_i\}$ denote the system at the rate $1/\tau$

$$x_{k+1} = \Phi_{\tau i} x_k + \Gamma_{\tau i} u_k \quad (5.3)$$

$$y_{k+1} = C_{0i} + D_{0i} u_k \quad (5.4)$$

Where

$$C_{0i} = \begin{bmatrix} C_i \\ C_i\Phi_i \\ . \\ . \\ C_i\Phi_i^{N-1} \end{bmatrix}, \quad D_{0i} = \begin{bmatrix} 0 \\ C_i\Gamma_i \\ . \\ . \\ C_i \sum_{j=0}^{N-2} \Phi_i^{j}\Gamma_i \end{bmatrix}$$

Assume that the state feedback gain F has been designed that $(C_{0i} + D_{0i}F)$ has no eigenvalues at the origin.

Then, assuming that in intervals $k\tau < t < k\tau + \tau$

$$u(t) = Fx(k\tau) \quad (5.6)$$

One can define the fictitious measurement matrix

$$C_i(F,N) = (C_{0i} + D_{0i}F)(\Phi_{\tau i} + \Gamma_{\tau i}F)^{-1} \quad (5.7)$$

which satisfies the fictitious measurement equation $y_k = C_i x_k$.

For L to realize the effect of F, it may satisfy

$LC_i = F \qquad i = 1,,\ldots\ldots,M \quad (5.8)$

This equation can be written as

$$LC = F \quad (5.9)$$

Where

$$C = [C_1 \quad C_2 \quad . \quad . \quad C_M], F = [F_1 \quad F_2 \quad . \quad . \quad F_M]$$

To reduce this effect we relax the condition that L exactly satisfy the above linear equation and include a constraint on the L.

$$\|L\| < \alpha_1$$

$$\|LD_{0i} - F\Gamma_{\tau i}\| < \alpha_{2i} \qquad i = 1,\ldots..,\ M \quad (5.10)$$

$$\|LC_i - F\| < \alpha_{3i}$$

LMI Formulation of above equations are

$$\begin{bmatrix} -\gamma_1^2 I & L \\ L^T & -I \end{bmatrix} < 0$$

$$\begin{bmatrix} -\gamma_{2i}^2 I & (LD_{0i} - F\gamma_i) \\ (LD_{0i} - F\gamma_i)^T & -I \end{bmatrix} < 0$$

$$\begin{bmatrix} -\gamma_{3i}^2 I & (LC_i - F) \\ (LC_i - F) & -I \end{bmatrix} < 0$$

Particle Swarm Optimization (PSO) Algorithm

PSO is an evolutionary computation technique developed by Eberhart and Kennedy [59] in 1995, which was inspired by the Social behavior of Bird flocking and fish schooling. PSO has its roots in artificial life and social psychology as well as in Engineering and Computer sciences. It is not largely affected by the size and non-linearity of the problem and can converge to the optimal solution in many problems where most analytical methods fail to converge.

Particle Swarm Optimization has more advantages over Genetic Algorithm as follows: PSO is easier to implement and has fewer parameters to adjust. Every particle in PSO remembers its own previous best value as well as the neighborhood best. PSO utilizes a population of particles that fly through the problem space with given velocities. Each particle has a memory and it is capable of remembering the best position in the search space ever visited by it. The Positions corresponding to the Best fitness is called Pbest (also called local best) and the global best out of all the particles in the population is called gbest. At each iteration, the velocities of the individual particles are updated according to the best position for the particle itself and the neighborhood best position.

Particle Swarm Optimization (PSO) is a stochastic search technique with reduced memory requirement, computationally effective and easier to implement com-pared to other evolutionary algorithms (EAs). Also PSO has very fast converging characteristics among the EAs. Its basic idea was inspired by natural flocking and swarm behavior of birds and ants. PSO is started with a randomly generated solution as an initial population called particles, which evolve over generations in approaching the optimum solution. Each particle is treated as a point in a D dimensional space and represented as X=(x1,x2,,…,.x_D). Each particle has a fitness value which is the optimization index. The velocity and the position in the hyperspace of a particle are tracked. The best previous position of particle that corresponds with the minimum fitness value is represented as pbest=(p_{i1},p_{i2},…,p_{1D}), and the best position of all particles in the population is denoted as gbest.

When in an iteration the value of gbest and pbest are calculated. Particle's position and velocity are updated as follow for the next iteration:

$$v_{id}^{k+1} = v_{id}^{k} + c1 \times r1 \times (p_{id}^{k} - x_{id}^{k}) + c2 \times r2 \times (p_{gd}^{k} - x_{gd}^{k}) \quad (6.1)$$

$$x_{id}^{k+1} = x_{id}^{k} + v_{id}^{k+1} \quad (6.2)$$

where v is the particle's velocity, x is its position, p_{id} and p_{gd} are, respectively, pbest and gbest, the subscript k^{th} iteration, c1 and c2 are, respectively, cognition parameter and social parameter that can be variable or constant (generally both of them set as 2), r1 and r2 are random numbers in the range (0,1).

Note that the eqn. (2.51) without first part is similar to the local search and all particles will incline to move toward the same position. Only when the global optimum is within the initial search space, there is a chance to find the solution. But when the first part of eqn. (2.51) is considered particles move toward the stochastic average of pbest and gbest. To balance the global and local search the parameter 'w', called inertia weight, is introduced. This parameter can be constant in the range [0.9, 1.2]. In that case, eqn. (2.51.a) is modified as below:

$$v_{id}^{k+1} = w.v_{id}^{k} + c1.r1.(p_{id}^{k} - x_{id}^{k}) + c2.r2.(p_{gd}^{k} - x_{gd}^{k}) \quad (6.3)$$

6.1 Model order reduction using PSO algorithm

Consider the following n^{th} order LTI system:

$$\dot{x}_f(t) = A_f x(t) + B_f u(t) \quad (6.4)$$

$$y_f(t) = C_f x(t) + D_f u(t) \quad (6.5)$$

Where $x_f \in R^n$ is the state vector, $u \in R^p$, and $y_f \in R^m$ are the input and output vectors, respectively. The matrices A_f, B_f, C_f, and D_f are the full order system matrices with their appropriate dimensions. Let the eigenvalues of the above full order system is given as:

$$-\lambda_1 < -\lambda_2 < .... < -\lambda_n . \quad (6.6)$$

On the other hand, consider the reduced order LTI system with order r:

$$\dot{x}_r(t) = A_r x(t) + B_r u(t) \quad (6.7)$$

$$y_r(t) = C_r x(t) + D_r u(t) \quad (6.8)$$

$x_r \in R^r$ is the state vector of the reduced order system, $u \in R^p$, and $y_r \in R^m$ are the input and output vectors, respectively. The matrices A_r, B_r, C_r, and D_r are the reduced order system matrices with their appropriate dimensions. The eigenvalues of reduced order system are chosen to be the dominant eigenvalues of the full order system given as:

$$-\lambda_1 < -\lambda_2 < .... < -\lambda_r . \quad (6.9)$$

The A_r matrix is chosen to be diagonal matrix with the dominant eigenvalues are assigned as the diagonal elements. The elements of other matrices are chosen by PSO algorithm.

In order to describe the steps of the PSO algorithm for MOR, we will define the given parameters and the necessary specifications.

Various parameters setting:

1. Set the full order system parameters i.e. $N_{full=}40$.
2. Set appropriate level step inputs to the system.
3. Simulate the outputs y_f, of the full order system with a suitable sampling time.
4. Choose a suitable order of the reduced order system based on the dominant eigenvalues i.e. $N_r=10$.
5. Set the PSO parameters:

a. The size of the particle, P=200.
b. The number of particles in the swarm, M=25.
c. The counter of iteration (I = 1) and the maximum number of iterations, Lmax=100.

6. A reasonable range for the parameters should be chosen. This requires specifications of the minimum and maximum values for each parameter.
7. A good fitness function that is well representative of the parameters is crucial in the PSO algorithm. The mean-squared error

$$MSE = \frac{1}{N}\sum_{k=1}^{m}\sum_{i=1}^{N}[y_f(k,i) - y_r(k,i)]^2 \qquad (6.10)$$

where N is the number of samples, m is the number of outputs, $y_f(k, i)$ is the i^{th} sample of the k^{th} output of full order system and $y_r(k,i)$ is the i^{th} sample of the k^{th} output of reduced order system.

In this paper, the fitness function used in the PSO algorithm is the minimization of mean-squared error (MSE),

Fitness = min (MSE) (6.11)

Figure 4: Flowchart for PSO

6.2 Model Order Reduction Based On Dominant Modes Retention Method

It is usually possible to describe the dynamics of physical systems by a number of simultaneous linear differential equations with constant coefficients.

$\dot{x} = Ax + Bu$, where A = n × n matrix (6.12)

$y = Cx.$ (6.13)

The simulation and design of controllers become very cumbersome if the order of the system goes high. One way to overcome this difficulty is to develop a reduced model of the higher order system. One of the well known techniques is based on dominant eigenvalue retention.

Davison technique

A system of higher order can be numerically approximated to one of smaller order by Davison's method [51]. The method suggests that a large (n × n) system can be reduced to a simpler (r × r) model (r << n) by considering the effects of the r most dominant (dominant in the sense of being closest to instability) eigenvalues alone. The principle of the method is to neglect eigenvalues of the original system that are farthest from the origin and retain only dominant eigenvalues and hence dominant time constants of the original system in the reduced model. This implies that the overall behavior of the approximate system will be very similar to that of the original system since the contribution of the un-retained eigenvalues to the system response are important only at the beginning of the response, whereas the eigenvalues retained are important throughout the whole of the response [42,66,67].

For the system represented eqns. (B.1-B.2), consider the linear transformation

$x = Pz,$ (6.14)

which transforms the model eqns. (B.1-B.2) into the following form:

$\dot{z} = \hat{A}z + \hat{B}u$ where $\hat{A}$ =r × r matrix (6.15)

$y = \hat{C}z,$ (6.16)

where

$$\hat{A} = P^{-1}AP,$$

$$\hat{B} = P^{-1}B, \text{ and } \hat{C} = CP; \quad (6.17)$$

$\hat{A}$ is in the diagonal form as

$$\hat{A} = \text{diag}\left[\lambda_1, \lambda_2, \quad , \lambda_n\right], \quad (6.18)$$

and

$$\mathrm{Re}(\lambda_1) \geq \mathrm{Re}(\lambda_2) \geq \ldots \geq \mathrm{Re}(\lambda_n). \quad (6.19)$$

Further assume that r eigenvalues are only dominant; i.e., the order of the reduced model is r, and partition the model in eqns. (B.4-B.5) as

$$\dot{z}_1 = \hat{A}_1 z_1 + \hat{B}_1 u, \quad (6.20)$$

$$\dot{z}_2 = \hat{A}_2 z_2 + \hat{B}_2 u, \quad (6.21)$$

and

$$y = \hat{C}_1 z_1 + \hat{C}_2 z_2, \quad (6.22)$$

where

$$\hat{A}_1 = \mathrm{diag}[\lambda_1, \lambda_2, \ldots, \lambda_r], \quad (6.23)$$

$$\hat{A}_2 = \mathrm{diag}[\lambda_{r+1}, \lambda_{r+2}, \ldots, \lambda_n], \quad (6.24)$$

$\hat{B}_1$ = first r rows of $\hat{B}$, (6.25)

and

$\hat{B}_2$ = remaining (n-r) rows of $\hat{B}$, (6.26)

and are, respectively, r × r, (n-r) × (n-r), r× m and (n-r) × m matrices obtained by partitioning of $\hat{A}$ and $\hat{B}$ suitably. In eqns. (B.9-B.10), the order of z_1 is r and that of z_2 is (n-r).

Now, because the contribution of the modes represented by the eigenvalues $\lambda_{r+1}, \lambda_{r+2}, \ldots, \lambda_n$ is not significant, it may be assumed that z_2=0, whereby we have from eqn. (B.3)

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} P_{11} \\ P_{21} \end{bmatrix} z_1, \quad (6.27)$$

Where P_{11} and P_{21} are, respectively, r × r and (n-r) × r sub-matrices obtained by partitioning of P, and z_1 and z_2 are, respectively, r and (n-r) dimensional state vectors corresponding to the original state variables. It follows from eqn. (B.16) that

$$z_1 = P_{11}^{-1} x_1, \quad (6.28)$$

With which the model in eqn. (B.9) can be transformed to

$$x_1 = P_{11}\hat{A}_1 P_{11}^{-1} x_1 + P_{11}\hat{B}_1 u = A_r x_1 + B_r u, \quad (6.29)$$

and

$$y = \hat{C}_1 P_{11}^{-1} x_1 = C_r x_1. \quad (6.30)$$

Moreover, from eqns. (B.16-B.17), we have

$$x_2 = P_{21} P_{11}^{-1} x_1. \quad (6.31)$$

Thus, the original n^{th} order model represented by eqns. (B.1-B.2) is reduced to an r^{th} order model given by eqns. (B.18-B.19). The state variables of the approximate model are the same as the first r state variables of the original higher-order model. The remaining state variables are given in terms of the first r state variables by eqn. (B.20).

Decentralized fast output sampling technique for multi-model synthesis

Let us consider a family of plant S = { A_i, B_i, C_i} , defined by [42,49]

$$\dot{x} = A_i x + B_i u \qquad (7.1)$$

$$y = C_i x \qquad i=1,.....M \qquad (7.2)$$

The discrete time invariant systems with sampling interval tau sec. can be represented as

$$x(k+1) = \Phi_{\tau i} x(k) + \Gamma_{\tau i} u(k), \qquad y(k) = C_i x(k). \qquad (7.3)$$

Let u(k) = Fx be a stabilizing control for the reduced order system in eqn.(4.5). Thus closed loop reduced system eqn. (4.5) $(\Phi_i + \Gamma_i F)$ becomes stable and has no eigenvalues at the origin.

Using this F, If the LMI constraints given in eqns. (2.49-2.50) are solved, the robust fast output sampling feedback gain matrix may become full [44]. This results in the control input of each machine being a function of outputs of all machines. As robust decentralized control scheme may be more feasible than the centralized control scheme, robust decentralized fast output sampling feedback control is obtained by making the off diagonal elements of L_0, L_1,….,L_{N-1} matrices zero.

So the structure of L_i (i = 0,…,N-1) matrices for 10 machine and 39 bus power system (machine model 1.0). With this structure of L_i, the problem can be formulated in the framework of Linear Matrix Inequalities using eqns. (2.49-2.50) and the desired matrices can be obtained.

$$L_i = \begin{bmatrix} l_{i11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & l_{i22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & l_{i33} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & l_{i44} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & l_{i55} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & l_{i66} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & l_{i77} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & l_{i88} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & l_{i99} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & l_{i1010} \end{bmatrix}, i = 0, \ldots, N-1.$$

Now it is evident that the control input of each machine is a function of that machine only and this makes the fast output sampling based power system stabilizer design a decentralized one.

