



### ***Editorial Note***

I feel immense pleasure to present before you another issue of “New Horizons” Journal of the Institution of Electrical and Electronics Engineers Pakistan. Continuing the tradition of disseminating latest technical knowledge, IEEEEP journal has covered emerging topics and novel aspects of technology, application and service development within the multidisciplinary framework of Electrical, Electronics, Computer, and Telecommunication Engineering. In this issue total 10 research papers are included covering diverse fields.

In 1st paper, considering the important of Hybrid Power System, Fuzzy Logic Controller based control scheme is proposed and Frequency Shift Key based power line communication scheme is tested over proposed hybrid power system.

In 2<sup>nd</sup> article the major challenges of Economic Dispatch are reviewed i.e. planning, evaluation of demand, weather forecasting and security constrains, existing algorithms, unit commitment and reduction in carbon emissions. The proposed system is verified over IEEE 30-bus bar and six generators along with wind and solar units considered as non-schedulable.

In next paper, linear stability analysis of harmonic oscillator in the domain of superconductivity is carried out to determine the stability of fixed points in a circuit to visualize the qualitative analysis of resonance frequency when an LC circuit is operated from an external supply.

In fourth paper, using image processing techniques, the faults in PV arrays are investigated and a mathematical modelling framework is proposed to correctly determine a faulty cell within a PV module.

The next paper demonstrates the generation of multiple signals due to nonlinearities between two or more wavelengths interacting with each other. It is concluded that WDM via FWM offers less BER compare to WDM system via XPM.

In sixth paper, VPN is deployed between virtual cloud and physical IoT devices to obtain faster communication with security allowing transferring of data proficiently and safely. Moreover, L2TP technology is used to achieve VPN connectivity with two phase authentication and encryption of data, which results as a secure and fast tunnel for data transfer minimizing time from 240ms to 140ms.

In next paper, the power saving requirement for IoT devices LTE, LTE-A is used to turn off receptions and go to sleep when no data need to be received or transmitted. This guarantees the Quality of Services.

The paper titled as “Social Network YouTube a Source of Earning” explores the online money earning opportunities like Freelancing, Affiliate marketing, Blogging and Youtubing.

The ninth paper Analysis the world’s top YouTube Channels in 2017.

In final paper to secure the future of digital banking in Pakistan, the concept of ATM PIN verification via Smartphones is proposed.

In the end, I am extremely grateful to the National advisory board of experts and paper review experts for their valuable input to improve the quality of journal. In this issue four volumes have been merged together as vol. 97 to vol.100.

Finally, On behalf of IEEEEP journal management committee, I welcome the submission for the upcoming issue and look forward to receive your valuable feedback.

The Chief Editor  
Engr. Prof. Dr. Bhawani Shankar Chowdhry

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# Designing of Control Scheme For Hybrid Power System Using Fuzzy Logic Controller

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## Abstract:

*The development of renewable energy sources is a critical topic in 21<sup>st</sup> century. With growing problems of global warming and other environmental issues, researcher from all over the worlds have shown their interest in developing alternative energy resources i.e solar and wind for electric power generation. The objective of this paper is to introduce an innovative hybrid power energy system powered by solar and conventional power system which controlled by Fuzzy controller. Additionally, In Solar energy a maximum point tracking (MPPT) system is designed by fuzzy logic controller and tracked optimal power point. According to current revolution of communication in power system, FSK (Frequency Shift Key) based power line communication scheme is tested over this new hybrid power system. This proposed Fuzzy MPPT algorithm is implemented using MATLAB/Simulink. From these simulation results, it is definite that this fuzzy model delivers superior power tracking performance in any weather conditions compared to already existing models.*

**Keywords** Maximum Power Point Tracking, Renew-able Energy Resources, Power line Communication

## I. Introduction

The demand of energy is increasing because of growing population and living way of people is going to be efficient. In addition, the harmful and serious effects on environment of petroleum products resources are also a big issue. Renewable energy resources are an option to full these energy requirements and have capabilities to overcome the burden on power system. Solar energy is more reliable but have some issues like climate changes that badly effect the solar power. To overcome these effects on solar energy, researchers proposed some maximum power point tracking algorithms and schemes but there found bundles of drawbacks of each algorithm. After the rapid changes of temperature and irradiation, these algorithms have no capabilities to track Maximum power point. There is need of an efficient MPPT scheme that can meet and resolve all these climate concerns. One method of open circuit voltage ( $V_{oc}$ ) of PV panel and one issue with this method is to measure  $V_{oc}$  the power converters should shut down for some instant after each measurement there will be power losses. One more problem is the MPP voltage that is not able to measure continuously and also depend on approximation of one constant term, that's why it cannot say that is real. One more method that is based on short circuit ( $I_{sc}$ ) and measurement of  $I_{sc}$  is a problem at running time of solar

system because this configuration requires an extra device to short the converters for some instant. It is also problematic situation to measure  $I_{sc}$  after some time [1] and is caused of power losses. Perturb & observe and incremental conductance algorithms which observes if there is an increment in power then perturbation should be on same path but power is decreased then then perturbation should be on opposite path. Although these both are not bad options but it is not possible for both schemes to obtain maximum point at rapid change in power. The other problem of these two methods is the oscillations of voltage and current around the MPP in the steady state. [2] - [6]. The already exist algorithms for MPPT are worked on same purpose, but cannot able to judge the rapid changes in voltages are current.

As was earlier mentioned that MPPT algorithms are very essential for PV applications. The reason is the MPP of a solar panel is varied with variation of irradiation and temperature, so by using of MPPT algorithms it can obtain the maximum power from a solar panel. PV panels are generated DC power and supplied their electrical power to grid or home but AC power is needed for that purpose. Inverter is a device which can convert DC power into AC power in [7] to get maximum power from solar array MPP tracking algorithms are designed. Despite all these algorithms different inverter configuration is also very important [8]. To decide that what configuration is exact suitable for the solar panel MPP because there is continuously environmental variation. One important reason of inverter configuration is different MPP of each panel, so it is necessary to choose a best suitable configuration [9].

The distributed power generation systems based on RES like solar energy, wind energy and micro-turbines are called a hybrid renewables power system. According to [10] there is need to overcome the dependency to conventional energy power system. The distributed generation system integrated with various RES are allowed to attain higher efficiency and better performance. There are many methods of integrating different RES to a hybrid system. These methods are decoupled, ac-coupled, and hybrid-coupled [11]. In this hybrid system, various RES are integrated to a DC bus over associated power electronic devices like rectifiers or DC-DC converters. The DC bus voltage is converted to AC and DC loads is directly connected to DC bus. The generated voltage, current, and apparent power of each renewable source are measured and then decided the priorities of energy resource.

However, because of this huge size of power network and big investment that has been done over the years, then a

small significant change can be very much expensive and also needs an extra intention. The complexity is also increased by integration of huge amount of energy generation through renewable. After the integration of these alternative resources with conventional power system, it is required a communication setup to facilitate these complexities as well as to ensure its smooth operations, to overcome security concerns and facilitate the interconnected operations of supply side generators to end customers. Power line communication is an example of smart grid application but faces difficulties in communications networks like noise on channel is a very unfamiliar characteristics and that level of noises may be excessive. Moreover, the electromagnetic compatibility is also an issue in interfacing of PLC circuits with electrical power lines then there are required coupling circuits that can merge communications equipment's with power lines.

After studied the detailed scenarios, the goals of this paper are an efficient MPPT algorithm for solar arrays with their proper adjustments and a communication link between these suggested models. A fuzzy logic based optimize algorithms is referred to track maximum power. Finally, the main purpose is to develop a model with integration of these alternative resources and Power line communication is used as communication link with frequency shift key modulation schemes.

## II. Layout of Hybrid Power System Model

A hybrid power system that is controlled and optimized with FLC as shown in Figure 1. There is modeled a solar panel and then by fuzzy logic scheme the MPP is optimized. Solar panel is constructed under these parameters like open circuit voltages, short circuit current, optimum voltages and optimum current. Then Fuzzy Logic Controller with Rule viewer is selected to design FLC based hybrid power system. That is fixed the panel voltages as per battery required and also meet optimum current. The panels configuration is developed that is made of different arrays in string structures to feed power converters. After merged these sources a FLC is placed to select the power source according to its loads as shown in Figure 1. To fulfill the need of communication between power system and end load, the power line communication setup is tested.

### A. MPPT of Solar Panel

This proposed configuration where it is suggested that each PV panel have its own inverters and therefore MPPT is also connected to each panel and from this configuration each panel have its own MPPT. Although this configuration is very expensive but very optimize configuration. In addition, it is very useful for large size of solar panels.

There are two inputs of FLC based MPPT as shown in figure.2. One is irradiation (S) and second one is Temperature. The reason of taken these two input is that both have continuously variation and the parameters of

controller are depended on both these two inputs. The parameters of input are given below. Irradiation are changed continuously that's why it has four input variables of different ranges. There are input variables of S are given with their different ranges and similarly temperature is changed continuously therefore five input variables of different ranges are taken. The output and rules are set by rule editor. PV array is constructed over Table.1 parameter.

