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Highlights

Electrical Power Distribution System

Cross Spectrum Switching in Mobility

Discovering Thoughts, Inventing Future

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Contents of the Issue

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Cross Spectrum Switching in Mobility Scenario for Signaling Overhead Minimization in Het net

By Sudha Arvind & Dr.V.D.Mytri
Jntu Hyderabad

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Sudha Arvind [α] & Dr. V.D. Mytri [σ]

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I. Introduction

Heterogeneous network have up come as a new model for data exchange, where, multiple networks are integrated together to formulate a larger network, providing long range communication, with grouping of different wireless networks. With the development of such network, different architectures have been proposed in recent past [1], in which the network is incorporated with cognitive devices to achieve an efficient communication. The incorporation of cognitive devices has gained the advantage of utilizing frequency spectrum more efficiently in heterogeneous network. The radio devices are developed as a software defined radio unit [3], where the network user utilizes the spectrum by sensing its availability from other active users. The spectrums are shared to communicate data from free spectrum [2], sensing and allocating to exchange data with higher spectrum efficiency. The network [4]consists of users to share spectrum for data exchange[5],[6]. The objective of Het Net is to share the spectrum among users to exchange data without interfering the communication of any current user[7]. For interference controlling each secondary user process a spectrum sensing, spectrum allocation and spectrum utilization process. In the operation of cognitive network, the radio unit is defined for spectrum sensing of existing spectrum and utilizing for transmission rather to adding new spectrum. This usage helps in providing higher network performance with the exiting resources. Due to the advantage of providing higher service compatibility without additional spectrum, has made this network a new prospective architecture for next generation communication system. In Het Net, the radio unit improves the spectrum efficiency by implementing the approach of dynamic spectrum access approach (DSA). The users in such network operated as a secondary user, which uses the frequency bands allocated to a current user. This form of spectrum utilization is standardized under IEEE 802.22 and ECMA-392. Though spectrum sharing improves the performance of communication network, the mobility monitoring is also required. In this mobility driven spectrum sensing and allocation is focused. Even with a proper approach of spectrum sensing, the data exchange could face high degradation in mobility or in many a case may not meet the demanded quality of service. In the provisioning of mobility driven spectrum allocation in [1] an approach of joint optimization of energy efficiency and spectrum efficiency is proposed. An optimization problem of signaling overhead and spectrum allocation is formulated for a heterogeneous network. The problem of spectrum allocation is defined as a mutual interference model of spectrum efficiency (SE) and signaling overhead (SO) in this network. In the communication approach, detection of spectrum status is a prime issue. The vacant spectrum is used by the user for its communication and re-allocate to the current user when required. In practical scenario, two sensing error occurs, the misdetection error and the false alarm error. In the misdetection error the secondary user detect the current user spectrum as vacant, when actually used. Whereas, in false alarm condition, the user detect a spectrum as used, when the spectrum is vacant. These two errorsminimize the probability of detection in Het Net. The misdetection error result in co-channel interference and the false alarm minimizes the spectrum utilization efficiency and signaling overhead. In [8] to optimize the Het Net efficiency the optimization of SO to SE under this condition is proposed. The converging of this SO-SE approach was derived as a SNR based approach. In a similar approach in [9] an analysis to SE to SO for Het Net was developed. This approach defines an additional parameter of link information to optimize the SO-SE problem. This

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approach optimize the problem link fading condition is considered. The channel inference at the current user is considered to bound the derived interference margin in allocating the sensed spectrum. The mobility governance in this case is observed to be high due to interference limit of current user for spectrum allocation. With the constraint for SNR the throughput of the network is to be enhanced. In [10]a imperfect spectrum prediction based on the state condition of the current user. The Ideal state condition is used for spectrum sensing in this case. This provides a higher throughput performance in Het Net. In the spectrum utilization process, the spectrum sensing approach is carried out at the Medium access control (MAC) layer [11]. In such an approach, the spectrum utilization is performed to achieve the objective of efficient resource utilization towards solving the issue of un fairness problem in heterogeneous network. However, the approach of MAC layer oriented controlling is performed with a single objective of fairness provisioning measured via network throughput. To improve the network throughput during the spectrum sensing and allocation approach, a back off controlled spectrum utilization at MAC layer was presented in [11]. The issue of spectrum sensing at coexisting heterogeneous network [12],was addressed. The co-existing heterogeneous cognitive radio network was recently been presented in [11], where different clusters of network are defined with CR- devices to communicate. The basic issue of current user spectrum sensing [13], [14] by secondary user under such network was presented. To achieve the detection of free PU spectrum a collision based approach, using the concept of Jamming was suggested. The effect of jamming on the network throughput was addressed. However, the fairness metric was evaluated in terms of network throughput and no concern was given on the mobility of the user. No approach was suggested to control the data lost in case of observed distortion due to propagating channel is introduced. The node positioning in the utilization of resources for spectrum sensing or spectrum utilization is also not addressed. As, the mentioned limitations effect the service efficiency in heterogeneous network, the issue of distortion monitoring and mobility governance w.r.t. spectrum allocation is suggested. The global issue of node position in spectrum sensing is also addressed in this paper. To present the stated objectives, this paper is outlined in VI section. Wherein, section II outlines the issue of unfairness in heterogeneous network. The conventional modeling of decentralized MAC protocol for resource allocation is presented in section III. Section IV presents the proposed approach of multi objective coordination approach for co-existing cognitive heterogeneous network under mobility constraint.

II. Communication System

In general cooperative communication is that which allow single-antenna mobiles to achieve the benefits of multiple communication systems. The basic idea is that single-antenna mobiles in a multi-user scenario can “share” their spectrum in a manner to create a virtual network. The mobile wireless channel suffers from fading, meaning that the signal attenuation can vary significantly over the course of a given transmission. Transmitting independent copies of the signal generates diversity and can effectively combat the deleterious effects of fading. In particular, spatial diversity is generated by transmitting signals from different locations, thus allowing independently faded versions of the signal at the receiver. Cooperative communication generates this diversity in a new and interesting way. Figure 1 depicts an ideas behind cooperative communication. This figure shows two mobile agents communicating with the same destination. Each mobile has one antenna and cannot individually generate spatial diversity. However, it may be possible for one mobile to receive the other, in which case it can forward some version of “overheard” information along with its own data. Because the fading paths from two mobiles are statistically independent, this generates spatial diversity. In the course of the development of cooperative communication, several complicating issues must be addressed, including the loss of rate to the cooperating mobile, overall interference in the network, cooperation assignment and handoff, fairness of the system, and transmit and receive requirement on the mobiles. In the figures as is depicted the icons resembling base stations or handsets, but this is only a convenient graphical representation. The idea of cooperation is general, and perhaps even more suitable to Heterogeneous Network.

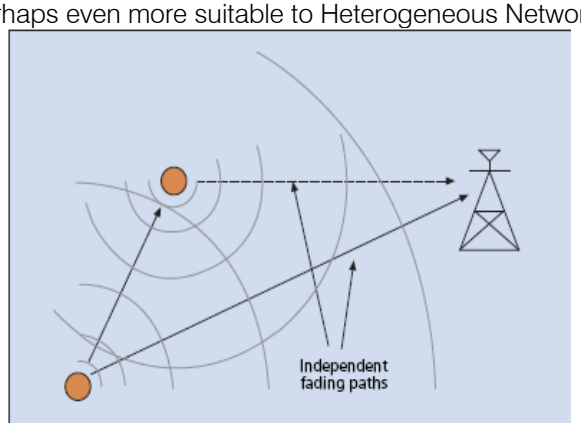

Figure 1: Cooperative Communication

In cooperative wireless communication, we are concerned with a wireless network, of the cellular or ad hoc variety, where the wireless agents, which we call *users*, may increase their effective quality of service (measured at the physical layer by bit error rates, block

error rates, or outage probability) via cooperation. In a cooperative communication system, each wireless user is assumed to transmit data as well as act as a cooperative agent for another user (Figure 2). Cooperation leads to interesting trade-offs in code rates and transmit power.

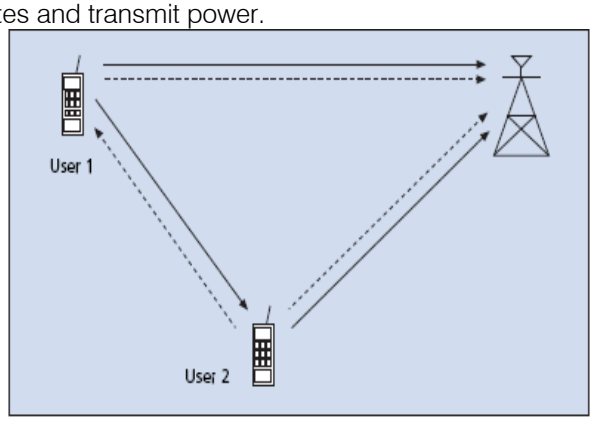

Figure 2: In cooperative communication each mobile is both a user and a relay.

In the case of power, one may argue on one hand that more power is needed because each user, when in cooperative mode, is transmitting for both users. On the other hand, the baseline transmit power for both users will be reduced because of diversity. In the face of this trade-off, one hopes for a net reduction of transmit power, given everything else being constant. Similar questions arise for the rate of the system. In cooperative communication each user transmits both his/her own bits as well as some information for his/her partner; one might think this causes loss of rate in the system. However, the spectral efficiency of each user improves because, due to cooperation diversity the channel code rates can be increased. One may also describe cooperation as a zerosum game in terms of power and bandwidth of the mobiles in the network. The premise of cooperation is that certain (admittedly unconventional) allocation strategies for the power and bandwidth of mobiles lead to significant gains in system performance. In the cooperative allocation of resources, each mobile transmits for multiple mobiles. If we assume there are two users U1 and U2 along with a single active user U, the unfairness problem arise if any one of the user don't have active user detection ability. For given U1 and U2, in the absence of active User, the channel will be occupied by U1 whereas the U2 also tries to occupy it. But due to the non-existence of active User detection ability, it can't occupy. This unfairness occurred due to the non active User detection capability, the throughput of the U2 will be reduced. In [11], this unfairness problem due to uncoordinated active User detection is solved through a MA layer approach which improves the performance of active User detection. The main objective of [11] is to identify if the user who occupies a busy channel belongs to a active User or an User from another by a low-overhead mechanism under mobility condition. It is an assistant function to improve the active User -detection ability to achieve a better Dynamic Frequency Selection (DFS) decision.

III. Proposed Coordinative Function

To achieve the objective of higher service compatibility the network throughput factor is considered with the offered channel interference in node mobility condition. The interference of the network impacts on the delivered service of the network. The throughput of the network is monitored by the traffic interference, wherein the processing overhead is observed at the process of signaling overhead. During the process of coding, which is initialized at the beginning of a communication. A Back off coding is used because this method is most widely used in computer network. It is a general agreement that the more the times of coding is, the higher the signaling level (SL) of coding is. For the same process, the SL is determined by which way it adopts. For example, process through Media access control (MAC) address has lower SL than one through credentials with a shared resource allocation of spectrum. To achieve the simulation of optimal resource utilization the SL optimization when a user switches from one network to other. In this case, the service quality is measured by the number of packets in unit time. In a given network, r_a is defined as arrival rate of packet request to measure times of packet in one minute. As the data rate changes, the SL of packet varies accordingly. For simplicity, it is assumed that data rate is proportional to the SL of coding, and a linear function is adapted to describe the relationship between coding and it's SL. The value of SL is just its relative. When the SL of packet is not lager than *lm*, it can be carried out as follow:

$$e = l_m/(r_m - r_{min}), \quad (1)$$

$$l_a = (r_a - r_{min}) \times e. \quad (2)$$

Here, l_a is the SUL of packet with the allocated rate r_a, eis proportional coefficient of data rate. r_{min} is the minimum data rate used in simulations and r_m is the allocated rate corresponding to l_m. When the SUL is higher than l_m, the additional SUL of service can be expressed as:

$$e = (L_{max} - l_m)/(r_{max} - r_m) \quad (3)$$

$$\Delta l_a = (r_a - r_m) \times e \quad (4)$$

Here, r_{max} is the maximum of offered data rate.

Once the data exchange is implemented successfully, the performance of the application is not basically affected by its offered service.

Back off delay is the time duration from sending an data request to receiving the reply. It is proportional

to the data rate in network scenarios. Here, number of packages for transmission is used to measure the impact of service on QoS. The packet delay T_a as well as the data delay per package T_a can be denoted as follows:

$$T_a = c \times r_a + d \tag{5}$$

$$t_a = r_a \times \frac{T_a}{\frac{1}{T}} = r_a \times T_a \times T \tag{6}$$

Here, the parameter *c* is proportional coefficient, *d* and is a constant that is determined by network status. *ra*×*T*ameans time of packet delivery in one unit. That is to say, how many packets for exchange were sent in one unit. At last, the end-to-end delay can be obtained by substituting (6) into (8), which is expressed by:

$$T = (t_{net} + t_k)/(1 - r_a \times T_a) \tag{7}$$

and we can get the corresponding minimal end-to-end delay and maximum SUL by substituting (*klen*, *ra*) into (7). To observe the impact of exchange process over transmission operation, an analysis to the data exchange process of transmission and reception is proposed. In the process of data coding, data encoding and spectrum allocation are two main quality mechanisms used generally in various coding protocols. By this means, the evaluating model is setup directly from the two mechanisms. Note that data encoding just refer to the encoding of message in this research, while encoding and key exchange for data are all regarded as a part of communication. In this way, data exchange consists of initial measuring and data encoding. Generally, encoding algorithm translates the plain text into cryptograph before transmission according to key used in it, so that users without key cannot know the content of session, except for the valid receiver. It can also be used for data integrity. If the fragmented coding text is modified, the receiver end cannot decrypt. Although encoding provides information secrecy and integrity check, it also takes additional time delay and consumes power due to encoding and decoding. On the other hand, spectrum allocation is used as an initial process to authorize a user through coding credentials for communication. By rejecting blocked users, suggested approach can thus control resource access. At the same time, the back off can not only result in additional delay, but also increases call dropping probability that causes degradation in QoS.

It is well known that switching services can influence QoS metrics, such as end-to-end delay, call dropping probability and throughput of communication. In the paper, end-to-end delay is approximately taken as QoS because it is the most important among various QoS factors. We defined the end-to-end delay as the time that a packet is sent from one end to the other. If both encoding and quality encoding are applied, the time delay *T* can be written as:

$$T = t_{net} + t_k + t_a \tag{8}$$

Here, t_{net} is the transmission delay, t_k is the encoding and decoding time, and t_a is the coding delay per packet. It is noted that although encoding is just implemented in initial stage of session, to describe its effect on end-to-end delay, we averagely add back off delay to every packet. By this means, packet transmission takes more time due to back off. In this way, the effect of data exchange on QoS can be reflected by the end-to-end delay.

IV. Experimental Results

For the simulation of the suggested approach a randomly distributed network, with the operational network characteristic as outlined in [1]. The network parameters used for simulation is given by,

Table 1: Network parameters used for simulation

Network parameter	Characteristic
Node density (N_d)	30,45
Network Area	N_d x N_d
Communication range	80 Units
Mobility	Non-static
Topology	Random
MAC	802.11
Power model	IEEE 802.11-NIC card

The Network is defined for a randomly distributed node, comprising of nodes with a power conservation unit. The devices are incorporated with solar radiation energy generation units. Each node is defined for an average radiation reception of about 0.2 KWh/m^2 [16]. The minimum power required for a node to drive is taken as 0.5mW [16]. The operational time period and data exchange times are set as per IEEE 802.11 standards [17]. These values are set to 10 and 20μs for energy request and data exchange respectively. The charging energy level is taken as E_{max} is taken as 10E, where E is taken as 100mW over a time slot period for communication [18]. The conservation approach when induced to a cluster based network, with optimal scheduling the overall network performances are improved. The observations made for the proposed approaches are as illustrated below;

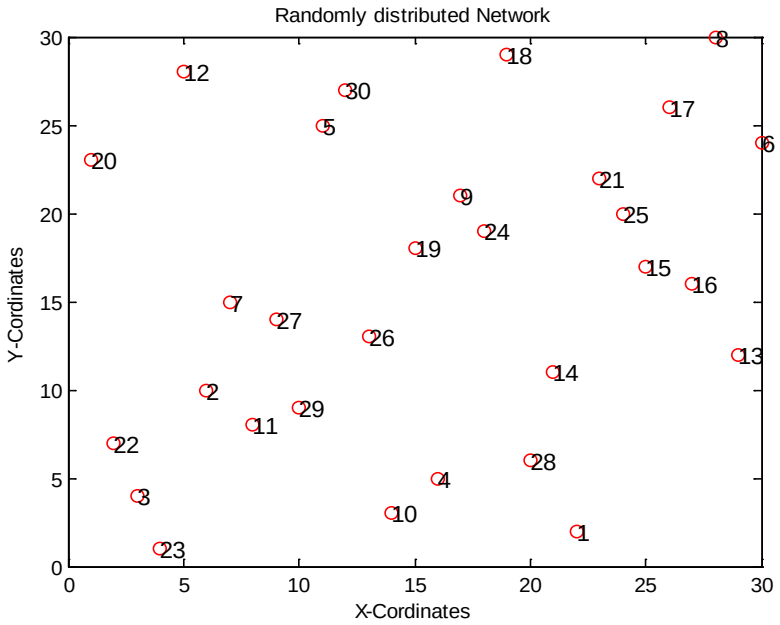

Figure 3: Random scattered Network topology

The randomly scattered network topology, for simulation is shown in figure 3. Each of the node is randomly placed in a network area of 30x30, with number of nodes as 30. Each node in the network is defined by its ID, geographical coordinates, defined by x and y coordinates, and a randomly defined power level at each node. These nodes process the routing protocol and select the optimal route for data communication using Multi hoping approach. At each of the hope, the node dissipates power based on the IEEE 802.11 standards for receiving, transmitting, and ideal condition. For the developed communication, the obtained parametric observations are as illustrated in following figures.

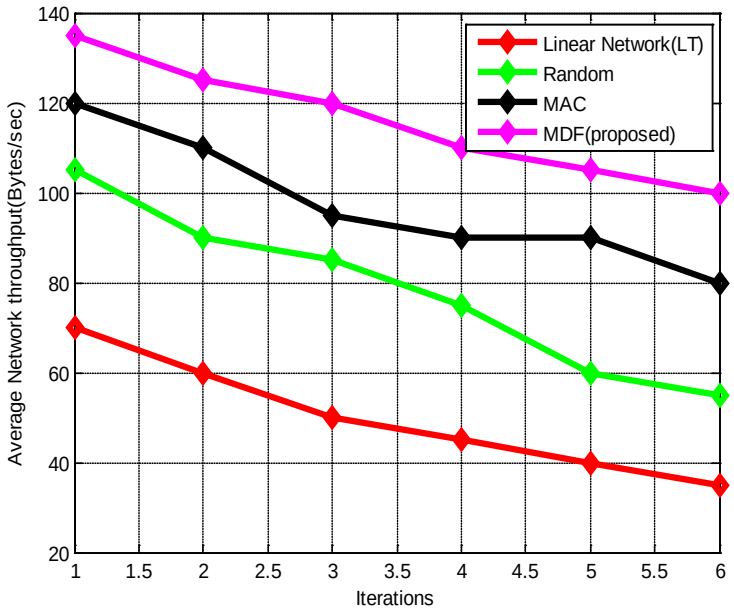

Figure 4: Average throughput with E=100mW and conservation time set to 10μs

The average throughput for the developed system is shown above. The average throughput for the proposed approach of energy conservation at master nodes result in higher throughput as, they are operable for more period. It is observed that the throughput for the linear network with energy conservation is also improved. However as with the increase in number of communication iterations, it is observed that throughput decrease due to the power dissipation per node and time taken to harvest energy. However, the throughput is

comparatively observed to be improved in case of proposed MDF driven power saving scheme with energy conservation.

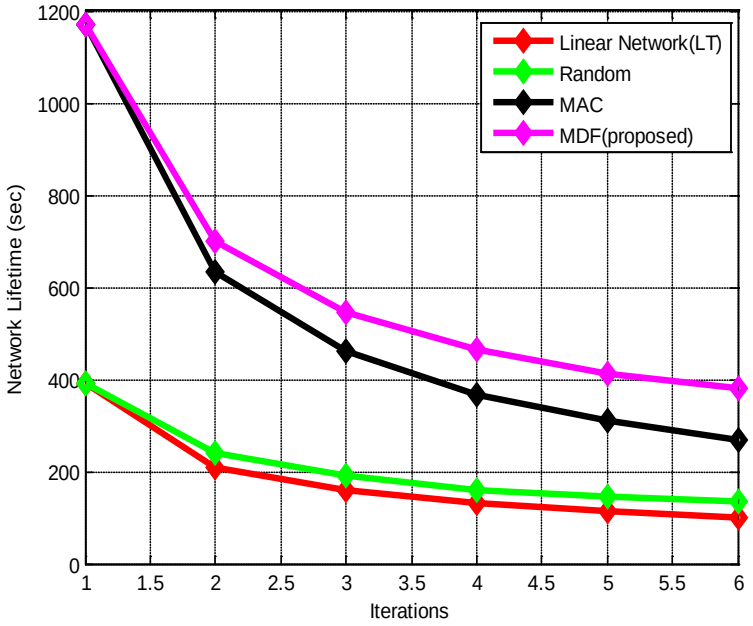

Figure 5: Network lifetime over communication period

The observed network life time for the simulated network is observed to be improved with the increase in communication iteration, using the approach of proposed MDF. The lifetime is computed as the number of nodes retained in the network in active path for data exchange. It is observed that, the network life time is increased by the incorporation of energy conservation at the node level.

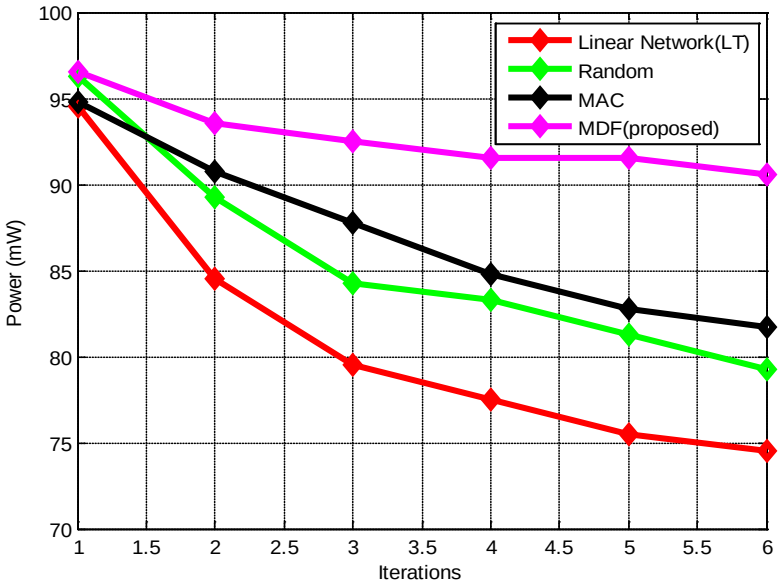

Figure 6: Power level with communication iteration with E=100mW and conservation time set to 10μs

Power at each node is measured and it is observed that, with the increase in the communication time period, the power level at each node is minimized, due to energy dissipation during transmission and reception operation. However, due to the incorporation of conservation approach to the developed network, it is observed that, the power level for active nodes is increased. This improvement is higher in the proposed MDF approach. As each node in such network remain in sleep mode, and master nodes are periodically been improved with energy conservation.

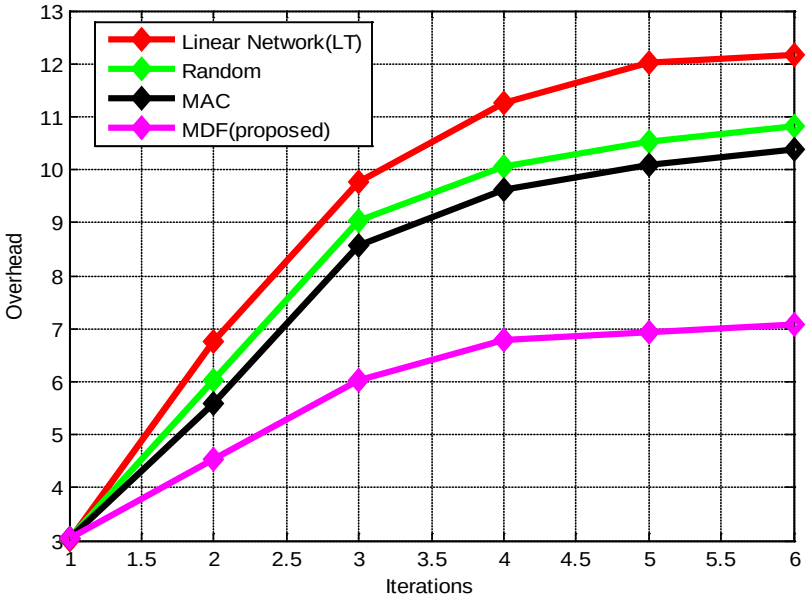

Figure 7: Network overhead over communication iteration

The Network overhead is observed to be minimized in case of the topology preserved with energy conservation. The concept of energy conservation makes more number of nodes available in the network, which results in higher throughput. Due to more traffic clearance the overhead is observed to be less in proposed approach. The effect of node density on the network performance is also evaluated for the simulation model. With the variation of node density fro Number of nodes varying from 10 to 50 in the network is evaluated.

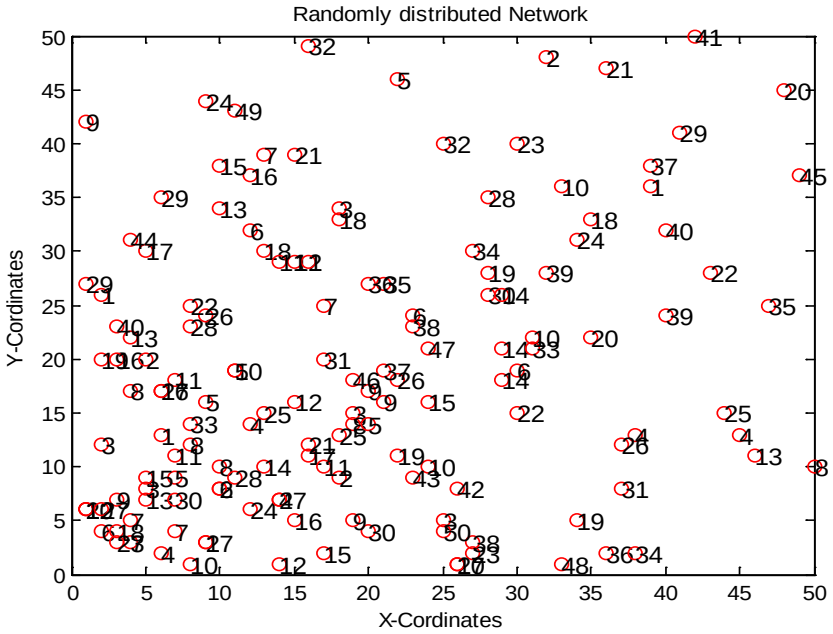

Figure 8: A randomly scattered network topology with Node density of 50 nodes

For the evaluation of variation in node density and its impact over network parameter, node density is varied from 10 to 50. The evaluative parameters observed for the simulated network is presented below. For the simulation a network with node density of 50 nodes is shown in figure 8. The scattering of nodes in such network can be seen in figure 8. Due to higher density the nodes are very near to each other. This leads to more route probability and more reliability. However, as number of nodes is more, probability of node participation in data forwarding also increases, resulting in faster power drain.