Simulation with nonlinear model for 10 Machine 39 bus systems via reduced order model:

A SIMULINK based block diagram including all the nonlinear blocks is generated using machine model 1.0 [42-44]. The output slip signal with robust decentralized gain L and a limiter is added to V_{ref} signal. The output must be limited to prevent the PSS acting to counter action of AVR. Different operating points are taken as the different models.

The location of fault considered for various models is given in Table 1:

Table 1: Location of faults: 10 machine and 39 bus system

S.No.	Model	Fault at Bus
1	Model1	Bus16
2	Model 2	Bus 13
3	Model 3	Bus 11
4	Model 4	Bus 9
5	Model 5	Bus 7
6	Model 6	Bus 17
7	Model 7	Bus 19
8	Model 8	Bus 21

Conclusion

This paper endeavors to exploit the properties of fast output sampling technique and endorses design method of robust decentralized power system stabilizers (PSS). One of the primary requirements of a good decentralized method is that the resulting PSS should be robust enough to wide variations in system parameters, while also being computationally convenient. In this respect, the intended fast output sampling methods provide adequate results.

The paper proposes a novel design on robust decentralized fast output sampling feedback controllers via reduced order model using Particle Swarm Optimization (PSO) method which provide good damping enhancement for diverse operating points of multi-machine power systems. This work also presents a comparatively study of design of fast output sampling feedback controllers via reduced order model using Particle Swarm Optimization (PSO) method, Davison method and Balance-Truncation technique for multi-machine system stability enhancement. Particle swarm optimization (PSO) model reduction method gives very good results in the design of Power System Stabilizers and also economic and less complexity in designing of power system stabilizers comparatively Davison method and balance truncation technique. The limitation of dominant pole and balance truncation methods are the reduction of order not less than 20^{th} and 15^{th} order for this full 40^{th} order system model. PSO MOR method provides 10^{th} order reduced model, it means less order of model system less complexity to design controller for system and also economic. The proposed method results are satisfactory response to damp out the oscillations.

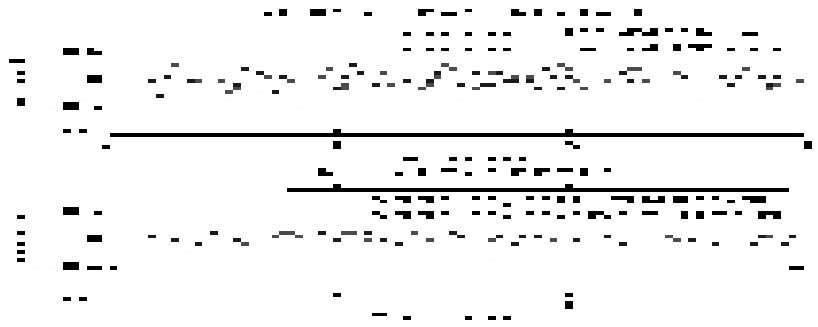

Figure 5: Closed loop responses with fault using decentralized fast output sampling feedback controller via reduced order Model.

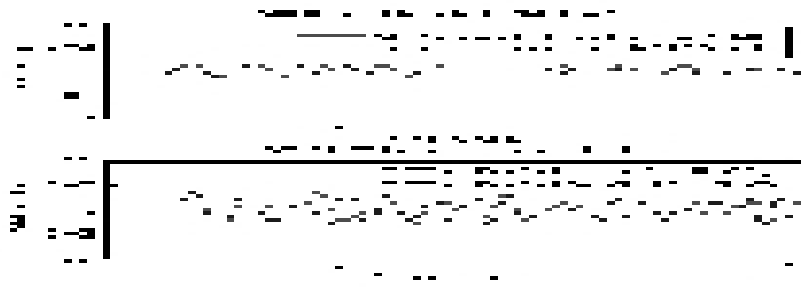

Figure 6: Closed loop responses with fault using decentralized fast output sampling feedback controller via reduced order Model.

Figure 7: Closed loop responses with fault using decentralized fast output sampling feedback controller via reduced order Model.

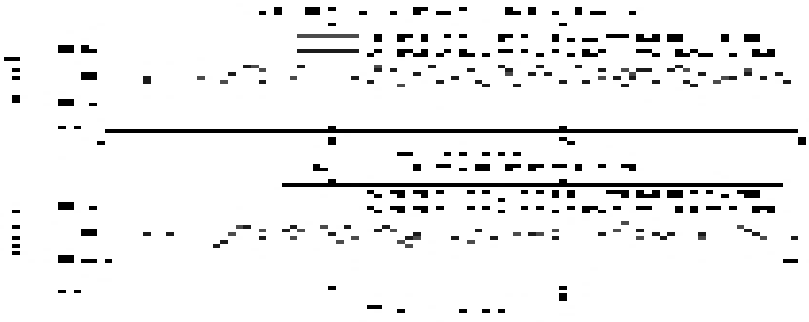

Figure 8: Closed loop responses with fault using decentralized fast output sampling feedback controller via reduced order Model.

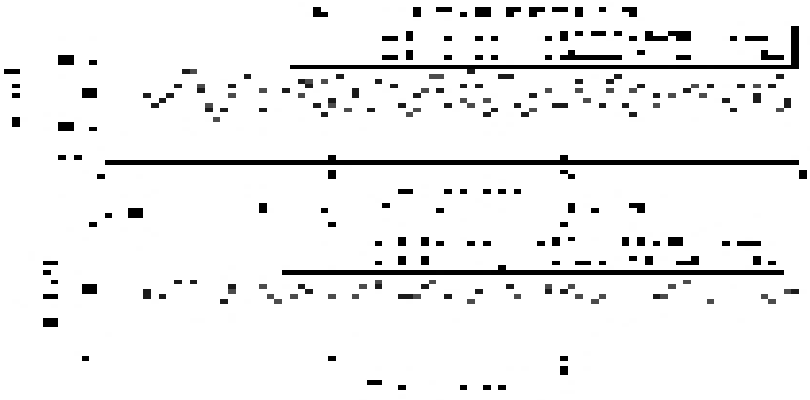

Figure 9: Closed loop responses with fault using decentralized fast output sampling feedback controller via reduced order Model.

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Appendix

Using LMI approach, eqns. (2.49-2.50) are solved for different values ρ_1, ρ_2 and ρ_3 to find the robust decentralized gain matrix, L. The robust decentralized fast output sampling feedback gain matrix L (10x100) is obtained as follows:

A Robust decentralized PSS design for multi-machine power system by fast output sampling feedback technique via PSO reduced order model:

L_0=diag[106.6392 -245.2845 13.3129 194.5492 109.4888 -107.2899 -200.6774 -17.4186 261.1293 -114.4652],

L_1=diag[-41.1830 94.4447 -5.0348 -74.5871 -41.9658 40.9277 76.5270 6.6832 -99.1869 43.3794],

L_2=diag[8.4805 -19.3724 1.2824 14.9212 8.0079 -8.1388 -14.5278 -1.0278 18.3513 -7.9745],
L_3=diag[-109.5222 251.1609 -12.9064 -198.7529 -112.4911 108.9194 204.8557 18.3963 -265.8447 116.1964],
L_4=diag[-17.7994 39.5412 -1.2361 -30.0271 -17.5387 15.2516 29.7878 3.4788 -37.0635 15.5959],
L_5=diag[-0.5453 1.0622 0.3023 -0.8958 -0.9204 0.2931 1.3083 0.4599 -1.7525 0.6877],
L_6 =diag[183.4209 -418.2130 21.9982 326.6334 183.1089 -177.0277 -330.0311 -29.1990 423.1863 -183.8656],
L_7 =diag[122.5075 -281.7046 17.9774 220.6844 120.3689 -121.9868 -221.2423 -16.5058 284.5842 -124.6864],
L_8 =diag[-6.4049 15.5244 -1.8921 -12.5122 -5.9367 7.6649 12.3096 0.0759 -16.3092 7.4833],
L_9 =diag[-70.3567 160.4827 -6.9245 -126.9291 -73.2851 68.6756 131.8121 13.0937 -170.8664 74.3000].

B Calculated robust decentralized FOS output feedback gain matrix for 10 machine system using Davison MOR technique:

L_0= diag[0.1727 -0.0199 -0.1030 -0.1067 -0.0619 0.0024 0.0568 0.0726 0.0225 -0.1215],
L_1= diag[-1.3924 -0.1895 0.6458 1.1121 1.2085 0.9336 0.2866 -0.7335 -2.1276 -3.8964],
L_2= diag[-0.4563 -0.0217 0.2077 0.2723 0.2316 0.1224 -0.0079 -0.1138 -0.1517 -0.0809],
L_3= diag[-2.6028 0.5858 1.89851.8310 0.9262 -0.3088 -1.3635 -1.7403 -0.9711 1.4274],
L_4= diag[2.6775 -0.8526 -2.1983 -1.9583 -0.7648 0.7132 1.8776 2.1268 0.8776 -2.4474],
L_5= diag[-3.9001 -1.2902 0.6616 1.9587 2.6033 2.5964 1.9406 0.6369 -1.3071 -3.9001],
L_6= diag1.0e-006 * [-0.0483 0.0971 -0.0844 -0.0166 0.0627 -0.1706 0.6250 -0.2602 -0.6373 0.4327],
L_7= diag1.0e-011 * [0.6691 0.2122 -0.1501 -0.1375 -0.3461 -0.6090 -0.3940 -0.1200 -0.0651 0.9651],
L_8= diag[-1.6907 -0.5613 0.2856 0.8496 1.1314 1.1306 0.8464 0.2809 -0.5686 -1.6990],
L_9= diag[-0.9853 -0.3272 0.16670.4952 0.6589 0.6580 0.4935 0.1622 -0.3315 -0.9914].

A Review of Generations of Mobile Wireless Technologies (1G to 5G)

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Abstract : Mobile communication system is growing at a rapid speed with advanced techniques. With advanced techniques it has completely revolutionized the way people communicate. Beyond 4G the key objective and demands that need to be fulfilled are enhanced capacity, increased data rate, decreased latency , and better quality of services. The worldwide revolution in mobile and internet have changed our style and way of living life. Every new mobile wireless technology has come to hide and compensate the limitations of previous one. In this paper we throw light on various generation of mobile wireless technologies(1G to 5G) and also present an overview of 5G technology trends in wireless technology market, a comparative overview of 5G v/s all other previous generation technologies.

Key words : 1G, 2G, 3G, 4G, 5G, CDMA, GSM

Introduction

The cellular communication industry has witnessed explosive growth in the past few years in term of technology and number of subscribers. Wireless communications networks have become much more persistent than anyone could have imagined when the cellular concept was first developed in 1960s and 1970s.The rapid growth in cellular telephone subscriber has demonstrated that wireless communication is a robust, viable voice and data transport mechanism. The pervasive success of cellular communication system has led to the development of newer wireless systems and standardsfor many other types of telecommunication traffic besides mobile voice telephone call [1]. As the communication industry has got the custom of classifying the developments into various generations. Likewise the wireless networks are classified into five generations, namely, first generation, second generation, third generation, fourth generation and fifth generation networks. Many more designing scenarios have developed with not only 1G network but also with the evolution of 2G, 3G, 4G and 5G networks. Along with this, inter-operability of the networks has to be considered. The cellular concept was introduced in the 1G technology which made the large scale mobile wireless communication possible.1G refers to analog cellular technologies and it becameavailable in the 1980s. 2G denotes initial digital systems, introducing services such as short messaging and lower speed data. CDMA2000 1xRTT and GSM are the primary 2G technologies, although CDMA2000 1xRTT is sometimes

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called a 3G technology because it meets the 144 kbps mobile throughput requirement. EDGE, however, also meets this requirement. 2G technologies became available in the 1990s. 3G requirements were specified by the ITU as part of the International Mobile Telephone 2000 [3]. 2G denotes initial digital systems, introducing services such as short messaging and lower speed data. CDMA2000 1xRTT and GSM are the primary 2G technologies, although CDMA2000 1xRTT is sometimes called a 3G technology because it meets the 144 kbps mobile throughput requirement. EDGE, however, also meets this requirement. 2G technologies became available in the 1990s. 3G requirements were specified by the IMT(2000) project, for which digital networks had to provide 144 kbps of throughput at mobile speeds The ITU has recently issued requirements for IMT- Advanced, which constitutes the official definition of 4G. Requirements include operation in up-to-40 MHz radio channels and extremely high spectral efficiency. 5G technologies began to be deployed [3]. The Generation blocks are shown below figure 1.

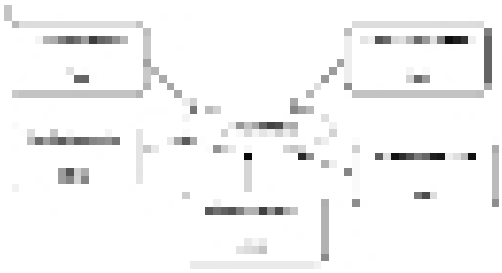

Fig.1: Mobile wireless technology.

Cellular Systems

A cellular system is one which provides a wireless connection to public switched telephone network (PSTN) for any user location within the radio range of the system. Cellular system accommodates a large numbers of users over a large geographic area, within a limited frequency spectrum. Cellular system provides high quality service. High capacity is achieved by limiting the coverage area of each base station transmitter to a small geographic area called cell so that same radio channels may be reused by another base station located some distance away. A sophisticated switching method called a handoff enables a call to proceed uninterrupted when the user moves from one cell to another [1].

Evolution of Generations

G. Marconi, an Italian inventor, unlocks the path of recent day wireless communications by communicating the letter ‘S’ along a distance of 3Km in the form of three dot Morse code with the help of electromagnetic waves. After this inception, wireless communications have become an important part of present day society. Since satellite communication, television and radio transmission has advanced to pervasive mobile telephone, wireless communications has transformed the style in which society runs. The evolution of wireless begins here [2] and is

shown in Fig. 2. It shows the evolving generations of wireless technologies in terms of data rate, mobility, coverage and spectral efficiency. As the wireless technologies are growing, the data rate, mobility, coverage and spectral efficiency increases. It also shows that the 1G and 2G technologies use circuit switching while 2.5G and 3G uses both circuit and packet switching and the next generations from 3.5G to nowi.e. 5G are using packet switching. Along with these factors, italsodifferentiate between licensed spectrum and unlicensed spectrum. All the evolving generations use the licensed spectrum whiles the Wi-Fi, Bluetooth and Wi -MAX are using the unlicensed spectrum. An overview about the evolving wireless technologies is below:

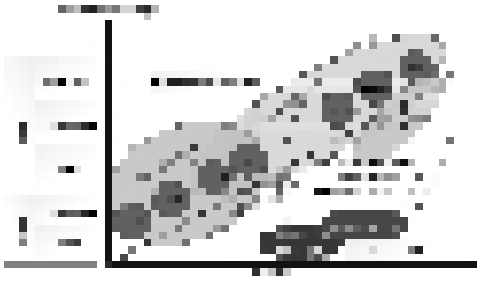

Fig.2: The evolution of mobile technology.