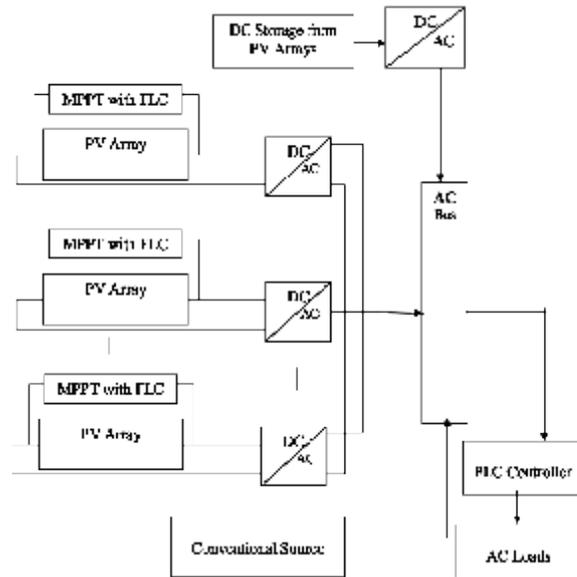


Fig. 1. Model Layout of Hybrid Power system

TABLE I  
PV PANEL PARAMETERS & RATINGS

Sr.no	Parameters	Ratings
1.	Maximum Power	240 watts
2.	Optimum Power Voltage (Vmp):	30.72 volts
3.	Optimum Operating Current (Imp):	7.81 amps
4.	Open Circuit Voltage (Voc):	36.60 volts
5.	Short Circuit Current (Isc):	8.36 amps
6.	Temperature Coefficients of Isc (%)	°C: +0.04
7.	Temperature Coefficients of Voc (%)	°C: -0.35
8.	Temperature Coefficients of Pm (%)	°C: -0.45
9.	Temperature Coefficients of Im (%)	°C: +0.04
10.	Temperature Coefficients of Vm (%)	°C: -0.35
11.	Temperature Range:	-40°C to +85°C
12.	Tolerance Wattage	+/- 3%
13.	Surface Maximum Load Capacity	5400Pa
14.	Cell Efficiency (%):	16.77%
15.	Module Efficiency (%):	14.78%
16.	Standard Test Conditions	1KW/m,25+/-2°C

These are rules when all climate changing is set as input. Then the output action can set by rules where zero means that is situation when there is need to power ON devices. Zero= 0, Check =5-7 Volts, rated= 30.72 volts are observing parameters. The action on zero output will be turn OFF devices that will be at night time or when the sun is not available. The output action check means that is condition when panels placing is not adjusted well so action will be any alarm. So, that panels placing is needed

to adjust. The output action rated means that power is available and just need to track MPP and battery will be charged at fix voltage constant. The rules are clearly shown that  $V_m$  always be tracked continuously then output is attached with PWM generator that is further connected with MOSFET. Then output will remain optimized at every possible situation whenever sun is available. The voltage level is controlled by controller that is connect with DC converters. This power system based on solar power with integration of conventional power and to meet with the challenges of climate changing that effects to solar power there is a FLC based MPPT algorithm is designed. This algorithm is placed to overcome the drawbacks of others MPPT algorithms. Although all these schemes are in used for different application of solar energy but FLC that is suggested in this model more attractive and more optimizing technique to obtain MPP. This not only feasible for the change in power due to changing in PV voltages and PV current as well as PV power and also very suitable for the sudden change in irradiation. It is clear that there is a need of DC-AC inverter to utilize DC power of solar array in useful purpose because most of the loads are founded AC loads. Each PV array has its own MPP so it is impossible to optimize all panels at same MPPT. Therefore, a need of inserting an individual MPPT for each panel and arrangement of inverters, both can see in figure1. Here, it can observe that the FLC algorithm based MPPT for each panel is placed. Although this is a very expensive way but also a very optimize method to operate each panel at MPP. The results are discussed further in details.

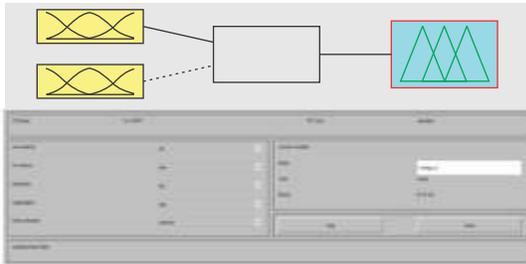


Fig. 2. Two inputs of FLC based MPPT

## B. Fuzzy controller for Hybrid Power Station

This attained AC power from this above configuration is linked to the AC bus bar. The objective of this proposed model is to introduce an innovative energy system for consuming renewable energy. To increase reliability of electrical power there is an option of conventional energy resources. So, AC bus is powered by solar energy, conventional energy and DC storage bank. The one more FLC is placed to facilitate the selection from input powers. There are some conditions to operate FLC on desired purpose and simulation results of this controller are also discussed in detail in next section and condition are:

- If load is higher than the production of power from RES, then controller will switch ON the conventional supply in order to operate the load.

- If load is less than the production of power from RES, then the controller will switch on the supply of RES system as well as store the remaining power in dc bank.
- Of load is equal to the production of electricity from RES then both supply conventional supply (for store power) as well as solar system will on to continue the supply of electricity.
- Is there is no solar supply from RES as well as no supply of conventional supply then there is a backup supply of electricity as a dc battery (storage system) to continue the supply of electricity.

## C. Power Line Communication of Proposed Hybrid Power System

Most of the power systems that are developing for upgradation, they are using power line communication to achieve this purpose. PLC have provided an option to use same power line for dual purpose. That is a major point of power systems of using electrical infrastructure for data communication. The main problems are the different values of their different parameters. For example, power system ratings are high power, high voltages and low frequency but in PLC there are low power, low voltages and very high frequency. It is impossible to do direct communication through power lines, there are needed some line matching unit or coupling unit to engage information with power lines. In addition, there is further two topologies to deal with this compatibility problem based on power line voltage that are low voltage coupling circuit and high voltage coupling circuit. Each are used inductive coupling or capacitor coupling but the different is only to implement according to their voltage level. There is digital communication through PLC, so there is tested FSK techniques to make sure that PLC is also applicable.

## III. Simulation and Results

All these models test over MATLAB Simulink. Then Fuzzy Logic Controller with Rule viewer is selected to design FLC based hybrid power system. Solar panel is constructed according to table 1 parameters ratings.

TABLE II  
PV PANEL RESULTS WITHOUT MPPT

Sr.no	Parameters	Ratings
1.	Irradiation	1000 W/ m <sup>2</sup>
2.	Temperature	25 Co
3.	Power	14.4 Watt
4.	Current	0.4 ampere
5.	Voltage	36 Volt
6.	Efficiency=	6%

## A. MPPT Results

It can observe that whenever irradiation is decreased then sudden change in current of PV array as well as sudden

change in power. Voltage variation is very problematic to charge the battery because batteries need continuously constant voltage of rated value at which battery is charged efficiently. So without using MPPT algorithm, it is impossible to track even ten percent of rated power as shown in figure.2. Observed result from Figure are shown in Table II.

TABLE III  
PV PANEL RESULTS WITHOUT FLC BASED MPPT

Sr.no	Parameters	Ratings
1.	Irradiation	1000 W/ m2
2.	Temperature	40 Co
3.	Power	14.4 Watt
4.	Current	0.4 ampere
5.	Voltage	36 Volt
6.	Efficiency=	6%

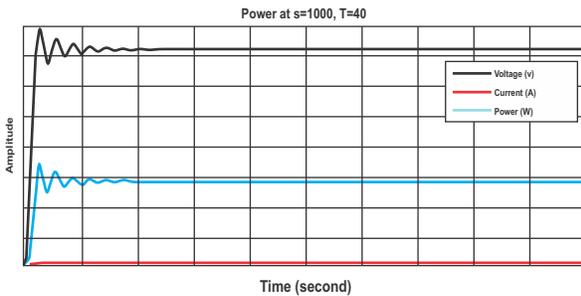


Fig. 3. Solar Panel results without MPPT

It is fact that with FLC Based MPPT, the power is optimized to 92%. That can see in Figure under these parameters.  $T= 25\text{ Co}$  and  $S= 1000\text{ W/ m}^2$  Then the results are:  $P= 220\text{ Watt}$  Voltage =  $30.72\text{ Volt}$ , Efficiency= $92\%$  as shown in Table III as well as Figure 4.



Fig. 4. Solar Panel results with FLC based MPPT

### B. Fuzzy controller for Hybrid Power Station

To Move towards power line communication, there is developed FLC controller for selection of power according to load. This controller read loads measurement and then decide how much power is required from RES. Inputs of FLC are solar and conventional generation and their ranges are adjusted in such way every possibility can be adjusted as shown in Figure 5. After getting the input and output ranges there is constructed rules according to load values. These results are shown at one instant of power systems where some power is getting from solar

and remaining power is obtaining from conventional source according to load measurements. The surface view is shown in 6.