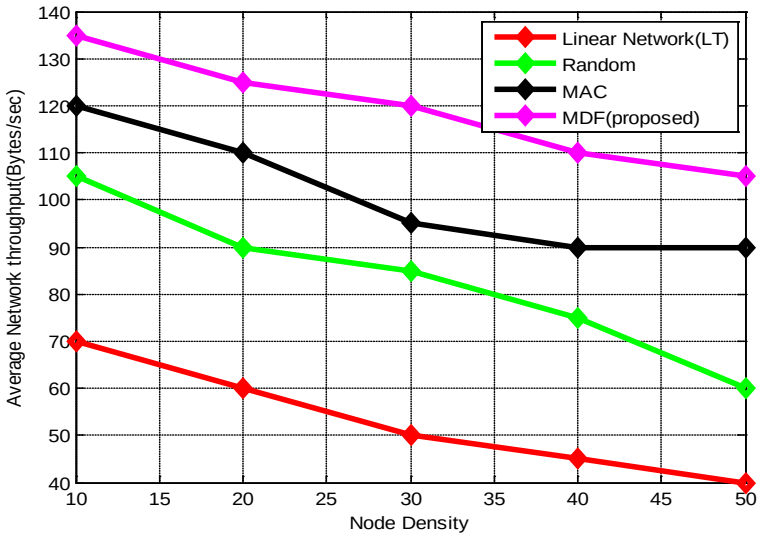

Figure 9: Average throughput with variant in node density

The average throughput w.r.t. Variation in node density is observed. It is seen that, throughput for the developed approach is improvised with increase in node density. The average node density available for the routing in such case increases, and due to faster processing and rescheduled conservation the nodes are processed for higher data transfer. As the data transfer is higher in such network the observing quality and intern the network reliability for Quality oriented service increases.

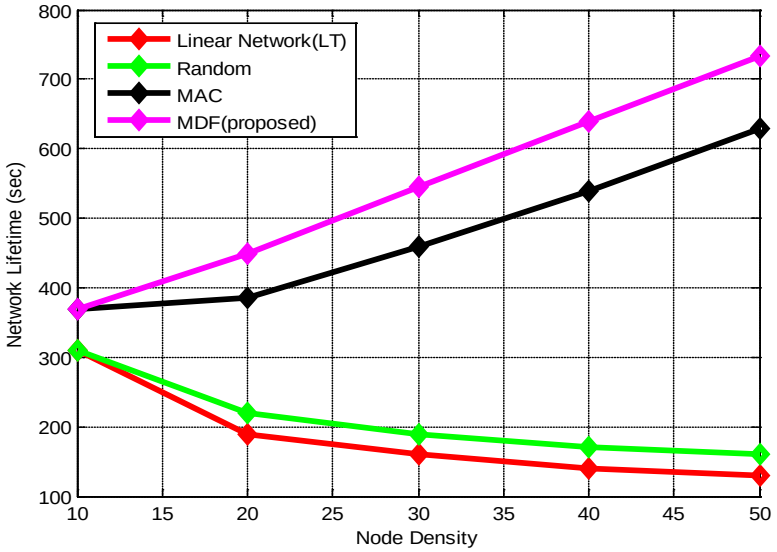

Figure 10: Network Lifetime over node density

The network life time is observed to be improved in such case. As the number of nodes are high, the network sustaining increases. In addition due to energy conservation, power is refreshed in a particular interval. These features increase the power per node in the network, hence resulting in longer life time. In comparison to the observation for network life time for a fixed node density as shown in figure 10, this network life time get increased; due to large number of node remain at higher energy level.

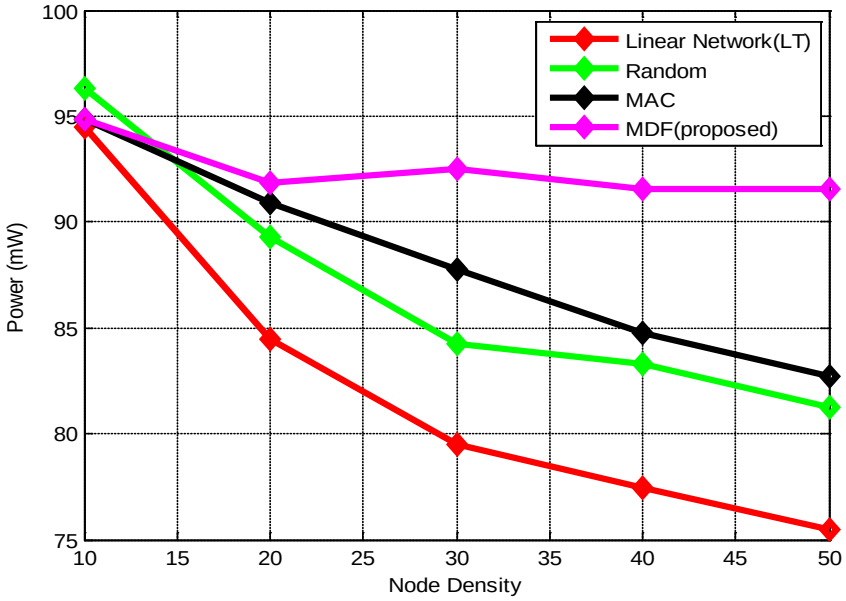

Figure 11: Power in the network over Node density

The power consumption for such network will be lowered and hence the power conserved per node gets improved. In the case of MDF driven power scheduling approach with energy conservation, the nodes are scheduled for sleep and wakeup period, as well the master node keep the energy refreshment, this result in higher power in the network, as observed in figure 11.

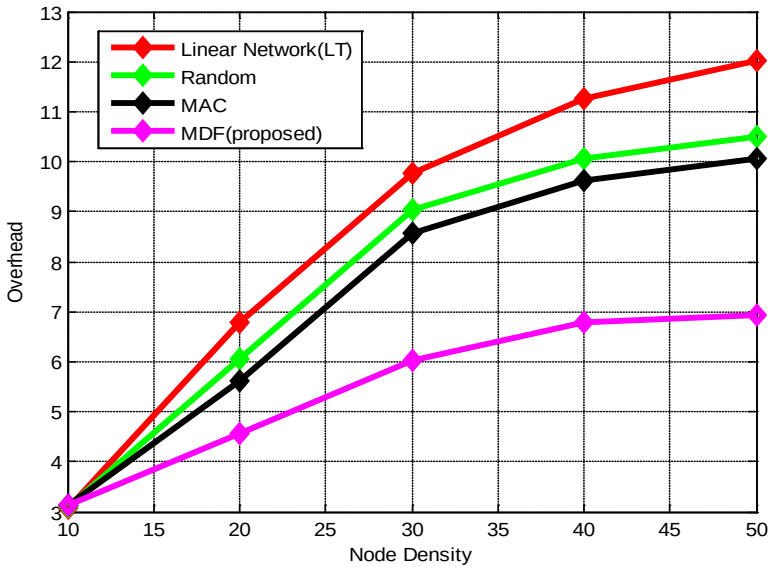

Figure 12: Network overhead with variation in Node density

The Network overhead in such case is observed to be optimized in case of the topology preserved with energy conservation. The overhead in such case is reduced, due to faster release of data, as due to availability of more nodes for data exchange as compared to its conventional counterparts.

V. Conclusion

This paper outlines a co-ordinate distribution approach to achieve the objective of fairness in heterogeneous network under mobility condition. The network is outlined with different devices of spectrum sensing with active users and junction users. To optimize the spectrum utilization in Het Net, a service level optimization coding is defined. A coding approach is used to sense free spectrum from other standing free users in other network cluster. The objective of spectrum sensing Is severed via multiple attributes monitoring, and the fairness is measured in terms of offered quality of service with higher throughput. The offered quality of service is observed in terms of service quality level, measured as a parametric value for offered service in heterogeneous network.

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Ultraviolet Photo Catalytic Oxidation (UVPCO) Sensor for Air and Surface Sanitizers Using CS amplifier

By Pawan Whig & Syed Naseem Ahmad
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GJRE-F Classification: FOR Code 090699

Strictly as per the compliance and regulations of :

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Keywords: bio aerosol, photo catalytic oxidation (PCO), hydroxyl, hydrogen peroxide, SPICE, surface sanitizer.

I. Introduction

Now day's air pollution is increasing because of harmful material in earth atmosphere causing infections, diseases, deaths, and damage to crop. These harmful material can beman-madeornatural origin. The main source of these harmful material are power plant and industrialised factories. The main air pollutant which can have adversarial effects on humans and the ecosystem are sulphur oxide (SO_X), nitrogen oxide (NO_X), carbon monoxide (CO), volatile organic compound, chlorofluorocarbons (CFCs), ammonia (NH_3) and some toxic metals. These air pollutants can have adverse effect on human health like headache, fatigue, poor memory, respiratory irritation, pneumonia in children, lung cancer, heart disease, eye and throat irritation. Hence, there is a need to purify air by using advanced process called Photo Catalytic Oxidation (PCO).

In PCO, Titanium dioxide used as a catalyst which cleans the air [1]. As air falls on this catalyst, electron will get energy and released at its surface. Then it will interact with water molecules in the air, as we know that electron having energy which breakthe water molecules into hydroxy1 radicals, hydroxide and hydrogen peroxide.

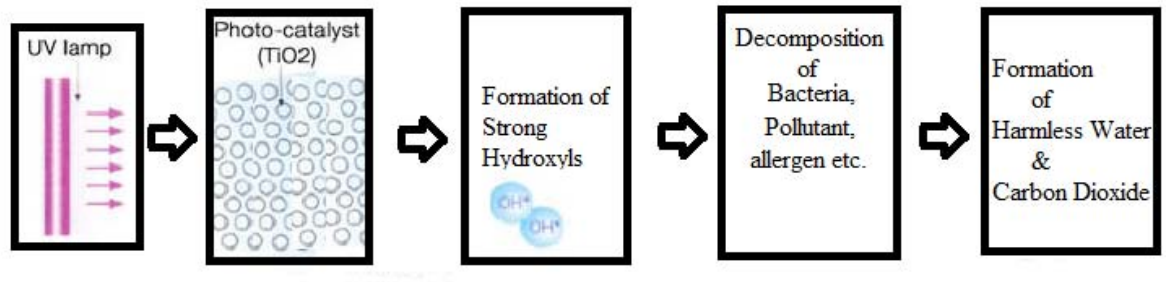

Fig.1: Process of Photo Catalytic Oxidation

Being reactive these hydroxy1 radicals attack organic pollutant molecules, breaking them into carbon dioxide and water which are harmless substance and thus help in cleaning environment. The conventional method used for TiO_2 PCO applications includes bulky and complex set ups and require ample time for computation. The complete photo catalytic oxidation process is shown in Figure 1 This process is responsible for purify air up to significant level, to measure that level there is a serious need of sensor which tell the percentage purification of air.

Semiconductor technology is very popular and widely used for sensor development as it provides an advantage of low power, high speed, small size integration and their signal processing capability. More often, Computer aided design tools are used which provide simulation and synthesis of semiconductor

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sensors [2]. Spice has built in models for most semiconductor devices but there is scarcity of appropriate models available for semiconductor sensors. This approach requires a deep knowledge of the code structure, subroutines and it is strictly linked to a particular version of Spice [3]. In this paper, spice macro model for UVPCO is used in Tanner tool version 15 for 70nm technology. This tool contains a large set of MOSFET models which operate in sub threshold region. The simplest PCS is O_2 sensitive where the sensitive surface is made up of insulator layer like Titanium Oxide (TiO_2) exposed to an electrolyte solution. A p–type semiconductor and TiO_2 insulator are placed into aqueous electrolyte solution where the response of PCS to O_2 can be explained in terms of photo catalysis. In the submicron level the thickness of gate oxide is very small in dimension. As the dimension of gate oxide decreases this results in tunneling of charge carriers which significantly increases the leakage current of MOSFETS and results in the decrease of device reliability.

One way to continue scaling is possible by using materials having much higher permittivity than silicon dioxide.

$$E_g \approx 20 \left[\frac{3}{2+\epsilon}\right]^2 \quad (1)$$

Where E_g is band gap ϵ permittivity of the dielectric.

The relationship is given in eq. 1 between the band gap and the permittivity. The inverse relation of permittivity of dielectric shows that the band gap decreases with increase in the value of permittivity. The band gap of titanium oxide is above 3.5eV which restrict tunneling. The capacitance in accumulation is generally found to depend on gate bias. But as compared to Capacitance Voltage (CV) curve of SiO_2 capacitor, this effect is less pronounced in TiO_2 capacitorsensor [7-8].

The magnitude of the interface state density for TiO_2 capacitor is given in equation (2).

$$D_{IT} = \left[\frac{G_p}{w}\right]_{w_p} [f_D(\sigma_s)]^{-1} \quad (2)$$

Where $f_D$is a peak conductance frequency given as

$$f_D(\sigma_s) = \frac{1}{2\xi_p\sqrt{2\pi}\sigma_s} \int_{-\infty}^{+\infty} e^{-\frac{\eta^2}{2\sigma_s^2}} e^{-\eta} \ln\left[1 + \xi_p^2 e^{2\eta}\right] d\eta \quad (3)$$

The width of accumulation layer is determined by the wave function of the Eigen states. The solution of the Schrodinger equation at the interface leads to Airy function which produces an average position for accumulation of carriers in the ith energy state which is given in eq. 4

$$Ei \approx \left[\frac{h^2}{8\pi^2 m^*}\right]^{\frac{1}{3}} \left[\frac{3\pi}{2} qF_s \left(i + \frac{3}{4}\right)\right]^{\frac{2}{3}} \quad (4)$$

Where q is the electron charge, F_s is the electric field at the surface, E_i is the ith energy level, m* is the effective mass and h is Plank's constant. For reasonable assumptions the accumulation layer thickness (x) should be of the order of 40 Å [9-11]. Thus the effect is small for SiO_2 layers with thickness much greater than 15 Å, while the effect is quite noticeable in much thicker TiO_2 films. Taking this effect into account a series capacitance is added to C_{ox} which is called quantum capacitance C_q.

$$\frac{1}{C_M} = \frac{1}{C_{ox}} + \frac{1}{C_q} = \frac{t_{Tio\,2}}{A\varepsilon_{Tio\,2}\varepsilon_o} + \frac{\langle x \rangle}{A\varepsilon_{Si}\varepsilon_o} \quad (5)$$

The main reason of employing a CMOS Based common source PCS circuitry, is the fact that the fluctuation of ions influences the threshold voltage, which is internal parameter of the PCS and can manifest itself as a voltage signal at output but as a function of the trans conductance .The trans conductance is a passive parameter and in order to derive voltage or current signal from its fluctuations the sensor has to be attached to conditioning and transmitting circuit.

II. Common Source Amplifier

In the case of CS amplifier, source of the input transistor is connected toground. The source is the reference point for both the input signal and for the output voltage.Gate of the input transistor is the input node; its drain is output node as shown in Figure 2.There is a resistance R between the output node and the positive supply VDD.The resistance can be realized as resistor or as transistor acting as current source. The small signal model of common source amplifier is shown in Figure 3.

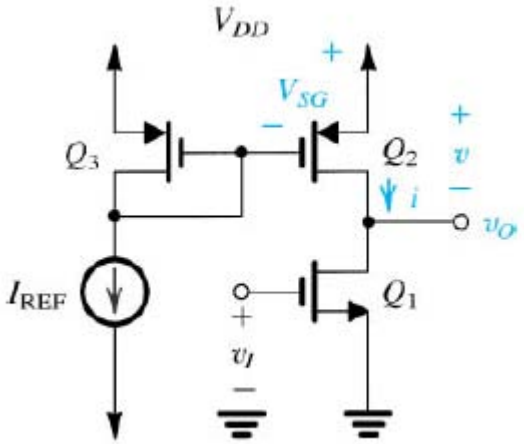

Fig. 2: Basic circuit of common source amplifier

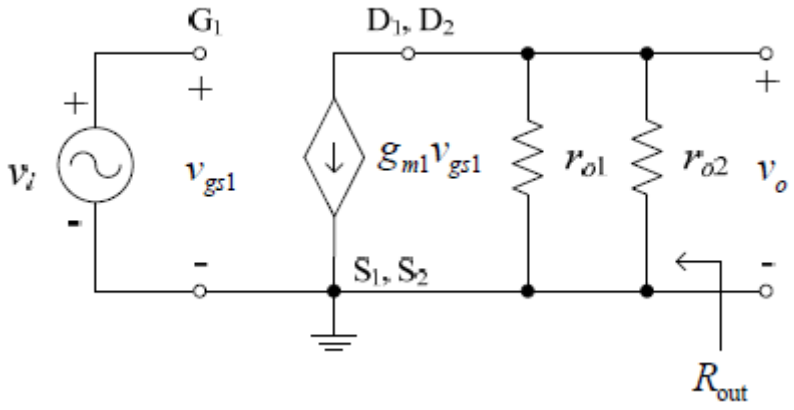

Fig.3: Small signal model of common source amplifier

$$A_{vo} = -\frac{\sqrt{2K_n\frac{W}{L}}}{\frac{1}{V_{A1}}+\frac{1}{V_{a2}}\sqrt{I_{REF}}} \quad (6)$$

$$R_{out} = r_{o1}||r_{02} \quad (7)$$

The small signal model of common source amplifier have high voltage gain, and input output resistance which increased the sensitivity of the circuit.

III. PCS Macro Model

The PCS is just like a MOSFET the only difference in their construction is that the gate terminal is connected with chip in the form of reference electrode placed in an aqueous solution. The current – voltage (CV) relationship in non-saturated mode for PCS is same as that of MOSFET as given below in eq. 8.

$$I_d = C_{ox}\mu\frac{W}{L}\left[(V_{gs}-V_t)V_{ds}-\frac{1}{2}{V_{ds}}^2\right] \quad (8)$$

Where C_{ox} is the oxide capacity per unit area, μ is the electron mobility in the channel, W and L the width and the length of the channel, respectively. In the above relation I_d is made sole function of V_{gs} only if all other parameters like $\beta = \mu\, C_{ox}W/L$, $V_{ds,}V_t$ are taken constant. The relationship of threshold voltage with other parameters is given below in eq. 9.

$$V_t = \frac{\phi_M-\phi_{si}}{q}-\frac{Q_{ox}+Q_{ss}+Q_B}{C_{ox}}+2\phi_f \quad (9)$$

Where

ϕ_M: work function of gate metal.

ϕ_{si} : work function of silicon gate.

Q_{ox}: oxide charge.

Q_{ss} : Interface charge carriers.

Q_B : depletion charge carriers.

The fabrication steps follows in PCS is same as MOSFET, as a result of which the threshold voltage equation of PCS resembles with MOSFET. Although the concept of forming the equation is same but there are two additional terms added.

(1) Constant reference electrode potential $E_{ref.}$

(2) Interfacial potential which consists of chemical input parameter (Ψ) which depends upon concentration of O_2in the solution and surface dipole potential(χ^{sol}).

The above mentioned two parameters along with eq. 9 constitute the resultant threshold eqn. of the PCS shown below in eq. 10.

$$V_{th\,(PCS)} = E_{Ref}-\Psi_{sol}+\chi^{sol}+\frac{-\phi_s}{q}-\frac{Q_{ox}+Q_{ss}+Q_B}{C_{ox}}+2\phi_f \quad (10)$$

According to the characteristics of the MOSFET gate to source voltage, Vgs known as reference voltage drain current is allowed to vary with drain to source voltage keeping reference voltage constant. Comparing PCS with MOSFET keeping the concentration of O_2 = $1_{mg/l}$ it is found that the curve resembles with the characteristic Vds /Ids curve of MOSFET keeping Vgs constant as shown in Fig.4. Now keeping the reference voltage Vgs=0 it is observed that for different concentration levels of O_2 , different Vds/Ids curves are obtained as shown in Fig.5. From the above it is observed that as the oxygen concentration level decreases saturation cut off current I_{ds} increases hence it is concluded that PCS can be treated as MOSFET on the basis that the chemical input parameter $\Psi_{sol}$is a functionof O_2 (Ψ_{sol} = f (Oxygen)).

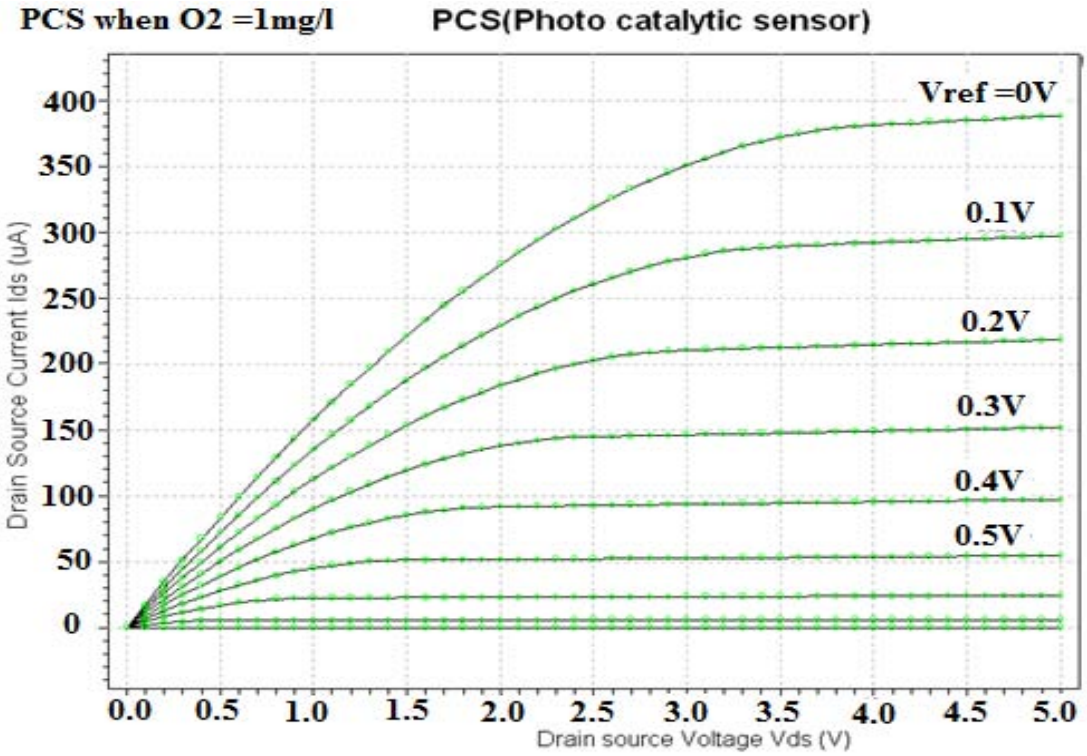

Fig. 4: Id/Vds curves can be recorded as function of Vgs

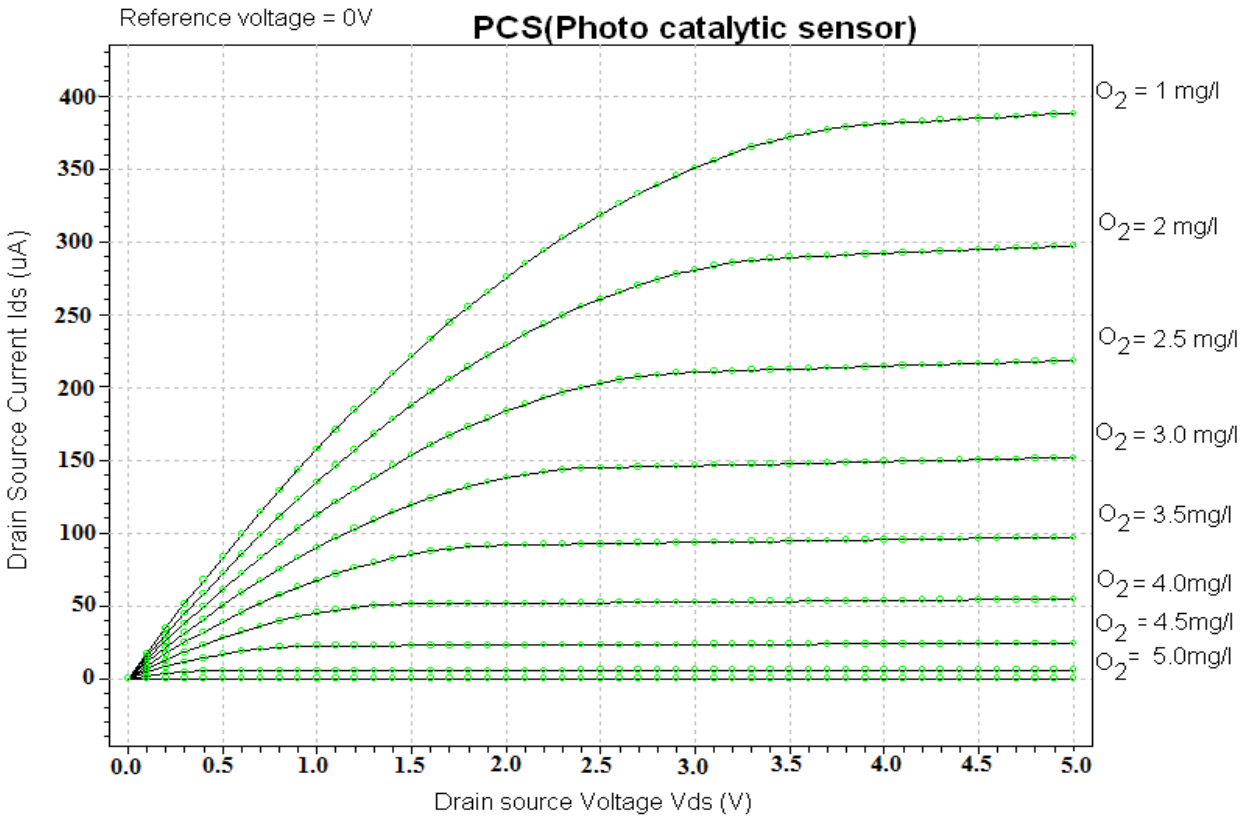

Fig.5: Id/Vds curves when the reference electrode connected to the source (Vgs = 0)

IV. Device description and Analysis

The PCS generates potential proportional to activity of detected oxygen ion. Potential in PCS is measured against the reference electrode. The common source configuration has been used to measure the change in the concentration of dissolved oxygen through a corresponding shift in the device threshold voltage. The sensing readout circuit detect the ion concentration of the solution with the feature of CVCC operation mode and floating reference electrode which made the design simple and robust. In this configuration, two constant voltage sources 0.7V and 0.2V are fed to the two positive terminals of the amplifiers causes the drain terminal and the source terminal of the PCS to keep a constant drain source voltage difference of 0.5V.To maintain and operate the PCS in the linear region, the gate to source voltage variation of PCS threshold voltage should be directly proportional to the variations of the dissolved oxygen values. Potential difference between the gate sensing membrane and the reference electrode is determine by the ion concentration of the solution. The readout circuit is to be implemented by integrated circuit. The measured signal is the output from amplifier

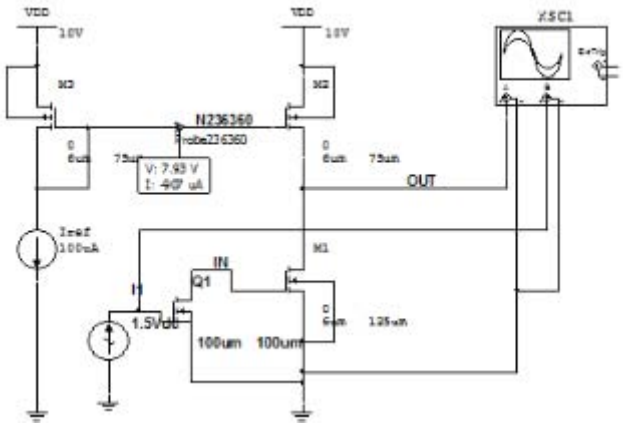

Fig. 6: Simulated Circuit diagram of PCS

a) Fourier analysis

Fourier analysis is a method of analysing complex periodic waveforms. It permits any non-sinusoidal period function to be resolved into sine or cosine waves and a DC component. This permits further analysis and allows you to determine the effect of combining the waveform with other signals. Each frequency component of the response is produced by the corresponding harmonic of the periodic waveform. Each term is considered a separate source. According to the principle of superposition, the total response is the sum of the responses produced by each term. It is observed that, amplitude of the harmonics decreases progressively as the order of the harmonics increases. This indicates that comparatively few terms yield a good approximation. Fourier analysis of the device is shown in Figure 7.