A. First Generation(1G)

The 1st generation was pioneered for voice service in early 1980‘s, where almost all of them were analog systems using the frequency modulation technique for radio transmission using frequency division multiple access (FDMA) with channel capacity of 30 KHz and frequency band was 824-894 MHz [6], which was based on a technology known as Advance Mobile Phone Service (AMPS). Through 1G, a voice call gets modulated to a higher frequency of about 150MHz and up as it is transmitted between radio towers. This is done using a technique called Frequency-Division Multiple Access (FDMA).In terms of overall connection quality, 1G compares unfavourably to its successors. It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties.However, 1G did maintain a few advantages over 2G. In comparison to 1G's analog signals, 2G's digital signals are very reliant on location and proximity. If a 2G handset made a call far away from a cell tower, the digital signal may not be strong enough to reach it. While a call made from a 1G handset had generally poorer quality than that of a 2G handset, it survived longer distances. This is due to the analog signal having a smooth curve compared to the digital signal, which had a jagged, angular curve. The carrier spacing of the channel was 25 to 30 kHz. Therefore the first generation system developed did not cater to the needs of all four kinds of information like voice, picture, data, and text [3].

Figure 3: 1G technology.

B. Second Generation (2G)

Second generation is based on GSM (Global System Module). It is launched in Finland in year 1991. This generation standards provide to the needs of all four types of information text, picture data and voice. Second generation 2G cellular telecom networks were commercially launched on the GSM standard. 2G technologies can be divided into Time Division Multiple Access (TDMA) based and Code Division Multiple Access (CDMA) based standards depending on the type of multiplexing used. Through this technology, a 2G network can pack more calls per amount of bandwidth as a 1G network. 2G cell phone units were generally smaller than 1G unit, since they emitted less radio power [3]. Next to 2G, 2.5G system uses packet switched and circuit switched domain and provide data rate up to 144 kbps. E.g. GPRS, CDMA and EDGE [9].

C. Third Generation (3G)

Third generation (3G) services combine high speed mobile access with Internet Protocol (IP)-based services. The main features of 3G technology include wireless web base access, multimedia services, email, and video conferencing. The 3G W-CDMA air interface standard had been designed for ―always-on‖ packet-based wireless service, so that computer, entertainment devices and telephones may all share the same wireless network and be connected internet anytime, anywhere [6]. 3G systems offer high data rates up to 2 Mbps, over 5 MHz channel carrier width, depending on mobility/velocity, and high spectrum efficiency. The data rate supported by 3G networks depends also on the environment the call is being made in; 144 kbps in satellite. 3G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. Services include wide area wireless voice telephony, video calls, and broadband wireless data, mobile television, GPS (global positioning system) and video conferencing [4] all in a mobile environment. Since 3G involves the introduction and utilization of Wideband Code Division Multiple Access (WCDMA), Universal Mobile Telecommunications Systems (UMTS) and Code Division Multiple Access (CDMA) 2000 technologies, the evolving technologies like High Speed Uplink/Downlink Packet Access (HSUPA/HSDPA) and Evolution-Data Optimized (EVDO) has made an intermediate wireless generationbetween3Gand4Gnamedas3.5Gwithimproved data rate of 5-30 Mbps [2].

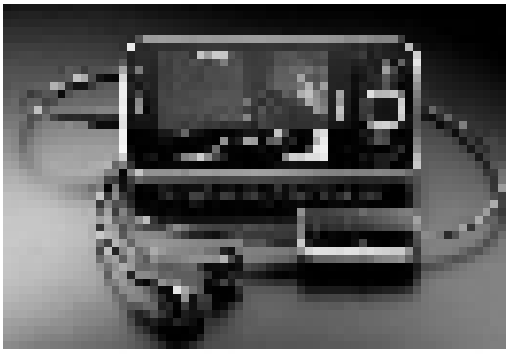

Figure 4: 3G mobile phone

D. 3.75 – HSUPA (High –speed uplink packet access)

The 3.75G refer to the technologies beyond the well defined 3G wireless/mobile technologies. High Speed Uplink Packet Access (HSUPA) is a UMTS / WCDMA uplink evolutiontechnology. HSUPA will enhance advanced person-to-person data applications with higher and symmetric data rates, like mobile e-mail and real-time peer to peer file sharing. Traditional business applications along with many consumer applications will benefit from enhanced uplink speed [4].

E. Fourth Generation (4G)

It is basically the extension in the 3G technology with more bandwidth and services offers in the 3G. The expectation for the 4G technology isbasically thehigh quality audio/video streaming over end to end Internet Protocol [3]. 4G is a conceptual framework and a discussion point to address future needs of a high speed wireless network. It is expected to emerge around 2010 – 2015. 4G should be able to provided very smooth global roaming universally with lower cost [10].A 4G system provides mobile ultra-broadband Internet access, for example to laptops with USB wireless modems, to smart phones, and to other mobile devices [8]. Two 4G candidate systems are commercially deployed: The Mobile Wi MAX standard, and the first-release Long term evolution (LTE) standard .

F. Fifth Generation (5G)

With an exponential increase in the demand of the users, 4G will now be easily replaced with 5G with an advanced access technology named Beam Division Multiple Access (BDMA) and Non- and quasi-orthogonal or Filter Bank multi carrier (FBMC) multiple access. The concept behind BDMA technique is explained by considering the case of base station communicating with the mobile stations. In this case an orthogonal beam is allocated to each mobile station and BDMA

technique will divide that antenna according to the location of the mobile stations for giving multiple accesses to the mobile stations, which correspondingly increased the capacity of the system [2]. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of telecommunications. The new coming 5G technology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future [3].

COMPARISON OF GENERATIONS

The comparison of all generations is shown in below table in which the 5G technology is up grading one when compared to other technologies[9]

Technology ▪ Features▮	1G	2G	3G	4G	5G
Start/development	1970-1980	1990-2004	2004-2010	Now	Soon (probably in 2020)
Data rate	2kbps	64kbps	2Mbps	1Gbps	10 to 50 Gbps. (expected)
Technology	Analog cellular technology	Digital cellular technology	CDMA 2000 (1xRTT, EVDO) UMTS, EDG	Wi-Max, LTE, Wi-Fi	Beam division multiple access(BDMA),filter bank multi-carrier(FBMC) multiple access
Service	Mobile telephony (voice)	Digital voice ,SMS,Higher capacity packetized data	Integrated high quality audio, video and data	Dynamic Information access, Wearable device	Ultra high definition video + virtual reality applications
Multiplexing	FDMA	TDMA,CDMA	CDMA	Orthogonal /single carrier frequency division	CDMA

				multiplexing (OFDMA/SCFDMA)	
Switching	Circuits	Circuit, packet	Packet	All packets	All packet
Core network	PSTN	PSTN	Packet network	Internet	Internet

.Table1: Comparison of all mobile generations

Future Prospective of 5G Communications

In the 5G system, each cell phone will have permanent "Home" IP address and "care of address" which represents its actual location. When a computer on the Internet wants to communicate with cell phone after that first, it sends a packet to the home address and subsequently server on home address send a packet to the actual location through the tunnel. Server also sends a packet to the computer to inform the correct address so that future packets will send on that address.5G network technology will reveal a new era in mobile communication technology. The 5G mobile phones will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. 5G technology offer high resolution for crazy cell phone user. 5G technology will provide supper and perfect utilization of cellular communication in future. We can monitor any place of the world from anywhere, observe space and watch TV channels at HD clarity in our mobile phones without any interruption

Conclusion

Mobiles are becoming the most essential requirement of human being nowadays. Their current development is the outcome of various generations. Every new technology has come to hide the drawbacks of previous one .In this paper we have focused on first, second, third, and fourth generations of mobile communication technology and predicted about 5G technology. 1G was based on analog signal and usually used for voice call only with speed up to 10kbps. The second generation is based on digital signal. In 2G one additional feature of text messaging is present in context to1G with a speed up to 64kbps. Further 3G is introduced, it is based on high broad band data. In comparison to 2G it is much better because of high speed than 2G and also because it provide digital navigation as well as video access. After 3G, 4G is introduced with HD. Multimedia streaming with speed up to 40mbps. Further we conclude that upcoming 5G technology will be the most important and fastest technology of wireless communication world.

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Efficient Browsing using ASR and TTS techniques on Google Chrome and Mozilla

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Abstract : Automatic speech reorganization and Text to speech are well known technologies for hands free browser. In these techniques browsers can be navigated using voice. There are several interface frameworks available for the said techniques.
The paper presents overview of techniques which can be used in ASR and TTS. Also the paper presents the architecture and methodologies which can be used in development of hands free browser.

Keywords : ASR, TTS, hands free browser

Introduction

Need of browser can be described as a browser which is using speech base interface. Visual browser are very common these days. Visual browser is not always practical, especially for the visually impaired persons. In the browser using ASR and TTS techniques, the command input and the delivery of web contents are entirely in voice. [10]

Technologies

For development of efficient browsing using ASR and TTS techniques on browser, lots of technologies were proposed. The methodology has been shown in the figure below.

Methodology

(1) Automated Speech Recognition (ASR) component is responsible for managing the associated application grammars and recognition state, and processing the spoken utterances, attempting to recognize the spoken utterances to a set of known valid inputs, which drive the flow and logic of the web application.
Text-to-Speech (TTS) component is responsible for turning textual output into synthesized audio that can be played back to the user as if it was spoken by a

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human. Text-to-speech is useful when dynamic content does not lend itself to pre-recording.

(2) Web browser is based on the HTML (Hyper Text Markup Language) and it support graphical user interfaces for example, by letting users format text and images. But it does not support voice user interfaces. For example, HTML doesn't standardize how speech recognition grammars and voice prompts are specified or how the steps in a dialog between a user and a digital person are sequenced.

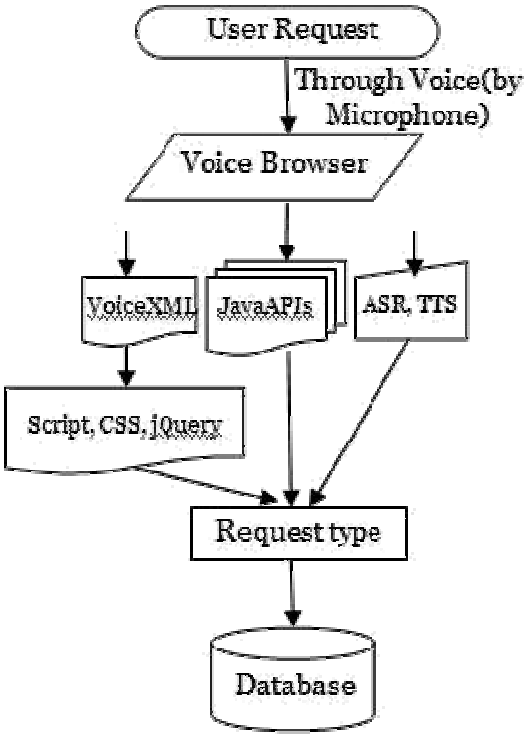

Figure 1: Methodology of efficient browsing using ASR and TTS Techniques on Browser

VoiceXML supports the following input forms: audio recording, automatic speech recognition, and touch-tone. Output may be prerecorded audio files, text-to-speech synthesis, or both.

(3) Java API enables developers of speech-enabled applications to incorporate more sophisticated and natural user interfaces that can be deployed on a wide range of platforms.

The Java Speech API defines a standard, easy-to-use, cross-platform software interface to state-of-the-art speech technology. Speech synthesizers and speech recognizers can be written in Java software. These implementations will benefit from the portability of the Java platform and from the continuing improvements in the execution speed of Java virtual machines.
The Java Speech API is an extension to the Java platform. Extensions are packages of classes written in the Java programming language (and any associated native code) that application developers can use to extend the functionality of the core part of the Java platform.

The Java Speech API is one of the Java Media APIs, a suite of software interfaces that provide cross-platform access to audio, video and other multimedia playback, 2D and 3D graphics, animation, telephony, advanced imaging, and more.

Architecture
"Efficient browsing using ASR and TTS techniques on browser" will be prepared in object oriented language with their overall impact on mankind would be mentioned and then recommendations for their improvement would be made.
Input will be provided by using phone or microphone that will interact with the client side application programming interfaces (APIs) and telephony application interfaces. These APIs use automatic recognition system. These interfaces will be used to convert speech to text and text to speech. So for the Speech Grammar Markup Language and Text to Speech Markup Language will be used.
The architecture of efficient browsing using ASR and TTS techniques on browser has been shown below.

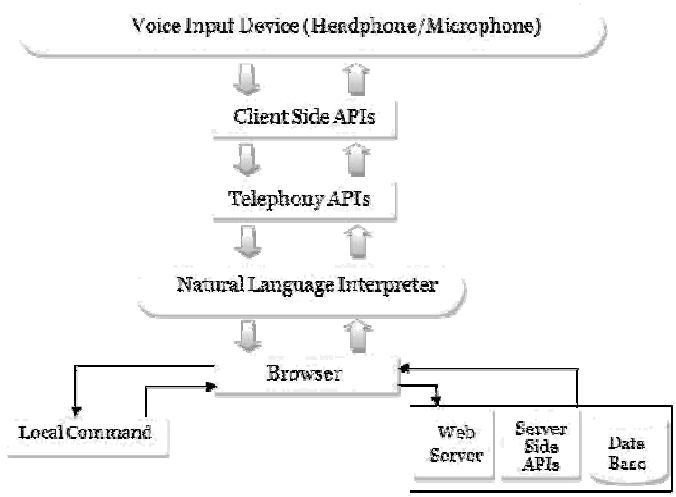

Figure 2: Architecture of proposed system

Traditional web browser is shown below

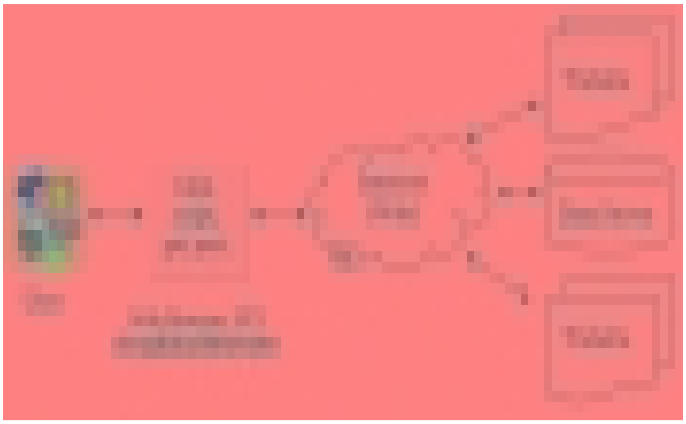

Figure 3: Traditional Browser

Efficient browsing using ASR and TTS techniques on browser is shown below:

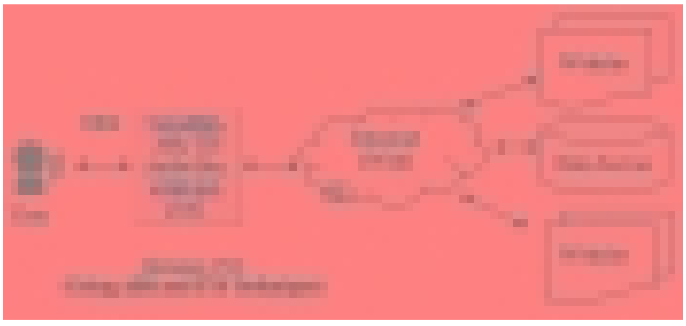

Figure 4: Efficient browsing using ASR & TTS techniques on browser

Expected Outcome

The proposed study will be useful in the social and technical aspects. It is expected that the proposed study will be helpful for upcoming researcher students and practitioner. Also the study will be useful various businesses in which the application of Hands Free Browser can be used.