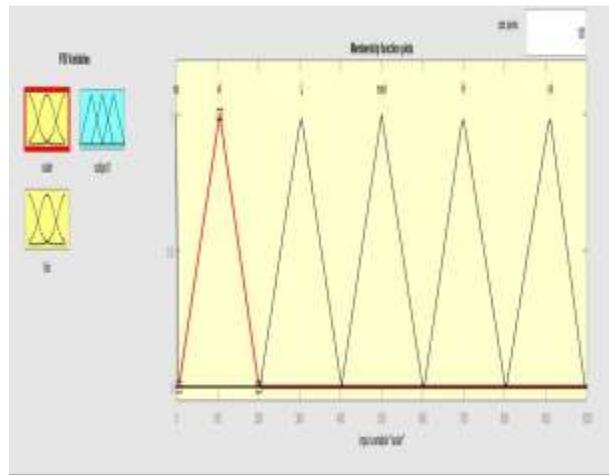


Fig. 5. Solar and conventional generation Inputs of FLC

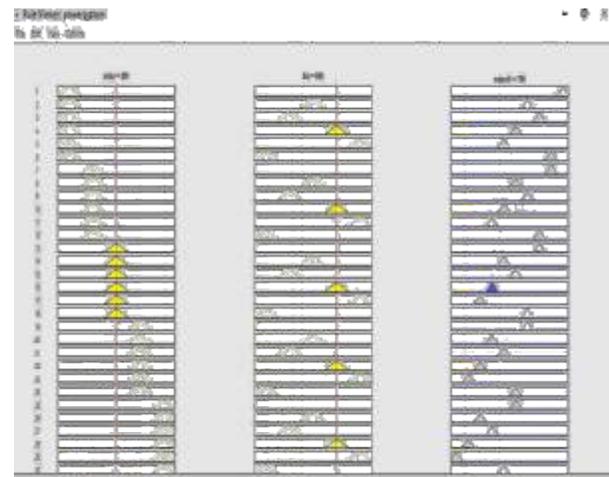


Fig. 6. Results at one instant of Hybrid Power System

### C. Testing of Power Line Communication using FSK

A digital data from MATLAB Simulink library is taken where binary number as input. That can see in Figure 7. (plot of input). Then it modulated on Simulink that is shown in Figure.7 (Modulated Signal) where the modulated signal generated of almost  $1200\text{c}00$  hertz. The carrier signal is sine wave from signal generator. Now next task is to couple this modulated signal with power lines. Then this FSK modulated signal with noise is coupled with power lines as shown in Figure.7 (Coupling signal). That have frequency of  $50\text{ hertz}$  and amplitude of  $220\text{ volts}$  because AC power line is designed on same parameters. High pas filter is used and other coupling is provided at receiver end to connect with demodulator that is shown in Figure.8 (Demodulated signal) Band limited white noise and random noise, there is an option to select that which noise we want to insert. In Simulink we can change manually with the help of switch. This time random noise is selected.

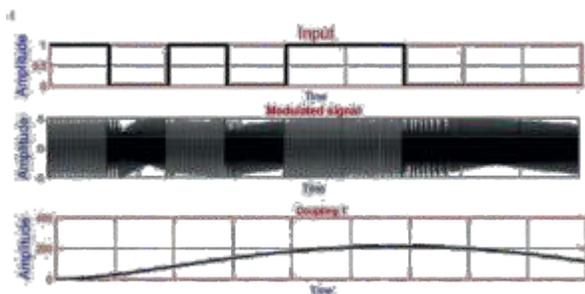


Fig. 7. PLC results of Input, Modulation and Coupling

Then a coupling circuit is provided to couple demodulator with power line, it's just like coupling provided to modulator. There are low pass and high pass filter are inserted in cascade with cut of frequencies 10000,100000 hertz respectively. It is desired band that is required to demodulator that is shown in Figure.8 (coupling). Further that signal is converted into digital data where there are provided 9 pulse to logic operator.

Logic AND operator is used and input of logic operator are FSK input and pulse. Pulse is generated through unit step function. It compares with FSK where its high then AND operator send logic high otherwise low. That is shown in Figure.(output plot). The demodulator is shown in Figure8. That is constructed over the features of FSK modulator. The modulated signal, both coupling, demodulator and out results are shown in Figure.8. These results are shown a communication link for hybrid power system using Power Line Communication that is tested over AC line of hybrid power system.

#### IV. Conclusion

This hybrid power system is merged through solar energy and conventional power system to increase the reliability of electrical power and it is a forwarding step to utilize renewable energy with small scale energy systems. Panel's selection, panel's adjustment, MPPT of PV array and its utilization with their suitable application are key parts of this research. In addition, there is also inserted a FLC on AC bus to facilitate in the selection of energy resources according to their loads. All results of proposed schemes are shown then briefly discussed where it is found that without MPPT algorithm it is not possible to optimize MPP. The deficiencies of different MPPT schemes are discussed and then FLC based MPPT shows that it is not only optimized and also resolve the issues that were found in previous schemes. At the end simulation test of PLC is successfully tested over AC bus bar of hybrid power system.

#### V. Future Work

This proposed methodology is validated for Low Voltages. These schemes can applicable for medium voltage and high voltages and more flexible for different RES based power system and power distribution units. It can more enhance towards smart metering, load management and home automation. There is also need to improve semiconductors devices more efficiently.

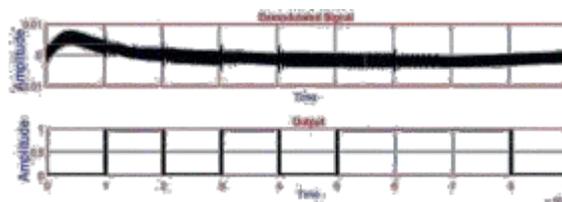


Fig 8. Results of Demodulation and output

#### REFERENCES

- [1] V. Agarwal S. Jain. "Comparison of the performance of maximum power point tracking schemes applied to single-stage grid-connected photovoltaic systems". Electric Power Applications, IET, vol. 1, no. 5:pp. 753{762, Sept. 2007.
- [2] Masood, B.; Asif R.M; Naqvi. Designing of a control scheme for the solar rickshaw in comparative study with conventional auto rickshaw. 4th International Conference on Engineering Technology and Technopreneuship (ICE2T),2014.
- [3] Masood, B Siddique. Asif R.M.; Zia-ul-Haq. "maximum power point tracking using hybrid perturb & observe and incremental conductance techniques". 4th International Conference on Engineering Technology and Technopreneuship (ICE2T),2014.
- [4] K.A.; Kumar Mahalakshmi, R.; Aswin. , a , design of fuzzy logic based maximum power point tracking controller for solar array for cloudy weather conditions. ,Power and Energy Systems Conference: Towards Sustainable Energy, Pages: 1,2014.
- [5] Sivaramakrishnan S, "Linear extrapolated MPPT - an alternative to fractional open circuit voltage technique", Biennial International Conference on Power and Energy Systems: Towards Sustainable Energy (PESTSE),2016
- [6] Francisco Paz; Martin Ordonez, "High-PerformanceSolarMPPTUsing Switching Ripple Identification Based on a Lock-In Amplifier",IEEE Transactions on Industrial Electronics, Volume: 63, Issue:6 Pages: 3595 – 3604,2016
- [7] Sandip Uprety; Hoi Lee, "A 0.4W-to-21W Fast-Transient Global-Search-Algorithm Based Integrated Photovoltaic Energy Harvester With 99% GMPPT Efficiency and 94% Power Efficiency", IEEE Journal of Solid-State Circuits, Volume: 51, Issue:9, Pages: 2153 – 2167,2016
- [8] Vivek Nandan Lal; Sri Niwas Singh, "Modified particle swarm optimisation-based maximum power point tracking controller for single-stage utility-scale photovoltaic system with reactive power injection capability", IET Renewable Power Generation, Volume: 10, Issue:7, Pages: 899 - 907,2016

- [9] Jose Aller; Julio Viola; Flavio Quizhpi; Jose Restrepo; Antonio Ginart; Andrés Salazar, “Explicit model of PV cells considering variations in temperature and solar irradiance”, 2016 IEEE ANDESCON, Pages: 1 - 4, 2016
- [10] A.; Lin Chen; Martignon F.; Paris S. Barbato, A.; Capone. Distributed demand-side management in smart grid: How imitation improves power scheduling, IEEE International Conference on Communications (ICC), (DOI: 10.1109/ICC.2015.7249305,); Pages: 6163 { 6168,, 2015.
- [11] Shahab Bahrani, Francis Therrien, Vincent W.S. Wong, Juri Jatskevich, “Semidefinite Relaxation of Optimal Power Flow for AC–DC Grids”, IEEE Transactions on Power Systems, Volume: 32.