PCS- CS amp

1	Fourier analysis for V(out):					
2	DC component:	4.90294				
3	No. Harmonics:	9				
4	THD:	290.589 %				
5	Grid size:	256				
6	Interpolation Degree:	1				
7						
8	Harmonic	Frequency	Magnitude	Phase	Norm. Mag	Norm. Phase
9	1	1000	0.0855345	-92.541	1	0
10	2	2000	0.0876052	-94.58	1.02421	-2.0395
11	3	3000	0.0851216	-95.947	0.995172	-3.406
12	4	4000	0.0847375	-97.886	0.990683	-5.3457
13	5	5000	0.084285	-99.878	0.985393	-7.3373
14	6	6000	0.110092	109.89	1.28711	202.43
15	7	7000	0.0831564	-103.86	0.972198	-11.315
16	8	8000	0.0825704	-105.93	0.965346	-13.392
17	9	9000	0.0819833	-108.03	0.958483	-15.485
18						

Fig. 7: Fourier analysis of the device

b) Monte Carlo analysis

Monte Carlo Analysis is a statistical technique that explore how changing component properties affects circuit performance. Monte Carlo Analysis will perform DC, AC or Transient Analysis and vary the component properties. The Triangular outcome defines the minimum, most likely, and maximum values. The Monte Carlo analysis of the device is shown in figure 8. Values around the most likely are more likely to occur. Variables that could be described by a triangular distribution include past information about signal per unit of time. In Monte Carlo simulation, it's easy to see which inputs had the biggest effect on bottom-line results.

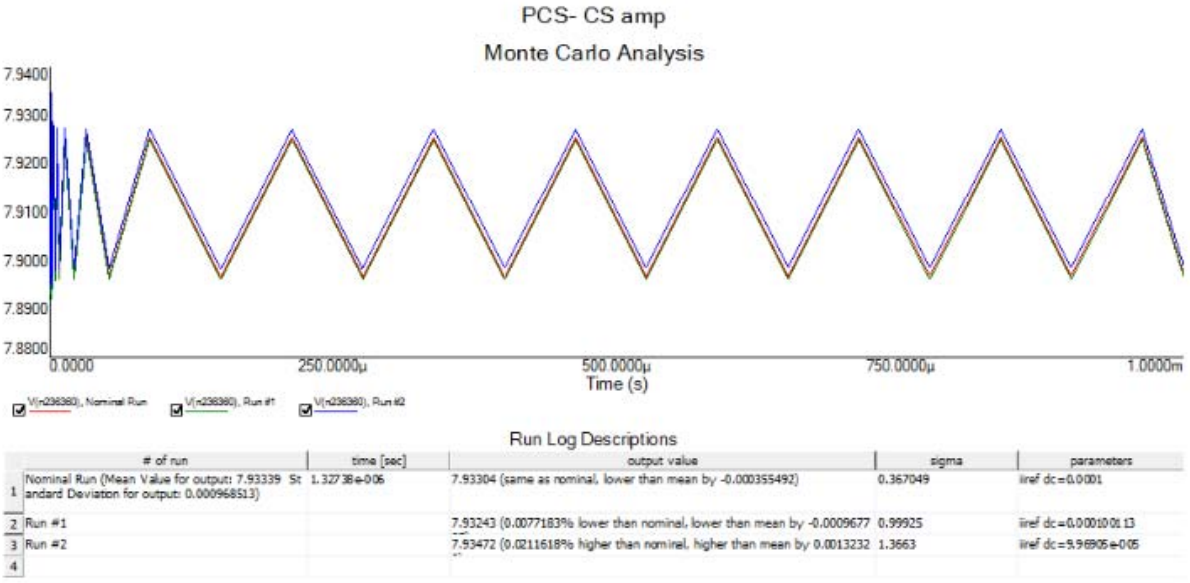

Fig. 8: Monte Carlo analysis of the device

c) Temperature Sweep

Using Temperature Sweep Analysis, one can quickly verify the operation of circuit by simulating it at different temperatures. The effect is the same as simulating the circuit several times, once for each temperature. Figure 9 shows the variation of output with temperature for a given device. It is found that as the temperature increases, the output of the device decreases.

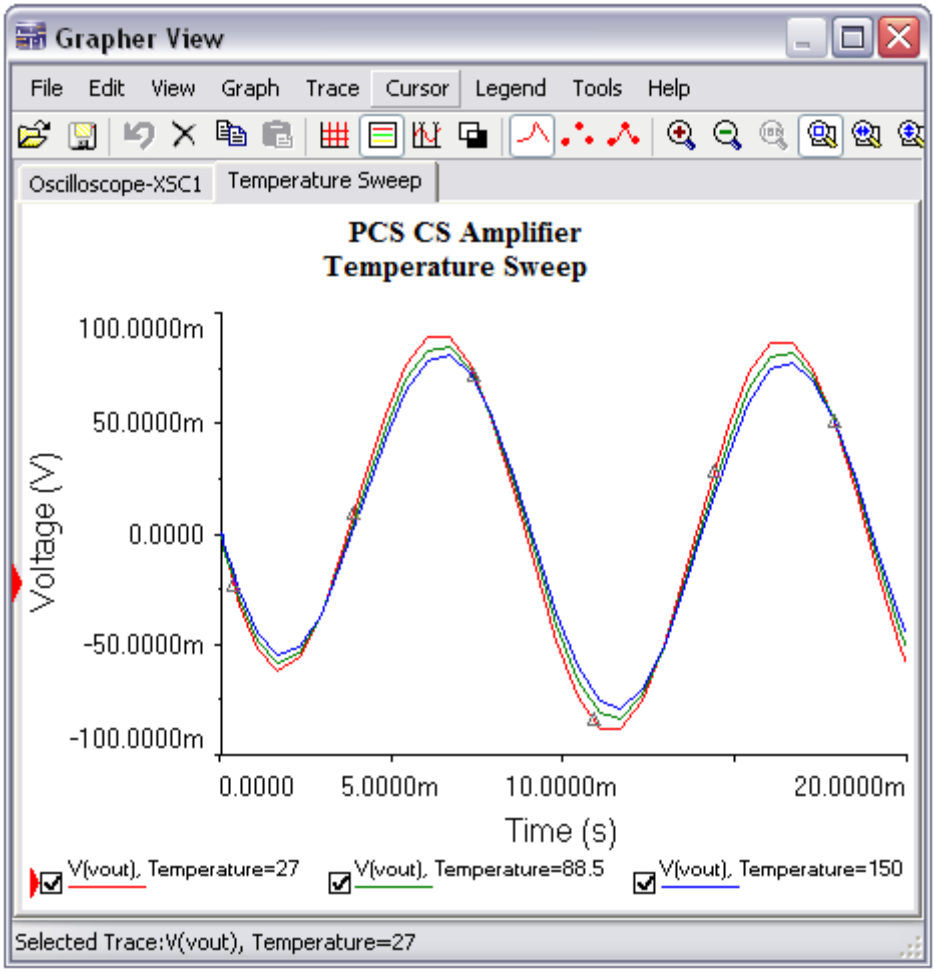

Fig. 9: Temperature sweep analysis of the device

d) AC Analysis

AC Analysis is used to calculate the frequency response of linear circuits. In AC Analysis, the DC operating point is first calculated to obtain linear, small-signal models for all nonlinear components. Then a complex matrix (containing both real and imaginary component parts) is created. To construct a matrix, DC sources are given zero values. AC sources, capacitors, and inductors are represented by their AC models. Nonlinear components are represented by linear AC small-signal models, derived from the DC operating point solution. All input sources are considered to be sinusoidal. The frequency of the sources is ignored. If the function generator is set to a square or triangular waveform, it will automatically switch internally to a sinusoidal waveform for analysis. AC Analysis then calculates the AC circuit response as a function of frequency. AC analysis of the given device is shown in Fig. 10.

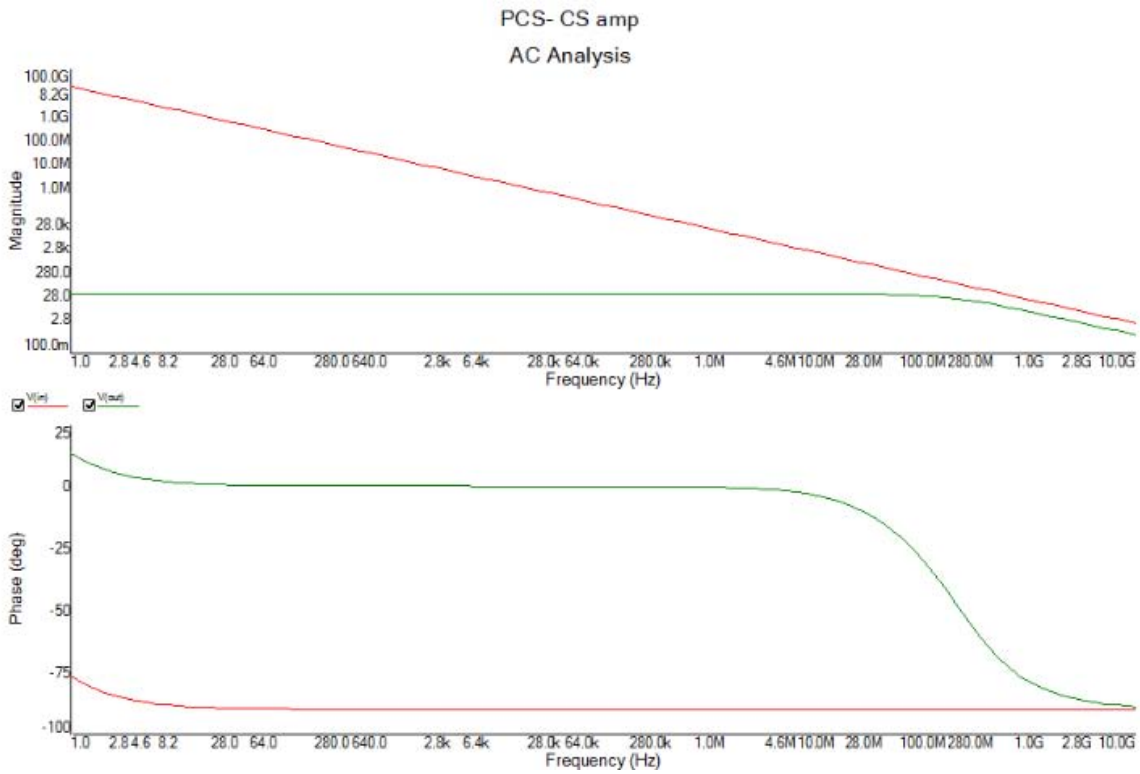

Fig. 10: AC analysis of the device

The Regression statistics including multiple R, R square Adjusted R square and Standard error obtained during experiment is shown in Table 1.

Table 1: Regression Statistics

Regression Statistics	
Multiple R	0.983
R Square	0.966
Adjusted R Square	0.960
Standard Error	0.026
Observations	8.000

Table 2: Variation of Oxygen concentration with maximum current decrease

Oxygen Concentration	Maximum Current decrease
0	0
0.5	0.08
1	0.16
1.5	0.21
2	0.216
2.5	0.32
3	0.35
3.5	0.37

e) Normal Probability Plot

The normal probability plot is a special case ofthe probability plot. The points on this plot form anearly linear pattern, which indicates that the normaldistribution is a good model for this data set. The normalProbability plot for the device is plotted and shownin Figure 6.

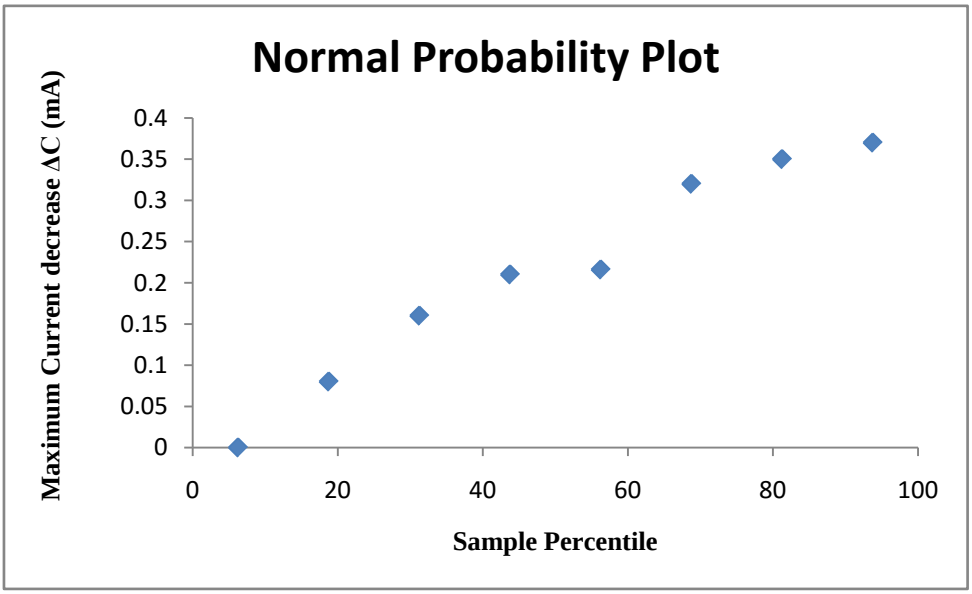

Fig. 11: Normal Probability Plot

On plotting a linear trend line between ΔC and ΔO_2 the coefficient of determination R^2 is found to be 99.57% with standard error of 0.081 shown in Figure 7. The coefficient of determination R^2 is useful because it gives the proportion of the variance (fluctuation) of one variable that is predictable from the other variable. It is a measure that allows us to determine how certain one can be in making predictions from a certain model.

The coefficient of determination is a measure of how well the regression line represents the data. If the regression line passes exactly through every point on the scatter plot, it would be easy to explain all the variations.

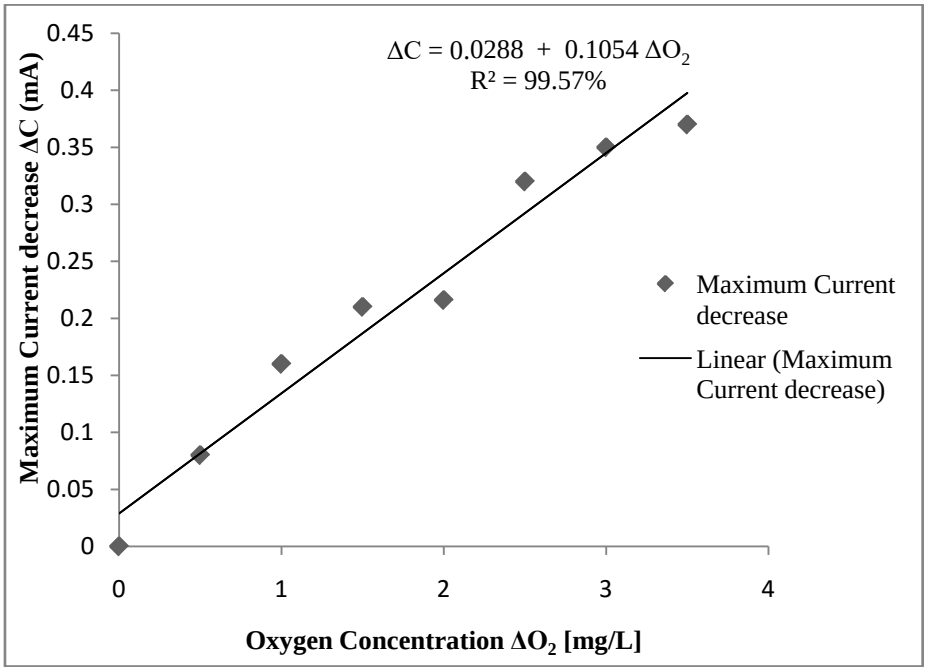

Fig. 12: Trend line between ΔC and ΔO_2obtained from SPICE model

f) Residual plot

A residual plot between output and input shows that for a regression model to be good fit when residuesare random. There should be no recognizable pattern. Good regression models give uncorrelated residuals.

The residual Plot for the device is plotted and shown in given Figure 8.

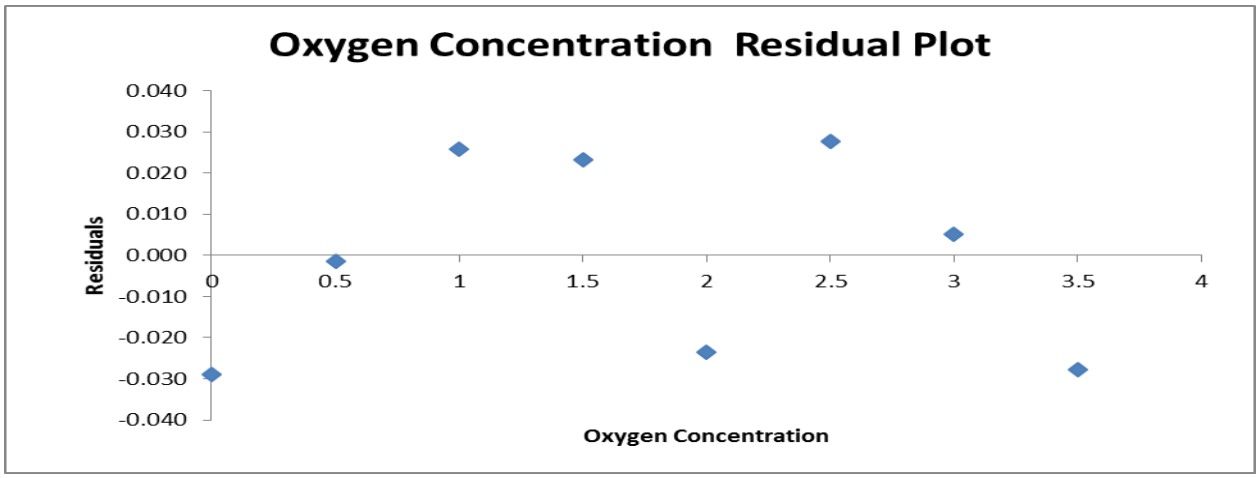

Fig. 13: Residual plot for Oxygen Concentration

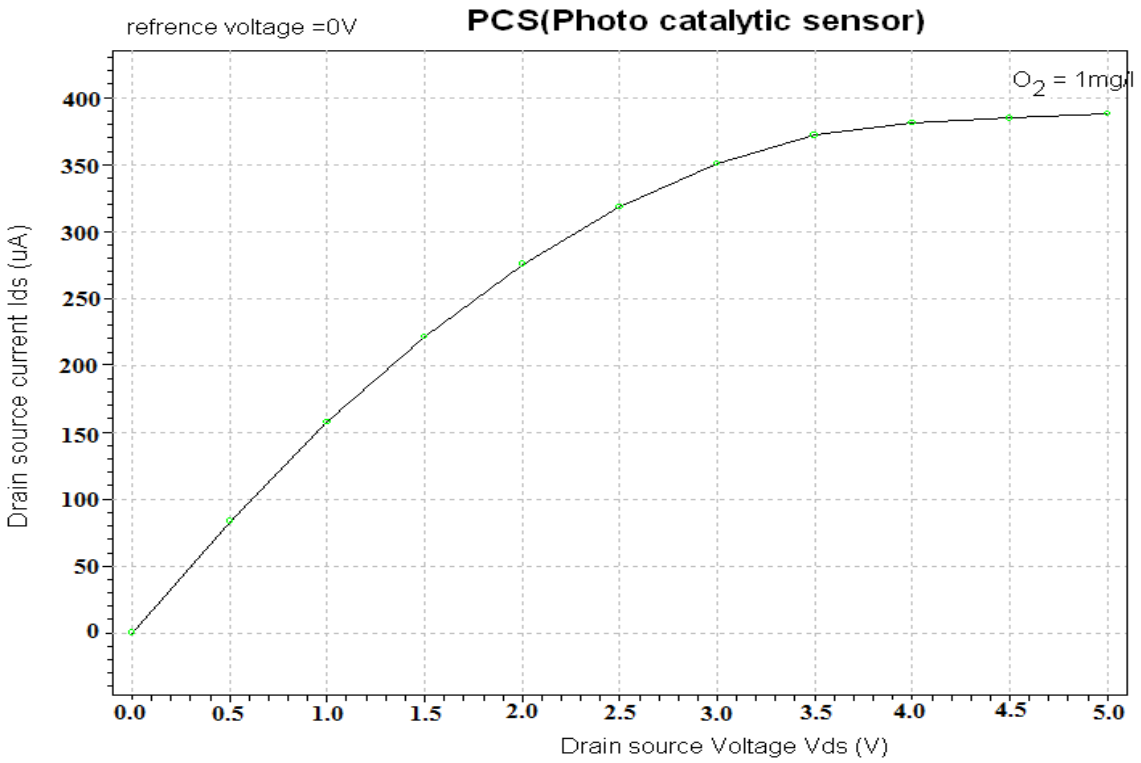

Fig. 14: Waveform between I_{ds} and V_{ds} at O_2 =1mg/l

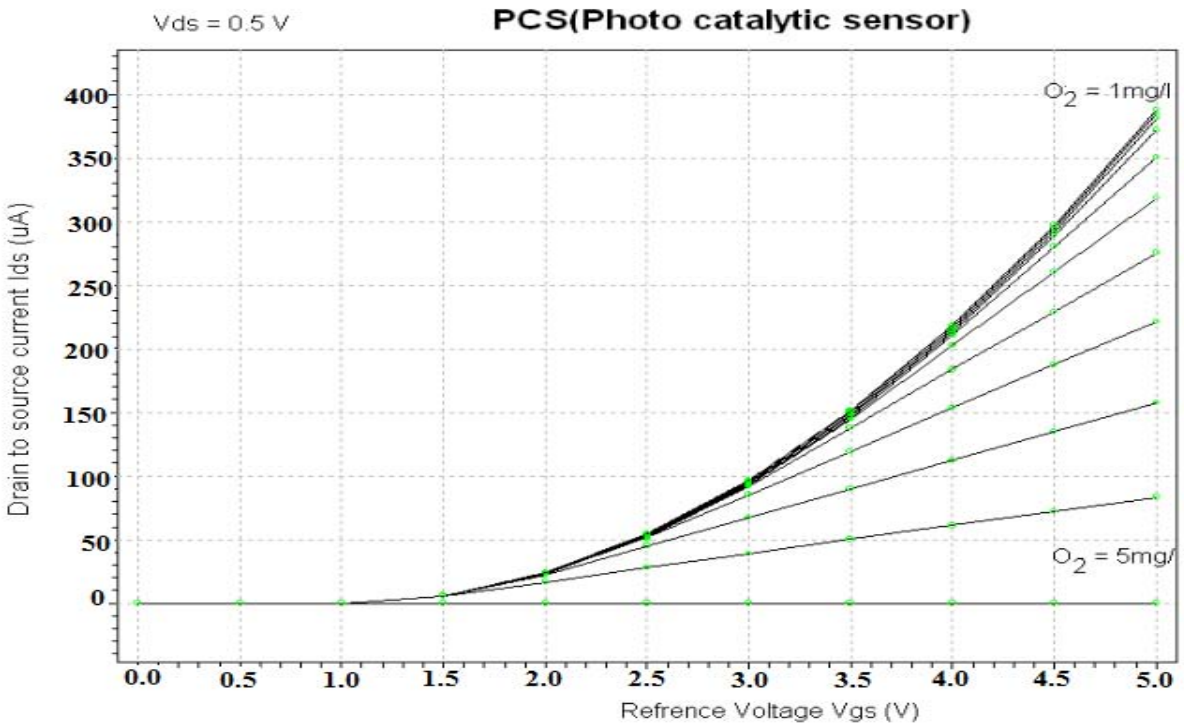

Fig.15: Waveform between Id and Vgs at O_2 =1-5 mg/l

V. Results & Discussion

The simulation results have been compared both with experimental data and with the previously validated physicochemical model results. The relationship between drain current (I_d) and gate to source voltage (V_{ds}) is shown in Fig.9. in which at fixed value of O_2=1mg/l the Value of I_d varies directly with V_{ds}. also, the relationship of I_d with V_{gs} is shown in the Fig. 10 which shows that PCS exhibits linear characteristic in the range of V_{gs} = 2.5V to 5.0V this is an improvement over FIA. Fig.10. is a family of curves for O_2 concentration from 1mg/l to 5mg/l. The curves are drawn between I_{ds} and V_{gs} of PCS for V_{ds}=0.5V it can be seen that the proposed PCS is extremity linear for concentration more than 1mg/l extending towards 5mg/l of O_2. This is an obvious advantage of this PCS model over the other models discussed in the introduction. The linear variation of I_{ds} facilitates high accuracy measurements of quality of air. In addition the calibration of the instrument is also easier due to this linear behavior.

VI. Conclusion

In this paper a simple and powerful approach to develop simulated computer models of bio- electronic sensors such as UVPCS using CMOS common source is shown. This approach relies on the Spice model .The developed macro model can be easily extended for simulating non- ideal behaviors and temperature dependence of the available sensors. This study may be extended and more improvement in terms of power and size can be achieved at layout level and thus more effective results may be obtained.