The proposed study is off heavy public use and interest. This study might be taken as future era for IT industry. Till now there is only small work is done in this area and this area is having very huge scope in future.

In our study we are planning to investigate the pitfalls of the existing work in this area also we are planning to propose future technologies for voice recognition search engine. At the end of studies we will be having complete picture of this area with our own.

It is useful to enable such browsers to have hands free functionality to enable people to use them when their hands are occupied when driving or performing other tasks. It would be also useful for disabled or paralyzed people. So this is a better idea of the usability of such a browser.

Compare between traditional web browser and efficient browsing using ASR and TTS techniques on Browser.

Sr. No.	Browsing with Web Browser	Browsing using ASR and TTS techniques on browser
1.	Audio input is supported by browser for searching only not browsing.	Audio input/output is supported by browsers for browsing with using ASR and TTS techniques.
2.	"Hands busy situation" is not handled by the web browser. If hands are occupied or performing other task than browsing cannot be done.	"Hands busy situation" is easily handled. If hands are occupied or performing other task than browsing can be done easily.
3.	Next generation are wearable devices like smart watches, health bands, headsets so web browser would not become a reality and usable for them.	This is viewed for the future. With the advent of a wide variety of wearable devices including smart watches and health bands and headsets, such a browser can become a reality. It will be a boon.
4.	A major barrier to usability of these mobile platform is their user interface. Because of their small form factor, tiny keypads or small styluses are typically used today, and text input is inconvenient, especially when searching for information.	Speech provides a compelling solution. Next generation of mobile devices will include a multi-modal user interface with speech used for data entry. using voice input is simply more fun than the alternatives.
5.	Web browser is used as a Graphical User Interface (GUI) with Interaction display, keyboard, mouse. Instruction or input is given by clicking mouse button or keyboard key press to computer.	Proposed system is used as a Voice User Interface (VUI) with interaction audio input, audio output, and keypad input. Instruction is given by voice to computer.

Table 1: Compare between web browser and browsing using ASR and TTS techniques on Browser.

Conclusion

This paper presented general overview of browsing using ASR and TTS techniques. The paper presents various technologies which are useful for development of the hand free browser system. Even after a huge need of it in social and business

aspects still the hand free browser are not very common in use. Still the work is going on for betterment of these technologies.

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Application of Automated toll collection in ITS (Intelligent transportation system)

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Abstract : Today a large portion of the toll charges are gathered physically in significant parts of our nation. Electronic Toll Collection (ETC) is an innovation that takes into consideration electronic instalment of tolls. A so on framework can figure out whether a vehicle is enlisted in a toll instalment project, alarms implementers of toll instalment infringement, and charges the taking an interest record. Toll charges are for the most part focused around mileage, support necessities, or blockage levels. In this paper a framework comprises of a transponder (label), spectator/journalist, radio wire, and machine host. Under this each client will gave an exceptional card and watchword. At the point when client goes under the extent of RF card then he needs to enter the legitimate secret key. On the off chance that secret word matches then he will be permitted to enter else not. With the end of human communication in the whole toll accumulation process, we can make a better ETC framework. It can likewise essentially enhance the proficiency of toll stations and the movement capabilities of the toll street.

Keywords : Workstation, transponder, spectator

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Introduction

Electronic toll collection (And so on) is an engineering empowering the electronic collection of toll installments. This system is fit for figuring out whether the auto is enrolled or not, and after that advising the powers of toll installment infringement, charges, and partaking records. Thus exploratory following and observing system turns into a need of the toll charge division. So under this the system comprises of a transponder (label), spectator/essayist, reception apparatus and workstation host. Under this every client will be given exceptional card and watchword. At the point when a client goes under the reach of RF card then he need to enter the substantial secret key. On the off chance that secret word matches then he will be permitted to enter else not. The most evident point of interest of this engineering is the chance to dispose of clogging in tollbooths, particularly throughout happy seasons when movement has a tendency to be heavier than ordinary. Programmed toll charge

collections are much better than manual collection.[1] Few favourable circumstances of And so forth are:

1. Speedier and more proficient administration (no trading toll charges by hand).
2. Decrease of toll administration expenses and money free comfort for drivers.
3. The utilization of post-paid toll articulations (no compelling reason to ask for receipts). Other general points of interest for the drivers incorporate fuel investment funds and diminished versatile discharges by diminishing or dispensing with deceleration, holding up time, and quickening. Along these lines, the And so on system is a win-win circumstance for both the drivers and toll administrators. A complete RFID system comprises of a transponder (label), onlooker/essayist, radio wire, and workstation host. The transponder, also called the tag, is a microchip joined with a radio wire system in a smaller bundle. The microchip holds memory and rationale circuits to accept and send information again to the spectator. These labels are named either dynamic or aloof labels. Dynamic labels have interior batteries that permit a more extended perusing reach, while aloof labels are controlled by the sign from its followers and consequently have shorter perusing reach. An onlooker holds a reception apparatus to transmit and accept information from the tag. The spectator additionally holds a decoder and a RF module. It could be mounted or assembled as a convenient handheld gadget. The workstation host goes about as an interface to an IT stage for trading data between the RFID System and the end-client. This host system then changes over the data acquired from the RFID system into valuable data for the end-client.

Background Overview

A. EXISTING SYSTEM

There are two methods for gathering toll duty being in practice at present. First and foremost is the conventional manual technique where one man gathers the cash and issues a receipt. The other one is Shrewd
Card system where the individual needs to demonstrate the keen card to the system introduced at the toll charge
Terminal to open the hindrance [2].

B. DRAWBACKS OF EXISTING SYSTEM

Both the above mentioned method for collecting toll tax is time consuming method. Chances of escaping the payment of toll tax are there. It leads to queuing up of following vehicles.

C. PROPOSED SYSTEM

Every vehicle will be given by a RF TX label holding a remarkable ID. This tag will ceaselessly transmit RF signs. At the point when the vehicle will arrive at the toll corner the RF beneficiary will locate these RF signs. The signs are intensified and are gone to microcontroller. This microcontroller will show the id on LCD. Presently, with the assistance of PC interface unit the information
gathered is gone to PC through serial port. Programming created will demonstrate all the insights about the vehicle on the screen. Points of interest like date, time and

id will be put away in the right to gain entrance database. Taking into account these points of interest a report will be ready.[3] At the end of the month the system will print the definite bill and the aggregate sum of the toll charge for the month will likewise be printed. This bill will be sent to the client for installment.

Need of Automatic Toll Tax Collection In Developing

Country like India

In nation like India where greatest of the toll is gathered physically, the programmed toll collection is of incredible significance. It spares the time as well as the cash. The programmed toll collection is far superior to manual collection, in this exploration paper I present a straightforward numerical dissection to demonstrate it. Considering the present toll collection system where every vehicle need to stop and pay charges. Assume the manual toll collection system is extremely productive then for one vehicle to stop and pay charges aggregate time taken is 60 seconds. What's more assume 100 vehicles cross the toll square. At that point, time brought by 1 vehicle with 60 second Normal stop in a month is: 60x30= 1800 seconds Yearly aggregate time taken = 1800x12 = 216200seconds = 6.0 hours On normal each one vehicle that passes through the toll square need to hold up 6.0 hours in motor begin condition subsequently helping contamination and squandering fuel and cash[4]. Hence Programmed toll charge collections are obviously better than manual collection. Assume, If there are 100 manual toll-charges system and ordinary 100 vehicles cross through each system, then No of vehicle that pass through one system yearly= 100 x 30 x 12 = 36,000.
No of vehicle that pass through 100 system yearly= 100 x 36,000 = 36, 00,000.

Working

The E-Z Pass electronic toll collection works like this. Customers utilize an electronic "tag" (transponder) about the extent of a sound tape which is joined to a vehicle's inside windshield, as a prepared vehicle approaches a toll line, a receiving wire in the path peruses the purchaser's vehicle and record data implanted in the tag. Utilizing high recurrence radio waves, the innovation sends the data to an in-path machine that checks the information against a database of legitimate labels and dynamic records, deducts the proper toll from the client's account, and supports entry or raises a tollgate to permit the vehicle to pass through the toll plaza. Each worker's tag transmits an indicator appointed particularly to him or her. This empowers the worker's utilization of all And so forth prepared offices to be followed and logged. And so on clients set up a prepaid record which is charged for each one utilization of a prepared roadway, scaffold, or passage. (The labels are especially worthwhile to armada administrators who overall would need to development money to drivers for tolls or participate in time intensive money repayment.) Each one tag holds an recognizable proof number, information recognizing the issuing organization, label sort, a depiction of the vehicle, also other organization particular information. The label ID, organization ID, and label sort are encoded by the seller also can't be adjusted. The tag is focused around perused

compose engineering equipped for putting away parkway passage and passageway focuses for toll figuring's in shut systems (i.e., where the toll is focused around separation voyaged). Vehicle horrible weight for toll counts focused around weight or for checking most extreme expressway weight additionally could be acquired. Since the personality of And so forth prepared vehicles might be perused while vehicles are in movement (up to 40 mph), And so on guarantees to dispose of long activity reinforcements at toll squares, created by drivers halting to pay the toll physically[5] .A RFID tag is a little protest that might be joined to or fused into an item, creature, or individual. RFID labels hold silicon chips and radio wires to empower them to accept and react to radio-recurrence inquiries from a RFID transceiver. Uninvolved labels oblige no inward power source, although dynamic labels oblige a force source. The motivation behind a RFID system is to empower information to be transmitted by a cell phone, called a label, which is perused by a RFID spectator and prepared as per the needs of a specific application. The information transmitted by the label may give distinguishing proof or area data, on the other hand specifics about the item labelled, for example, value, colour, date of procurement, and so forth. In a common RFID system, individual items are furnished with a little, reasonable tag. The tag holds a transponder with a computerized memory chip that is given a novel electronic item code. The investigative specialist, a reception apparatus bundled with a transceiver and decoder, transmits an indicator actuating the RFID label so it can read and compose information to it. At the point when a RFID label passes through the electromagnetic zone, it locates the onlooker's actuation indicator. The onlooker deciphers the information encoded in the label's coordinated circuit (silicon chip) and the information is gone to the host machine.

Privacy Implications of Existing Tolling Practices

A. UNIQUE IDENTIFIER TAGS

With electronic monetary transactions, the record to be charged must be particularly distinguished. In the instance of ETCS, this special recognizable proof is accomplished by doling out the RFID tag to transmit a exceptional identifier at toll gantries which is then matched against a record a while ago set up by the label client and the toll supplier. The toll supplier is not intrigued by which specific vehicle was conceded section as long as the right toll expense is charged.

B. EXTENDED DATA RETENTION

And so on operations bring about transactional information which is put away with the end goal of receipt era. This information may be put away for a time of up to seven years regardless of the possibility that a supporter ends an agreement prior to that time (Wander E-Tag, 2007). While the necessity for information
maintenance may be simply lawful or duty related, the allurement to utilize it for optional reasons would
be so incredible it is not possible stand up to, also seven years is sufficient time to empower 'capacity creeps'. In tolling connections, once a bill has been paid for,

information identified with that transaction, or in any event, recognizable proof data including the area where the toll occasion happened ought to be cleansed. Amplified information maintenance conveys noteworthy dangers for all stakeholders since the likelihood of information trade off can't be precluded, whether this is performed by an authentic client for illegitimate utilizes, or by illegitimate programmers with points of filtering data about drivers [6]. These situations can result in conceptual misfortunes e.g. notoriety and maligning to budgetary ramifications e.g. Visa burglary and government fines for related information breaks.

C. FUNCTION CREEP

Capacity web blanket implies that data gathered for a specific reason additionally winds up serving other unnecessary purposes. An intriguing auxiliary application focused around tolls has been utilized to
foresee how congested current streets are. An outsider application mirrors the correspondence trade that a toll corner would request from a transponder, and endeavors this defenselessness to manufacture a system of RFID book fans introduced on different segments of the thruway. The results are then used to figure the normal movement speed on each one stretch of street, and are
made accessible in close ongoing on a site for drivers to arrange their voyages (Houston Transtar, 2008). While this application may be a gift for drivers who can get access to street conditions before setting out, it can additionally turn into a genuine danger as there exists powerlessness to misapply by people with malevolent purpose by utilizing it as a reconnaissance gadget.

Features

ATCS is a programmed collection system utilized for gathering assessment naturally. In this we do the ID with the assistance of radio recurrence. Adaptability is the principle characteristic and with the scarcest change this could be changed over to a totally new execution.[7] With the assistance of the most recent engineering (RFID), the usage of this undertaking is extremely streamlined. RFID innovation together with an extremely secure database yields into an exceedingly effective and secure system. Emulating are the gimmicks and headway of ATCS over without further ado existing system:]

[1] RFID tag can't be cloned, so can't be bamboozled.
[2] Extremely proficient sparing of time.
[3] Wastage of cash decreased.
[4] Utilization of oil is decreased.
[5] Contamination is decreased to a substantial degree.
[6] Fast transport.
[7] Less clogging on the roadways.
[8] Relatively less support cost

Related Work

The ETC system is currently being used throughout the world. In the United States alone, various states have implemented an ETC system called E-Z Pass. Other

countries that have applied the ETC system are Canada, Poland, the Philippines, Japan and Singapore, among many others.

Scope & Applications

[1] Automated Vehicle Identification
[2] Automated Vehicle Classification
[3] Transaction Processing (Toll Calculation)
[4] Can be used to trace the vehicle if this system is centralized.