# Real Time Extra Economic Dispatch For Renewable Energy Uncertainty Over IEEE Bus Bar

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## Abstract:

*Load prediction and power generation uncertainties are biggest challenges to economic dispatch of power at minimum operational cost of different energy sources since decades. The economic dispatch (ED) in hybrid power system is becoming an exciting research topic courtesy to weather reservations. In this article major challenges of Economic Dispatch are briefly reviewed i.e. planning, evaluation of demand, weather forecasting and security constrains, existing algorithms, unit commitment and reduction in carbon emissions. The proposed methodology consists of renewable, price, security and conventional resource sections and for each section a Real Time Extra Economic Dispatch model is presented to tackle aforementioned parameters. The System will be verified over IEEE 30-bus bar and six generators along with wind and solar units considered as non-schedulable. Scheduling period is considered as 60 min (six intervals, each of 10-min duration) to show the effects of sequential and dynamic approaches. This 10-min interval is subdivided into ten 1-min subintervals.*

**Keywords** Economic Load Dispatch, Renewable Energy Resources.

## I. Introduction and Background

The economic dispatch is an extensively studied problem in power system research. A recent trend towards alternative energy resources may cause a serious problem economic dispatch in the upcoming electrical generation, where the reason is that the amount of controllable generators will decrease while disturbances increase. So, some new dynamic economic load dispatch (ELD) method are introduced to meet the general requirements for real-time use in a future power system, where load following capability is critically limited. A genetic algorithm has been tested over wind generation power plant by J.-C. Lee in 2011. He highlights the best solution to solve the economic dispatch (ED) issues regarding wind energy generation by creating a scenario to avoid the increment in cost by adding more wind generation Plants [1]. He discussed that mostly the droop schemes are focused on the power sharing in the control of distributed generations and other factors are ignored like cost, efficiency and also penalties on the emission as they are different for every type of distribution generation (DG). It will help in dropping the generation cost for micro-grids. Basically it was about the production of power sharing based on dropping the cost of generation and combining different factors. This scheme is enhanced by Inam Ullah Nutkani in 2014 where it is based on to linear

expressions in which different variables are involved like quantity of DG units, active, reactive power, frequency, apparent power and terminal voltage. Different cost functions were also introduced. Experimental results have shown robustness. The contingencies and black outs are not considered here [2]. In 2014 keeping in mind the realistic variation of these wind plants, M. Zhou proposed an interval based optimal model by taking two worst case situations by demolishing all other situations. This method speeds up the solution so that the scheduling is in accordance with the security limitations and make the scheduling more cost effective [3]. To benefit from the speedy and fast regulation skills of the distributed generation while making the security and economics of power system more efficient idea of virtual power plant (VPP) is getting famous. Then J. Zhao introduced power systems with Multi-source scenarios. These became more renowned because of the large amalgamation of distribution energy units and dispatch-able loads [4].

One was the time when hydro-thermal unit commitment integrated with wind energy was gaining popularity. In this regard X. Li compared to other sources of energy with hydro power and found it more dependent on number of factors that can be easily united in time and space [5]. The problems related to win-thermal –hydro power becomes difficult to solve with the SO model because of its simplicity and no economically response at very high penetration. In 2014 A. L. Diniz and T. M. Souza introduced a short term model for scheduling developed to solve these problems [6]. Then a linear programming based model is separated into some time intervals but there was a sheer need to design uncertainty sets for robust optimization method carefully. A small set could not be able to cover the whole of the spectrum which could be a big problem. As compared to small if a set is big then it can compromise the robustness of the results and this become more cost effective procedure [7]. This issue was highlighted by Q. S. Xu where he suggests a multi scenario robust dispatch method for power grid integrated with wind farms. This model works at high penetration but integration of wind form and this become less reliable because of weather constrains of wind power. Then forecasting error for renewable energy resources becomes a problematic concern for ED. In 2014 H. Y. Wu with his team analyzed these forecasting issues a made some mathematical models for forecasting wind schedule and then developed a forecasting error scheduled system for the renewable energy generation plants that can be curtailed using day ahead scheduling and the probabilistic limitations was

the warrantee for this purpose [8]. The later on S. Chakrabarti and J.-C. Lee worked on day ahead scheduling in their separate articles where a robust optimization method in wind generation is introduced under extreme states. The unit commitment is solved with Ro method under some uncertainty. As compared with the linear programming based model, the robust model is much appreciated and it gives dependable ED processes [9]. The consensus algorithm needs transfer of information between all the nodal points, so It becomes really difficult for a very large power system as it has multiple node points and large number of devices which need to communicate with each other so it becomes a burden and very private data could be compromised. [10].

## II. Literature Review

In 2014, Hristiyan Kanchev proposed an idea of micro grid of renewable Energy resources (RES) is promoted by considering a photovoltaic (PV) model with conventional sources to minimize the carbon emissions as well as cost. This is also dynamic program based algorithms to solve the unit commitment problem and optimize the carbon emissions. A new concept of active generators (AG) is also the part of this work in which solar power is converted into desirable form it might be AC or DC. [14] In this article a new idea of AG proposed that is basically 3.6-kW PV generator, 106-Ah batteries, and a 160-F super capacitor bank. This is called generators because it operates at real scenario because DC load are connected with directly DC power, AC load connected with DC/AC converters and super capacitors are for back up. This model operates on three goals where first is no interruption of power supply, second is maximum utilization of AG at low per unit cost and last is minimum emission of CO<sub>2</sub>. Some forecasting techniques are also considered for the availability of PV power according to load demand. Fuel consumption of generator can be assessed by using their partial load efficiency characteristics and calculated its mathematical model and then modeled an emissions of carbon with mathematical model. After getting this information there is approached a Scheme of the day-ahead optimal operational planning. It is like a flow chart of this planned scheme. [11] In literature, author is found that a huge work is done on maximum power point tracking (MPPT) of solar panels. Although it's very necessary to obtain maximum point (MP) but here he is focusing on active generators where PV generators are formed into AG [11]. In others proposed solution, there is focused on unit commitment (UC) but it facilitates not only the UC problem but also deal with smart grid application like provide a communication link between generation and consumption [12]. It has main focus on PV cells power but there is lightly focused on other conventional sources. Secondly no details are provided of communication link either its power line communication or wireless communication.

In 2015, Hao Xing reviewed in his study a distributed bisection algorithm is presented in the situation of smart grid to tackle the problem for economic dispatch. The

major purpose of the study is to reduce the cost of total working of the generators with communication link, which supportively equip a specified volume of power within their discrete capacity restraints. The essence of this algorithm is that it is based on bisection rather than a having a sole decision maker. If the communication aspects are reasonable, the iterative solution becomes a global level optimal solution [13]. There is pair of stopping criteria which proposed for the real-world applications. Sign consensus for this is already fixed. There is no need for global information for the presented algorithm. There is no node which knows total demand. The proposed model is difficult to apply for overall convex functions. In the proposed algorithm the cost functions are not limited to the quadratic functions only. The future work could be done by extending this proposed algorithm to the line capacity limitations [15]. In a same year Haijun Xing enhanced this model by increase in the renewable energy sources has made the conventional grid to accommodate more reserves for power supply as well as demand balance. Demand Response DR strategy has become famous and it is used for cost effectiveness and to reduce emissions etc. The constraints considered like demand response (DR), maximum participating time and DR ramp rate are used to establish the cost effectiveness and for the economic dispatch [16]. After some time, H. Xing introduced a Sample average approximation method that is used as combinatorial optimization which has shown promising results in economic dispatch for power systems. The metal is cooled down in this procedure until the minimum value is reached by the total energy. The metal is recrystallized overall before the annealing [17]. This model raised issue of Unit commitment and it has been the talk in 2015 where it is used for day-ahead scheduling of the generators' regulations and wind curtailments. With the minimizing of the generator regulation and that of wind curtailment a problem of economic dispatch is framed keeping in mind several scenarios. The economic dispatch is based on several forecasted power generations rather than relying on single one. Generator regulation is presented as optimal variable in the model developed by Jinghua L [18]. After the unit commitment of these generation there was a need of multi area economic dispatch that that can merge the concept of decentralization in economically way [19]. So, Xiaowen Lai and W. Wei proposed the multi area economic dispatch and wind related study for decentralization respectively, where concept of decentralization lagrangian relaxation approach (dynamic multiplier based) can be used. During the iteration for the interchange of neighboring areas lagrangian multipliers sensitivity is examined to produce dynamic multipliers. These multipliers are different than those of conventional ones. Wind power related studies are mostly based on the stochastic optimization as well as robust optimization [20].