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Appendix

The SPICE model of a PCS includes a variety of parasitic circuit elements and some process related parameters in addition to the elements previously discussed in this paper. The syntax of a PCS includes several parameters, which can be specified to enhance the accuracy of the model. The commonly used parameter list is given below. The spice code used during the simulation process is also given below to specify the process and technology related parameters of the PCS.The SPICE parameters in this work have been set for the specific example. If some another sensitive layer of material is considered for PCS, then some electrochemical parameters have to be changed i.e., the dissociation constant, surface site densities and some other parameters values have to be adjusted.

Spice code for PCS

```
.model nmos external winfile="mos1.dll"
+   type=str("nmos")
+   Vto=1.0          Kp=3.0E-5                Gamma=0.35
+   Phi=0.65         Lambda=0.02              Tox=0.1u
+   Nsub=1.0E+15     Nss=1.0E+10              Ld=0.8u
+   Tpg=1.00         Uo=700.0        Af=1.2
+   Kf=1.0E-26       Is=1.0E-15               Js=1.0E-8
+   Pb=0.75          Cj=2.0E-4                Mj=0.5
+   Cjsw=1.00E-9     Mjsw=0.33       Fc=0.5
+   Cgbo=2.0E-10     Cgdo=4.00E-11            Cgso=4.00E-11
+   Rd=10.0          Rs=10.0                  Rsh=30.0
.SUBCKT PCS 6 1 3 4 101
*drain<ref.el<source<bulk<PCS
+ q=1.6e-19 NAv='6.023e23*1e3'
+ epsw=78.5
+ Cbulk=0.1 Cox= 0.2    Cq=0.3
+ Eabs=4.7 Phim=4.7 Erel=0.200 Chieo=3e-3 Philj=1e-3
+ ET='q/(k*T)'
+ sq='sqrt(8*eps0*epsw*k*T)'
+ KK='Ka* Kb'
+ C_M='1/(1/Cox+1/Cq)'
+Cin = Cgs + CM1
+Cout = Cds + CM2
Eref 1 10 VOL='Eabs-Phim-Erel+Chieo+Philj'
Ceq 10 2 C='1/(1/Cox+1/Cq)'
.end
x1 d g s b nmos l=5u w=5u
vd d 0 5
vg g 0 5
```

```
vs s 0 0
vb b 0 0
.dc vd 0 5 0.1 vg 0 5 0.5
.print dc i1(x1)
.ends
```

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Design and Analysis of Small Hydro Power for Rural Electrification

By Alie Wube Dametew
Wollo University KioT

Abstract- Hydropower, large and small, remains by far the most important of the "renewable" for electrical power production worldwide. Small-scale hydro is in most cases "run-of-river", with no dam, and is one of the most cost-effective and environmentally benign energy technologies to be considered both for rural electrification in less developed countries and developed countries for further hydro developments countries(like Ethiopia). This paper addresses power generation for rural applications by means of small hydropower plants by using cross-flow turbine systems .The cross-flow turbine is suitable for installing small hydro-electric power plants in case of low head and flow rate. Using mathematical analysis a complete design of such turbines has been done in this paper.

Keywords: *design and analysis, hydro power, rewnable energy.*

GJRE-F Classification: *FOR Code: 290901*

Strictly as per the compliance and regulations of :

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Chapter-One

I. Introduction and Back Ground of the Study

a) Introduction

The demand for energy is growing throughout the world. A combination of population growth, desire for improved living standards, and public policy has increased interest in green energy sources. Reliable access to electricity is a basic precondition for improving people's lives in rural and urban areas, for enhanced health care and education, and for growth within local economies (By Ryan Cook, 2012). At present, more than 1.5 billion people worldwide do not have access to electricity in their homes (Kari Sørnes, 2010). An estimated 80% of these people live in rural areas; most have scant prospects of gaining access to electricity in the near future. According to International Energy Agency projections, by 2030, the number of people without electricity is not likely to drop due to population growth (www.ruralelec.org). Hence Electrical energy is an essential component in the developing process of any given location of the globe. Therefore, rural electrification remains an important issue in many countries. More often rural areas, which can also be seen as developing areas, are prone to several electrification problems and a common alternative to this has been for decade the use of diesel power supplies. However, diesel supplies are environmentally not friendly, less reliable and less efficient. A better alternative could be the use of renewable energy sources (such as, hydro-turbine, Biomass and wind-turbine), in order to achieve optimum system design in terms of cost and efficient load demand satisfaction.

b) Back Ground of the Study

Hydro-power is considered as one of the most desirable source of electrical energy due to its environmental friendly nature and extensive potential available through out the world. Within the scope of hydro-electric power, small power plants have gained much attention in recent years. Small Hydro power Plants, being a mature technology may be optimally employed for sustainable power generation in rural communities in world wide. Hydropower plants convert potential energy of water at a height to mechanical energy which is used to turn a turbine at a lower level for generation of electricity (Anyaka Boniface Onyemaechi, 2013). In rural areas, small run-of-river hydro turbine is suitable for electrification because it is green, inexpensive, not fuel dependent, and is simpler to implement than other green energy technologies. A small hydropower scheme requires both water flow and a drop in height called a head to produce useful power. Water in nature is considered a source of power when it is able to perform useful work, particularly turn water wheels and generate electricity at a rate such that the development of power can be accomplished in a most efficient and economical way(Adejumobi, I.A, (2011). The research concerns to generate electric power From Small rivers and waterfalls could generate electricity to energize many off-grid rural areas in Ethiopia.in addition to this the power gereateted by constracting small dam or by the water water fill with two Continaeres and circulating them, and then to generet Power.

c) Problem Statement

In our country rural electrification will always be a challenging responsibility, due to reasons such as:

- The spreading of the villages
- The complications with grid extension alternatives

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- The relatively high electrification cost, especially for customers with low income
- The limitations of diesel power. However, substantial amount of Hydro -power is usually available in rural areas, and electric power generation systems are often installed in these areas but still it is cost. Local electricity generation from hydro-turbine(Hydro powe) could overcome the above drawbacks and provide better economical alternative for the electrification system in remote and rural areas. This paper shows the design, analysis and fabrication of small rural hydro-turbine electric power system.

d) Objective of the study

The main objective of the study is to design and Analysis of small scal hydro power.

i. Specific objective of the paper

- Select the proper materials for production of small rural electric power
- Design , and analysis of \ small hydro turbine rural electric power
- Contribute rural electrification system
- To develop a sustainable, environmentally friendly alternative Renewable energy production (Contribute green environment /environmental friendly).

e) Scope of the paper

- ✓ Select proper material for small Hydro pwer
- ✓ Asses the potentials and Impacts of Small Hydro power for development
- ✓ Design and analysis of small rural electric power
- ✓ System Design of Samall hydro power

f) Research Methodology

- In order to solve problems, engineers follow and apply different procedure and principles based on the problem identifications. This project focus on the following activities
- Collecting relevant data related to hydro power
- Design, analysis of hydro-turbine systems using mathematical and Numerical Methods(Matlab)
- Drive systems and opraing principls
- Hydro-turbine system Design and Development
- Prepare Fabrication procedure each elements of hydro turbine components
- Sammury and conclusion of the project

II. Literature Review

a) General

Hydropower energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy is used, it will be one of most important supplies of energy specially when other sources in the country have depleted. hydroelectric power comes from water at work, water in motion. it can be seen as a form of solar energy, as the sun powers the hydrologic cycle which gives the earth its water. In the hydrologic cycle, atmospheric water reaches the earth's surface as precipitation [Adejumobi, I.A,2011]. Some of this water evaporates, but much of it either percolates into the soil or becomes surface runoff. Water from rain and melting snow eventually reaches ponds, lakes, reservoirs, or oceans where evaporation is constantly occurring. Moisture percolating into the soil may become ground water (subsurface water), some of which also enters water bodies through springs or underground streams. Ground water may move upward through soil during dry periods and may return to the atmosphere by evaporation. Water vapor passes into the atmosphere by evaporation then circulates, condenses into clouds, and some returns to earth as precipitation. Thus, the water cycle is complete. Nature ensures that water is a renewable resource.

Current hydro power status (World Wide)

Hydropower, large and small, remains by far the most important of the 'renewables' for electrical power production worldwide. The World Hydropower Atlas 2000, published by the International Journal of Hydropower and Dams, reported that the world's technically feasible hydro potential is estimated at 14,370 TWh/year, which equates to 100% of today's global electricity demand. The economically feasible proportion of this is currently considered to be 8080 TWh/yr. The hydropower potential exploited in 1999 was 2650 TWh/yr, providing 19% of the planet's electricity from an installed capacity of 674 W. 135 W of new hydro capacity is expected to be commissioned in the period 2001–10. All other renewable combined provided less than 2% of global consumption. As illustrated in Fig. 1,

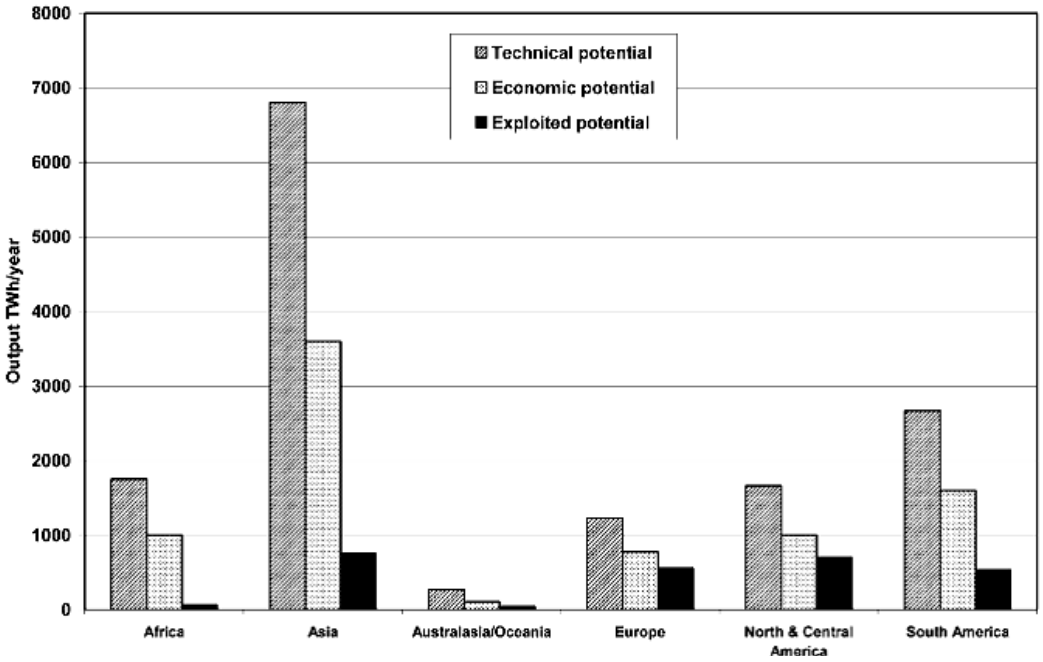

Fig. 1: Exploited hydro potential by continent

North America and Europe have developed most of their economic potential, but huge resources remain in Asia, Africa and South America. Small hydro (<10 MW) currently contributes over 40 GW of world capacity. The global small hydro potential is believed to be in excess of 100 GW. China alone has developed more than 15 GW, and plans to develop a further 10 GW in the current decade.

Small-scale hydro Hydropower (World wide)

Hydropower on a small-scale is one of the most cost-effective energy technologies to be considered for rural electrification in less developed countries. It is also the main prospect for future hydro developments in Europe, where the large-scale opportunities have either been exploited already, or would now be considered environmentally unacceptable. Small hydro technology is extremely robust (systems can last for 50 years or more with little maintenance) and is also one of the most environmentally benign energy technologies available [Anyaka Boniface,2013]. The development of hydro-electricity in the 20th century was usually associated with the building of large dams. Hundreds of massive barriers of concrete, rock and earth were placed across river valleys world-wide to create huge artificial lakes. While they created a major, reliable power supply, plus irrigation and flood control benefits, the dams necessarily flooded large areas of fertile land and displaced many thousands of local inhabitants [Igbinovia, S.O,2007]. In many cases, rapid silting up of the dam has since reduced its productivity and lifetime. There are also numerous environmental problems that can result from such major interference with river flows. Small hydro is in most cases 'run-of-river'; in other words any dam or barrage is quite small, usually just a weir, and generally little or no water is stored[Ryan Cook,2012]. The civil works purely serve the function of regulating the level of the water at the intake to the hydro-plant. Therefore run-of-river installations do not have the same kinds of adverse effect on the local environment as large hydro. Hydropower has various degrees of 'smallness'. To date there is still no internationally agreed definition of 'small' hydro; the upper limit varies between 2.5 and 25 MW. A maximum of 10 MW is the most widely accepted value worldwide, although the definition in China stands officially at 25 MW. In the jargon of the industry, 'mini' hydro typically refers to schemes below 2 MW, micro-hydro below 500 kW and pico-hydro below 10 kW. These are arbitrary divisions and many of the principles involved apply to both smaller and larger schemes (Oliver Paish,2002).

Table 1: The Development and Current hydro power status in Ethiopia

Population	91,195,675
Area	1,104,300 km^2
Topography	High plateau with central mountain range divided by Great Rift Valle High plateau with central mountain range divided by Great Rift Vally.
Rain Pattern	Mean annual rainfall ranges from 2,000 mm over some pocket areas in the southwest highlands, and less than 250 mm in the lowlands. In general, annual precipitation ranges from 800 to 2,200 mm in the highlands (altitude >1,500 m) and varies from less than 200-800 mm in the lowlands (altitude <1,500 m).2 Parts of Ethiopia have uni-modal and others bimodal rainfall patterns.

Source: World Small Hydropower Development Report 2013.

The Ethiopian government has for long recognized that economic progress will depend principally on the development of the hydropower resources of the country. Ethiopia is endowed with abundant water resources distributed in many parts of the country however, it has not made significant progress in the field of water resources development during the past four decades. In particular, the exploitation of hydropower potentials was not noticeably successful in spite of being given priority as a major field of national development Considering the substantial hydropower resources, Ethiopia has one of the lowest levels of per capita electrical consumption in the world. Out of hydropower potential of about 15,000-30,000 MW, only about 360 MW (i.e. less than 2 percent) has been exploited by 1997 (Table 1).

Table 2: Hydropower Plants and Installed Capacity

Plant	System	Installed Capacity MW	Guaranteed Capacity MW	Energy Generation in GWH/year	Year of Commission
Finchaa HPP	ICS	100	100	616	1973
MelkaWakena HPP	ICS	153	148	434	1988
AwashII HPP	ICS	32	26	135	1966
AwashLII HPP	ICS	32	32	135	1974
Koka HPP	LCS	43.2	25	70	1960
TisAbbay I HPP	ICS	11.4	3.8	27	1964
Total ICS		371.6	334.8	1,417	
Yadot HPD	SCS	0.35	0.3,5	1.2	1990
Sor HPP	SCS	5	5	48	1990
Dembi HPP	SCS	0.8	0.8	2.8	1991
Total SCS		6.15	6.15	52	
Grand Total		377.75	340.95	1,469	

Presently, more than 90% of energy consumed in the country is derived from biomass fuels and is almost entirely used for cooking. The use of these fuels has resulted in massive deforestation and soil erosion. The population of Ethiopia was estimated in 1995 at 57 million and is thought to be growing at an annual rate of about 3.1%. In recent years, since the country has merged from the drought and civil war of the 1980's and since the implementation of a comprehensive program of economic reform, the economy has recuperated and is now growing. Such economic growth is essential to lift the people from severe poverty but can only be sustained by adequate infrastructures and in particular adequate supplies of electrical energy. The expected continued economic growth (in an environment of power shortage that had recently resulted in rationing) coupled with the rapid expansion of the transmission grid, will increase the number of consumers and thus the total energy demand in the next few years. This condition should evidently lead to an energy development program for accelerating the development process notably in the undertaking of studies and preparation of detailed engineering designs of hydropower projects that could be implemented within the shortest possible time. The major electric power planning and market survey study conducted so far had forecasted power and energy demand and supply to the year 2040. A 1993 forecast predicted the possibility of both power and energy shortages being very acute starting from 1995. The existing power generation in Ethiopia and the projected energy requirements from the .year 1990 through 2040 indicate and prove that the power generation needs to be increased by 4 times by the year 2000, more than 14 times by 2020 and about 25 times

by 2040. To overcome the deficiency in electric power supply, in Ethiopia, special attention has, recently, been given by the government to Medium Scale Hydropower Development (MSHD) in the range of 40 MW to 60 MW capacities, (rather than Large Scale Hydropower Development Schemes). Experience has shown that the latter require huge investment, lengthy processes for securing finances as well as longer construction periods which might consequently not meet and fulfill the targeted demands for electricity in the different regions of the country within the shortest possible time. With this set goal, for surmounting the acute shortage in hydroelectric energy in Ethiopia, the government has given priority to the development of a number of favorably and fairly distributed hydropower resources. The rapid development of these schemes will definitely promote and speed up National and Regional developments at different and strategic river basins which is one of the government's program for harnessing the immense water resources potential of the major river basins of Ethiopia. Under the Ethiopian Government's Emergency Program, following the detailed reconnaissance studies, hydropower potential sites within Tekeze, Gojeb and Abbay River Basin had been identified and accordingly the selected sites, one in each basin, are now being looked into in detail in order to clear ground for effective implementation. The hydroelectric potential of Ethiopia is very considerable and is presented in Table 2. The total production of the above mentioned hydropower plants is 1,469.0 GWh/yr. (1994-1995).

Table 3: Hydropower Potential of Ethiopia

Name of River Basin	Number of Potential Sites				Technical Hydropower Potential (GWh/year)	Percentage Share of the Total %
	Small Scale 40 MW	Medium Scale 40-60 MW	Large Scale > 60 MW	Total		
Abbay	74	11	44	129	78,800	48.9
Rift Valley Lakes	7	-	1	8	800	0.5
Awas	33	2	-	35	4,500	2.8
Omo – Gibe	4	-	16	20	35,000	22.7
Genale – Dawa	18	4	9	31	9,300	5.8
Wabi Shebelle	9	4	3	16	5,400	3.4
Baro Akabo	17	3	21	41	18,900	11.7
Tekeze – Angereb	11	1	8	20	6,000	4.2
Total	173	25	100	300	159,300	

Ethiopian Projects Identified for Power Development The Hydropower Potential of Ethiopia indicate

Ethiopia has a vast hydropower potential, which is estimated to be about 15,000 - 30,000 MW. So far very little percentage (less than 2%) of the vast potential has been harnessed. In order to develop this vast potential of power several projects have been initiated to generate more and more hydroelectric power. Some 300 hydropower plant sites in the whole eight river basins of the country with a total technical power potential of 159,300 Gwh/year have been identified. Out of these potential sites, 102 are large scale (more than 60 MW) and the rest are small (less than 40 MW) and medium scale (40-60 MW) hydropower plant sites (See Table 1.2).

Ethiopian Electricity sector overview After 2008

In 2009, 89 per cent of Ethiopia's population lived in rural areas and rural electrification was estimated at a mere 2-per cent (Gaul, 2010). The Government of Ethiopia launched its Rural Electrification Strategy in 2002 as a large governmental programme for electrification, consisting of three parts: grid extension by the public utility, Ethiopian Electric Power Corporation (EEPCo), private sector led off-grid electrification and promotion of new energy sources. The Rural Electrification Fund (REF) with its loan programmes for diesel-based and renewable energy based projects is the main implementing institution. With an initial budget of €29 million, REF has been supporting 180-200 rural micro-hydropower and photovoltaic (PV) mini-grids for educational and health care facilities (Hakizimana, 2009). The fund provides loans up to 95 per cent of investment needs with a zero interest rate for renewable energy projects. Renewable energy technologies that receive support under this programme include solar PV, mini- and micro-hydro, and biomass co-generation. According to EEPCo, the number of electrified towns and rural villages has increased significantly in the last five years of the strategic plan period. By July 2011 it had reached a total number of 5,866, bringing the country's electricity access to 46 per cent. In contrast, World Energy Outlook 2011 reported Ethiopia's 2009 national electrification access as 17 per cent (International Energy Agency (2011). This difference is probably due to the different reference points and sources. The EEPCo has two electricity supply systems: the Inter - Connected System (ICS) and the Self Contained System (SCS). The main energy source of

ICS is hydropower plants and for the SCS the main sources are mini hydropower schemes and diesel power generators allocated in various areas across the country are shown in the figure below.

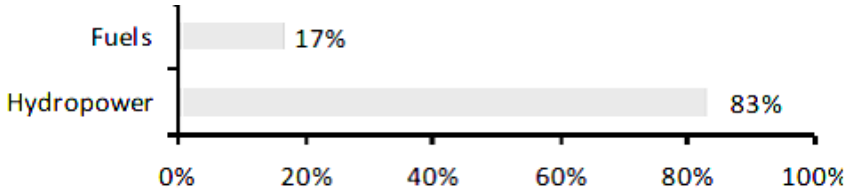

Figure 2: Electricity generation in Ethiopia

Source: Ministry of Energy and Mines

Small hydropower sector overview and potential In Ethiopia

According to a 2010-German Agency for Technical Cooperation Report, small- and micro-hydropower are not yet developed on a larger scale. Three small hydropower schemes exist in Yadot (0.35 MW), Dembi (0.8 MW) and Sor (5 MW) with a cumulative installed capacity of 6.15 MW (Shanko, Melessaw (2009, (figure).

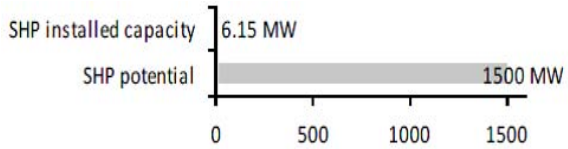

Figure 3: Small hydropower capacities in Ethiopia

Small rivers are being used to get people living in hard to reach areas on the electrical grid. three micro hydropower plants with a cumulative capacity of 125 kW were inaugurated in the villages of Ererte, Gobecho and Hagara Sodicha in Sidama zone in the Southern Nations, Nationalities and the Peoples' Regional State (SNNPR). The plants were implemented in partnership with Sidama Mines, Water and Energy Agency, the Sidama Development Association and local communities, and with the support of the Energy Coordination Office of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (Muluken Yewondwossen, 2012). Small rivers and waterfalls could generate electricity to energize many off-grid rural areas in Ethiopia. The Sor small hydropower plant has the potential to be expanded by an additional 5 MW. A feasibility study was undertaken in 1992 and another study conducted with the support of the United Nations Development Programme (UNDP) also calculated the same results, Ethiopia, Ministry of Water and Energy (2012). The Supervisory Review and Evaluation Process (SREP) Strategic Draft Report plans to implement this development between 2012 and 2014 by updating the existing feasibility study; design and tender document preparation; installation of additional penstock and additional 5 MW third unit, construction of a rock-fill dam, construction of annexed hydraulic structures (spillway, bottom out late and connection structure at the headrace tunnel) and finally refurbishment of the existing two units. As Exploer above, the government has given priority to the development of Medium Scale Hydropower potentials in the range of 40-60 MW in view of the urgency to fulfill the shortage of energy presently encountered, observed and experienced in the country. Typically, schemes of this size are considered to be more rapidly and easily brought to fruition as they require only modest investment and are likely to be appropriate for setting in rural areas to serve a number of communities. Any energy source that can 'be viably implemented in rural setting would contribute to the attractiveness of rural areas. Electric power would encourage the establishment of government offices and associated services in the more remote areas, improve the quality of educational, health and other services and enable individual rural households to have access to amenities which were formerly restricted to urban areas. The source of energy would also encourage the establishment of agro-processing and cottage industries, which would contribute to employment opportunities in rural areas. Nevertheless, since significant water resources are found in the rural areas, harnessing the power of falling water by means of small scale hydropower plants (less than 40 MW) as one way of providing affordable energy for the development of rural areas needs also to be looked into in detail along with the development of Medium Scale Hydropower Schemes and included in the top priority lists. Even if the the government has given priority to the development of Medium Scale Hydropowe potentials , but there is gap for the proper design, analysiss and the way to generate and impment the system. theis research work is conducted to design and analysis of Small Scale Hydropower. The research concerns to generate electric power From Small rivers and waterfalls could generate electricity to energize many off-grid rural areas in Ethiopia. in addition to this the power gereateted by

constracting small dam or by the water water fill with two Continaeres and circulating them, and then to generet Power. It is, therefore, in the next topic concerns the detail design and analysis of generating small hydro power for rular electrifications, so as to allow private individuals to be free in generating and selling electric power generated by small scale hydropower plants in rular cumminity in the country .

b) Components of Hydro System

A complete hydro power system consists of the following major components, which are discussed in this section.

- Water storage and Water filtering mechanism
- Penstock with valves
- Turbine
- Power-converting device (Generator or direct-drive)

i. *Generating Power*

In nature, energy cannot be created or destroyed, but its form can change. In generating electricity, no new energy is created. Actually one form of energy is converted to another form of diesel power to generate electricity, water must be in motion. This is kinetic (moving) energy, when flowing water turns blades in a turbine, the form is changed to mechanical (machine) energy. The turbine turns the generator rotor which then converts this mechanical energy into energy form electricity. Since water is the initial source of energy, we call this hydroelectric power or hydropower.

ii. *Water Filtering*

A major aspect of system design that often is not considered is the removal of solid bodies from the water before it enters the turbine. If no such system is installed the turbine could suffer damage from sticks and stones, as well as reduced performance from leaves that get stuck on the blades. As this can never be totally removed the turbine will probably require cleaning at some stage for this design. There are several technologies available in order to stop these solid bodies from damaging the turbine or reducing its performance. A slanted box may be used in order to remove any surface material and then the outlet pipe may be situated higher than the bottom of the box so that any rocks are also removed, [BH Teuteberg March, 2010]

iii. *Penstock*

Following on the intake a length of pipeline is needed to direct the water to the turbine. Depending on the pressure in the pipeline it may be made of PVC or one of many other alternatives. The material should be appropriate to the application, which may in some cases be seawater. The pipe should also be strong enough to withstand the water pressure caused by the change in head.

The diameter of the pipe should be chosen so as to minimize friction losses without inflating the cost. [BH Teuteberg March, 2010]

iv. *Hydraulic Turbines Classification by Principle of Operation*

Hydraulic turbines extract energy from water which has a high head. There are basically two types, reaction and impulse, the difference being in the manner of head conversion. In reaction turbines the water fills the blade passages and the head change or pressure drop occurs within the impeller. They can be of radial, axial or mixed flow types. In impulse turbines the high head is first converted through a nozzle into a high velocity jet which strikes the blades at one position as they pass by. Reaction turbines are smaller because water fills all the blades at one time in short

a. Reaction Turbines

Reaction turbines are low-head, high-flow devices. The flow is opposite to that in a pump (from volute to eye of impeller after transferring most of the energy of the water to the impeller) but a difference is the important role stationary guide vanes play. Purely radial and mixed flow designs are called Francis turbines. At even lower heads an axial flow, propeller turbine is more compact. It can be fixed bladed but better efficiency is obtained over an operating range by using adjust ble vanes, in the Kaplan turbine.