Conclusion

In this article, we have examined about Electronic toll collection utilizing RFID engineering. RFID is definitely not substitution of Standardized tag however it is an innovation offering different peculiarities. RFID offers exceedingly dependable information collection in merciless situations. RFID engineering can give new proficiencies and in addition a proficient technique to gather, oversee, scatter, store, and dissect data It not just disposes of manual information passage additionally moves new computerization results. It in a far-reaching way changes how techniques are overseen what's more how organizations work. RFID's characteristics give more noteworthy computerized following ability than existing advances, and in this manner make the chance to lessen loathe, enhance stockadministration and produce better market knowledge, prompting lower operational expenses and expanded income era

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Wind Energy- A Renewable Source

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Abstract : Energy is the most essential element of socio-economic development and nation's economic growth. Renewable energy sources can play an immense role to fulfill this need of energy. These sources will not only enhance independency of energy but also helps in many ways such as mitigation of climate change, swift development of rural areas, improved health status and will be the best way to move towards sustainable development. Renewable energy sources like wind energy are identified by International Energy Agency as key element to reduce fossil fuels dependency and helpful tool to combat global warming. Wind energy is indeed a form of solar energy produced by differential heating on the earth surface. Wind's kinetic energy can be captured and converted in to electricity via wind turbines. In this paper, the status of wind energy is explored in Indian context. The state wise status, different challenges, issues, barriers, wind power development (on and offshore) and policies are discussed in detail

Keywords : Energy, Renewable energy, Transformers, **Sweep area, Turbine**

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Introduction

Energy means, capacity to do work. It has different meaning in different field, for example-

In physics, energy is a property of objects which can be transferred to other objects or converted into different forms.

In chemistry, chemical energy is the potential of a chemical substance to undergo a transformation through a chemical reaction to transform other chemical substances. Examples include batteries, food, and gasoline.

Why We Need Energy

- Energy is an essential part of our daily lives.
- We use energy to heat and cool our homes, schools and businesses.
- We use energy for lights and appliances. Energy makes our vehicles go, planes fly, boats sail, and machines run.

All living things need energy too. Plants use the light from the sun to grow. Animals and people eat the plants and use the energy that was stored. Food is fuel for our bodies' energy needs like muscle power.

We also use our own bodies to make heat energy. When you have been running or working really hard, your body produces heat energy. When you wear clothing like a jacket in the winter, it holds in that heat energy and keeps you warm

What is the Energy Crisis?

The energy crisis is the concern on the world's demands on the limited natural resources that are used to power industrial society are diminishing as the demand rises. These natural resources are in limited supply.

The energy crisis is a broad and complex topic. Most people don't feel connected to its reality unless the price of gas at the pump goes up or there are lines at the gas station. The energy crisis is something that is ongoing and getting worse, despite many efforts. The reason for this is that there is not a broad understanding of the complex causes and solutions for the energy crisis that will allow for an effort to happen that will resolve it.

Types of Energy sources

Renewable energy sources

Resources that are naturally regenerative or are practically inexhaustible, such as biomass, heat (geothermal, solar, thermal gradient), moving water (hydro, tidal, and wave power), and wind energy. Municipal solid waste may also be considered a source of renewable (thermal) energy.

Definition of Wind Energy

"The energy of wind converted into useful form (usually electric current) is called wind energy". Wind energy is a Renewable energy source. Once used can be replaced.

Wind energy is the kinetic energy of air in motion, also called wind. Total wind energy flowing through an imaginary surface with area Aduring the time t is:

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(Avt\rho)v^2 = \frac{1}{2}At\rho v^3,$$

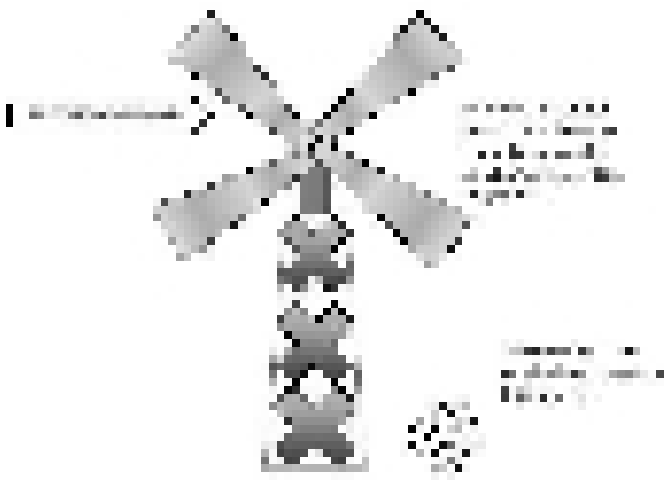
Where ▪ is the density of air; v is the wind speed Avt is the volume of air passing through A (which is considered perpendicular to the direction of the wind); Avt ▪ is therefore the mass m passing through "A". Note that ½ ▪v^2 is the kinetic energy of the moving air per unit volume.

Power is energy per unit time, so the wind power incident on A (e.g. equal to the rotor area of a wind turbine) is:

$$P = \frac{E}{t} = \frac{1}{2}A\rho v^3.$$

Wind power in an open air stream is thus proportional to the third power of the wind speed; the available power increases eightfold when the wind speed doubles. Wind turbines for grid electricity therefore need to be especially efficient at greater wind speeds.

It is a machine which converts the energy of wind to rotational energy with the help of large blades attached to it. The windmills are also used for lifting the ground water.



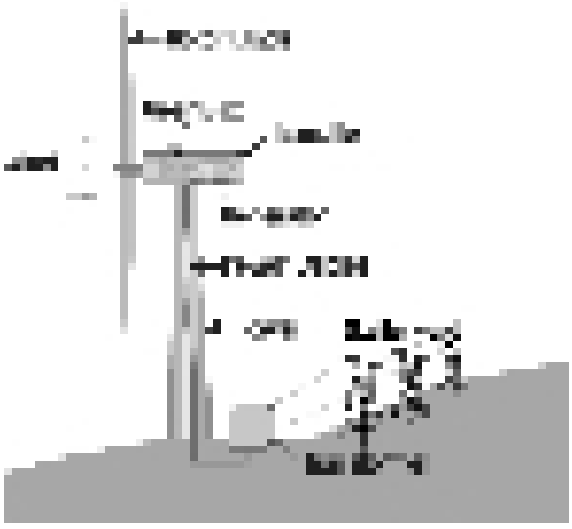
With technology getting to the next level, one can observe a notable improvement in renewable resources across the globe and one of the most imperative is the Wind Energy. On a larger and commercial scale, governments have been working on making wind energy a reliable and constant source of energy; giving a hint of relaxation to hydro and thermal sources. Wind Energy is effective and efficient

which surely makes it a reliable factor in the coming years. So, let's explore the wind energy pros and cons and how it can actually help you reduce your energy bills and increase your energy efficiency at your home and office.

General Process

The basic structure showing the wind energy process and how actually the wind turbine works is shown in the following diagram.

The diagram above shows the basic wind turbine which actually moves when the wind flows moving a gear box as well. The generator then converts this mechanical energy into electrical energy and with the help of power cables. The energy is then stored in transformers. Finally, it is transmitted to your homes by a channel of electric lines; stepping-down the voltage at every stage till it reaches your homes.



The wind energy plant should be placed in wide open areas where one can expect maximum wind exposure mostly in meadows and fields near seas. Wind energy plants may also be fixed within the sea maximizing both wind and tidal energy. This produced a considerable amount of energy.

Wind plants that are placed offshore have immense advantages, which are beyond the sea breezes. The seabed is relatively cheaper and since the ocean is not exactly prime real estate, much larger wind farms can be built there without citizens fussing over aesthetics.[1] It also helps bringing the costs down, which is a big positive on a large scale.

Measurement of power produced by wind turbine

Air density

Denser air is better. Cool air is denser than warm air, dry air is denser than moist air, and air near sea level is denser than air at the tops of mountains. At any given location, the actual air density can vary by an average of 16% from day to day and throughout the year.

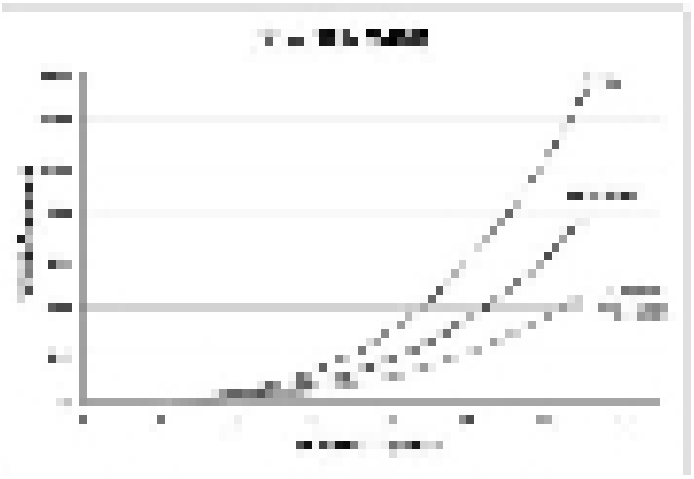
Sweep area

This is the circular area for a HAWT type turbine or the Height x Width area for a VAWT type turbine. The larger the sweep area, the more wind power that can potentially be captured.

Wind Speed

Wind power increases by the cube of the wind speed. This is very important to understand. The wind power at 10 mph with a given rotor size might be 100 watts but at 20 mph will be 800 watts. As the wind speed doubles, the wind power goes up by a factor of 8. The basic wind power formula is:

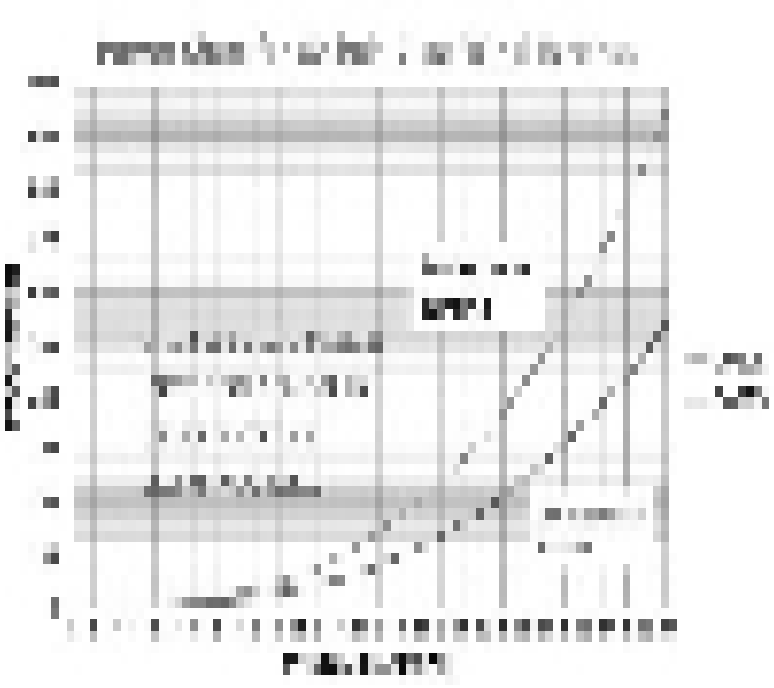
Power (watts) = Power (watts) = 1/2 x the density of air x the sweep area x wind speed3



1/2 x the density of air x the sweep area x wind speed3

The next consideration is called Coefficient of Performance (C_p). Sometimes this is referred to as efficiency. It is simply the percent of wind power that a given turbine is able to deliver.

In 1919, a German physicist named Albert Betz determined that no machine could achieve a $C_p > 59.3\%$. This is referred to as "Betz' Law" or the "Betz Limit". Most modern large turbines with variable pitch rotor blades are able to achieve a 40-45% C_p in 10-35 mph winds, while fixed pitch blades achieve usually between 15-35% C_p in similar winds. This C_p takes into account the combined efficiency of the blades and the generator.



Let's compare the power produced for a given rotor size (sweep area) at various Cp levels to see what can be expected for performance. The example we share here is for a typical 5-foot diameter turbine.

Blades
Well designed and made from either wood, metal, or advanced composite. They are stiff, strong, and quiet. They are contoured to produce lift and are well balanced as a set. Blades that bend, vibrate, or twist are relatively inefficient, falling to less than a Cp of 10% in high winds.

PMA
Well matched to the rotor size and blade performance (RPM vs. wind speed). They are purpose-built rather than salvaged from some other application (i.e.: automobiles or ceiling fans). They have low winding resistance (ohms), no cogging, and are sealed from the weather to prevent rusting and bearing wear.

Tail design
Properly sized and positioned to allow good tracking of the wind. If tracking is poor, either due to the yaw action being too stiff, or the turbine hunting for the

correct direction to point, performance will suffer. Read our article on proper tail design considerations.

Wind power and development in India

The development of wind power in India began in the 1986 with first windfarms being set up in coastal areas of Maharashtra (Ratnagiri), Gujarat (Okha) and Tamil Nadu (Tuticorin) with 55 kW Vestas wind turbines. These demonstration projects were supported by MNRE. The capacity has significantly increased in the last few years. Although a relative newcomer to the wind industry compared with Denmark or the United States, India has the fourth largest installed wind power capacity in the world. In 2009-10 India's growth rate was highest among the other top four countries.

As of 31 March 2016 the installed capacity of wind power in India was 26,743 MW, mainly spread across South, West and North regions. East and North east regions have no grid connected wind power plant as of March, 2015 end. No offshore wind farm utilizing traditional fixed-bottom wind turbine technologies in shallow sea areas or floating wind turbine technologies in deep sea areas are under implementation. However, an Offshore Wind Policy was announced in 2015 and presently weather stations and LIDARs are being set up by NIWE at some locations.

The worldwide installed capacity of wind power reached 435 GW by the end of 2015. China (148,000 MW), US (74,347 MW) and Germany (45,192 MW) are ahead of India in fourth position.

Monthly Electricity Generation

Wind power accounts nearly 8.6% of India's total installed power generation capacity and generated 28,604 million Kwh (MU) in the fiscal year 2015-16 which is nearly 2.5% of total electricity generation. The capacity utilization factor is nearly 14 % in the fiscal year 2015-16 (15% in 2014-15). 70% of wind generation is during the five months duration from May to September coinciding with Southwest monsoon duration.

Month	North	West	South	East	North East	Total (MU)
April, 2015	331	859	338	-	-	1,528
May, 2015	373	1,265	924	-	-	2,562
June, 2015	348	1,342	2,030	-	-	3,720

Month	North	West	South	East	North East	Total (MU)
July, 2015	510	2,527	3,122	-	-	6,157
August, 2015	472	1,605	2,328	-	-	4,405
September, 2015	319	792	1,344	-	-	2,455
October, 2015	307	414	393	-	-	1,113
November, 2015	250	734	414	-	-	1,061
December, 2015	156	801	522	-	-	1,480
January, 2016	149	462	553	-	-	1,164
February, 2016	220	728	463	-	-	1,411
March, 2016	293	830	425	-	-	1,548
Total (MU)	3,728	12,359	12,856	-	-	28,604

ReGen THE BIGGEST WIND ENERGY MENUFACTURING COMPANY OF INDIA

ReGen is the fastest growing Wind Energy Company in India in just 7 years of commissioning its state of the art manufacturing facility at Tada, Andhra Pradesh.