In 2016 a new scheme of Unit Commitment Problem (UCP) introduced by Chongxin Huang that is optimal dispatch by on/off states of generating units in some time

intervals These units may be the steam power generators, renewable generation or any other conventional generation. These all generating units in operation have one common target that is the demand of that particular time interval [21]. In case of committing thermal generating unit, the emergency reserve is maintained to cover the loss of largest generating unit. So the extra constraints because of the combination of wind power make the UCP difficult to achieve the optimal solution. Using Fuzzy Optimization Technique this constrains is going to be solve out. [27]. Firstly, there is formed mathematical models of thermal plants as well as wind power plant. After setting the minimum up time and minimum down time there is approached to cost model which is main concern of UC. Where non zero like 1 is offered that the unit goes to ON state from OFF state [22]. After setting all parameters and physical constrains the author developed an optimal fuzzy model

There are servals techniques for UC but it is solved only by some dynamic approaches or algorithms. Previously there were done dynamic programming techniques that's provides more flexibility, it makes the problem complex and increases computation time with the increase of the dimension of the problem. [23]. This author introduced CPLEX as an optimization tool is used to solve our UCP by using fuzzy logic optimal technique because it creates flexibility in modeling and makes Mixed integer linear programming (MILP) based solution more practical. In future the mathematical model can be enhanced by considering all wind constrains like wind speed fluctuations, uncertain production, weather forecasting, by adding more wind turbine and perform parallel operation of different wind turbine. Then, there is definitely need to add more member function of fuzzy model and also enhanced our math model. At the first in this study all the constraint like ram rate, maintenance time, Power and the capacity were taken into account, combining it with the wind turbine output, open downtime and additional constraints. In 2016, A UC model of Ning Yan basically a steady state method for power. If a wind power is integrated in a grid the net economy of the grid is increased in virtual power plant (VPP) At the practical level the generation of wind power, load distribution and reduction of the cost of generation is examined. It is studied that the power distribution can be united for all day through energy storage system and also the wind turbine load distribution decreases the total cost of the large scale power system [24]. The Economic dispatch method presented is based on the interval mechanism. The ED method is used for both central power plant and virtual power plant. The interval based method for economic dispatch is converted into deterministic model. The optimization of the dispatch is done based on this model [25]. The work is done in three steps. In the first step ED model is established based on the interval pattern to design objective function as well as constraints taking in to account all the issues of the power systems and second step the obtained functions are converted into simulation to get the desired results. Third step is about the deterministic ED model. As mentioned in

the literature the dispatch plan has not been worked on well for conventional power plants (CPPs) and virtual power plants (VPPs). The model basically uses interval as mean of elaborating uncertainties for VPP. Rather than going for PDFs and FMFs this interval based proposed solution of the uncertain variables is much more convenient for the engineers to apply. This proposed ED model of Chongxin Huang that is introduced in 2016, it can be easily explained by using quadratic programming. [26]. This proposed solution basically an interval-based ED model for a power system with conventional power plants CPPs and VPPs. It utilizes the interval to describe the uncertainty of load prediction and VPP power prediction. The probability degree in the interval optimization method is then employed to transform the interval-based ED model into a deterministic one. The optimal dispatch scheme of the power system with CPPs and VPPs is obtained by solving the deterministic ED model. Finally, the proposed interval-based ED scheme is applied to a 10-machine power system for simulation. [28]. First part the ED model is modeled in the interval scheme to establish objective functions and constraints according to the structural features and operational requirements of the power system. After taking these readings by two function of load and cost are developed on the basis of external characteristics of the VPP and try to minimize CPP importance. [29].

Recently Yue Chen modeled one more RES based ED by solar system integrated with thermal units is modeled. Then calculate its mathematically formulation into simulators. [31]. Dispatch prioritization and frequencies of distributed generation (DG) are acquired from number of factors involved quantity of the DGs. power rating and generation costs. The non-dispatch able DGs are also included, attributes of the droop are reserved. Generation cost of the combustion engine and renewable energy is used here. The presented economic dispatch scheme is an alternative for the cost-priority scheme Faults and life of the generation devices has not been taken into account [32].

In e 2017, the work is going on to reduce the cost of active power generated. Fixing Chen presented a cost based droop scheme without making any changes in the droop control decentralized nature and plainness. In this scheme the distributed generators' incremental costs are merged in to the droop schemes, basically this incremental cost is found by taking derivative of the DG cost function to the power output. A lone frequency is shared in steady state by DGs, incremental cost is computed by cost base droop scheme, hence reducing total generation cost for active power, in the form of incremental cost. The major issue for the cost based droop process was to compute the total cost of generation because all the generators are regulated for their individual generation cost. To resolve this problem incremental cost is merged in to this scheme. The main attributes of this model is that they do not have complex mathematic model, do not require communication network and have plug and play capability [33]. In 2017, Yingzhong Gu model offers the system to evaluate between stochastic and deterministic

strategies. Stochastic LAED is developed and criteria is developed to see that if stochastic approach is more effective it is totally dependent on the uncertainty response. This Horizon division method is used to divide the look ahead prospect in to two portions stochastic and deterministic. For the solution of the LAED-S a computer program is constructed which influences L-shaped model and algorithm. This technique is not necessarily applied on all the LAED-S but however in intervals with higher economic risk this could be applied. Future recommendations are theoretical digging of the approach [34]. The solution of these uncertainty is an economic dispatch model which can consider steady-state secure region for variable wind power. The base-case operation cost and the wind power integration are balanced via the introduction of secure regions. Before model the proposed solution, author illustrates the secure region for wind power and actual region for wind power and then formulates the proposed model and later on provides the algorithm for this proposed model [35]. In the short-term grid operation, the base-case schedule plays an important role but if apply to mid/long term grid operation the planning problems are accrued. So there is need to enhance the capability of the model for long term grid operation.

### III. Economic Dispatch Security Constrains For RES

Recent development in renewable energy that penetrated electrical power system then economic dispatch with conventional power system has become the challenging task to manage different security constrains, Followings are concerns that are mainly discussed:

#### A. Study State Security Constrains

Yanfeng Ma [36] (2017) highlights the security constrains for economic dispatch by considering the wind power integration with conventional power plant where he found over current issues, probability of outage for transmission and voltage protection failure. A numeric comparison based system is developed to validate these security concerns.

Hong chen [37] (2017) provides an schedule system that can control demand of power, meet the security constrains of over current and voltage protection. This hourly based scheme also satisfies the unexpected changes in power system of renewables.

#### B. Voltage Security Constrains

Xiaowen Lai [38] (2017) compared two technique that contains voltage security constrains where one has voltage fluctuation of wind power and second have missing of voltage in night time for solar. These both techniques have fixed algorithms at rated values of power system. Then minimize the generation cost and approve the voltage security by adding voltage collapse points in singular value ten take its derivative.

Yousef Pipelzadeh [39] (2017) indicates assessment on transmission line voltage security constrains which used the real coded variable that contains natural variables

with floating point. At the end proposed a transient controlled assistive measurement for correction.

#### C. Decentralization Constrains

Brijesh Sing and his team [40] (2011) suggests an optimal power flow decentralized system with solar power. He used IEEE-30 bus bar system for decentralization, so need was an AC power conversion of solar power to make independent optimal flow where he tries to approach the profit but cannot succeed. In 2016, authors highlight the decentralized constrains in details and on same 30 bus bar system, he approaches a centralized power system [30].

Ibrahim F [41] (2014) worked on decentralization of renewable resources and realized a control action and also compensates the Brijesh Singh constrains for decentralization. His simulation results have shown two switching constrains that is big reason to down the overall efficiency of whole power system. Then researches are shown their interest on only centralization.

#### D. Dynamic Security Constrains

Haicheng Zhang[42] (2016) work on issued that mentioned in literature where he implemented and designed a technical historical system integrated with Data Transfer Rate (DTR) technology which can forecast thermal rating as well as predict environmental situations for renewable sources. This system is capable to enhance power system security but exploited the potential transfer capability at dynamic environment changes. Hong Chen [43] (2017) improve economic efficiency while dynamic constrains remains because his focus on power system operational functionality. Market analysis on real time data software is made that is design to increase efficiency and made a center of electricity generation.

#### E. Contingency Selection Constrains

Yunfeng Wen [44] (2016) indicates a two stages programming issues that has combination of integer where a composition is also developed to solve Contingency selection problems. He demonstrates the two case studies on RTS-79 as well as RTS-96.

Pablo Ledesma[45] (2017) describes the transient stability issues in optimal power flow to find Contingency selection problem of power source either it be renewable or thermal. This model automatically read the data from standard files that are programmed in software. This schemes also facilitates the different application of power integration expect thermal and renewable.

### IV. Study Of RES Economic Dispatch Methods

#### A. Linear Programming

Already existing power systems have control methods that can only tackle with single wind farm, single solar system and single thermal unit. These units operated independently but power losses are major drawback of these systems. So linear programming based system were launched to dispatch economically. Li Lin [48] (2013) approached an active power ED model by considering short term wind weather forecasting and power prediction. He uses a linear programming method

to resolve nonlinear constraints under algebraic calculations. Further on Beatrice Lazzarini [49] (2015) made a model of emissions free, valuable distance and load balancing scheme from importing a function of linear programming which solves alternative configuration of system but no work on minimize the security constraints.

### B. Optimal Power Flow Method

Smart grid technologies development also a one reasons of economic dispatch with power flow dispatchment. Denis V. Armeev [46] (2016) proposed an optimal power flow method of renewable resources where it consists of generation resources price, real power losses control and other climate condition, He work on in this method by combining multiple objects into single one. This method only can reduce the power losses in power flow not target the security constraints.

Anya Castillo[47] (2017) provides a solution to voltage fluctuations constraints for commercial users and did test on IEEE RTS-79, and the IEEE-118 in Matlab Simulink but not been able to overcome uncertainty of power flow.