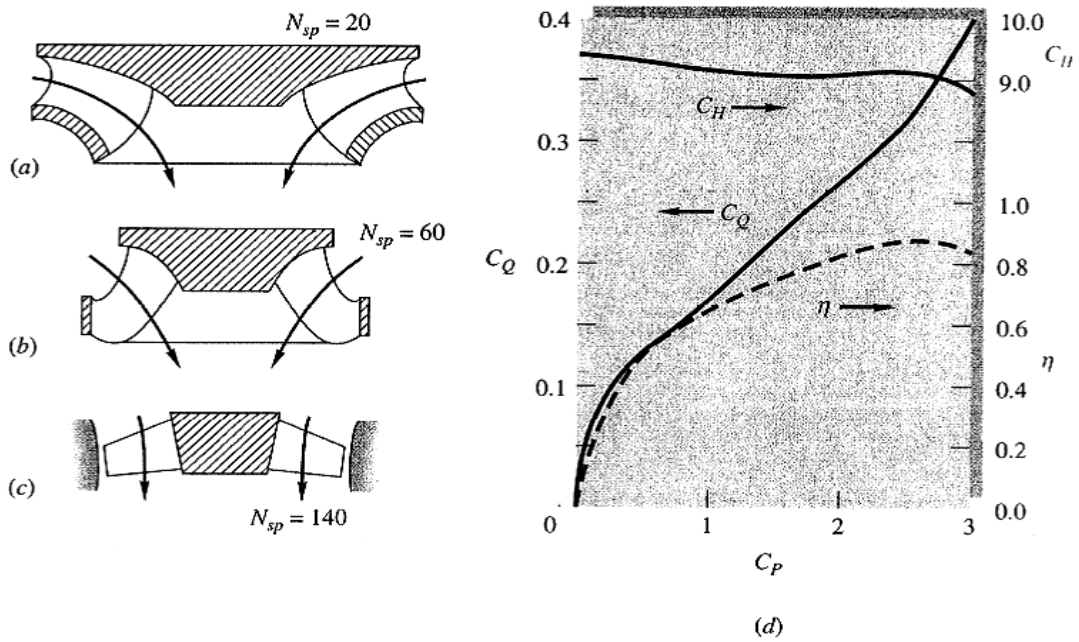

Fig. 4: Reaction turbines: (a) Francis, radial type; (b) Francis, mixed-flow; (c) propeller axial-flow; (d) performance curves for a Francis turbine, $n = 600$ rpm, $D = 0.686$ m, $Nsp = 29$.

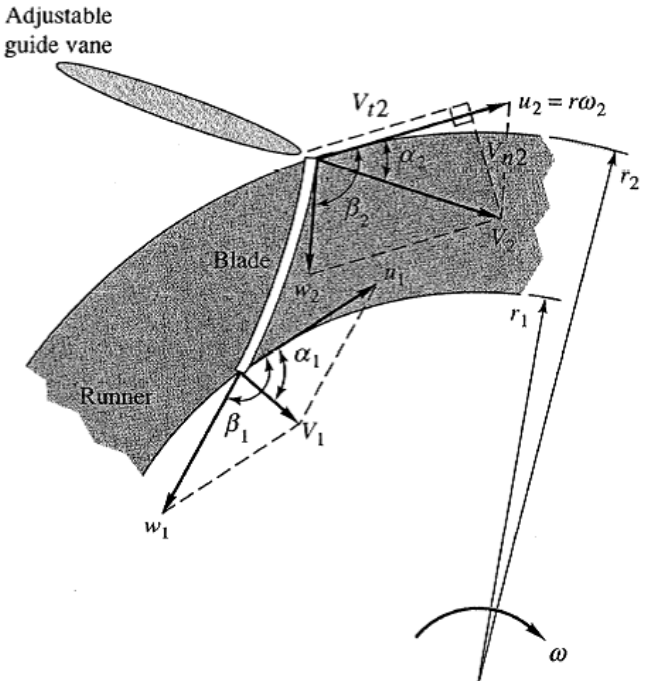

Fig. 5: Inlet and outlet velocity diagrams for an idealised radial-flow reaction turbine runner.

b. Impulse Turbines

For high head (typically above 250 m) and relatively low power (i.e. low *Nsp* from (10.2)) not only would a reaction turbine require too high a speed but also the high pressure in the runner would require a massive casing thickness. The impulse turbine in Fig. 10.3 is ideal for this situation. Since *Nsp* is low, *n* will be low and the high pressure is confined to the small nozzle which converts the head to an atmospheric pressure jet of high velocity *Vj*. The jet strikes the buckets and imparts a momentum change. The buckets have an elliptic split-cup shape and are called Pe ton wheels [Adam Harvey, MicrohydroDesign Manual].

Table 4: Various heads of turbines

Turbine type	Head range in meter
pelton	50 to 1770
Francis	10 to 350
Turgo	50 to 250
Kaplan and propeller	2 to 40
Cross flow(Michell-Banki)	3 to 250

Table 5: Specific speed(source S. Khurana2011)

Turbine	Specific speed
pelton	8.5 to 47
Turgo	30 to 85
Cross flow	20 to 200
Francis	85 to 188

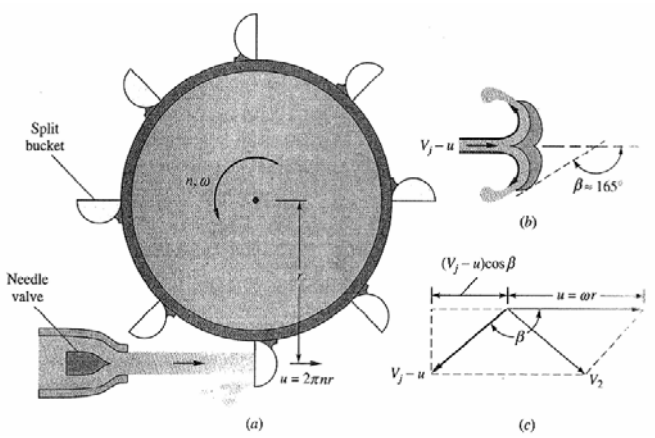

Fig. 6: Impulse turbine: (a) side view of wheel and jet; (b) top view of bucket; (c) typical velocity diagram

Hydro Turbine Electrical System

Hydro-turbines convert water pressure into mechanical shaft power, which can be used to drive an electricity generator, or other machinery to produce electrical power. The conversion process involves two main steps:

- The fluid dynamic power available in the water is first converted in to mechanical power
- The available mechanical power is then converted into electrical power. The power available is proportional to the product of pressure head and volume flow rate. The general formula for any hydro system's power output is: where *P* is the mechanical power produced at the turbine shaft (Watts), η is the hydraulic efficiency of the turbine, ρ is the density of water (kg/m3), *g* is the acceleration due to gravity (m/s^2), *Q* is the volume flow rate passing through the turbine (m^3/s), and *H* is the effective pressure head of water across the turbine (*m*). Water is taken from the river by diverting it through an intake at a container. The container is a main barrier which maintains a continuous flow through the intake. A turbine converts the energy from falling water into rotating shaft power.

III. Design and Analysis

Hydro System Components

Energy Consumption Estimate of Rural Community

Electricity consumption shows large variations depending on climate, culture, reliability of supply, and location. Generally, rural households in developing countries such as Ethiopia have very low electricity consumption, with the primary uses being for lighting and operation of radios, and televisions. In Ethiopa, official definition of a rural community is one with a population less than 10,000 [3], with an assumed average household of 10. An average energy demand estimate, E in kWh, of a given household within a rural setting may be computed using the energy equation described by (Igbinovia, (2007). Where P_r is the wattage rating of a given household appliance (component) in kilowatt (kW), t- is the duration for which the appliance is to be operated in hours (h), n is the number of the appliance. The energy demand estimate has been expressed in kWh because it is fundamental unit in which quantity of electricity (electric energy) used is

measured. One kilowatt-hour is equivalent the amount of work done by one kilowatt of electric power in one hour. Hence, in a rural household where lighting is the only primary use of electricity, for instance, six 60-watt incandescent lamps used for about five hours each night will have a daily consumption of 1.8 kWh based on equation (1). A radio set and a small fan of wattage ratings 20 W and 50 W respectively can be used for 10 hours each day for an additional consumption of 0.2 to 0.5 kWh. A small TV set of wattage rating used for 6 hours a day will add a further 0.72 kWh. A family could accommodate all these uses easily within a consumption range of 4 kWh daily. Adejumobi et al. [Oliver Paish, 2002] in their work using Nigeria as a case study estimated the energy needed by typical rural/remote environment ICT infrastructures, banking and hospital services. These results revealed that for a typical rural/remote environment as it is applicable in Nigeria because the definition of a rural community varies from communities to communities across different countries of the world, the total weekly hour energy consumptions of ICT infrastructures, banking and hospital services could respectively be in the range of 48.836kWh, 72.908kWh and 12.660kWh equivalent to a daily average of 6.976 kWh, 10.415 kWh and 1.809 kWh respectively (Adejumobi I.A.).

a) Water Diversion(Intake)

The intake is typically the highest point of a hydro system, where water is diverted from the stream into the pipeline that feeds the turbine. A water diversion system serves two purposes: provide a pool of water to create an air- free inlet to the pipeline, an d remove dirt and debris [H 2, H5]. See Figure 8.1. Diversion System refers to the means used to divert water from the source and transport it to your turbine. There are various methods for diverting and transporting the water, bu t diversion systems can be grouped into two basic types: Open and Closed systems. Matchi ng the correct type of diversion system to a particular style of micro hydro turbin e is critical to the optimal performance of the turbine. In general, impulse turbines (which produce power primarily from head pressure) will utilize a closed diversion system. Reaction turbines (which produce power primarily from water volume) will normally work best with an open diversion system.

i. *Closed Diversion Systems*

In a closed diversion system (such as a pi pe), the system is sealed and water is isolated from direct gravitational forces while in the pipe. The water surface at the inlet to the pipe is the point at which gravity directly affects the water, and is, therefore, the starting elevation for the system head. Closed diversion systems work well for developing high pressure head with relatively low water flow volumes [H11].

ii. Pen Diversion Systems

In an open diversion system (such as a canal), the water along the entire diversion system is directly exposed to gravity. In an open diversion system, then, the last point at which gravity directly impacts the water is the water surface directly above the turbine inlet. Thus, the starting elevation for the pressure head is often the water surface directly above the turbine. The ending point for pressure head is the turbine impeller. Open diversion systems work well for supplying large volumes of water to the turbine with low friction losses [H11].

b) Pipeline (Penstock)

The pipeline, or penstock, not only moves the water to the turbine, but is also the enclosure that creates head pressure as the vertical drop increases. The pipeline focuses all the water power at the bottom of the pipe, where the turbine is. In contrast, an open stream dissipates the energy as the water travels downhill [H6]. One or more bypass valves may be necessary. These should be installed at low points in the pipe to help get the flow going and to flush out air bubbles. Figure 8.6 shows an example of the location of a pipeline relative to point of use.

c) The Head of hydro power

Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. In this case the energy extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. This height difference is called the head. The amount of potential energy in water is proportional to the head [H1, H2]. To obtain very high head, water for a hydraulic turbine may be run through a large pipe called a penstock, see Figure 8.1.

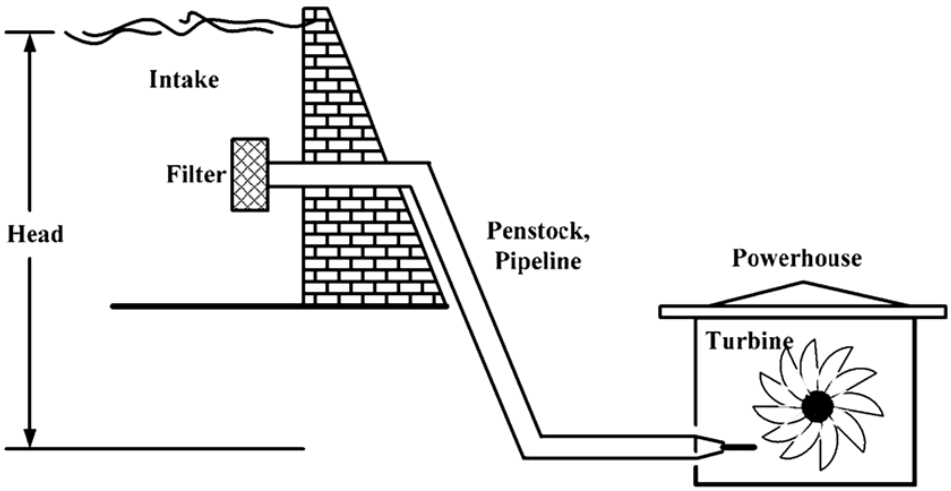

Figure 7: Hydroelectric power generation diagram

Based on the head of hydro power is the one based on the height of head. The height of the head is almost similar with the height of the dam used in the hydro electric power. There are three common types of hydro power based on the head level (High head (>100m), Medium head (50-100m), Low head (~20m) [P. Cunningham, 2007]. The following Figure shows the pictures for low, medium and high head hydro power. The height of head will also affect the choice of turbine type selected. Based on the picture, the low head does not seem to use dam, even it uses small dam (called barrage in the picture), meanwhile the medium and high head hydro power are using dam., the higher head means more installed capacity, which is defining the size of hydro power.

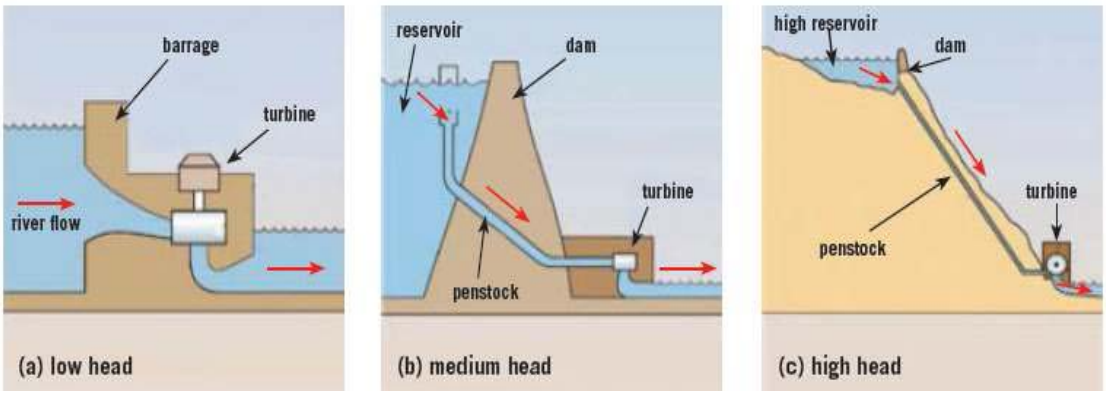

Figure 8: Three common types of hydro power plants based on the head level(low, medium and high head hydro power).

For a volume of a fluid which is not in motion or is in a state of constant motion, Newton's Laws states that it must have zero net force on it - the forces going up must equal the forces going down. This force balance is called the hydrostatic balance. The net force over one point is due to the fluid weight [H9]. In Figure 8.2 we can see the linear variation of pressure by water height, and then the basic hydrostatic equationis:

$$P = P_0 + \gamma h \qquad (8.2.1)$$

Where γ = Specific Weigh of the fluid (lb/ft^3),
P_0= Atmospheric pressure (lb/ ft^2),
h = Height (ft).

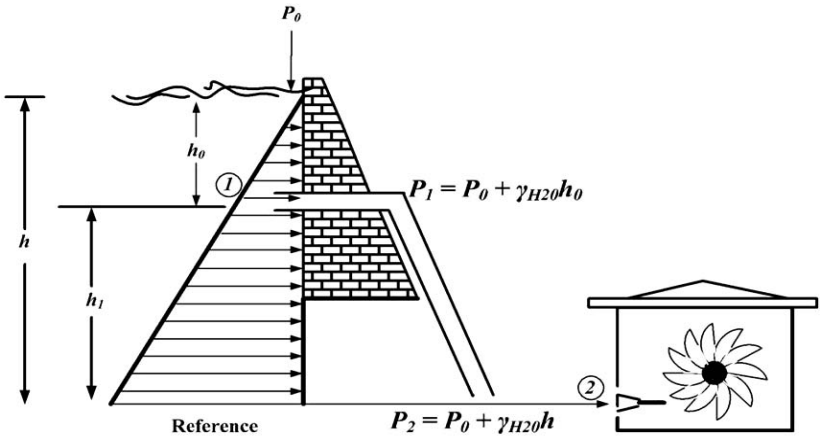

Figure 9: Variable Pressure by Water Height

To determine the hydraulic power we use the Conservation Energy Law which states that the energy can neither be created nor destroyed. This means that the total energy of a system remains constant. The total energy includes potential energy due to elevation and pressure and also kinetic energy due to velocity. Considering the system in the bove Figure, we can state that the total energy in point 1 is:

$$E_t = Wh_1 + W\frac{P_1}{\gamma} + \frac{1}{2}\frac{W}{g}v_1^2 = cons\tan t$$

$$E_t = Wh_1 + W\frac{P_1}{\gamma} + \frac{1}{2}\frac{W}{g}v_1^2 - H_l = Wh_2 + W\frac{P_2}{\gamma} + \frac{1}{2}\frac{W}{g}v_2^2$$

Where V1, V2 = velocities at point 1 and 2 respectively (ft/s), H1= Represents losses in pipe (ft). From Equation 8.2.3 we determine that the velocity at the intake of the system point 1 is the same as the velocity in point 2, but not necessarily the same at the turbine input. This is due to the use of nozzles at the pipe end in some cases. The Continuity Equation states that for steady flow in a pipeli ne, the weight flow rate (weight of fluid passing a given station per unit time) is the same for all locations of the pipe [H9, H10]. To illustrate the significance of the continuity equation, refer to Figure 8.3, which shows a pipe in which fluid is flowing with a weight flow rate W that has units of weight per unit time. The pipe has two different-size cross-sectional areas identified by stations 1 and 2. The continuity equation states that if no fluid is added or withdrawn from the pipeline between stations 1 and 2, then the weight flow rate at stations 1 and 2 must be equal.

$$w_1 = w_2 \qquad (8.2.4)$$

$$yA_1v_1 = yA_2v_2 \qquad (8.2.5)$$

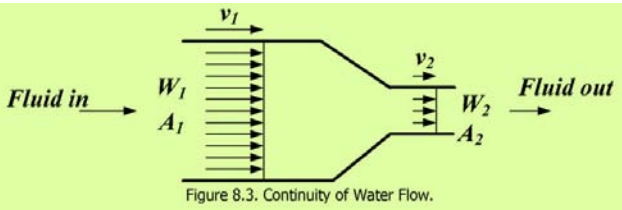

Figure 8.3. Continuity of Water Flow.

Where γ = Specific Weigh of the fluid (lb/ft^3),
A = Cross-sectional area pipe (ft^2),
v = Velocity of fluid (ft/s).

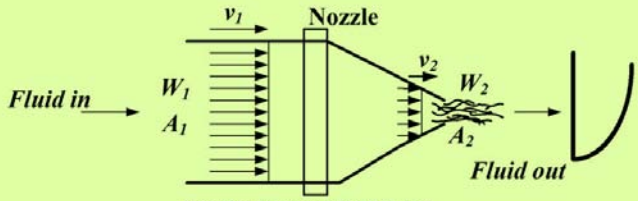

Figure 8.4. Nozzle Velocity Variations.

Once we have determined the velocity at point 1 in Figure 4, applying Equation 5 we find the velocity at point 2, then we know,

$$F = P(lb/ft^2).A(ft^2)$$
$$energy = F(lb).l(ft) = PAl$$
$$Power = \frac{energy}{time} = \frac{PAl}{t} = PAv$$
$$Caudal(Q) = Av,$$
$$HydraulicPower(ft.lb/s) = P(lb/ft^2).Q(ft^3/s)$$
$$HydraulicHousepower = HHP = P(lb/ft^2).Q(ft^3/s).\frac{1hp}{550\,ft.lb/s} \quad (8.2.6)$$

i. *Net Hea*

Net head is the pressure at the bottom of the pipeline when water is actually flowing to the turbine. This will always be less than the gross head measured, due to friction losses within the pipeline. Water flow figures are needed to compute net head. Longer pipelines, smaller diameters, and higher flows create greater friction. A properly designed pipeline will have a net head of 85 to 90 percent of the gross head measured.

ii. *Flow Measure*

The second major step in evaluating a site's hydro potential is measuring the flow of the stream. Stream levels change through the seasons, so it is important to measure flow at various times of the year. The use of the stream by wildlife and plants must also be considered. Applicable permits should be sought from local agencies overseeing natural resources and wildlife preservation. Never use all of the stream's water for your hydro system [H3]. Flow is typically expressed as volume per second or minute. Common examples are gallons or liters per second (or minute), and cubic feet or cubic meters per second (or minute).Three popular methods are used for measuring flow: container, float, and weir. The container fill method is the most common method for determining flow in micro hydro systems. Identify a spot in the stream where all the water can be caught in a bucket. If this is not possible, a temporary dam can be built that forces all of the water to flow through a single outlet. Using a bucket or larger container of a known volume, use a stopwatch to time how long it takes to fill the container [H3]. With the Net Head and Flow measurements one can determine the power output of a stream engine, as shown in The following Table shows. Higher head and flow bring out more power; however a right selection of the turbine is the critical stage of de design process and will determine the output capacity.

Table 7: Output Power (Watts) of Stream Engine [H5].

	Flow Rate (Liters per second)						
Net Head (m)	**0.67**	**1.33**	**2.50**	**5.00**	**6.67**	**7.50**	**9.50**
3		20	50	90	120	130	150
6	15	40	100	180	230	250	350
15	45	110	230	450	600	650	800
30	80	200	500	940	1100		
60	150	400	900	1500			
90	200	550	1200				
120	300	700	1500				
150	400	850	1900				

d) Turbine designs

i. *Material Selection*

a. *General*

The material qualification is at least to include:

- Requirements for repeatability of manufacturing processes
- Requirements for traceability of materials (e.g. name and trademark of manufacturer, material grade, batch number)
- Requirements for material storage (e.g. control of temperature, humidity and shelf life)
- Characteristic material parameters for all relevant limit states including: minimum and maximum service temperatures, and other environmental conditions (e.g., strength, toughness, density, cold deformability, ageing characteristics, resistance to rot and sun light)
- The material qualification shall cover changes in material properties over the range of service temperatures such as embrittlement at low temperatures and drastic changes near the glass transition temperature for the materials.
- The embrittlement may typically not influence stiffness or strength for the material without imperfections. The embrittlement may have a drastic impact on the sensitivity to imperfections.
- purchase specifications for the individual materials. the specifications shall as a minimum cover/cost: s

ii. *Design of Cross-Flow Turbine for Small Hydro-Power*

Hydro-power was considered as one of the most desirable source of electrical energy due to its environmental friendly nature and extensive potential available throughout the world. Within the scope of hydro-electric power, small power plants have gained much attention in recent years. Several small hydro-power schemes have been proposed and successfully implemented, which include radial, axial, and propeller type turbines.

iii. *Design steps for turbine*

a. Turbine Runner

The runner is the heart of the turbine. This is where water power is transformed into the rotational force that drives the generator. Regardless of the runner type, its buckets or blades are responsible for capturing the most possible energy from the water. The curvature of each surface, front and rear, determines how the water will push its way around until it falls away. Also keep in mind that any given runner will perform most efficiently at a specific Head and Flow. The runner should be closely matched to your site characteristics. Quality components and careful machining make a big difference in turbine efficiency and reliability. Look for all-metal runners with smooth, polished surfaces to eliminate water and air turbulence. One- piece, carefully machined runners typically run mo re efficiently and reliably than those that are bolted together. Bronze manganese runners work well for small systems with clean water and Heads up to about 500 feet. High-tensile stainless steel runners are excellent for larger systems or abrasive water conditions. All runners should be carefully balanced to minimize vibration, a problem that not only affects efficiency but can also cause damage over time.

b. The design procedure of the cross-flow turbine involves the following steps

1. Preparing the site data This involves the calculations and measuring the net head of the hydro-power plant and its water flow rate.

- Calculation of the net head (*Hn*)

$$Hn = (Hg - Htl)\ in\ metter$$

Where Hg = the gross head which was the vertical distance between water surface level at the intake and at the turbine. This distance can be measured by modern electronic digital levels.

Htl = total head losses due to the open channel, trash rack, intake, penstock and gate or value. These losses were approximately equal to 6% of gross head.

– the potential energy of the water calculate using the formula PE=mgh
– Calculate the water's final velocity just before hitting the turbine blades using, PE= KE=1/2mv^2

From this Equation V=(2gh)$^{1/2}$

- Calculation of the water flow rate (*Q*): The water flow rate can be calculated by measuring river or stream flow velocity (*Vr*) and river cross-sectional area (*Ar*), then:

$$Q = Vr * Ar \ (\mathrm{m}^3/s$$

2. Calculation of turbine power (*Pt*) The electrical power of the turbine in *Watt* can be calculated as $Pt = \rho * g\eta t * Hn * Q \ (watt)$

The output power available in a stream of water is;

P=rηghQ

P = power (J/s or watts)

η = turbine efficiency

ρ = density of water (kg/m3)

g = acceleration of gravity (9.81 m/s2),

h = head (m).

For still water, this is the difference in height between the inlet and outlet surfaces. Moving water has an additional component added to account for the kinetic energy of the flow. The total head equals the pressure head plus velocity head, Q= flow rate (m^3/s).

3. Calculation of turbine efficiency (*ηt*) The maximum turbine efficiency can be calculated as

$$\eta = \frac{1}{2} * C^2 * (1 + \psi) * cos^2(\alpha) \quad (4)$$

From equation (4) above, its clear that the attack angle (α) should be kept as small as possible for maximum turbine efficiency. The manufacturing of this type of turbine has shown that arc angle of (16°) can be obtained without much inconvenience.