ReGen is making a huge contribution to meet India's electricity demand with largest market share in the Independent Power Producers sector

ReGen Powertech (ReGen) is one among the largest manufacturer of multi megawatt direct drive (gearless) WECs with permanent magnet technology in Indian market and provides full turnkey installations for wind power projects. ReGen has a technology licence agreement with Vensys of Germany for 1.5 MW / 2.5 MW and 3 MW synchronous permanent magnet gearless turbines. The permanent magnet generators are manufactured at the state of the art facility at Tada, Andhra Pradesh with a capacity to manufacture 500 WECs per annum

ReGen has emerged as the largest player with the cumulative Installed capacity exceeding 1.8 GW as on Oct. 2015 which includes 45 MW in Sri Lanka. ReGen's growth over the last five years is over 100% CAGR.

Advantages

1. The wind is free and with modern technology it can be captured efficiently.
2. Once the wind turbine is built the energy it produces does not cause green house gases or other pollutants.
3. Although wind turbines can be very tall each takes up only a small plot of land. This means that the land below can still be used. This is especially the case in agricultural areas as farming can still continue.
4. Many people find wind farms an interesting feature of the landscape.
5. Remote areas that are not connected to the electricity power grid can use wind turbines to produce their own supply.

Disadvantages

1. The strength of the wind is not constant and it varies from zero to storm force. This means that wind turbines do not produce the same amount of electricity all the time. There will be times when they produce no electricity at all.
2. Many people feel that the countryside should be left untouched, without these large structures being built. The landscape should left in its natural form for everyone to enjoy.
3. Wind turbines are noisy. Each one can generate the same level of noise as a family car travelling at 70 mph.
4. Many people see large wind turbines as unsightly structures and not pleasant or interesting to look at. They disfigure the countryside and are generally ugly.
5. When wind turbines are being manufactured some pollution is produced. Therefore wind power does produce some pollution.
6. Large wind farms are needed to provide entire communities with enough electricity. For example, the largest single turbine available today can only provide enough electricity for 475 homes, when running at full capacity

The Future Is Now

In the near future, wind energy will be the most cost effective source of electrical power. In fact, a good case can be made for saying that it already has achieved this status. The actual life cycle cost of fossil fuels (from mining and extraction to transport to use technology to environmental impact to political costs and impacts, etc.) is not really known, but it is certainly far more than the current wholesale rates. The eventual depletion of these energy sources will entail rapid escalations in price which averaged over the brief period of their use -- will result in postponed actual costs that would be unacceptable by present standards. And this doesn't even consider the environmental and political costs of fossil fuels use that are silently and not-so-silently mounting every day.
The major technology developments enabling wind power commercialization have already been made. There will be infinite refinements and improvements, of course.

The eventual push to full commercialization and deployment of the technology will happen when the consequences of climate change are finally recognized and admitted.

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Plastic & E-Waste Management Strategies

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Abstract : Plastic, and electronic waste is currently the largest growing stream in most of the countries. The increase in production of plastic materials and electronic goods and their rapid obsolescence has resulted in generation of e-waste. Every year around 50 million tones of electrical and electronic waste and plastic are generated worldwide, which could bring serious risk to human life and the environment. The European Union (EU), Japan, Taiwan and several states of USA have introduced legislation making producers responsible for their end-of-life products. In India the e-waste generation is more than 8 lakhs tones in the year 2012. The e-waste generated in few countries across the world show an alarming picture. This paper reveals the current scenario of plastic and e-waste generation in the world and India and the various work done in e-waste recycling. Mechanical recycling and chemical recycling are the two main types of recycling processes widely adopted by several manufacturers. Mechanical recycling involves separation of various types of plastics shredding them into small pieces and reprocessing it using an extruder and converted into pellets. Chemical recycling mainly involves depolymerisation and unzipping of molecular level constituents which are subsequently processed and converted into petro products.

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Introduction

Plastic or e-waste is a collective name for discarded electronic devices that enter the waste stream or nearing the end of their "useful life". It consists of obsolete electronic devices such as computers, monitors and display devices, telecommunication devices such as cellular phones, calculators, audio and video devices, printers, scanners, copiers and fax machines besides household equipments such as refrigerators, air conditioners, televisions and washing machines.

New technologies are rapidly superseding millions of analogue in prescribed landfills despite potentially their adverse impacts on the environment. The

consistent advent of new designs, smart functions and technology during the last 20 years is causing the rapid obsolescence of manyelectronic items. The life span of many electronic goods has been significantly shortened due to advancements in electronics, attractive consumer designs, marketing and compatibility issues, for example the average life span of a new computer has decreased from 4.5years in 1992 to 2 years in 2005 and is further decreasing .

The biggest concern with e-waste is the presence of toxic materials such as lead, cadmium, mercury and arsenic, toxic flame-retardants, printer cartridge inks and toners that pose significant health risks. These components can contaminate soil, groundwater and air, as well as affect the workers of the recycling units and the community living around it. The huge range and complexity of component materials in e-products makes it difficult and expensive to dispose or recycle them safely.

The Concept

The global market for electrical and electronic products continues to accelerate, while the lifespan of the products is dropping, resulting in a corresponding explosion in electronic scrap [4]. Eco-designing of products, source reduction, close-loop recycling are potential options to reduce the e-waste stream. Designers could ensure that the product is built for re-use, repair and/or upgradeability. Stress should be laid on use of less toxic, easily recoverable and recyclable materials which can be taken back for refurbishment, remanufacturing, disassembly and reuse. Recycling and reuse of materials are potential options to reduce e-waste. Recovery of metals, plastic, glass and other materials reduces the magnitude of e-waste. These options have a potential to conserve the energy and keep the environment free of toxic material that would otherwise have been released.

Characterization

A. Categorization of E-Waste

Category of e-waste is very diverse and complex. More than 1000 substances are present the e-waste which are classified as the hazardous and non-hazardous substances.

B. Global View on E-Waste

As the fastest growing component of municipal waste across the world, it is estimated that more than 50 MT of e-waste is generated globally every year. In other words, these would ill enough containers on a train to go round the world once.

C. Quantum of E-Waste In India

In India, most of the operations related to e-waste such as collections, segregation, dismantling, recycling and disposal are performed manually. Figure 1 reveals the trend in growth of e-waste in India is steadily increasing . According to the Comptroller and Auditor- General¬Ís (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medicalwaste, 48 MT of municipal waste are generated in the country annually.

D. Environmental Management of E-Waste

Collection center -

Collection of e-waste is prime importance for environmentally sound management of e-waste. Collection center is a store or warehouse where the e-waste are collected and stored safely for necessary channelization for dismantling and recycling.

Collection points are designated at various places like residential areas, office complexes, commercial complexes, retail outlets etc to channelize the e-waste to dismantler. The e-waste collected through these points are send to the collection centres.

Mobile collection bins can also act as collection systems for door-door collection of e-waste or from institution/individuals/small enterprises and send for dismantling and recycling.

The major criteria for setting up the collection centers are:

- The collection, transportation, storage and handling of E-Waste in the collection centres has to be done carefully without breaking the end of life equipments**.**

  The space used for collection centre has to be clearly demarcated from the space meant for new goods.
- The storage capacity of any collection centre should be commensurate with available area, volume of operations (in weight) and type of E-waste.
- Covered shed/spaces may be used for storage of e-waste generated from IT and Telecommunication equipments.
- Open space can be used for storage of refrigerators/washing machines/air conditioners.

E. Environmentally Sound Dismantling and Recycling of E-Waste

The e-Waste comprising of IT &TE including TVs can contain up to 60 different elements of which some are valuable, some are hazardous/toxic and some are both. Printed Circuit Board (PCB) commonly called as motherboard or printed wire board (PWB) contains a complex mix of elements and needs a very careful handling for recovery of precious metals and for minimizing impact on the environment during recovery process. The electrical and electronic equipments require very large amounts of non-ferrous/precious/semi-precious metals and are among the major contributors to the demand for non-ferrous/precious/semi-precious metals in the world. The substances within the components of electrical and electronic equipment which have adverse impact on the environment are lead, mercury, cadmium, chromium (VI), halogenated substances (CFCs), polychlorinated biphenyls and poly-brominated di-phenyl ethers. Plastics and Printed circuit board contains brominated flame retardants (BFRs). BFRs can give rise to dioxins and furans during incineration. Recoveries of these non-ferrous/precious/semi-precious metals from e-waste, if not done in a scientific and environmental friendly manner, will result in large emissions of hazardous substances into the environment. In view of this, environmentally sound recycling of e-waste is a must. Environmentally sound recycling with best available technology will lead to efficient recovery of non-

ferrous/precious/semi-precious metals and will have low greenhouse gas emissions compared to extraction of these metals from ores. Urban mining of e-waste and recoveries of nonferrous/ precious/semi-precious metals needs significantly low energy compared to recoveries from ore.

F. Dismantling

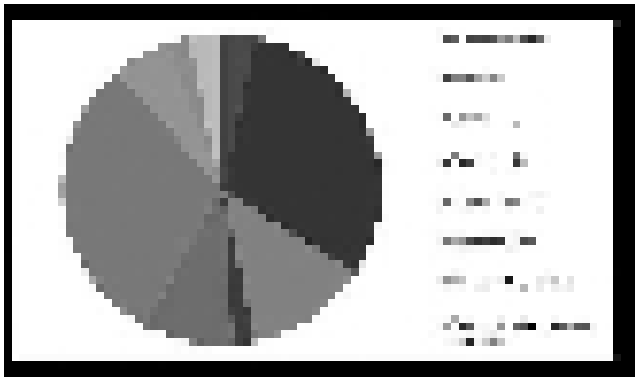
Dismantling operations are a dry process that may cover the following operations;

- The first step is to decontaminate E-waste and render it non-hazardous by separating hazardous components and materials. Hazardous electronic components such Hg switches, Poly Chlorinated Biphenyl (PCBs) etc. can be recovered and sent to TSDFs for treatment and disposal. In case of refrigerators and air conditioners, the refrigerant gases such as chlorofluorocarbon (CFCs), hydro chlorofluorocarbons (HCFCs) etc. can be collected by using gas recovery equipment for their recovery and storage. The refrigerant gases may be re-used or may be disposed by thermal destruction adopting any of the following options;
  i. By incineration in existing common HW incinerators.
  ii. By co-processing in cement kiln
  iii. By plasma destruction
- Manual dismantling can be carried out over the dismantling table with space de-dusting hoods connected with bag dust collectors venting out through a chimney of 3 meter above roof levels so as to maintain desirable work zone air quality as per the Factories Act 1948. Collection boxes with adequate capacity in sufficient number should be placed near dismantling table for keeping the dismantled components. The workers involved in dismantling operation should have proper equipment for dismantling the e-waste.
- Mechanized dismantling shall comprise of physical separation after opening the material by manual or semi-mechanical operations or directly feeding into a crusher (attached with bag dust collectors) to crush the wastes into fragments that will be segregated on a moving belt by manual collection. Fine grinding, Wet grinding, gravity separation / magnetic/density/eddy current/electromagnetic separators shall not be employed by dismantlers.
- Dismantling operations shall not include Fine grinding / wet shredding / wet grinding operations. Dismantling operations shall not be permitted for chemical leaching or heating process or melting the material. Dismantlers shall not shred segregated LCDs.
- Dismantler shall have adequate facilities for disposal of bag filter residue and floor cleaning dust in secure manner or shall obtain membership with TSDF for safe disposal.
- Dismantlers can be permitted shredding or cutting of printed circuit boards not below the size of 20mm which have to be handled by employing minimal manual handling and with adequate air pollution control systems.

- Dismantled circuit boards, CRTs, capacitors, batteries, capacitors containing PCBs (Polychlorinated biphenyls) or PCTs (Polychlorinated ter phenyls) etc shall not be stored in open.
- The dismantling operation shall not discharge any process wastewater except workers utilities and re-circulated machine cooling water.
- The premise for dismantling operation should fulfill the following requirements:

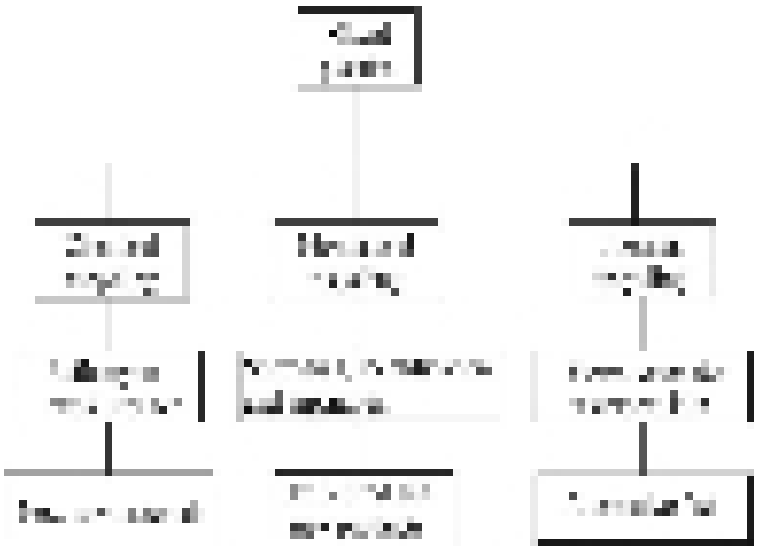
a) Weather proof roofing and Impermeable surfaces for appropriate areas with appropriate spillage collection facilities, decanters, degasser, and degreasers.
b) Appropriate storage for dissembled spare parts.
c) Appropriate containers for storage of batteries, capacitors containing PCBs (Polychlorinated biphenyls) or PCTs (Polychlorinated ter phenyls).

Composition of E- waste



Recycling Methods

There are three types of recycling processes for plastics. Chemical recycling processes use waste plastics as raw materials for petrochemical processes or as a reductant in a metal smelter. Mechanical recycling is a conventional method, which uses a shredding and identification process to eventually make new plastic products. In thermal recycling, plastics are used as an alternative fuel.



A. Mechanical Recycling

Mechanical recycling is a way of making new products out of unmodified plastic waste. It was developed in the 1970s, and is now used by several manufacturers. Mechanically recycled waste has until now consisted largely of industrial plastic waste. Industrial plastic waste generated in the manufacture, processing and distribution of plastic products is well suited for use as the raw material for mechanical recycling. Used plastics from households, stores and offices are now being mechanically recycled.

All kinds of recycled products are made from industrial plastic, including containers, construction sheeting, products for packaging, transportation, and other goods and facilities.

Recycled products have a number of attractive characteristics: they are durable, light; easy to process and easy to cut and join, just like wood. We can expect greater adoption of recycled products with these features being usedin place of other materials, such as steel, concrete and wood.

Used plastics emitted from the home, such as PET bottles and expanded polystyrene, are turned into textile products, packaging materials, bottles, stationery, daily necessities, video cassettes and similar products. The paint and coatings must be removed. If paint and coatings are not completely removed, the properties of recycled plastics can be reduced because of stress concentration created by these coating materials.