### C. Non-Linear Programming

Nonlinear programming only can deal power resources that have nonlinear nature like solar are wind mainly. So Shama Bansal[50] (2016) presented nonlinear programming based model that have ability to transferred security constraints but cannot resolve. Pablo Ledesma [51] (2017) also try to reduce or highlights the ED constraints but only can reduced in thermal power plant.

### D. Artificial Intelligence Method

Now a day artificial intelligence models are developing in power system to control different scenarios. These methods are to be considered as not-deterministic. particle swarm optimization (PSO) based algorithm that is based on Eigen value analysis for the evaluation of system stability and normal operating conditions. [52], [53]. The relative analysis of power flow exposes that PSO based algorithm that is example of artificial intelligence models make optimal power flow without any constraint violations and the system is under stable operation conditions.

### E. Quadratic Programming

Earlier mentioned methods are missing one security constraints or one optimal power dispatch term but this quadratic programming based dynamic model not only optimize the power from different energy resources wind and conventional but also evaluate fuel consumption, gas pollution emission fees, and electricity purchase costs as the optimized objective. [54], [55]. A little Drawback of this method is that it cannot easily tackle the barrier opposed by penetration of wind and solar in power system but comparatively best from others methods.

### V. Proposed Methodology

In order to optimize costs, keep in knowledge the PF for the wind and solar power outputs, weather forecasting and load forecasting. So that there is proposed five Real-

time extra economic dispatch (RTED) models:

1. To make Cost model of conventional sequential RTEED approach.
2. To establish a Model of Price for power and changeable costs using proposed sequential RTEED approach.
3. To apply the Cost model of conventional dynamic RTEED approach.
4. Model of Pricing energy and variability costs using proposed dynamic RTEED approach.
5. Model of Sequential RTEED with Variable Load and Renewable Power Generation units.

The System that have IEEE 30-bus with six generators located at buses 4, 7, 8, 9, 16, and 17. Here, the IEEE 30-bus system is proposed to tackle the wind and solar injections at buses 16 and 17. In this proposal, wind and solar units are considered as non-schedulable and they can supply the power up to the maximum available wind and solar irradiation. Scheduling period is considered as 60 min (six intervals, each of 10-min duration) to show the effects of sequential and dynamic approaches. This 10-min interval is subdivided into ten 1-min subintervals. These optimization models with equation and code insert in MATLAB and solve using a MATLAB Optimization Tool.

### VI. Conclusion

This paper presents a detailed study of various option of renewable energy that can integrate with conventional power plant or independently run. After all option review it is suggested that any option which is avail according to situation can optimize for power dispatch but each method have to overcome security constraints. Different security constraints are discussed and which method overcome which constraints this is also a part of this research. All methods found a multiple solution but artificial intelligence models provide better performance than other conventional optimal techniques. Further in detail that PSO method of artificial intelligence can be used for complex and multiple unit's combination due to fast convergence speed. After summarization of this research a RTEED based ED model presents which ability to overcome all renewable security concerns by providing a separate model for renewable as well as price and other concerns.

### References

- [1] J.-C. Lee, W.-M. Lin, G.-C. Liao and T.-P. Tsao, "Quantum genetic algorithm for dynamic economic dispatch with valve-point effects and including wind power system," *International Journal of Electrical Power & Energy Systems*, vol. 33, no. 2, pp. 189–197, 2011
- [2] Inam Ullah Nutkani, Member, IEEE, Poh Chiang Loh, Senior Member, IEEE, and Frede Blaabjerg, Fellow, IEEE "Droop Scheme with Consideration of Operating Costs" *IEEE Transactions on Power Electronics* ( Volume: 29, Issue: 3, March 2014 ).
- [3] M. Zhou, S. Xia, G. Li, and X. Han, "Interval optimization combined with point estimate method for stochastic security-constrained unit

- commitment,” *International Journal of Electrical Power and Energy Systems*, vol. 63, pp. 276–284, 2014.
- [4] J. Zhao, C. Wang, B. Zhao, F. Lin, Q. Zhou, and Y. Wang, “A review of active management for distribution networks: Current status and future development trends,” *Electric Power Components and Systems*, vol. 42, no. 3-4, pp. 280–293, 2014.
- [5] X. Li, T. J. Li, J. H. Wei, G. Q. Wang, and W. W.-G. Yeh, “Hydro unit commitment via mixed integer linear programming: a case study of the three gorges project, China,” *IEEE Transactions on Power Systems*, vol. 29, no. 3, pp. 1232–1241, May. 2014.
- [6] A. L. Diniz and T. M. Souza, “Short-term hydrothermal dispatch with river-level and routing constraints,” *IEEE Transactions on Power Systems*, vol. 29, no. 5, pp. 2427–2435, Sep. 2014.
- [7] Q. S. Xu, C. H. Deng, W. X. Zhao, J. He, and Z. K. Wu, “A multiscenario robust dispatch method for power grid integrated with wind farms,” *Power System Technology*, vol. 38, no. 3, pp. 653–661, Mar. 2014.
- [8] H. Y. Wu, M. Shahidehpour, Z. Y. Li, and W. Tian, “Chance-constrained day-ahead scheduling in stochastic power system operation,” *IEEE Transactions on Power Systems*, vol. 29, no. 4, pp. 1583–1591, Jul. 2014.
- [9] W. C. Wu, J. H. Chen, B. M. Zhang, and H. B. Sun, “A robust wind power optimization method for look-ahead power dispatch,” *IEEE Transactions on Sustainable Energy*, vol. 5, no. 2, pp. 507–515, Apr. 2014.
- [10] S. Chakrabarti, M. Kraning, E. Chu, R. Baldick, and S. Boyd, “Security constrained optimal power flow via proximal message passing,” in *Proc. Power Systems Conf. (PSC), 2014 Clemson Univ.*, Mar. 2014, pp. 1–8.
- [11] K. V. Bhadane, M. S. Ballal, and R. M. Moharil, “Investigation for causes of poor power quality in grid connected wind energy—A review,” in *Proc. Asia-Pacific Power Energy Eng. Conf. (APPEEC), Shanghai, China*, Mar. 2012, pp. 27–29.
- [12] B. Robyns, A. Davigny, B. Francois, A. Henneon, and J. Sprooten, *Electricity Production from Renewable Energies*. Hoboken, NJ, USA: ISTE Ltd, Wiley, 2012. ISBN 978-1-84821-390-6. B. Ernst and B. Engel, “Grid integration of distributed generation,” in *Proc. IEEE Power energy Soc. Gen. Meet. (PES'12), San Diego, CA, USA, Jul. 22–26, 2012*, pp. 1–7.
- [13] B. Ernst and B. Engel, “Grid integration of distributed generation,” in *Proc. IEEE Power Energy Soc. Gen. Meet. (PES'12), San Diego, CA, USA, Jul. 22–26, 2012*, pp. 1–7.
- [14] Hristiyan Kanchev, Frederic Colas, Vladimir Lazarov, And Bruno Francois, *Ieeeemission Reduction and Economical Optimization of an Urban Microgrid Operation Including Dispatched Pv-Based Active Generators*, *IEEE Transactions On Sustainable Energy*, Vol. 5, No. 4, October 2014
- [15] Hao Xing, Student Member, IEEE, Yuting Mou, Minyue Fu, Fellow, IEEE, and Zhiyun Lin, Senior Member, IEEE “Distributed Bisection Method for Economic Power Dispatch in Smart Grid” *IEEE Transactions on Power Systems* ( Volume: 30, Issue: 6, Nov. 2015 )
- [16] Haijun Xing, Member, IEEE, Haozhong Cheng, and Libo Zhang “Demand Response Based and Wind Farm Integrated Economic Dispatch” *Csee Journal of Power and Energy Systems*, Vol. 1, No. 4, December 2015
- [17] H. Xing, H. Cheng, and Y. Zhang, “Optimal Coordination of Intermittent Distributed Generation with probabilistic power flow,” *Journal of Electrical Engineering & Technology*, vol. 10, no. 6, pp. 2211–2220, 2015
- [18] Jinghua Li, Member, CSEE, Jiakun Fang, Member, IEEE, Jinyu Wen, Member, CSEE, Member, IEEE, Yi Pan, and Qiang Ding “Optimal Trade-Off Between Regulation and Wind Curtailment in the Economic Dispatch Problem” *Csee Journal of Power and Energy Systems*, Vol. 1, No. 4, December 2015
- [19] Xiaowen Lai, Student Member, IEEE, Le Xie, Member, IEEE, Qing Xia, Senior Member, IEEE, Haiwang Zhong, Member, IEEE, and Chongqing Kang, Senior Member, IEEE “Decentralized Multi-Area Economic Dispatch via Dynamic Multiplier-Based Lagrangian Relaxation” *IEEE Transactions On Power Systems*, Vol. 30, No. 6, November 2015
- [20] W. Wei, F. Liu, S. W. Mei, and Y. H. Hou, “Robust energy and reserve dispatch under variable renewable generation,” *IEEE Transactions on Smart Grid*, vol. 6, no. 1, pp. 369–380, Jan. 2015.
- [21] Long Zhao and Bo Zeng “Robust Unit Commitment Problem with Demand Response and Wind Energy” *Power and Energy Society General Meeting*, 2012
- [22] C. Christoper Asir Rajan and M. R. Mohan “An Evolutionary Programming-Based Tabu Search Method For Solving The Unit Commitment Problem” *IEEE Transactions On Power Systems*, Vol. 19, No. 1, February 2014
- [23] A.H. Mantawy, Youssef L. Abdel-Magid and