4. Calculation of the turbine speed (*N*): The correlation between specific speed (*Ns*) and net head is given for the cross-flow turbine as :

$$N_s = {513.25}/{H_n^{0.505}} \quad (5)$$

Also the specific speed interms of turbine power in Kw, turbine speed in (r.p.m) and net head in (m) is given as

$$N_s = {N * \sqrt{P_t}}/{H_n^{5/4}} \quad (6)$$

From equations (5) and (6) above, the turbine/runner speed can be calculated as:

$$N = {513.25 * H_n^{0.745}}/{\sqrt{P_t}} \quad (r.p.m) \quad (7)$$

5. Calculation of runner outer diameter (*Do*) At maximum efficiency, the tangential velocity of the runner outer periphery is given as

$$V_{tr} = \frac{1}{2} * C * \sqrt{2 * g * H_n} * \cos(\alpha) \quad (8)$$

Also

$$V_{tr} = w * \frac{D_o}{2} = \frac{2\pi N D_o}{120} \quad (9)$$

From equations (8) and (9) the runner outer diameter can be calculated as:

$$D_o = 40 * {\sqrt{H_n}}/{N} \quad (m) \quad (10)$$

6. Calculation of blade spacing (*tb*): The thickness of jet entrance (*te*) measured at right angles to the tangential velocity of runner is given as

$$t_e = K * D_o \quad (m) \quad (11)$$

Where *K* = constant = 0.087, the tangential spacing (*tb*) is given as

$$t_b = {t_e}/{\sin(\beta_1)} = {K * D_o}/{\sin(\beta_1)} \quad (12)$$

Where *β1* = blade inlet angle = 30° when α = 16°. Then

$$t_b = 0.174 * D_o \quad (13)$$

7. Calculation of the radial rim width (*a*): It is the difference between the outer radius (*ro*) and inner radius (*ri*) of the turbine runner, and it is also equal to the blade spacing and can be given as:

$$a = 0.174 * D_o \quad (m) \quad (14)$$

8. Calculation of the runner blade number (*n*) The number of the runner blades can be determined as

$$n = {\pi * D_o}/{t_b}$$

9. Calculation of the water jet thickness (*tj*) It is also defined as nozzle width and can be calculated as

$$t_j = {A_j}/{L} = \frac{Q/V_j}{L} = {Q}/{(C * \sqrt{2 * g * H_n} * L)} = {0.233 * Q}/{(L * \sqrt{H_n})} \quad (16)$$

Where Aj = jet area (m2).

10. Calculation of runner length (L): The runner length in (m) can be calculated as: From reference

$$L * D_o = {210 * Q}/{\sqrt{H_n}} \quad (17)$$

By transforming the British units of equation (17) above into metric units, it can be obtained as:

$$L * D_o = {0.81 * Q}/{\sqrt{H_n}} \quad (18)$$

Substitute equation (10) into (18) to obtain

$$L = {Q * N}/{(50 * H_n)} \quad (m) \quad (19)$$

Substitute equation (19) into (16) to obtain:

$$t_j = {11.7 * \sqrt{H_n}}/{N} \quad (20)$$

Also substitute equation (10) into (20) to obtain the jet thickness at maximum efficiency as:

$$t_j = 0.29 * D_o \qquad (m) \tag{21}$$

11. Calculation the distance between water jet and the center of runner shaft (*y1*) [2]:

$$y_1 = 0.116 * D_o \tag{22}$$

12. Calculation the distance between water jet and the inner periphery of runner (*y2*) [2]

$$y_2 = 0.05 * D_o \tag{23}$$

13. Calculation inner diameter of the runner (*Di*)

$$D_i = D_n - 2 * a \tag{24}$$

14. Calculation of the radius blade curvature (*rc*)

$$r_c = 0.163 * D_n \tag{25}$$

15. Calculation of the blade inlet and exit angles (b*1*and b*2*)[2]: The blade inlet angles can be calculated as

$$\tan(\beta_1) = 2 * \tan(\alpha) \tag{26}$$

The blade exit angle *2* = 90° for perfect radial flow, but it must be equal to (*1*) at maximum efficiency.

16. The difference in elevation between the turbine and the upper reservoir is called the "head". Any losses in the pipe due to friction or viscosity are converted into an equivalent form and when subtracted from the head the result represents the "net available head". The losses are normally expressed in terms of a head loss Coefficient

$$h_{loss} = k\left(\frac{v^2}{2g}\right)$$

The first head loss that is considered is friction losses in the pipe. The friction factor is highly dependent on the Reynolds number of the flow, $Re = \frac{dv}{\nu}$, If the Reynolds number is below 2100 it can be assumed that laminar flow is occurring, in which case the friction factor is simply: $f = \frac{64}{Re}$, If the Reynolds number is above this value there is a transitional period where it is not certain whether fully laminar or turbulent flow is occurring. In this case turbulent flow is assumed and the applicable equation is:

$$f = \frac{1.325}{\left(\log\left(\frac{\frac{e}{d}}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2}$$

In this equation the pipe roughness factor (e) is required. In The following Table

Table 8: Values of pipe roughness for various materials

Material	e(mm)
Drawn tubing, brass, lead, glass, bituminous lining	0.0015
Commerical Steel or Wrought Iron	0.046
Welded Steel pipe	0.046
Galvanized Iron	0.15
Concrete	0.3-3
Riveted Steel	0.9-9

When the friction factor is know it is simple to calculate the friction head loss coefficient using equation

$$k_{friction} = f\left(\frac{L}{D}\right)$$

There are also certain losses that occur at the pipe entrance. The losses occur as a result of the contraction and subsequent expansion of water stream lines flowing into the pipe section. Some commonly encountered pipe sections also induce losses in the system.

Table 9: Head loss coefficient for various pipe segments

Fitting	$K_{sections}$
Gate Valve (wide open)	0.19
Gate Valve (half open)	2.06
Long radius bend	0.6
Short radius bend	0.9
T(through side outlet)	1.8
Smoothly curved contraction	0.05

The total head loss can now easily be calculated by using the head loss coefficient for each entrance, pipe section and pipe material.

$$h_l = \left(\sum k_{friction} + \sum k_{entrance} + \sum k_{sections}\right)\left(\frac{v^2}{2g}\right)$$

e) Drive System

The drive system couples the turbine to the generator. At one end, it allows the turbine to spin at the velocity that delivers the best efficiency. At the other end, it drives the generator at the velocity that produces correct voltage and frequency (frequency applies to alternating current systems only). The most efficient and reliable drive system is a direct, 1 to 1 coupling between the turbine and generator. This is possible for many sites, but not for all head and flow combinations. In many situations, especially with AC systems, it is necessary to adjust the transfer ratio so that both turbine and gene rator run at their optimum (but different) speeds. These types of drive systems can use gears, chains, or belts, each of which introduces additional efficiency losses into the system. Belt systems tend to be more popular because of their lower cost [H2].

i. *Generator*

Typically in hydro systems the torque from the output shaft of the turbine is converted into electricity by use of a generator. This provides great flexibility for the use of the power as the electricity is easy to transport and use for multiple devices at the same time. In converting the energy from the shaft into electricity some energy is lost. As the power from the turbine may be used to drive a pump, there will again be losses when the electricity is used in the pump motor. Generator performance is comparable to motor performance and thus the range of typical total efficiencies for just the electrical sub-system would be between 50% and 92%. The efficiency of the motor is also relative to the load as motors running at partial load will be less efficient. It is thus crucial to choose the correct size for the motor and therefore also the generator.

ii. *Direct Drive Pump*

The losses experienced in the generation and use of electricity may be avoided by connecting the shafts of the Turbine and the pump. This means that most of the power generated in the turbine will reach the pump, with small losses experienced in possible clutches and gearboxes. However, a major negative aspect of this solution is that the location of the turbine system becomes more constrained as it needs to be situated next to the pump it would power. This solution should be more efficient than a generator when powering a single constant load such as a pump which runs all the time. As soon as multiple or variable loads are to be powered by the turbine system a generator may prove to be a simpler and more effective solution.[BH Teuteberg March, 2010]

Table 10: Differences between generators and direct drive systems

	Generator	Direct Drive Pump
Advantages	Produces electricity which can be used in various areas	Much higher total efficiency
	Can be purchased as a commercial package with the turbine/PAT	Simpler design, requires fewer components
	The reliability of the turbine/PAT will not affect the flow of water	Cheaper, if existing pumps can be driven
Disadvantages	Energy is lost in the generator	Pump has to run at same rotational speed as turbine/PAT or gearbox is required
	Requires a complex electrical regulating system with a dump load	Operation of system is dependent on reliability of both turbine/PAT and the Pump.
	More expensive	The PAT/turbine has to be situated next to the pump

f) Small Hydro turbine System Design

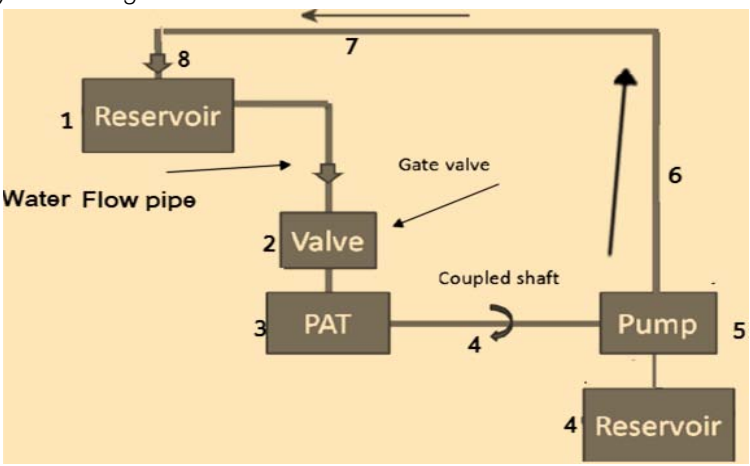

Figure 10: Schematic of systeme

Operation procedure of Small Hydro turbine

The generator in the system is the mechanical-electrical converter in the water turbine and the gearbox and rotor blades need to be designed to supply the motor with an input that will yield the desired output power. This being said, a suitable motor first needs to be selected and tested to determine the input speed required to produce 1- 5 kW before any other design goes ahead. Once this has been determined a rotor system and gearbox can be designed to produce the required revolution speed and torque to supply mechanical power to the motor. In selecting a motor consideration needs to be made as to what type of current is being produced and where it will flow to, if it will be stored or if it will be directly applied in an electrical device and water pump. After connecting the motor shaft with water pump, the pump lift out water from lower container to deliver the upper water tanker and then the water is circulating. the motor shaft is used as an input for water pump and at the same time it generating power.

Case-1, Reservoir Tanker-Valve/pipe PAT-Motor-Gear Box/Mechanism-Water pump and also posible

Case-2, Reservoir Tanker-Valve/pipe PAT- Gear Box/Mechanism- Motor- -Water pump

IV. Results

In this study, the design and Analysis of small - hydro-electric power for rural electrification is done, the theoretical electric power generating potential and capacities for container (run-of-river) the systems are developed. Following the standard small hydropower guide and past works are included, the turbine and generator efficiencies are selected and designed. This design and Analysis of small -hydro-electric power is done using mathematical and Numerical (Matlab) methods is applied. After introducing the site measurements and calculations as input data to the computer program, the weir dimensions, open channel dimensions, penstock dimensions, turbine type, turbine size, turbine power, turbine speed, turbine efficiency, generator specifications and gear box ratio are determined. Figures (3, 4) show the relation between turbine power and speed with gross head at different values of water flow rate. Figures (5, 6) show the variation of turbine power and speed with water flow rate at different values of head. From these results, the turbine power and speed were directly proportional with the gross head, but there were specific points for maximum power and maximum speed in case of water flow variation. Figures (7, 8) show the variation of head loss with the gross head and water flow rate. It can be shown that the head loss was increased very high with increasing the water flow rate than that with increasing the gross head.

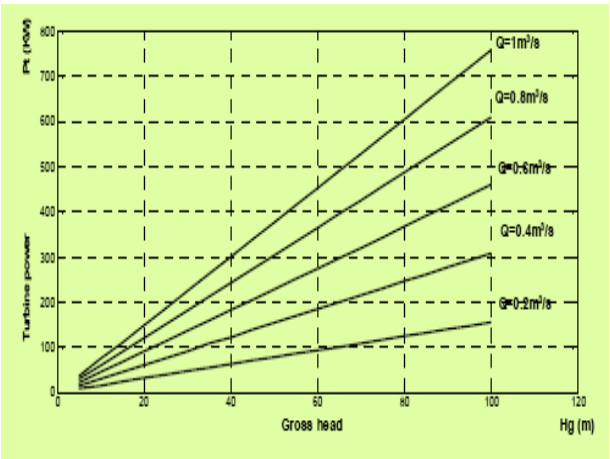

Figure 11: Variation of turbine power with gross head at different values of water flow rate

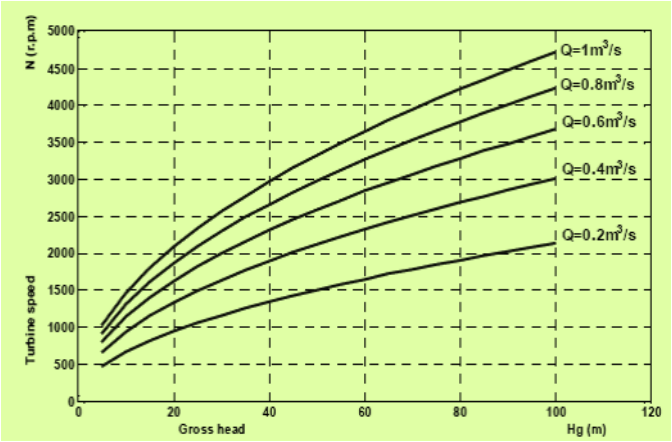

Figure 12: Variation of turbine speed with gross head at different values of water flow rate

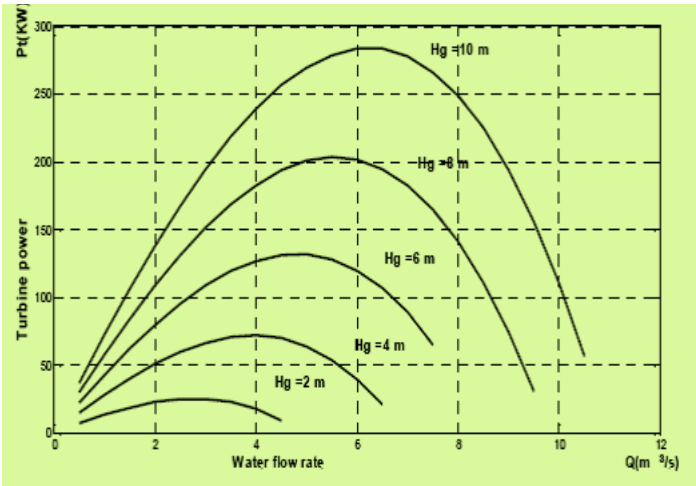

Figure 13: Variation of turbine power with water flow rate at different values of gross head

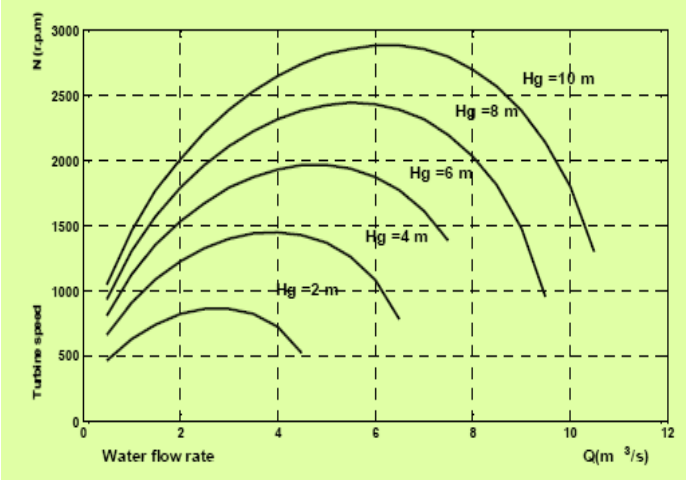

Figure 14: Variation of turbine speed with water flow rate at different values of gross head

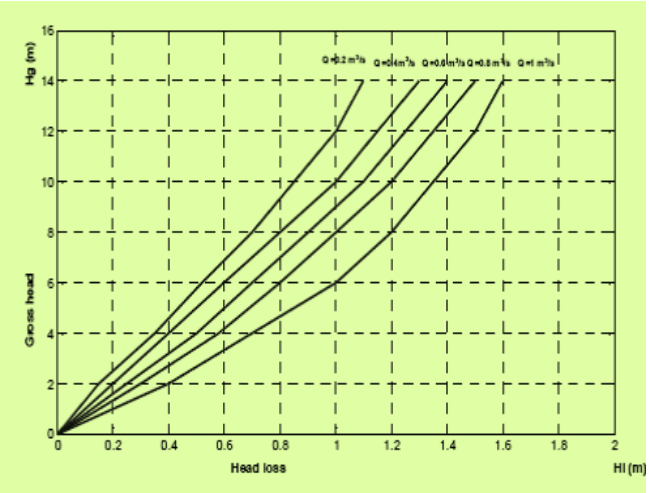

Figure 15: Variation of gross head with head loss at different values of water flow rate

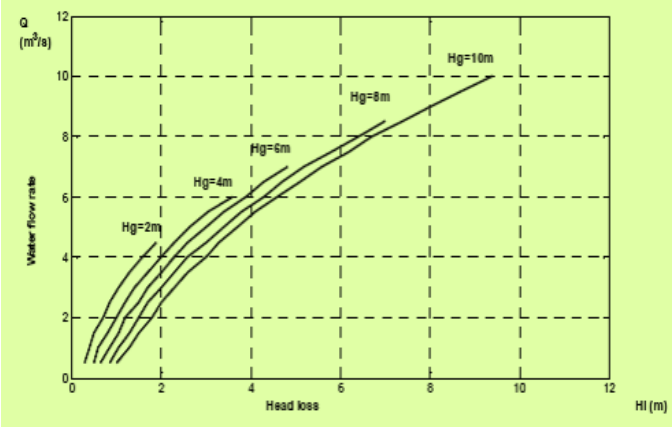

Figure 16: Variation of water flow rate with head loss at different values of gross head

V. Conclusions

Hydropower, large and small, remains by far the most important of the "renewables" for electrical power production worldwide. Small-scale hydro is in most cases "run-of-river", with no dam, and is one of the most cost-effective and environmentally benign energy technologies to be considered both for rural electrification in less developed countries and developed countries for further hydro developments. The cross-flow turbine is suitable for installing small hydro-electric power plants in case of low head and flow rate. A complete design of such turbines has been presented in this paper. The complete design parameters such as, Trbine material, runner diameter, runner length, water jet thickness, blade spacing, radius of blade curvature, turbine power, turbine speed, number of blades, and any losses in the pipe due to friction, were determined at maximum turbine efficiency.

i. Small-hydro power continues to grow around the world, it is important to show the public how feasible small-hydro systems actually are in a suitable site. The only requirements for small-hydro power are water sources, turbines, generators, proper design and installation, which not only helps each individual person but also helps the world and environment as a whole.

ii. Run-of-river or containwer small-hydro turbine schemes generate electricity when the water is available and provided by the continer . When the container dries-up and the flow falls below predetermined amount or the minimum technical flow for the turbine, generation will ceases.

iii. Medium and high head schemes use Weirs to divert water to the intake, it is then conveyed to the turbines via a pressure pipe or penstock. Penstocks are expensive and the design is usually uneconomic due to the high penstock friction head loss. An alternative is toconvey the water by a low-slope canal, running a long side the container or river to the pressure intake or forebay and then in a short penstock to the turbine.

iv. The choice of turbine will depend mainly on the pressure head available and the water flow rate. There are two basic modes of operation for hydro power turbines: Impulse and reaction. Impulse turbines are driven by a jet of water and they are suitable for high heads and low flow rates. Reaction

turbines run filled with water and use both angular and linear momentum of the flowing water to run the rotor and they are used for medium and low heads and high flow rate.

v. Regulated turbines can move their inlet guide vanes or runner blades in order to increase or reduce the amount of flow they draw. Cross-flow turbines are considered best for micro-hydro projects with a head of (5) meters or less and water flow rate (1.0) m3/s or less.

vi. Small-hydro power installations are usually run-of-river or container systems, which do not require a dam, and are installed on the water flow available on a year round basis. An intake structure with trash rack channels water via a pipe (Penstock) or conduit down to a turbine before the water released down-stream. In a high head (greater than 50 m) and low water flow (less than 0.5 m3/s), the turbine is typically Pelton type connected directly to a generator with control valve to regulate the flow of water and turbine speed.

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Reconfigurable Sierpinski Monopole Antenna for Cognitive Radio Applications

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Abstract- The changing scenario of the wireless connectivity has insisted the usage of the spectrum in an efficient manner which in turn demands for the new paradigms to be adopted in practice. The Cognitive Radio (CR) termed by Joseph E Mitola III in 1999, a prominent technology to overcome the above difficulty which continuously monitors the spectrum and allocates the un used portions of the spectrum to other users in a systematic approach. The most important task in this context is the design of the antenna to cater the needs of the CR networks and they must adapt the changes in the environment and must be reconfigurable.

Keywords: ultra wide band, fractal geometries, sierpinski monopole, multi band behavior, hair pin band pass filters, reconfigurability, electromechanical switching, taconic switches, cst microwave studio, cognitive radio.

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Reconfigurable Sierpinski Monopole Antenna for Cognitive Radio Applications

Mr.Manikya Krishna Chaitanya Durbhakula [α] & Dr.Venkata Koteswara Rao Nalam [σ]

Abstract- The changing scenario of the wireless connectivity has insisted the usage of the spectrum in an efficient manner which in turn demands for the new paradigms to be adopted in practice. The Cognitive Radio (CR) termed by Joseph E Mitola III in 1999, a prominent technology to overcome the above difficulty which continuously monitors the spectrum and allocates the un used portions of the spectrum to other users in a systematic approach. The most important task in this context is the design of the antenna to cater the needs of the CR networks and they must adapt the changes in the environment and must be reconfigurable. Besides this, the major attributes that are to be considered in the context of antenna design are the low profile, low cost, weight and size considerations, ease of integration in the system, most importantly the reconfigurability and multi band behavior. The fractal antenna technology can be best fit in these environments because of their self similarity; affinity in their structure supports the wide, multi band operation and also eases the integration of switching mechanism. This paper describes a Re-configurable monopole antenna structure which consists of two hairpin band pass filters which are switched alternatively by using two separate electro mechanical Taconic switching elements. In this design, the Sierpinski monopole antenna shows the multi band behaviour and the structure resonates at four different frequencies based on its fractal geometry. However, only two frequencies within the Ultra Wide Band (UWB) frequency, 3.1 GHz -10.6 GHz range are considered i.e 3.5 GHz and 7.5 GHz for demonstrating the reconfigurability mechanism. The complete structure was designed theoretically; analyzed using CST Microwave suite simulation tool, the same was fabricated, tested and the results were reported. This structure offers higher gains with reasonably good radiation patterns along with reconfigurability in the bands of interest and can perform both the spectrum monitoring and communication mechanisms within the UWB frequency range. As the antenna structure shows the reconfigurability, independent operation at the desired frequencies, it can be employed in the Cognitive Radio applications.

Keywords: ultra wide band, fractal geometries, sierpinski monopole, multi band behavior, hair pin band pass filters, re configurability, electromechanical switching, taconic switches, cst microwave studio, cognitive radio.

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I. Introduction

This section deals with the basic fractal antenna structures [1] ,their types, the basic configurations along with the related literature. The term Fractal was named by B.B. Mandelbrot, a French Mathematician in 1970 from the Latin word "Frangere" which means to break or to make irregular structures. The "Fractal structures" are formed by repetitive geometry of the basic structure by the number of iterations of their fundamental blocks and the fractals are considered to be the scaled versions of their basic shape. Most importantly, these structures show the self similarity, space filling properties which make the antennas so compact [2]. These antennas find many applications in the wireless communications, image compression algorithms, filtering circuits and are suitable in ultra wideband operation.

The basic fractal geometries that are in practice are Koch curve, Minkowski curve, Sierpinski carpet, Sierpinski gasket, Cohen-Minkowski etc. They are classified either into random fractal structures or deterministic structures [4]. However, they offer multi band operation and ease of integration in to the circuits, economical which makes them suitable for the design of new generation of antennas. Some of the basic geometries found more suitable in the construction of the fractal antenna structures are shown below in Fig 1.1,1.2,1.3 and 1.4.

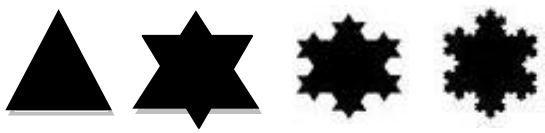

Fig.1.1: Koch Snowflake

Fig.1.2: Hilbert Curve

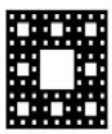

Fig.1.3: Sierpinski Carpet

From the above Figures, it can be observed that the similarity in the construction of the fractal structures makes the antenna very compact in size at low cost. The Fig 1.1 shows the triangle shaped base structure makes the Koch structure and the same base may be

used to construct the sierpinski gasket as shown in the Fig.1.4. The basic square structure is used to construct the Hilbert curve, Sierpinski carpet and is shown in Fig.1.2 and Fig.1.3 respectively.

However, the study of the fractal structures was done much earlier [3], but the verification with the antenna design was done by Kim in 1986, later they are further extended by Cohen using Koch curve. The sierpinski gasket named after polish mathematician Sierpinski and the antenna was first designed by Puente in 1998. The Sierpinski gasket is composed basically the triangular structure and the central part of was removed and the fractal shaped structure was constructed. The design of the Sierpinski monopole antenna with four iterations is explained in the later section.

II. Antenna Reconfigurability

The reconfigurability of the Antenna is the ability to change the basic operational characteristics of the antenna by inserting the additional mechanism such as switching [6]. This in turn changes the distribution of the surface currents of the antenna structure makes it to resonate at different operating frequencies with altered characteristics independently. The Re-configurability may be either in terms of frequency, pattern, and polarization or may be with the combinations of the above. However, the reconfigurability of either type may be achieved by using electrical switching, optical switching or change in the materials or by altering the physical structure. The electrical switching includes incorporates the basic switching elements like PIN diodes, Varactor diodes, RF-MEMS, Mechanical Switches etc [6] where as the optical switching employs the photo switching elements like Laser diodes, Photo diodes etc. The reconfigur ability of the antenna also can be achieved by changing the materials like ferrites; liquid crystals etc and finally the altering the physical structure of the antenna also can introduce the reconfigurability of the antenna. However, the electrical switching using PIN diodes are much in practice because of its faster switching compared to other types and they provide high isolation between the antenna elements. The other factors that are to be considered in the selection of the switching is the isolation, power consumption, operating voltages, usage of additional biasing, compensation circuitry if any needed, physical properties, electrical, magnetic properties of the materials etc.

III. Sierpinski Monopole Antenna

The sierpinski gasket is named after the polish mathematician Waclaw Sierpiñski in 1915 and the first frequency independent and multiband sierpinski was developed by Puente in 1996. The design process of a sierpinski gasket is obtained by removing the central part of the main triangle by an inverted triangle with vertices located at the midpoint of the original triangle and the same will be repeated for the next stages. The antenna shown in Fig 3.1 shows the basic design of the sierpinski monopole antenna [5] printed over Arlon Cu Clad substrate (ε_r = 2.2, h= 1.6 mm) and mounted over a circular ground plane of dia 15.6 cm and is fed with the co axial probe with SMA connector. The simulated Sierpinski Monopole and the fabrication of the same were depicted in Fig 3.2 and Fig 3.3 respectively.