B. Chemical Recycling

i) Depolymerisation and Conversion process

For chemical recycling of plastics several processes have been developed. In this process, mixed plastic waste (MPW) is depolymerized at about 350–400C and dehalogenated in this stage. During this stage, metals are removed. The remaining

polymer chains from the depolymerization unit are cracked at temperatures of 350–450 C in the Hydrogenation Unit. The open carbon bonds are saturated by hydrogen because of high hydrogen pressure, more than 10 million N/m2. The liquid product goes through the distillation process. Any left-over inert material, which is not separated and removed in the depolymerization step, and the unconverted plastic portion are collected in the bottom of the distillation column and removed as a residue, hydrogenation bitumen. The final highquality products, off-gas and syncrude, are obtained by hydrotreatment. These final products are sent to conventional petrochemical processes.The mixed plastic waste is converted into the following products: 80 wt.% into liquid product, 10 wt.% into off-gas (methano-butane), and 10 wt.% residue. The liquid product is free of chlorine and extremely low in oxygen and nitrogen; 85 wt.% can be used as cracker feed (Association of Plastics Manufacturers in Europe, 1997). The rest, depending on the properties of the plastic waste, is ethylbenzene, which is an excellent gasoline component. The solid residue, which could also be blended with the coal for a power plant, can beused to improve the properties of coal for coke production.

ii) Coke oven process

This process was developed by Nippon steel company for plastic chemical recycling.The coke making process is essentially the carbonization of coal. The process conditions for carbonization in a coke oven are also suitable for the recycling of waste plastics, because at high temperature in a reducing atmosphere, charged plastics can be decomposed thermally without combustion.

In the pretreatment step, foreign materials, such as metal, glass, and sand, are removed. The remaining plastic waste is then crushed and reduced in size, before being charged into a coke oven. This process involves high temperature and a reducing atmosphere (Fig.9) General waste plastics were added to coal at a level of 1 wt.%, and the plastics decomposed easily. In the coking chamber, the waste plastics are heated to about 12000C in an oxygen-free environment. The charged plastics are pyrolyzed at 200–450 C, generate gas and are completely carbonized at 500 C. The hydrocarbon oils and coke oven gas are refined from high-temperature gas generated by pyrolysis, and the residue is recovered as coke. The yields from carbonization of general waste plastics were 20 wt.% of coke, 40 wt.% tar and light oil, and 40 wt.% of gases, approximately. The primarycomponents of the product gas are methane and hydrogen.Plastic waste collected from factories and homes is cleansed of non-combustible matter and other impurities such as metals, then finely pulverized and packed to reduce its volume. Plastics that do not contain PVC are granulated, then fed into the blast furnace with coke. Plastics that do contain PVC are fed into the blast furnace after first separating the hydrogen chloride at a high temperature of around 3500c in the absence of oxygen, as the emission of hydrogenchloride can damage a furnace. The hydrogen chloride thus extracted is recovered as hydrochloric acid and put to other uses, such as acid scrubbing lines for hot rolling at steel mills.

C. Thermal Recycling

Thermal recycling means to use plastics as a fuel so that the main purpose of thermal recycling is energy recovery. Plastics have a high heat value. Because plastics are derived

From oil, plastics have a calorific value equivalent to or greater than coal. Plastic materials can be combusted andproduce energy in the form of heat. For instance, 1 ton of plastics can replace 1.3 tonnes of coal in cement kilns.

Gasification with melting furnace waste power generation first converts waste to gas at a high temperature then uses the emitted pyrolysis gas and char as fuel to turn a steam turbine and generate power. This method turns the burned ash into a solid. Gasification with reformer furnace power generation subjects the waste to pyrolysis, then adds oxygen to the resulting gas, carbonized solids, tar and other substances. Gas rich in carbon monoxide and steam is recovered and used as fuel for power generation or as chemical feedstock. Any method of gasification for waste material can be used with shaft furnaces, fluidized bed furnaces or rotary kilns. Also, power can be generated not only via steam turbines, but also with high efficiency gas engines, gas turbines and fuel cells.

Management of E-Waste

Green national electronics Action plan was started by environmental protection agency USA. Basel convention is not established in USA yet. The range of NEAP is restricted to computers, televisions and cell phones. Advance recycling fee (ARF) has been collected by the state of California during the purchase of a new product. The advance recycling fee ranges from $6 to $10 for products such as TVs, Computers and Monitors.

United Kingdom

The European union directive is enforced by the parliament to control the WEEE in 2007. The legislation has delegated the responsibilities to the operators to report, finance, and control the treatment of WEEE under producer compliance schemes. A registration fees is collected from the producers, preprocessors, and exporters as operational fees for running the scheme. They have to ensure that WEEE selected from different sources must be treated by using the best available treatment, recovery and recycling techniques (RafiaAfroz et al.,2013).

India

In india the ministry of environment and forests is the national authority responsible for formulating legislations related to waste management and environmental protection. At present the hazardous materials found in WEEE are covered under the purview of “The Hazardous and Waste management Rules, 2008” in the category of hazardous and non hazardouswaste .

B. Strategies To Manage E-Waste

There has been several tools developed and applied to e-waste management to mitigate problems both at national and international levels. LCA, MFA,MCA, and

EPR are some the tools used for the better management of e-waste. In developed countries the management of e-waste has taken to a step further with the release of a waste electric and electronic equipment directive that is expected to reduce the disposal of such waste and improve the environmental quality.

(i) Life cycle assessment(LCA)

Life cycle assessment is a tool used to design environmentally friendly devices to minimize e-waste problems. Research has been conducted on early 1990s on the LCA of electronic devices in terms of eco-design, product development and environmental impacts. For identifying environmental impacts to develop eco-design products such as printers, washing machines LCA is a powerful tool. It is a systematic tool to define many environmental impact categories such as carcinogens, ozone layer, acidification, ecotoxicity, climate change and eutrophication to improve environmental performance of products.

In e-waste management life cycle analysis is widely used, research has been conducted in Europe to evaluate the environmental impacts of end of life treatment of e-waste. Environmental impacts of e-waste were much lower than previously determined due to the recycling of plastics instead of incineration.

In Asia LCA has been applied to estimate the impacts of e-waste. It is found that the recycling potential in terms of environmental score showing the highest value was for glass and circuit boards, followed by copper, aluminium, iron and plastic. In terms of economic score the highest value was found to be for copper, followed bbyaluminium, iron, plastic, glass and circuit boards.

In India Life cycle analysis was used as a decision making tool for computer waste management. The results showed that the optimal life cycle of a computer desktop was observed to be shorter by 25% than the optimized cost and the optimized value of computer waste impacts to either the environment or any perceived risk to the public.

(ii) Material Flow Analysis

Large volumes of e-waste was exported from developed countries to the developing countries for recycling before the Basel convention came into force. Material flow analysis is a tool used to study the pathway of e-waste flow in recycling sites, or disposal areas and stock of materials in space and time. For proper e-waste management materialflow analysis can be applied. Material flow analysis is used in Asia to investigate the flow of material and it is found that secondhand electronic devices from japan are reused in southeast Asia.

Conclusion

Thus in this literature review categorization of e-waste, global scenario of e-waste, recycling methods, latest technologies in recycling of e-waste, concerns in plastic recycling impacts of e-waste are discussed in detail.

Generation of e-waste has rapidly increased in both developed and developing countries. U.S.A tops the list in the generation of e-waste. Countries like U.S.A,

Japan etc. have introduced legislations for making producers responsible for the end of life products.

There are many strategies followed by each country in order to manage e-waste in an efficient and in eco-friendly manner. Life cycle assessment, material flow analysis, multi criteria analysis and extended producer responsibility are some of the techniques followed for the management of e-waste.

It is found that an extensive pollution is emitted from the recycling processes, and also investigation shows the presence of heavy metals like Ag, Hg, Pb in air and in fresh water near recycling sites. In order to overcome these problems new techniques like plasma pyrolysis are introduced.

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Ocean Thermal Energy

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Abstract : Earth may be better called **Oceanus:** most of it is, after all, covered in water—much of it *very warm* water. The really interesting thing about the ocean is not how hot it is, but the difference in temperature between the surface (where the Sun keeps the sea relatively hot) and the depths (where the water, never warmed by the Sun, is considerably cooler). As any engineer knows, a temperature difference like this is very useful indeed if you're trying to make power. So why not use the heat in Earth's vast oceans to generate useful energy? That's the basic thinking behind **OTEC (ocean thermal energy conversion)**, first suggested in 1881, which involves extracting useful energy from the heat locked in the oceans.

Introduction

Ocean thermal energy conversion (**OTEC**) uses the temperature difference between cooler deep and warmer shallow or surface seawaters to run a heat engine and produce useful work, usually in the form of electricity. OTEC is a base load electricity generation system. However, since the temperature differential is small, the thermal efficiency is low, making its economic feasibility a challenge. OTEC is one of the continuously available renewable energy resources that could contribute to base-load power supply the resource potential for OTEC is considered to be much larger than for other ocean energy forms [World Energy Council, 2000]. Up to 88,000 TWh/yr of power could be generated from OTEC without affecting the ocean's thermal structure [Pelc and Fujita, 2002]. OTEC can also supply quantities of cold water as a by-product. This can be used for air conditioning and refrigeration and the nutrient-rich deep ocean water can feed biological technologies. Another by-product is fresh water distilled from the sea.

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History

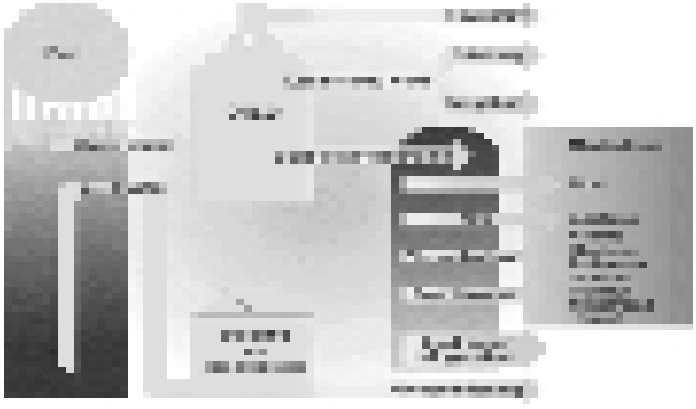
The OTEC concept was first proposed in the early 1880s by the French engineer Jacques-Arsène d'Arsonval. His idea called for a closed-cycle system, a design that has been adapted for most present-day OTEC pilot plants. Such a system employs a secondary working fluid (a refrigerant) such as ammonia. Heat transferred from the warm surface ocean water causes the working fluid to vaporize through a heat exchanger. The vapor then expands under moderate pressures, turning a turbine connected to a generator and thereby producing electricity. Cold seawater pumped up from the ocean depths to a second heat exchanger

provides a surface cool enough to cause the vapor to condense. The working fluid remains within the closed system, vaporizing and reliquefying continuously.

Ocean Thermal Energy Conversion

Ocean thermal energy conversion (OTEC) uses the temperature difference between cooler deep and warmer shallow or surface seawaters to run a heat engine and produce useful work, usually in the form of electricity. OTEC is a base load electricity generation system. However, since the temperature differential is small, the thermal efficiency is low, making its economic feasibility a challenge. Among ocean energy sources, OTEC is one of the continuously available renewable energy resources that could contribute to base-load power supply. The resource potential for OTEC is considered to be much larger than for other ocean energy forms Up to 88,000 TWh/yr of power could be generated from OTEC without affecting the ocean's thermal structure.

OTEC can also supply quantities of cold water as a by-product. This can be used for air conditioning and refrigeration and the nutrient-rich deep ocean water can feed biological technologies. Another by-product is fresh water distilled from the sea. Most of the electricity we use comes from heat engines of one kind or another. A heat engine is a machine that cycle between two different temperatures, one hot and one cold, usually extracting heat energy from a fuel of some kind. In OTEC, we use the temperature difference between the hot surface of the ocean and the cooler, deeper layers beneath to drive a heat engine in a broadly similar way—except that no fuel is burned: we don't need to create a difference in temperature by burning fuel because a temperature gradient exists in the oceans naturally. Since the temperature difference is all-important, we need the biggest vertical, temperature gradient we can possibly find (at least 20° and ideally more like 30–40°). In practice, that means a place where the surface waters are as hot as we can find and the deep waters (perhaps 500–1000m or 1000–3000ft beneath) are as cold as possible. The best place to find such a combination is in the tropics (between the latitudes of about 20°N and 20°S).

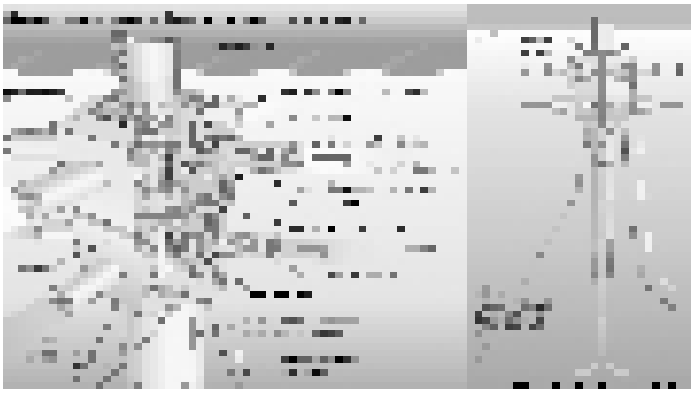


There are essentially two different kinds of OTEC plant-

1. Closed Cycle
2. Open Cycle

1. Closed cycle

1. Ammonia (or another low-boiling, heat-transport fluid) flows around a closed loop at the heart of the system. That's the white square in the center of this illustration.
2. Hot water enters a completely separate pipe near the surface of the ocean and is piped toward the central loop containing the ammonia.
3. The hot water and the ammonia flow past one another in a heat exchanger, so the hot water gives up some of its energy to the ammonia, making it boil and vaporize.
4. The vaporized ammonia flows through a turbine, making it spin.
5. The turbine spins a generator, converting the energy to electricity.
6. The electricity is carried ashore by a cable.
7. Having left the turbine, the ammonia has given up much of its energy, but needs to be cooled fully for reuse. If the ammonia weren't cooled in this way, it wouldn't be able to pick up as much heat next time around.
8. How is the ammonia cooled? In a third pipe, cold water is pumped up from the ocean depths.
9. The cold water and ammonia meet in a second heat exchanger, which cools the ammonia back down to its original temperature ready to pass around the cycle again.
10. The cold water from the ocean depths, now slightly warmed, escapes into the ocean (or it can be used for refrigeration or air conditioning).
11. The hot water from the ocean surface, slightly cooled, drains back into the upper ocean.