- Shokri Z. Selim “A New Genetic-Based Tabu Search Algorithm for Unit Commitment Problem” *Electric Power Systems Research* 49 71–78
- [24] Ning Yan, Zuo Xia Xing, Wei Li, Bo Zhang “Economic Dispatch Application of Power System with Energy Storage Systems” *IEEE Transactions on Applied Superconductivity* ( Volume: 26, Issue: 7, Oct. 2016)
- [25] Na Li, Changhong Zhao and Lijun Chen “Connecting Automatic Generation Control and Economic Dispatch from an Optimization View” *IEEE Transactions on Control of Network Systems* ( Volume: 3, Issue: 3, Sept. 2016)
- [26] Chongxin Huang, Dong Yue, Senior Member, IEEE, Jun Xie, Yaping Li, and Ke Wang “Economic Dispatch of Power Systems with Virtual Power Plant Based Interval Optimization Method” *Csee Journal of Power and Energy Systems*, Vol. 2, No. 1, March 2016.
- [27] S. Kar, G. Hug, J. Mohammadi, and J. M. Moura, “Distributed state estimation and energy management in smart grids: A consensus innovations approach,” *IEEE J. Sel. Topics Signal Process.*, vol. 8, no. 6, pp. 1022–1038, 2014.
- [28] W. T. Elsayed and E. F. El-Saadany, “A fully decentralized approach for solving the economic dispatch problem,” *IEEE Trans. Power Syst.*, nvol. 30, no. 4, pp. 2179–2189, 2014.
- [29] S. Yang, S. Tan, and J.-X. Xu, “Consensus based approach for economic dispatch problem in a smart grid,” *IEEE Trans. Power Syst.*, vol. 28, no. 4, pp. 4416–4426, 2013.
- [30] Naveed Ahmed Khan, Guftaar Ahmad Sardar Sidhu, and Feifei Gao Optimizing Combined Emission Economic Dispatch for Solar Integrated Power Systems, *IEEE Journals & Magazines* Volume: 4 Pages: 3340 - 3348, Year: 2016.
- [31] Yue Chen, Feng Liu, Member, IEEE, Wei Wei, Shengwei Mei, Fellow, IEEE, and Naichao Chang “Robust Unit Commitment for Large-scale Wind Generation and Run-off-river Hydropower” *Csee Journal of Power and Energy Systems*, Vol. 2, No. 4, December 2016.
- [32] Inam Ullah Nutkani, Senior Member, IEEE, Poh Chiang Loh, Senior Member, IEEE, Peng Wang, Senior Member, IEEE, and Frede Blaabjerg, Fellow, IEEE “Decentralized Economic Dispatch Scheme With Online Power Reserve for Microgrids” *IEEE Transactions on Smart Grid* Volume: 8, Issue: 1, Jan. 2017.
- [33] Feixiong Chen, Minyou Chen, Senior Member, IEEE, Qiang Li, Kaikai Meng, Yongwei Zheng, Josep M. Guerrero, Fellow, IEEE, and Derek Abbott, Fellow, IEEE “Cost Based Droop Schemes for Economic Dispatch in Islanded Microgrids” *IEEE Transactions on Smart Grid* ( Volume: 8, Issue: 1, Jan. 2017
- [34] Yingzhong Gu, Member, IEEE, and Le Xie, Senior Member, IEEE “Stochastic Look-Ahead Economic Dispatch With Variable Generation Resources” *IEEE Transactions on Power Systems* ( Volume: 32, Issue: 1, Jan. 2017
- [35] Chengcheng Shao; Xifan Wang; Mohammad Shahidehpour; Xiuli Wang; Biyang Wang, Power System Economic Dispatch Considering SteadyState Secure Region for Wind Power, *IEEE Transactions on Sustainable Energy* Volume: 8, Pages: 268–278, Year: 2017.
- [36] YANFENG MA, YI HAO, SHUQIANG ZHAO, “Security constrained economic dispatch of wind-integrated power system considering optimal system state selection” *IET GENERATION, TRANSMISSION & DISTRIBUTION* ( Volume: 11, Page(s): 27–36, ISSUE: 1, 2017 Wiley-IEEE Press, Pages 288, 2017
- [38] Xiaowen Lai; Haiwang Zhong; Qing Xia; Chongqing Kang, “Decentralized Intraday Generation Scheduling for Multiarea Power Systems via Dynamic Multiplier-Based Lagrangian Relaxation”, Volume: 32, Issue:1 Pages: 454–463, 2017
- [39] Yousef Pipelzadeh; Rodrigo Moreno; Balarko Chaudhuri; Goran Strbac; Tim C. Green, “Corrective Control With Transient Assistive Measures: Value Assessment for Great Britain Transmission System”, *IEEE Transactions on Power Systems*, Volume: 32, Issue:2, Pages: 1638–1650, 2017
- [40] Brijesh Singh; R. Mahanty; S. P. Singh, “A decentralized congestion management using interior point method” 2011 IEEE Power and Energy Society General Meeting, Pages: 1 – 7, 2011
- [41] Ibrahim F. Jasim; Peter W. Plapper, “Enhanced decentralized robust adaptive control of robots with arbitrarily-switched unknown constraints”, 2014 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Pages: 4027 - 4032,, 2014
- [42] Haicheng Zhang; Mingtian Du; Quangang Zhao; Li Xue; Zhiqing Wei; “ Security constrained economic dispatch with dynamic thermal rating technology integration”, 2016 IEEE International Conference on Power and Renewable Energy (ICPRE), Pages: 709–713, 2016
- [43], “ Balance Economic Efficiency and Operation Risk Mitigation”, *Power Grid Operation in a Market*

- Environment: Economic Efficiency and Risk Mitigation, 2017
- [44] Yunfeng Wen; Chuangxin Guo; Hrvoje Pandzic; Daniel Kirschen, “Enhanced security-constrained unit commitment with emerging utility-scale energy storage”, 2016 IEEE Power and Energy Society General Meeting (PESGM), Pages: 1–1, 2016
- [45] Pablo Ledesma; Ignacio Antonio Calle; Edgardo Daniel Castronuovo; Francisco Arredondo, “Multi-contingency TSCOPF based on full-system simulation”, IET Generation, Transmission & Distribution Volume: 11, Issue: 1, Pages: 64–72, 2017
- [46] Denis V. Armeev; Yana A. Frolova; Anastasia G. Rusina; Efim S. Ivkin, “Applying of the electrical equivalent method for multi-objective power flow optimization”, 2016 11th International Forum on Strategic Technology (IFOST), Pages: 157–161, 2016
- [47] Anya Castillo; Carl Laird; César A. Silva-Monroy; Jean-Paul Watson; Richard P. O'Neill, “The Unit Commitment Problem With AC Optimal Power Flow Constraints”, IEEE Transactions on Power Systems Volume: 31, Issue: 6, Pages: 4853–4866, 2016
- [48] Li Lin; Chenchen Zhu; Qian Wang; Jie Zeng, “Active power economic dispatch of wind farm cluster based on integer linear programming”, 2013 IEEE Grenoble Conference Pages: 1–6, 2013
- [49] Beatrice Lazzarini; Francesco Pistolesi, “A linear programming-driven MCDM approach for multi-objective economic dispatch in smart grids”, 2015 SAI Intelligent Systems Conference (IntelliSys), Pages: 475–484, 2015.
- [50] Shama Bansal; Yajvender Pal Verma, “Dynamic scheduling of MicroGrid connected system with storage devices”, 2016 IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), Pages: 1–6, 2016
- [51] Pablo Ledesma; Ignacio Antonio Calle; Edgardo Daniel Castronuovo; Francisco Arredondo, “Multi-contingency TSCOPF based on full-system simulation”, IET Generation, Transmission & Distribution Volume: 11, Issue: 1, Pages: 64–72, 2017.
- [52] D. M. Anumod; M. Devesh Raj, “PSO based OPF technique ensuring small signal stability”, 2014 Annual International Conference on Emerging Research Areas: Magnetics, Machines and Drives (AICERA/iCMMD) Pages: 1–6, 2014
- [53] Siqing Sheng; Jinyao Zhu; Jingru Yan; Mengdi Li; Ran Li, “Economic optimal dispatching of power system with wind power-pumped storage-thermal power joint operation”, 5th IET International Conference on Renewable Power Generation (RPG) 2016, Pages: 1–5, 2016
- [54] Min Xie; Jing Xiong; Shaojia Ke; Mingbo Liu, “Two-Stage Compensation Algorithm for Dynamic Economic Dispatch Considering Copula Correlation of Multiwind Farms Generation”, IEEE Transactions on Sustainable Energy Volume: 8, Issue: 2, pages: 763–771, 2017
- [55] Arman Goudarzi; Andrew G. Swanson; Fatemeh Tooryan; Afshin Ahmadi, “Non-convex optimization of combined environmental economic dispatch through the third version of the cultural algorithm (CA3), 2017 IEEE Texas Power and Energy Conference (TPEC), Pages: 1–6, 2017



# Linear Stability Analysis of Harmonic Oscillator in The Domain of Super Conductivity

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## Abstract:

Harmonic oscillator or tank circuit is an idealized model because there is no dissipation of energy due to resistance. Tank circuit is used for creating signals at a certain frequency from a compound signal. In RLC circuit the resistor in series will start throwing away the power that should go to the load and due to unwanted resonance it would affect the stability of the system and it creates audible noise in RF circuits. In order to encounter this situation an LC circuit is used and this circuit will not waste that power. The technique used for analyzing the behavior mathematically and graphically is linear stability analysis. Linear stability analysis tells us about the behavior of a system near an equilibrium point. Linear stability analysis of harmonic oscillator in the domain of superconductivity determines the stability of fixed points in a circuit to visualize the qualitative analysis of resonance frequency when an LC circuit is operated from an external supply.