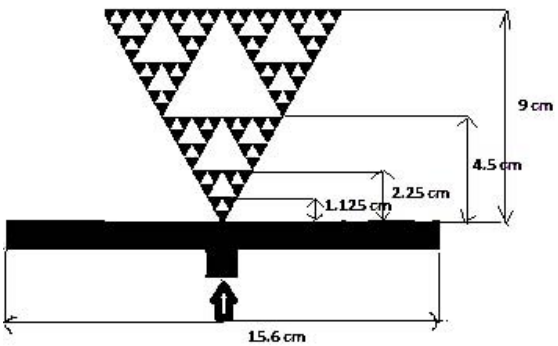

Fig.3.1: Sierpinski Gasket

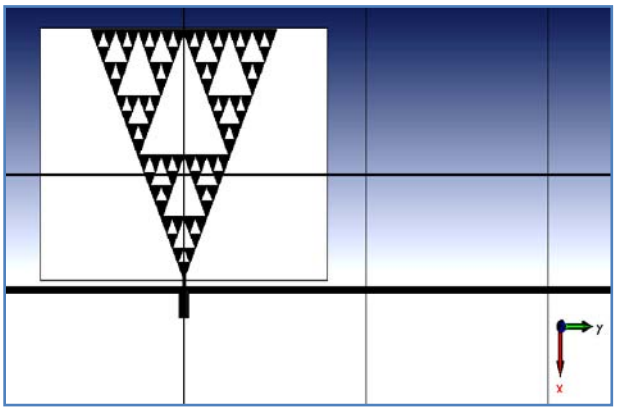

Fig.3.2: Simulation of Sierpinski Using CST

Fig.3.3: Fabricated Sierpinski Monopole Gasket

The Sierpinski antenna is designed for five iterations and appears at five different scales with a scaling factor of two such that the antenna heights are given by 9 cm, 4.5 cm, 2.25 cm, 1.125 cm and 0.5625 cm. It is expected that the structure should resonate at five different resonant frequencies with the multiple of factor two as the successive difference between the heights are considered exactly by half and is calculated using [2]

$$f_r = K \frac{c}{h} cos\frac{\propto}{2} \delta^n \qquad (1)$$

Where,

K = Constant and is 0.152 for Sierpinski Gasket for a given substrate

α= flare angle and is 60^0 for equilateral triangle

δ = scaling factor and is 2 and n= iteration number

As per the calculations using equation (1), the antenna should resonate at 0.86 GHz, 1.74 GHz, 3.46 GHz, 6.94 GHz and 13.86 GHz and the first one represents the sierpinski mode. Hence the antenna must be resonate at four frequencies other than the sierpinski basic mode in the practical measurement due to truncation effect [2]. The sierpinski gasket is simulated using CST Microwave Studio Suite software for the above dimensions as shown in Fig.3.1 and the same is fabricated manually using etching process as shown in Fig 3.3. The simulated and measured values are tabulated in the below Table 1. It gives the outlook of the resonant frequencies for both simulated and measured values

Table 1: Resonant Frequencies of the Sierpinski monopole

S.No	f_r (GHz) Resonant Frequency	
	Simulated	Measured
1	0.48	truncated
2	1.73	1.74
3	3.32	3.5
4	6.88	7.5
5	11.45	11.25

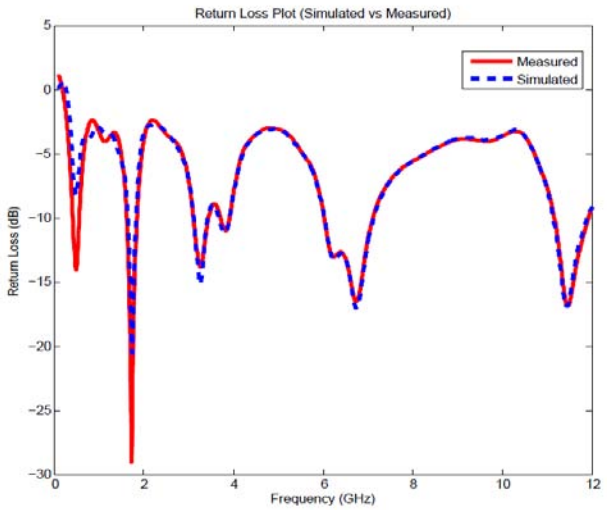

Fig.3.4: Simulated and Measured Return Loss Plot

As indicated, the designed antenna structure is radiating at 1.75 GHz, 3.5 GHz, 7.5 GHz, 11 GHz and the same was depicted in the Fig 3.4 for the Simulated and Measured values. This plot clearly shows that the Return Loss at 0.5 GHz which is the Sierpinski mode or the fundamental mode was not available in the practical measurements. The remaining frequencies are matched more or less exactly for the both Simulated and practically measured values. The radiation patterns at different resonant frequencies are shown from Fig 3.5 to Fig 3.8. Similarly the 3D radiation patterns are inserted from Fig 3.9 to 3.12.

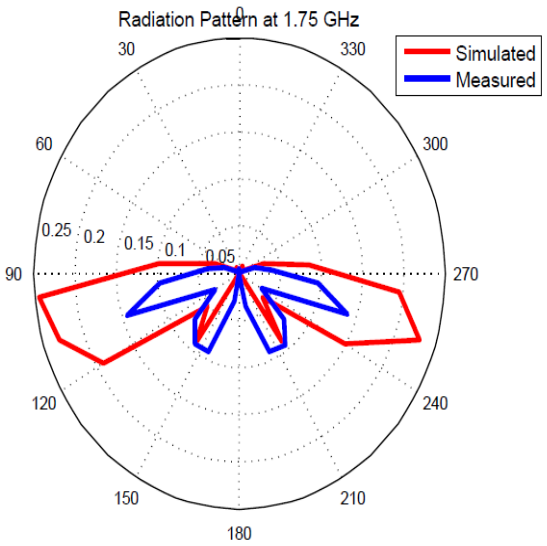

Fig.3.5: Radiation Pattern at 1.75 GHz

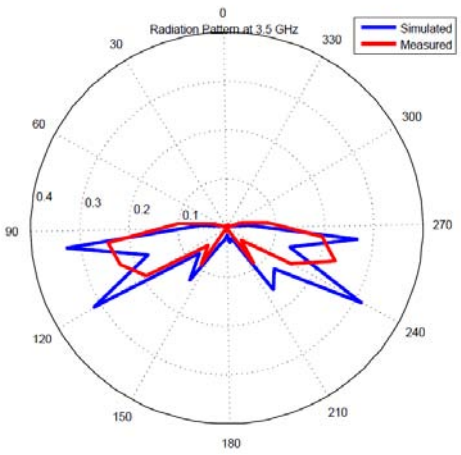

Fig.3.6: Radiation Pattern at 3.5 GHz

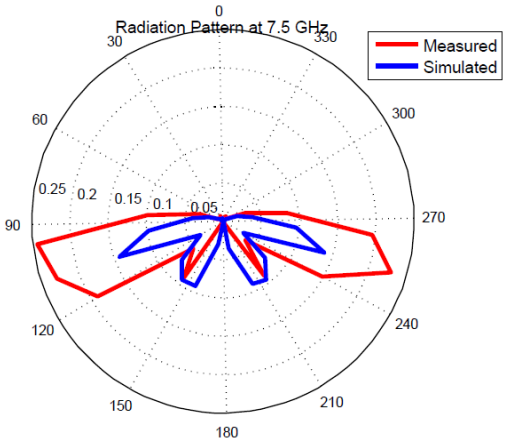

Fig.3.7: Radiation Pattern at 7.5 GHz

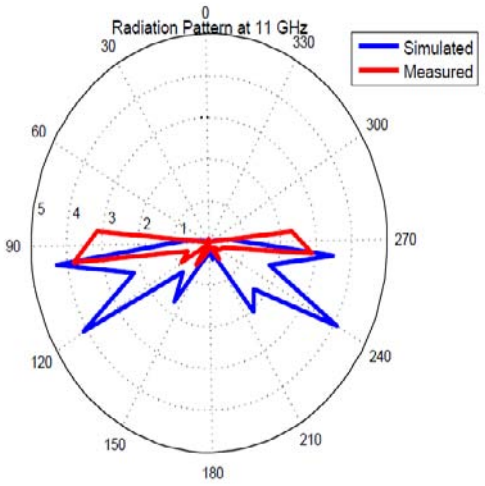

Fig.3.8: Radiation Pattern at 11 GHz

The above Polar plots are drawn with polarization dependent circular directional co-ordinate systems for different resonant frequencies. The plot for 1.75 GHz resonant frequency the main lobe magnitude

is 3.7 dB with an angular 3 dB width of 22^0 with a side lobe level of -1.8 dB is observed. For 3.5GHz, the main lobe magnitude is about 7.58 dB with an angular 3dB width of 11.6^0 with a side lobe level of -4.9 dB is obtained. Similarly for 7.5 GHZ frequency the main lobe magnitude of 8.51 dB and with an angular width of 15.7^0 with a side lobe level of -3.3dB is obtained and for 11 GHz frequency, the main lobe magnitude at about 7.3 dB and with an angular width of 19.1^0 with a side lobe level of -6.2 dB is achieved

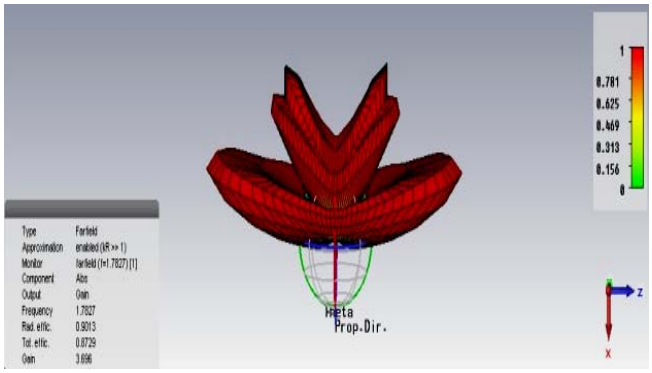

Fig.3.9: 3D Radiation Pattern at 1.75 GHz

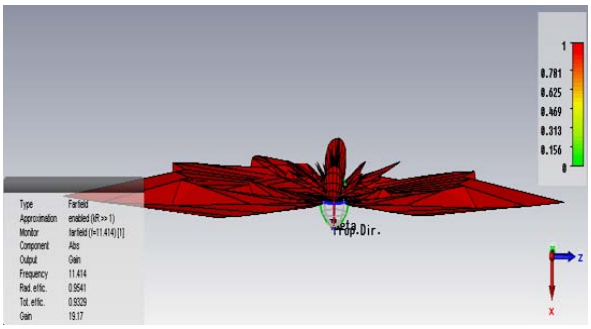

Fig.3.10: 3D Radiation Pattern at 3.5 GHz

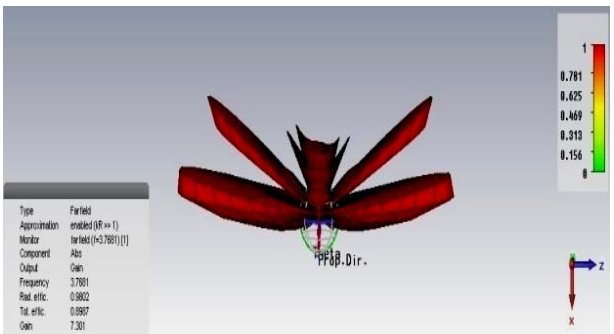

Fig.3.11: 3D Radiation Pattern at 7.5 GHz

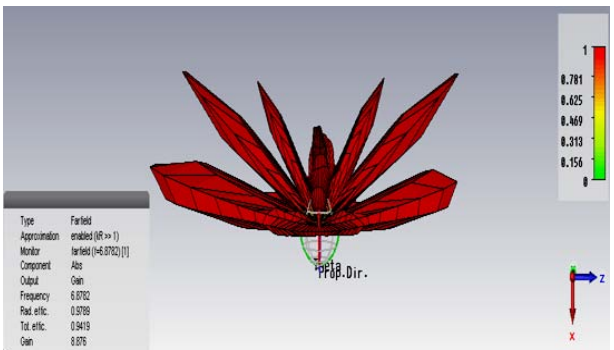

Fig.3.12: 3D Radiation Pattern at 11 GHz

From these Figures, it is clearly seen that the pattern becomes wider as the frequency with increased frequency and a gain of 3.696 dB is obtained for 1.75 GHz frequency. For 3.5 GHz the gain of 7.3dB is achieved. Similarly for 7.5 GHz, a gain of 8.876 dB is observed and for 11 GHz, the observed gain value is about19 dB.

IV. Reconfigurability Mechanism

It was observed that the Sierpinski monopole structure is having multi band operation and the above structure resonates at four resonant frequencies other than the Sierpinski mode. The reconfigurability is achieve by using suitable switching [6] mechanism along with filters of desired frequencies and it was for two frequencies in this case. The Hair Pin Band Pass Filters were designed [8] for the frequencies 3.5 GHz and 7.5 GHz on Arlon Cu clad substrate (εr = 2.2, h= 1.6 mm) and are shown below. Fig 4.1 shows the basic CST simulated model of 3.5 GHz Hairpin Filter and Fig 4.2 is the fabricated Filter. The dimensions of the Filters are calculated theoretically based on basic filter design and for 3.5 GHz Filter the width of the strip is taken as 3.16 mm and the distance between two successive hairpins is 1.86 mm and the length of the strips at the ends are taken as 5 mm. The length of each U arm is given by each arm is 41.24 mm (l_1=16.74 mm, w=7.76mm, l_2=16.74 mm) and the successive difference in between two arms is 1.44 mm. Similarly from the Fig 4.3 the dimension of the 7.5 GHz Filter is given below, the width of the strip is 2.6 mm, the separation between each U arm of the hairpin is 1.24 mm and the length of the strip at both ends is 5 mm. The length of each U arm is given by 22.24 mm (l_1=7.24 mm, w=7.76mm, l_2=7.24 mm) and the successive difference between each arm is given by 1.44 mm. The fabricated 7.5 GHz Hairpin filter is shown in Fig 4.4.

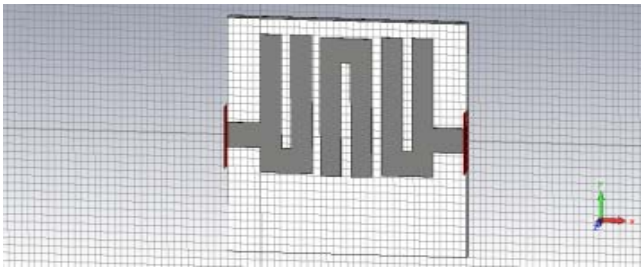

Fig.4.1: Hair Pin Filter 3.5 GHz Simulation

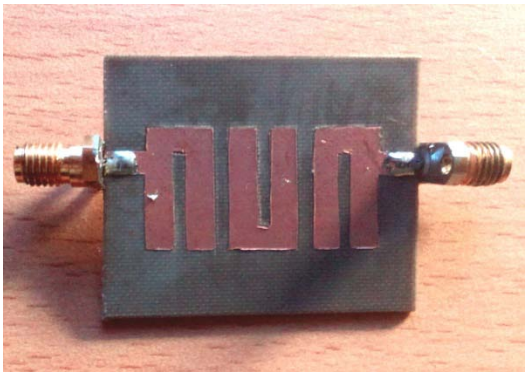

Fig 4.2: Fabricated 3.5 GHz Filter

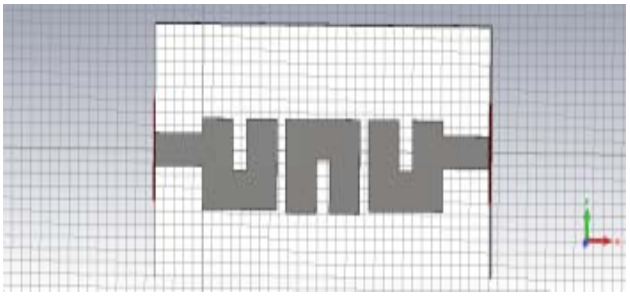

Fig.4.3: Hair Pin Filter 7.5 GHz Simulation

Fig 4.4: Fabricated 7.5 GHz Filter

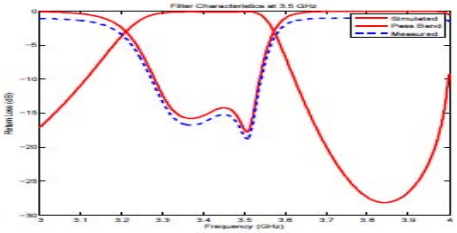

Fig 4.5: 3.5 GHz Filter Response Plot

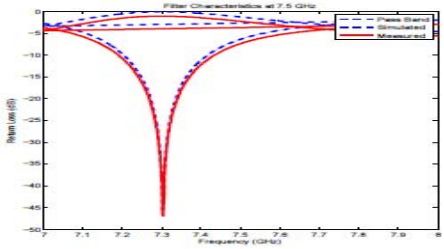

Fig 4.6: 7.5 GHz Filter Response Plot

The response of the 3.5 GHz Filter as shown in Fig 4.5 gives the pass band of the filter ranges in the given frequency range and the Fig 4.6 shows the pass band lies in the designed 7.5 GHz range.

The switching mechanism is achieved by using the electromechanical coaxial switches which have the extensive usage in the commercial and defense RF systems where low current consumption, small size, low insertion loss, high reliability are the major concern. The switch used in the design is of Teseol make from Stockholm [9], Sweden and model number is TS121 which is a "Single Pole Double Through" (SPDT) failsafe SMA stainless steel connector version. The operation of this type of switch by the requirement of holding current at only one position and the circuit is break before make and the actuating voltage is 12 V ±2.4 V and actuating current is 75 mA (+20^{0}C) and the switching time is 15 ms. The Fig 4.7 shows the basic Tesoel SPDT Switches.

Fig 4.7: Teseol SPDT switches

V. Modeling of the Antenna Re – configurability

From the earlier sections, it was proposed that the Sierpinski Monopole Gasket is to be incorporated with the Switches to select the appropriate filter to attain the reconfigurability. The design was simulated, fabricated, tested and measured. The Antenna is attached to the 3.5 GHz and 7.5 GHz Filter through two different switches and were operated and controlled through the switching mechanism. The CST simulated models of the same were shown in Fig 5.1, Fig 5.2 and the fabricated model was shown in the Fig 5.3.

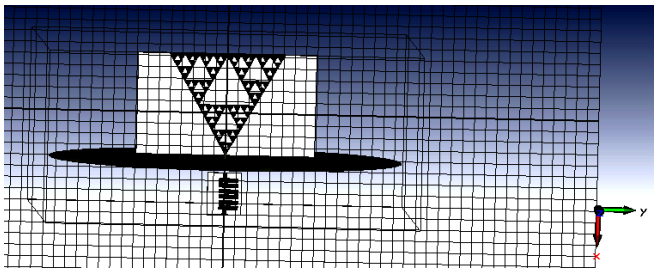

Fig.5.1: Antenna with 3.5 GHz Simulation

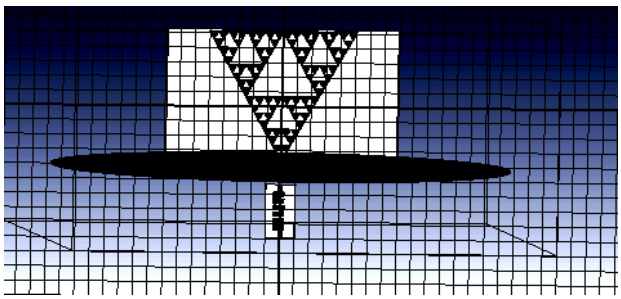

Fig 5.2: Antenna with 7.5 GHz Filter Simulation

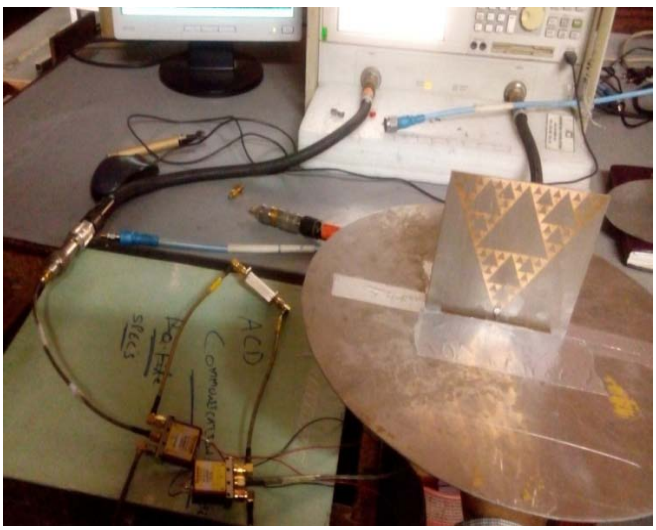

Fig.5.3: The Sierpinski Monopole Antenna along with Filters and Switches

The basic operation involved in this design was the first switch is connected to the 3.5 GHz Filter and was actuated by giving the voltage of +12 V and the other was connected to 0V. Therefore, it was observed that the antenna was resonating for 3.5 GHz only. Similarly, when the 7.5 GHz Filter was actuated through switch, the other switch was not actuated and observed that the antenna is resonating at 7.5 GHz. The responses of the individual filters according to their switching condition are shown in Fig 5.4 and Fig 5.5 respectively for 3.5 GHz and 7.5 GHz. The Radiation patterns of the individual filters are shown in the Fig 5.6 for 3.5 GHZ Filter and for 7.5 GHz Filter is shown in Fig 5.7.

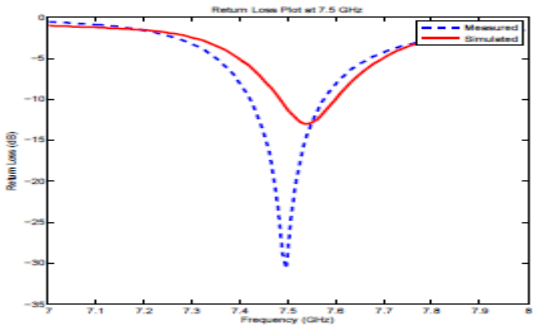

Fig.5.4: Antenna Response with 3.5 GHz Filter

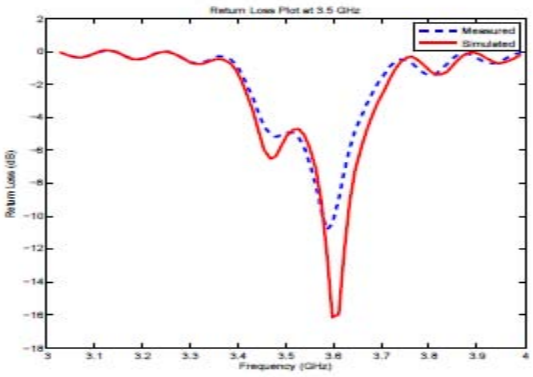

Fig 5.5: Antenna Response with 7.5 GHz Filter

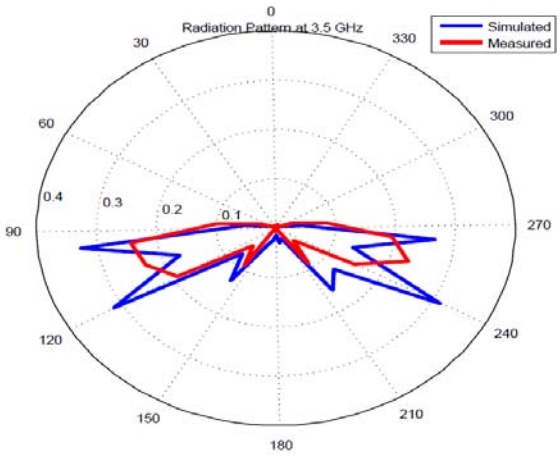

Fig.5.6: Radiation Pattern at 3.5 GHz

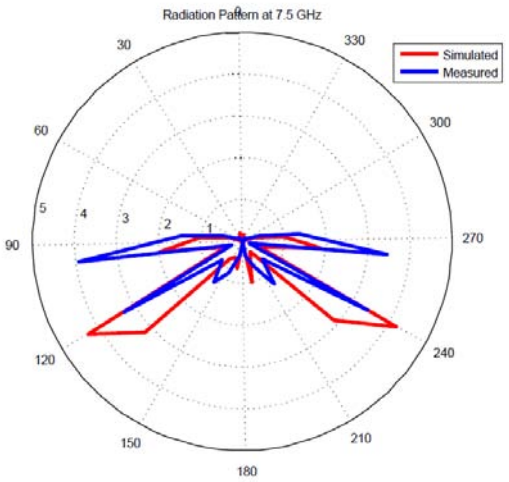

Fig 5.7: Radiation Pattern at 7.5 GHz

VI. Discussion of the Results

The basic idea of achieving the reconfigurability mechanism of the Sierpinski monopole antenna along with the 3.5 GHz and 7.5 GHZ filters with the incorporation of the Teseol electromechanical switches was shown along with the results in the previous section. Since the Sierpinski monopole gasket has been constructed through five iterations in this case, hence five scaled versions of the fractal structures has been observed on the antenna and the basic Sierpinski lower frequency was not observed practically because of the truncation effect. The Antenna was resonating at four different frequencies, since the scaling factor of the antenna is 2 (δ=2), it is observed that the resonating frequencies are also spaced by a factor of two. Due to the truncation effect of current distribution in the fractal structure, the lowest frequency is shifted closer to the next resonant frequency and therefore the basic sierpinski mode i.e the first resonant frequency was not observed practically.

Since the fractals appear at different scales, it is observed that the Sierpinski gasket would behave similarly to a triangular antenna but at different bands depends on the fractal geometry. All the plots clearly show a log periodic behavior, and the log-period (δ) is a factor of two. In particular, the antenna is matched at four frequencies, i.e. at 11, 7.5, 3.5, 1.75 GHz respectively and the fundamental mode is not visible in the measured value due to the truncation effect and the return loss plot is as shown in Fig.5.4 and Fig 5.5 for the Antenna structure with 3.5 GHz Filter and 7.5 GHz Filter respectively along with simulated and measured results. These plots clearly indicate that the antenna is resonating accordingly with the selected filtering section controlled by the appropriate switching.

The simulated and measured radiation patterns of the Sierpinski monopole along with 3.5 GHz Filter and 7.5 GHz Filter is presented in the Fig 5.6 and Fig 5.7 respectively, The patterns corresponding to the flare angle $\alpha = 60^0$, $\theta = 90^0$ it is observed that the beam becomes more wider and almost the same patterns were obtained without using the Filter sections. The H-plane pattern and almost Omni directional pattern for $\varphi = 0^0$, $\varphi = 180^0$ is traced. It is observed that the wider band width is obtained with the increase in the frequency from the radiation patterns also the gains of 3.6 - 19 dB is observed with almost 90% radiation efficiency with these structures.