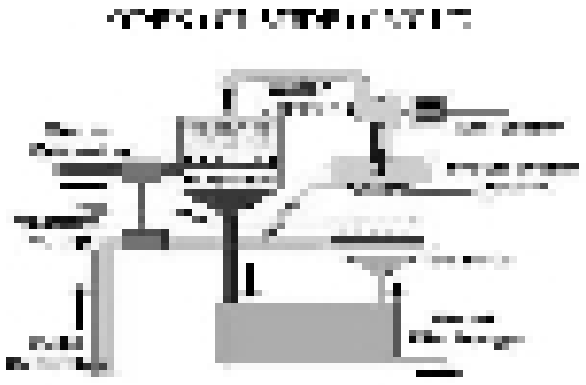
2. Open cycle

In open-cycle OTEC, the sea water is itself used to generate heat without any kind of intermediate fluid. At the surface of the ocean, hot sea water is turned to steam by

reducing its pressure (remember that a liquid can be made to change state, into a gas, either by increasing its temperature or reducing its pressure). The steam drives a turbine and generates electricity (as in closed-cycle OTEC), before being condensed back to water using cold water piped up from the ocean depths. One of the very interesting byproducts of this method is that heating and condensing sea water removes its salt and other impurities, so the water that leaves the OTEC plant is pure and salt-free. That means open-cycle OTEC plants can double-up as desalination plants, purifying water either for drinking supplies or for irrigating crops. That's a very useful added benefit in hot, tropical countries that may be short of freshwater.

Advantages of Open Cycle Process:

In open-cycle OTEC, the sea water is itself used to generate heat without any kind of intermediate fluid. At the surface of the ocean, hot sea water is turned to steam by reducing its pressure (remember that a liquid can be made to change state, into a gas, either by increasing its temperature or reducing its pressure). The steam drives a turbine and generates electricity (as in closed-cycle OTEC), before being condensed back to water using cold water piped up from the ocean depths. One of the very interesting byproducts of this method is that heating and condensing sea water removes its salt and other impurities, so the water that leaves the OTEC plant is pure and salt-free. That means open-cycle OTEC plants can double-up as desalination plants, purifying water either for drinking supplies or for irrigating crops. That's a very useful added benefit in hot, tropical countries that may be short of freshwater.



Advantage

- Power from OTEC is continuous, renewable and pollution free.
- Unlike other forms of solar energy, output of OTEC shows very little daily or seasonal variation.

- Drawing of warm and cold sea water and returning of the sea water, close to the thermocline, could be accomplished with minimum environment impact.
- Electric power generated by OTEC could be used to produce hydrogen.
- Tropical and sub-tropical island sites could be made free from pollution caused by conventional fuels for electricity generation.
- OTEC system might help in enrichment of fishing grounds due to the nutrients from the unproductive deep waters to the warmer surface waters.
- A floating OTEC plant can generate power even at mid sea and can be used to provide power for off shore mining and processing of manganese nodules.

Limitations of OTEC system

1. Capital investment is very high.
2. Due to small temperature difference in between the surface water and deep water, conversion efficiency is very low about 3-4%.
3. Low efficiency of these plants coupled with high capital cost and maintenance cost makes them uneconomical for small plants.

Environmental and Economic Challenges

In general, careful site selection is key to keeping the environmental effects of OTEC minimal. OTEC experts believe that appropriate spacing of plants throughout tropical oceans can nearly eliminate any potential negative effects on ocean temperatures and marine life.

OTEC power plants require substantial capital investment upfront. OTEC researchers believe private sector firms probably will be unwilling to make the enormous initial investment required to build large-scale plants until the price of fossil fuels increases dramatically or national governments provide financial incentives. Another factor hindering the commercialization of OTEC is that there are only a few hundred land-based sites in the tropics where deep-ocean water is close enough to shore to make OTEC plants feasible.

Desalination by OTEC Technique:

Desalinated water can be produced in open- or hybrid-cycle plants using surface condensers to turn evaporated seawater into potable water. System analysis indicates that a 2-megawatt plant could produce about 4,300 cubic metres (150,000 cu ft) of desalinated water each day. Another system patented by Richard Bailey creates condensate water by regulating deep ocean water flow through surface condensers correlating with fluctuating dew-point temperatures. This condensation system uses no incremental energy and has no moving parts.

Conclusion

Scientists and engineers have been trying to extract useful heat energy from the oceans for over a century, with varying amounts of success. So far, only a few small-scale experimental units are operating. One is producing about 100kW of electricity (about 5-10 percent as much as a single wind turbine) in Japan, another is generating about half as much in Hawaii, and a third is now producing about 1MW

in India; these are tiny amounts of energy that don't prove the long-term commercial viability of OTEC in a world where there are many other sources of power and the economics of energy have to be rewritten from one day to the next. All that could be about to change, however. After years of planning and construction, the Lockheed Martin company finally finished work on a 100kW prototype OTEC plant in Hawaii in August 2015. Depending on how successful that proves to be, bigger plants could follow; Lockheed has already announced plans for a 10MW offshore plant (with 100 times more generating capacity) in China. Under current economic conditions, OTEC plants are most likely to be constructed in or near small tropical islands that have little or no energy resources of their own, a high-dependence on expensive, imported oil, and perhaps a pressing shortage of freshwater as well; a combined OTEC power and desalination plant could be very attractive in that situation. Early customers are likely to include power-hungry US naval bases in tropical American territories—and that's one of the reasons why the US Navy is currently investing in the technology.

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Gestational Diabetes: A future predictor of type 2 diabetes

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Gestational diabetes (GD) is glucose intolerance first defined during pregnancy. However, the glucose intolerance resolves with delivery in most of the cases, therefore, it is usually seen as a transient phase and people don't take it seriously, and it is easily forgotten. There is plenty of scientific evidence to show that GD increases the risks of developing type 2 diabetes in the future which calls for action before the onset of diabetes in GD patients.

Historical background

Duncan in 1882 first noticed diabetic symptoms during pregnancy. Since then, for more than a century it has been known that diabetes can complicate pregnancy with severe adverse effects on foetal and neonatal outcomes. The term "gestational diabetes" was applied to this condition in the 1950's (Buchanan & Xiang, 2005). In1960s, O'Sullivan and Jackson found that the degree of glucose intolerance during pregnancy was directly proportionate to the risk of developing diabetes after pregnancy (Knopp, 2002; Buchanan & Xiang, 2005). It was realised that glucose intolerance during pregnancy not only cause complications during pregnancy, but it has long-term health consequences both for GD mother and her child. Evidence shows that without health interventions, about 60 percent of women with a history of gestational diabetes develop type 2 diabetes within ten years of delivery (GDM Guide, 2009). Lifestyle interventions can significantly delay or prevent the appearance of type 2 diabetes in this population (Billamy, Casas, Hingroni & Williams, 2009).

As a result, an urgent need to develop uniform guidelines for screening, diagnosis and intervention strategies for GD was realised, and a series of international workshops were held from 1979 to 2005 to resolve the issue (Negrato & Gomes, 2013). Unfortunately, even after so many workshops and several decades of research, there is still no consistency in the diagnosis and treatment of GD (Coustan, Lowe, Metzger, & Dyer, 2010) and there is no unified global approach (Wilkinson et al., 2013). There is a wide diversity of methods used for diagnosis and prevention in the most countries (Wilkinson et al., 2014; Negrato & Gomes, 2013) and it seems that there has not been much progress in the last decades.

Factors contributing to development of GD and type 2 diabetes after GD

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Prenatal screening is essential to diagnose gestational diabetes and provide antenatal care for GDM women to prevent the complications of pregnancy. Whereas, postnatal screening is crucial to diagnose the risk of developing type 2 diabetes in this potentially high-risk population.

Maternal age, low birth-weight and sedentary lifestyle and few other factors are indicated as high-risk warning for developing GDM (Yun, Kabeer, Zhu, Brownson, 2007; Corrado et al, 2007 ; Casas, Hingorani & Williams, 2009; Savil, 2012; Bellamy, Harreiter, Dovjak & Willer, 2014;). An Australian clinical controlled trial revealed a significantly increased risk of pre-eclampsia, caesarian section, neonatal hypoglycaemia and hyperbilirubinaemia for women with even a Borderline GDM compared with women with normal glucose tolerance (Ju, Rumbold, Wilson & Crowther, 2008). Therefore, ignoring risk factors and taking a risk of unidentified GDM could be life threatening for these women.

After having GDM, the risk of developing type 2 diabetes vary from 2% to 70%, reflecting differences in the population tested, the diagnostic criteria used, and the length of follow-up (Pierce et al., 2011). International guidelines (WHO) recommend a 6-week postnatal fasting glucose tolerance test (OGTT) for women with GDM (Holt, Goddard, Clarke & Coleman, 2003). There are some additional risk factors that contribute to the development of DM after GDM. Lifestyle, body weight (BMI>25), stress, nutrition choice, use of insulin during pregnancy, an early diagnosis of GDM(< 24 weeks gestation) and amount of breastfeeding are few factors that can predict the risk of developing DM (Cheng et al., 2008; Roche & Appel, 2009; Feig, 2012; Savill, 2012; Jones, Finkelstein, Keely, Feig, Yaseen & Walker, 2014; Harreiter, Dovjak & Kautzky-Willler, 2014)

However, in spite of all the risk factors research has well established a direct relationship between adoption of a healthy lifestyle and preventing type 2 diabetes in a high-risk population (Knowler et al., 2002; England et al., 2009; Kim et al., 2011; Feig, 2012). Providing clear and timely information about the future risk can delay or avoid the onset of type 2 diabetes in women with a previous history of gestational diabetes (Parson, Ismail, Amiel & Forbes, 2014). Health Belief Model can be used as a tool to understand why individuals do or do not engage in health-related actions. A critical review by Janz and Becker (1984) reviewed 46 HBM studies (18 prospective and 28 retrospectives studies) and recommended consideration of HBM dimensions to be used as a part of health education programmes.

HBM theory hypothesised that health behaviours depend on two primary variables. First, on the value placed on a particular goal by an individual and second, on individual's estimate of the likelihood the given action will achieve that goal (Janz & Becker, 1984). These two variables further depend on various dimensions such as perceived susceptibility, perceived severity, perceived benefits and perceived barriers. The model explains that a person will only adopt a health behaviour if he/she believes that he/she is susceptible to a disease, understands that the consequence of disease could be severe and believes that he/she can avoid the occurrence of disease by adopting certain health behaviour. The model also explains the connection between perceived benefits and barriers to be inversely

proportionate. A person is more likely to imply positive health changes if he/she believes that the benefits of taking action to avoid a health threat exceed associated barriers (Janz & Becker, 1984). Out of 46 studies reviewed, susceptibility, barriers and perceived benefits showed high levels of effectiveness. (Janz & Becker, 1984).

Raising risk awareness and involvement in intervention

The first dimension of HBM is risk perception. Health beliefs have a major influence on lifestyle behaviour for type 2 diabetes (Jones et al., 2009). Perceived risk is a significant factor in an individual's decision to adopt and sustain preventive behaviour (Kim et al., 2007). Low perceived risk for type 2 diabetes is a barrier to lifestyle change (Jones Roche & Appel, 2009; Zera, Nicklas, Levkoff & Seely, 2013). People reported with a high-risk perception of developing type 2 are also reported to implement healthy lifestyles (Hivert, Warner, Shrader, Grant & Meigs, 2009). Research indicates that women with a history of GDM have limited knowledge about their increased risk of developing type 2 diabetes in the future (Malcolm et al., 2009). The follow-up of women with a history of GDM is becoming increasingly important for a shortening of time between GDM and the development of diabetes. The follow-up is particularly important as there is clear evidence that progression to diabetes can be reduced by over 50% by appropriate health interventions (Simmons, McElduff, Mclntyre & Elrishi, 2009).

The recommended health behaviour to reduce the risk includes postpartum blood glucose screening, breastfeeding, weight loss, minimum 30 minutes of physical activity and choice of healthy diet (Alberti, Zimmet, & Shaw, 2007; Feig, 2012; Ferrara et al., 2011). Finnish Diabetes Prevention studies recruited 522 subjects as intervention and control groups. The participants in the intervention group received individual counselling and structured training about weight reduction, healthy diet, and physical exercise regularly. The control group was only given general information about diet and exercise at the beginning and on their annual visits. In 3.2 years time, a significant reduction of DM risk was noticed in the intervention group. A follow-up also identified sustained lifestyle changes and reduced incidence of diabetes in the prevention group (Lindstrom et al., 2006). Similarly, the diabetes prevention programme (DPP) was conducted among individuals with impaired glucose tolerance and approximately 15% of the study population was women with previous history of GDM. Participants in the lifestyle intervention group received counselling on diet, exercise, and behaviour modification during the 3-year study. As the result of participation in the prevention programme their risk of developing diabetes was reduced by 58% (Knowler et al., 2002). This proved that planning and implying health promotion programmes involving counselling to raise awareness regarding increased risk could be very beneficial for GDM women.

Understanding Barriers and raising awareness to benefits

Research shows a low compliance of positive post-natal health behaviours (Dasgupta et al., 2013). One of the main reasons for low compliance could be the information gap. Patients do not have access to research evidence or other health and medical information. Therefore, there is a need to better impress upon women

with a GDM history that they are at high risk of developing type 2 diabetes in future. They also need assurance that there are proven strategies to help them reduce this risk, with potential health benefits for themselves and their families (Yun, Kabeer, Zhu & Brownson, 2007; Dasgupta et al., 2013).

Moreover, studies show that women are positive about long-term support for self-management to reduce the risk of developing diabetes in the future (Lie et al., 2013) but they encounter some barriers in their quest to self-manage their condition (Dasgupta et al., 2013; Yun, Kabeer, Zhu & Brownson, 2007). Major barriers to lifestyle changes are reported to be a lack of risk awareness, time, financial constraints and familial and social support (Retnakaran, 2009). Women caring for newborn babies have unique needs. Moreover, women do not have an immediate concern of DM because they can't see any symptoms in the early development of the disease (Swan et al., 2007).

Providing sufficient and appropriate education and support to GDM women, during and post pregnancy is the greatest challenge. There is a need for targeted educational resources for women with GDM (Carolan, Gill & Steele, 2012). Use of collaborative approaches to behaviour change such as patient-centred counselling or motivational interviewing techniques, may be more acceptable in this population (Niclas et al., 2011).

In a qualitative study, women with GDM expressed a need for social support from family, health professionals, and peers to achieve changes in eating and physical activity behaviours. Most importantly, family-related considerations and direct involvement of partners in a programme were suggested to increase the support for behavioural change, specifically to achieve the positive changes in the home food environment (Dasgupta et al., 2013).

The significance of diabetes prevention and health recommendations is crucial in this population because the population in question is one of the young women of childbearing age, in whom the prevention of diabetes will have considerable implications for the patients, their children and society in general (Ratnakaran et al., 2010).

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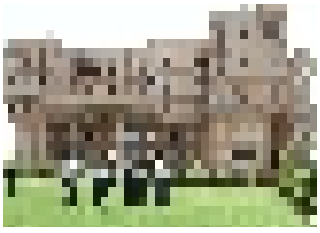

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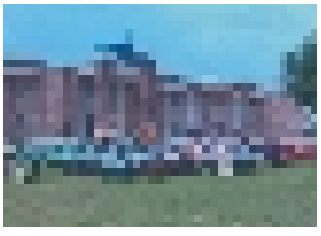

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