VII. Conclusions

The Triangular fractal sierpinski monopole antenna along with two different Filters with suitable switching arrangement has been designed, analyzed using simulation software, fabricated, tested and the results are reported. It is observed that the antenna showed multi frequency operation resonating at the following frequencies 1.74 GHz, 3.5 GHz, 7.5 GHz & 11.25 GHz. However the antenna is made operational (along with suitable filters and switching arrangement) covering the UWB frequency range 3.1 GHz to 10.6 GHz for commercial communication applications. To achieve the frequency reconfigurability mechanism, electro mechanical switching concept using Tesoel Taconic Switches is employed and the antenna exhibits resonance at 3.5 GHz and 7.5 GHz independently. The developed antenna structure exhibited excellent gain ranging from 3.6 dB to 19 dB along with good amount of radiation efficiency, impedance bandwidth parameters making it most suitable for Cognitive Radio applications. In future, the electro mechanical switches can be replaced by electrical switching methods using PIN diodes to achieve the reconfigurability. Similarly a single reconfigurable resonator instead of different filter sections can also be employed to reduce the design in to a simple structure. Further, this concept of

reconfigurability using suitable filter with multi band antenna can be extended further to any type of antenna under different communication applications.

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Modeling of the Transfer Function Characteristics of an Electrical Power Distribution System

By Onoriode K. Idiapho & Osagie Aitokhuehi
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Abstract- This study seeks to determine the mathematical model for the transfer function characteristics of a single-input-single-output (SISO) electrical power distribution system with a view to understanding better, how the variation in input variables affects the overall output of electrical power distribution. It involved taking input-output data from a real life electrical power distribution system over a given period of four months and developing a transfer function model for the system so as to determine its operations efficiency using SPSS software. From the analysis carried out, the value of ω_0 (coefficient of performance) in the month 1-2 was found to be 0.670 while the value was 1.065 in the month 3-4. The higher the value of $\omega_0$the more efficient is the power distribution system.

Keywords: transfer function, SISO, mathematical model, coefficient of performance (COP).

GJRE-F Classification: FOR Code: 090699

Strictly as per the compliance and regulations of :

Modeling of the Transfer Function Characteristics of an Electrical Power Distribution System

Onoriode K. Idiapho [α] & Osagie Aitokhuehi [σ]

Abstract- This study seeks to determine the mathematical model for the transfer function characteristics of a single-input-single-output (SISO) electrical power distribution system with a view to understanding better, how the variation in input variables affects the overall output of electrical power distribution. It involved taking input-output data from a real life electrical power distribution system over a given period of four months and developing a transfer function model for the system so as to determine its operations efficiency using SPSS software. From the analysis carried out, the value of ω_0 (coefficient of performance) in the month 1-2 was found to be 0.670 while the value was 1.065 in the month 3-4. The higher the value of ω_0 the more efficient is the power distribution system. The system performance was found to be more effective in the month 3-4 than in the month 1-2 because it has a higher value of (COP). This shows that the transfer function parameters could be used as performance indicators. In addition to this, effective determination of the capability of a process will lead to better monitoring, improved operations and maintenance of the distribution system.

Keywords: transfer function, SISO, mathematical model, coefficient of performance (COP).

I. Introduction

The focus of this research is to address the challenges of electrical power distribution systems in Nigeria. The relationship between the input and output of a single-input-single-output electrical power distribution system although fairly known, but it is least understood. A major reason for this is that electrical power distribution system transfer function which serves as a guide for measuring and monitoring electrical power distribution output is often never determined and factored into the distribution control system. The decision problem is which analytical technique to adopt to clarify the nature of the relationship. In this study, the transfer function model is employed. Transfer function modeling is an integral part of control and process monitoring which is used to determine the causal relationship between input and output of a process. Efforts at relating the input to output of a system statistically started with regression analysis (Lai, 1979). Hence, regression analysis formed the basis of the traditional statistical method of modeling the relationship between the input and output to systems. Regression analysis has many deficiencies, for example; regression analysis is inappropriate in situations where the output lags the input when there is a significant amount of noise in the system regression analysis cannot accommodate noise in the filter (Box and Jenkins, 1994).

In 1970, Box and Jenkins introduced an improved statistical method of modeling the relationship between the input and output to a system. This method was named Box-Jenkins transfer function modeling methodology (Lai, 1979). Box et al did a very significant work in transfer function modeling by introducing ARIMA and noise models into transfer function modeling. This significantly improved the efficiency and reliability of transfer function models. In addition to this, transfer function model forecasts usually have smaller forecasting errors than the forecasts based on univariate models which are based on the output, and gives good forecasts of the future output from a process which is very significant. Since the introduction of transfer function modeling in 1970, efforts have been made by various researchers to improve and extend its application in various fields of life. For example Lai (1979) applied it extensively in modeling geographical systems. DerLurgio (1998) applied it extensively in econometrics and economic forecasting. Nwobi-Okoye and Igboanugo (2011, 2012) applied transfer function modeling to better understand the complex relationship between the input and output of a production system. Talmon et al. (2009) applied transfer function modeling in speech recognition application and speech signal processing. Albarbar et al. (2008) carried out research to compare the performance of MEMS accelerometers for condition monitoring using input-output transfer function analysis based on frequency responses, as well as other performance indicators. They investigated the performances of three of the MEMS accelerometers from different manufacturers and compared them to a well calibrated commercial accelerometer which was used as a reference for MEMS sensors performance evaluation.

This work is therefore conceived to explore transfer function modeling as a possible monitoring and control tool for improving the operational efficiency of an electrical power distribution system. The hub of our

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investigation is Shell Forcados Terminal located Southwest of Warri, Delta State Nigeria.

II. The General Transfer Function Modelling Procedure

A discrete transfer function model applicable to a distribution process has been developed by Box et al. We shall assume the model as stated in equation (3.1) as follows:

$$Y_{t=\delta^{-1}}(B)\omega(B)X_{t-b} + N_t \quad (3.1)$$

The noise term, N_t, is represented by an ARIMA (p,d,q) process such that:

$$N_{t=\varphi^{-1}(B)\theta(B)a_t} \quad (3.2)$$

Here a_t is the white noise. Substituting equation (3.2) into (3.1), gives

$$Y_{t=\delta^{-1}}(B)\omega(B)X_{t-b} + \varphi^{-1}(B)\theta(B)a_t \quad (3.3)$$

III. Methodology

The basic model used in this research is the transfer function modeling. The transfer function modeling procedure consists of the following steps:

1. Model Identification
2. Model Estimation
3. Model Diagnostics
4. Forecasting

a) Transfer Function Modeling Procedure: Electrical Power Distribution

In order to realize the transfer function model based on equation (3.3), a plot of the 4-month input-output data was done using SPSS software. After the plot, the data was investigated for stationarity, using the plots of the autocorrelation functions (ACF) and Pearson's autocorrelation functions (PACF). The input and output series derived from the plots were found not to be stationary, hence differencing was used to achieve stationarity. Stochastic regularity was achieved after the second differencing. Following the achievement of stationarity of the input Y_t and output X_t, univariate model was individually fitted to X_t and Y_t in order to respectively estimate pre-whitened input and output series namely β_t and α_t. Calculation of the cross correlation function was used to identify r, s and b parameters of the transfer function model.

Furthermore, the transfer function was estimated using Y_t and X_t. The residual of the transfer function was used to identify the noise term N_t of the transfer function model. Finally, the model adequacy check and optimization was done using genetic algorithm.

As transfer function model parameters are continuous variables, the genetic algorithm method was the continuous version. The model parameters are: b, δ, ω, θ and ϕ as shown in equation (3.3).

IV. Results

Transfer Function Modelling: The data gotten from transformer (TR-102) at switchgears SG-101(Input) and SG-102 (Output) at Shell Forcados Power Terminal was analyzed in line with the theory and procedure developed and described earlier in the methodology.

The abscissas of Figures 1 to 4 are in days-of-the month (30). The distribution station is supplied with 33kv from the national grid and it is stepped down to 11kv for distribution to consumers. The power input depends on availability of power in the national grid which is fed by the generation stations. Thus as shown in Figures 1 and 3, the power supply does not follow any particular pattern. The output power depends on demand and the conditions of the distribution facilities. Hence, the output time series of Figures 2 and 4 follow the pattern described in the foregoing.

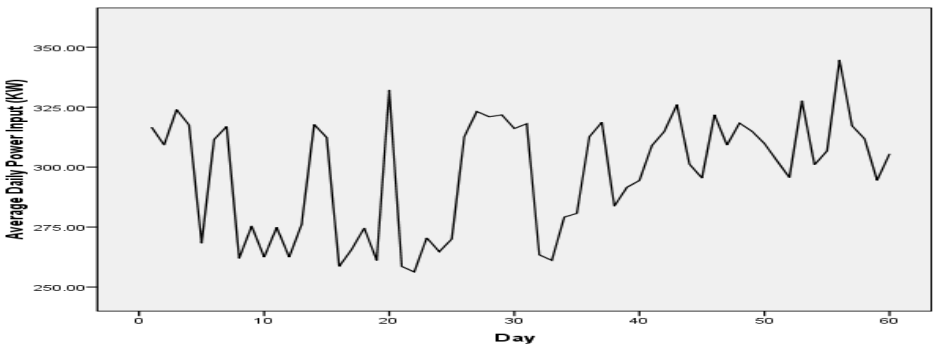

Figure 1: Input Series for month 1-2

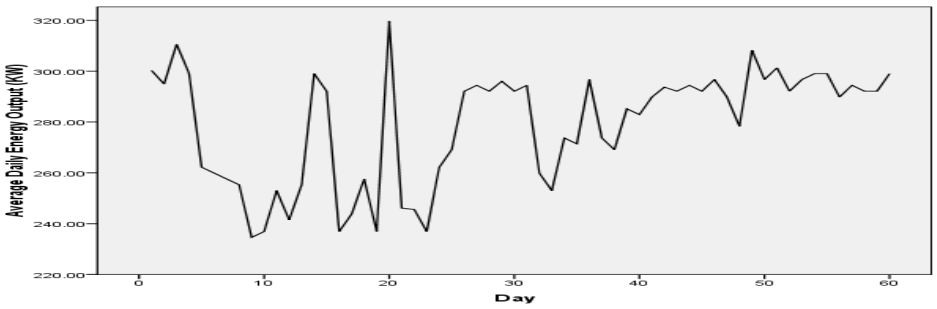

Figure 2: Output Series for month 1-2

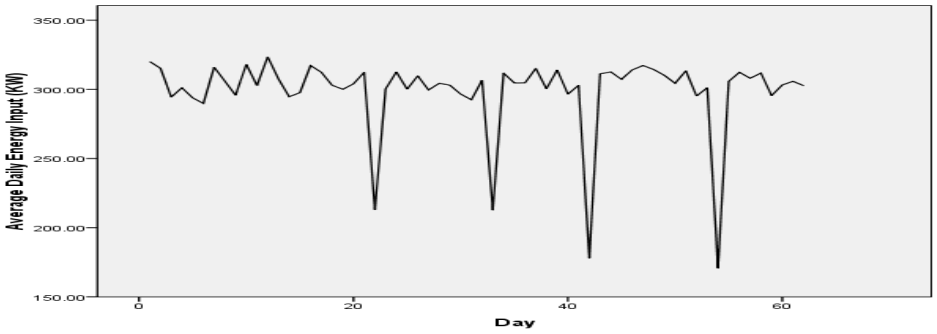

Figure 3: Input Series for month 3-4

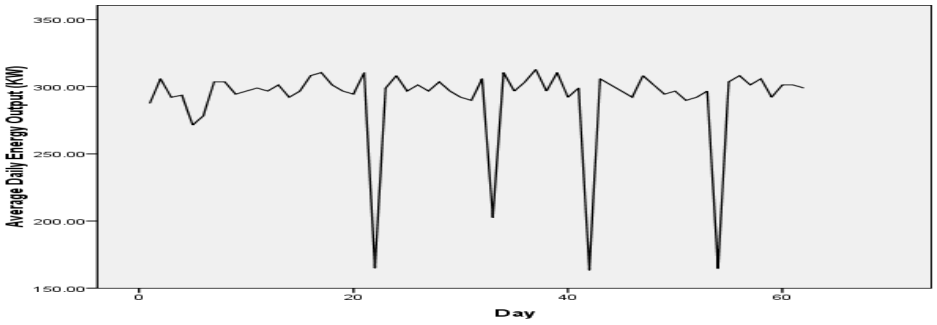

Figure 4: Output Series for month 3-4

Analysis of Input Series

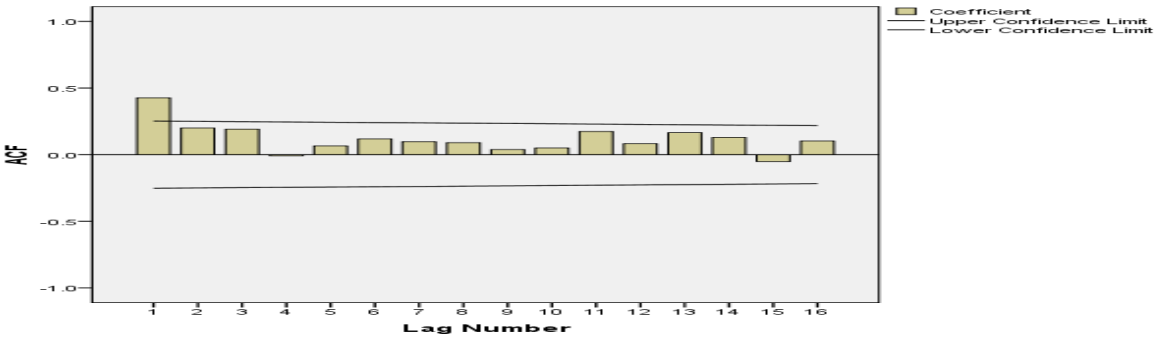

Figure 5: ACF of the input series

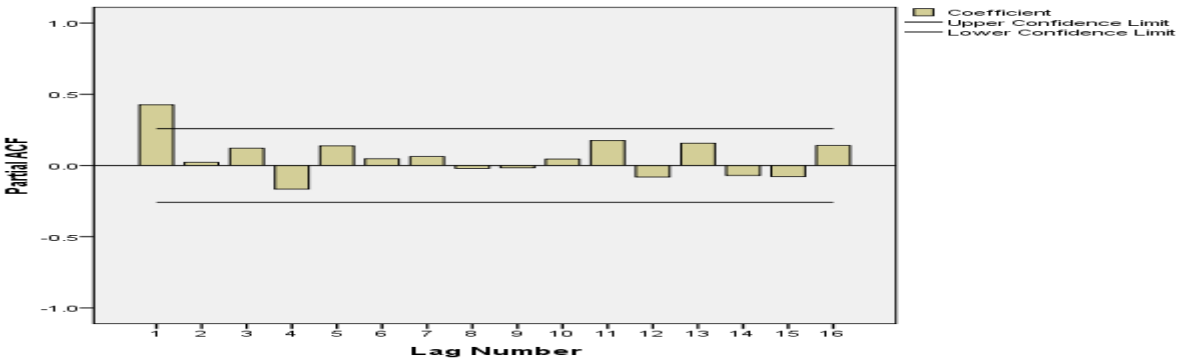

Figure 6: PACF of the input series

The input series upon analysis was found to be stationarity, hence differencing was not used. Examination of the ACF and PACF in Figures 4 and 5 are indicative that auto regression one (AR (1)) model is the appropriate model to use. The formula for AR (1) models [2, 14 and 15] is given by equation (4):

$$X_t = \theta_0 + \phi_1 X_{t-1} + e_t \quad (4)$$

But for AR (1) models, we have:

$$ACF(1) = \phi_1 = 0.427 \quad (5)$$

$$\theta_0 = (1 - \phi_1)\mu \quad (6)$$

$$\theta_0 = (1 - 0.427)297.42 \quad (7)$$

$$\theta_0 = 170.42 \quad (8)$$

Fitting the coefficients θ_0 and ϕ_1 into the formula for AR (1) models, equation (9) is obtained.

$$X_t = 170.42 + 0.427 X_{t-1} + e_t \quad (9)$$

But

$$e_t = \alpha_t \quad (10)$$

In forecasting form, equation (9) is transformed to equation (11):

$$\hat{X}_t = 170.42 + 0.427 X_{t-1} \quad (11)$$

a) Analysis of output series

The output series upon analysis was found to be stationarity, hence differencing was not used. Examination of the ACF and PACF in Figures 5 and 6 are indicative that auto regression one (AR (1)) model is the appropriate model to use.

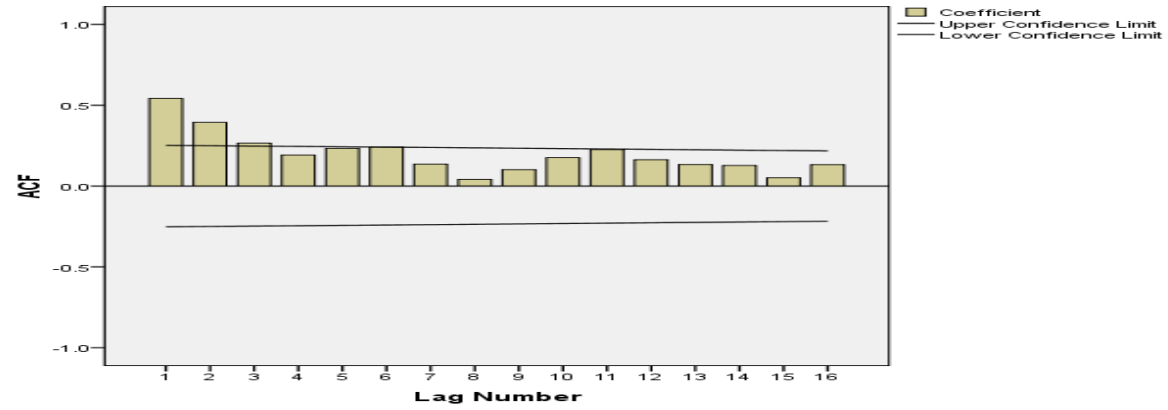

Figure 7: ACF of the output series

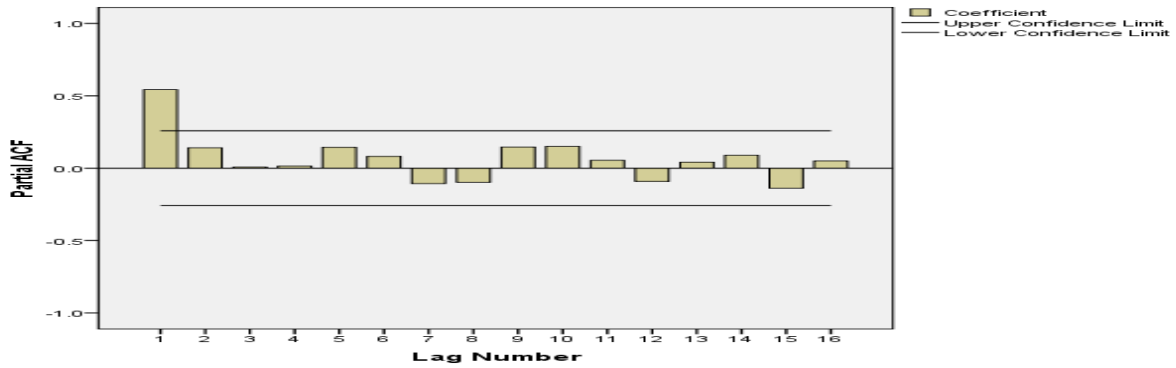

Figure 8: PACF of the output series

The formula for AR (1) models [2, 14 and 15] is given by equation (12):

$$Y_t = \theta_0 + \phi_1 Y_{t-1} + e_t \quad (13)$$

But for AR (1) models, we have:

$$ACF(1) = \phi_1 = 0.427 \quad (14)$$

$$\theta_0 = (1 - \phi_1)\mu \quad (15)$$

$$\theta_0 = (1 - 0.427)278.69 \quad (16)$$

$$\theta_0 = 159.69 \quad (17)$$

Fitting the coefficients θ_0 and $\phi_1$into the formula for AR (1) models, equation (18) is obtained.

$$Y_t = 159.69 + 0.427Y_{t-1} + e_t \quad (18)$$

But

$$e_t = \beta_t \quad (19)$$

In forecasting form equation (18) is transformed to equation (20):

$$\hat{Y}_t = 159.69 + 0.427Y_{t-1} \quad (20)$$

The CCF between β_t and α_t is shown in Figure 5.3.2. It has one significant CCF at lag zero (0).Hence, according to [14], the parameters r, s and b of the transfer function that supports such CCF pattern are 0, 0 and 0 respectively. In view of this fact, the CCF supports the following transfer function model:

$$y_t = \omega_0 x_t + N_t \quad (21)$$

Based on Ljung-Box statistics shown in Table 5.3 and analysis of the residuals, the transfer function was found to have white noise residuals, hence we disregarded the noise term N_t , to obtain equation (22).

$$y_t = \omega_0 x_t \quad (22)$$

As shown by [1] and [4],

$$v_0 = \omega_0 \quad (23)$$

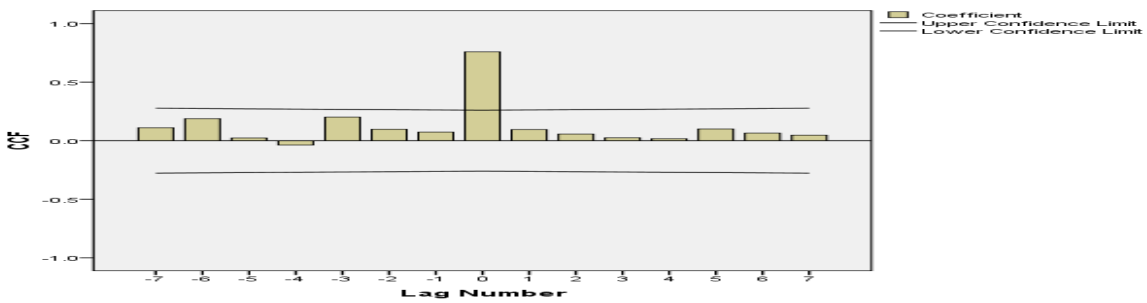

Figure 9: CCF of the pre-whitened series

But

$$v_0 = \frac{\gamma_{\alpha\beta}(0) S_\beta}{S_\alpha} \quad (24)$$

$\gamma_{\alpha\beta}(0)$ Is the cross correlation between α and β at lag zero (0).

But

$$X_t - \mu_x = x_t \quad (25)$$

And

$$Y_t - \mu_y = y_t \quad (26)$$

Substituting equation (26) into equation (22), equation (27) is obtained.

$$Y_t = \mu_y + \omega_0 x_t \quad (27)$$

In forecasting form equation (27) is transformed to equation (28).

$$\hat{Y}_t = \mu_y + \omega_0 x_t \quad (28)$$

b) Analysis for Month 1-2

The lag of 0 in the transfer function model shows that the average gas flow in the month is used for generation the same month. The model has intuitive and theoretical appeal. The model fit and statistics are good as shown for month 1-2 in Tables 1 and 2 respectively.

Table 1: Model fit for Month 1-2

Fit Statistic	Value
Stationary R-squared	.712
R-squared	.712
RMSE	12.362
MAPE	3.407
MaxAPE	12.212
MAE	9.300
MaxAE	30.309
Normalized BIC	5.234

Table 2: Model Statistics for Month 1-2

Model	Number of Predictors	Model Fit statistics	Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	Statistics	DF	Sig.	
Transfer Function Model	1	.712	9.592	17	.920	0

For month 1-2 operations of the Power Station we obtained:

$$\gamma_{\alpha\beta}(0) = 0.759$$

$$S_\beta = 19.12$$

$$S_\alpha = 21.68$$

Hence,

$$v_0 = \frac{0.759 \times 19.12}{21.68}$$

$$v_0 = 0.67$$

$$\omega_0 = 0.67$$

Hence from equation (22)

$$y_t = 0.67 x_t$$

Since $\omega_0 = 0.67$ for the month 1-2 operation of the power station, the transfer function is given by:

$$\hat{Y}_t = \mu_y + 0.67 x_t \quad (29)$$

c) *Analysis for Month 3-4*

The lag of 0 in the transfer function model shows that the average gas flow in the month is used for generation the same month. The model has intuitive and theoretical appeal. The model fit and statistics are good as shown for the month 3-4 in Tables 2 and 3 respectively.

Table 3: Model fit for Month 3-4

Fit Statistic	Value
Stationary R-squared	.587
R-squared	.067
RMSE	31.836
MAPE	7.766
MaxAPE	80.056
MAE	18.033
MaxAE	131.997
Normalized BIC	7.123

Table 4: Model Statistics for Month 3-4

Model	Number of Predictors	Model Fit statistics	Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	Statistics	DF	Sig.	
Transfer Function Model	1	.712	9.592	17	.920	0

From August to November 2012 operations at Shell Forcados Power Terminal, we obtained:

$$\gamma_{\alpha\beta}(0) = 0.954$$

$$S_{\beta} = 33.57$$

$$S_{\alpha} = 30.08$$

Hence,

$$v_0 = \frac{0.954 \times 33.57}{30.08}$$

$$v_0 = 1.065$$

$$\omega_0 = 1.065$$

Hence from equation (22)

$$y_t = 1.065 x_t$$

Since $\omega_o = 1.065$ for the month 3-4 operation of the Power station, the transfer function is given by:

$$\hat{Y}_t = Y_{t-1} + 1.065 x_t \qquad (30)$$

Table 5: Transfer Function Models of the Power Station

Months	Transfer Function Model (v(B))
1-2	$\hat{Y}_t = \mu_y + 0.67 x_t$
3-4	$\hat{Y}_t = Y_{t-1} + 1.065 x_t$

Table 6: Energy Transformed Vs Coefficient of Performance of the Power Station

Months	Total Energy Output (MWH)	Coefficient of Performance ω_0
1-2	401.32	0.670
3-4	432.73	1.065

V. Discussion

The transfer function parameter ω_0 is a measure of how effective the available gas is converted to electric energy, and could be regarded as the coefficient of performance of the Power Station's yearly operations. The higher the value of ω_0 the more efficient is the power distribution facility and the lower the value of ω_0 ; the power distribution facility is less effective in transforming the input power to suitable output state. Hence, ω_0 is analogous to the intercept m of the equation of a straight-line. The results indicate that the month 3-4 had the highest coefficient of performance (COP) in the 4-month sample studied. On the other hand the month 1-2 had the least COP. As shown in Table 3.10, the value of ω_0 in the month 1-2 was 0.670 while the value was 1.065 in the month 3-4.

VI. Conclusion

In this research study, the relationship between the input and output of a single-input-single-output electrical power distribution system was analyzed using the transfer function modeling technique. From the analysis carried out, the system performance of transformer (TR-102) was more effective in the month 3-4 than in the month 1-2. This is in conformity with the theoretical proposal that the transfer function parameters could be used as performance indicators. The lower energy output in the month 1-2 was partly because operations efficiency was poorer in those months when compared to the month 3-4.

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Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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All manuscripts submitted to Global Journals Inc. (US), ought to include:

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Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

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Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

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6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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(Free of charge) from the following website:

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TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

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7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

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10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
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- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
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Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

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This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
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- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
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- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

Index

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