**Keywords:** LC Circuit, Resonance, Linear Stability Analysis, Transfer function

## I. Introduction

The LC circuit, oscillating at its natural resonant frequency can store electrical energy. LC circuits are used either for producing signals at a certain frequency or picking out a signal at a specific frequency from a additional composite signal. The purpose of an LC circuit is usually to oscillate with minimal damping. LC circuits are often used as filters [1], [2], [3], [4] and [5].

The  $\frac{L}{C}$  ratio is one of the aspects that determine their quality factor. Resonance occurs when a LC circuit is driven from an external supply at angular frequency at which the inductive and capacitive reactances are equal in magnitude. Resonance is a phenomenon in which a vibrating system drives another system to oscillate with greater amplitude. In LC circuit the capacitor stores energy in its electrical field and inductor stores energy in its magnetic field. LC circuit is given in fig. 1.

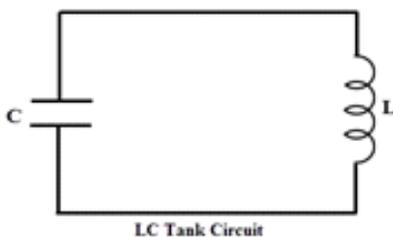


Fig. 1. LC Circuit

LC circuits perform as electronic resonators, which is very important component in many applications like filters, tuners and mixers [6]. The most extensively prominent use of tank circuits is tuning radio transmitters and receivers. For example, when we tune a radio to a particular station, the LC circuits are set at resonance for that particular carrier frequency. The characteristic frequency of an LC circuit is the frequency at which substantial amplitudes are developed when a driving force is connected at that frequency. In a LC circuit, electric charge oscillates forward and backward simply like the situation of a mass on a spring oscillates [7], [8] and [9]. The main advantage of this circuit is to make sure stability and in order to analyze the system near an equilibrium point; the linear stability analysis technique is used. This methodology is convenient to find out the behavior of dynamic system. RLC circuit can produce unwanted noise which can affect the whole dynamic system and in order to eradicate this noise tank circuit is used. The main concern of this research is to evaluate the behavior of tank circuit mathematically and graphically.

## II. Related Work

Department of Physics and Astronomy, University of North Carolina at Greensboro investigate a simple variation of the series RLC circuit in which anti-parallel diodes replace the resistor. This results in a damped harmonic oscillator with a nonlinear damping term. A set of nonlinear differential equations for the oscillator circuit is derived and integrated numerically for comparison with circuit measurements. Unlike the standard RLC circuit, the behavior of this circuit is amplitude dependent [10]. Recently in Geneva researchers derive a relationship to find out the uniqueness of stable oscillations, for this purpose they used nonlinear analysis of second order circuit [11]. In Madrid Spain the researchers analyze the oscillator with linear analysis. Common collector method is used to illustrate this method and linear methods for oscillator requires some verification as well [12]. In linear active circuits considering switched resistor is the problem of stability analysis. The analysis of resistor switched circuits transfer function has poles in the left plane and the stability of the circuit is examined. The stability of the second order circuit was anticipated and verified for any suitably confined DC input. It is found that there exists a class of AC inputs for this circuit is unstable over utmost of the dynamic range of the input. The methods were offered for the second order system to higher order systems and the analysis of second order linear system with a piecewise linear feedback block showing chaotic oscillations. The requirement of a feedback block which

cannot be a function is indicated. Stability analysis is one of the vital experiments in the design of large linear analog circuits with complex multi-loop arrangements.

### III. Methods and Experimental Analysis

Time domain solution of LC circuit by Kirchoff's voltage law is sum of capacitor and inductor voltage must be zero.

$$V_C + V_L = 0 \quad (1)$$

By Kirchoff's current law we can say that

$$I_C = I_L \quad (2)$$

From the constitutive relations for the circuit elements, we also know that

$$V_L(t) = L \frac{dI}{dt} \quad (3)$$

$$I_C(t) = C \frac{dV_C}{dt} \quad (4)$$

Rearranging and substituting gives the second order differential equation.

$$\frac{d^2}{dt^2} I(t) + \frac{1}{LC} I(t) = 0 \quad (5)$$

The resonant angular frequency is defined as

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad (6)$$

By using this expression in above differential equation

$$\frac{d^2}{dt^2} I(t) + \omega_0^2 I(t) = 0 \quad (7)$$

Differential equations designate the development of systems in continuous time. In ordinary differential equation (ODE) there is only one independent variable [13] and [14]. Consider the previous ordinary differential equation in which current is a function of time.

$$\frac{d^2}{dt^2} I(t) + \omega_0^2 I(t) = 0 \quad (8)$$

Let  $x = I(t)$  and use this in above equation as  $\dot{x} = x_1$  and further for second derivative  $\ddot{x} = \dot{x}_1$  Final equation in terms of linear system is

$$\dot{x}_1 + \omega_0^2 x = 0 \quad (9)$$

Equivalent system is said to be 3 linear.

$$\dot{x}_1 = -\omega_0^2 x \quad (10)$$

Because the "x" on the right hand side appear to the

first power only. Otherwise system would be nonlinear.

Linear Stability Analysis is a method to determine the stability of fixed points. Consider the equation  $\dot{x} = -\omega_0^2 x$  to find out the fixed point which is  $x^* = 0$ . We are considering the term  $\omega_0^2$  as constant to find out the derivative of previous equation which is

$$f'(x) = -\omega_0^2 \quad (11)$$

Inference of above equation is  $f'(0) = -\omega_0^2$  and we know that  $f'(x) < 0$  so the function is decreasing. An equilibrium solution is a constant solution of the system and is  $-\omega_0^2 x = 0$  such a system has exactly one solution located at the origin. Graphs of  $\dot{x}_1 = -\omega_0^2 x$  are situated below.

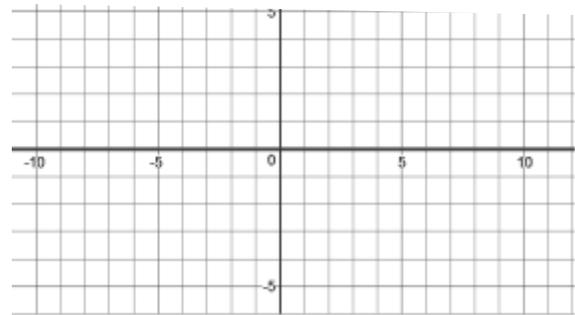


Fig.2. For  $\omega_0 = 0$

Above is a straight line graph when parameter is zero which is resonance in electrical LC circuit. From above  $\omega_0^2$  is also zero this is only possible in  $LC \rightarrow \infty$  circuit  $\frac{1}{LC} \rightarrow 0$  when value of and for zero resonance value.

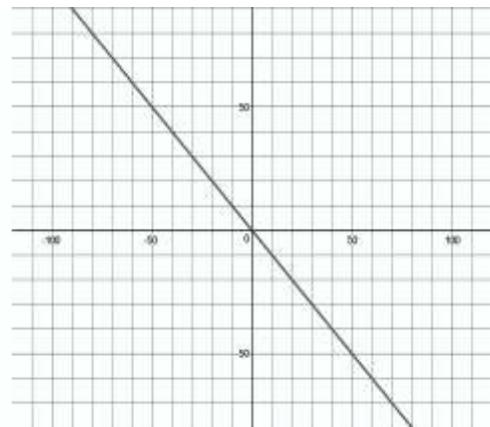


Fig.3 For  $\omega_0 > 0$  &  $\omega_0 < 0$

If  $\omega_0 > 0$  or it is equal to +1 then the graph looks like Fig.3 and the fixed point is at the origin which is stable. This graph is same for  $\omega_0 = -1$  and the behavior of fixed point is also same in this case to obtain some pictorial visualization of mathematical equation.

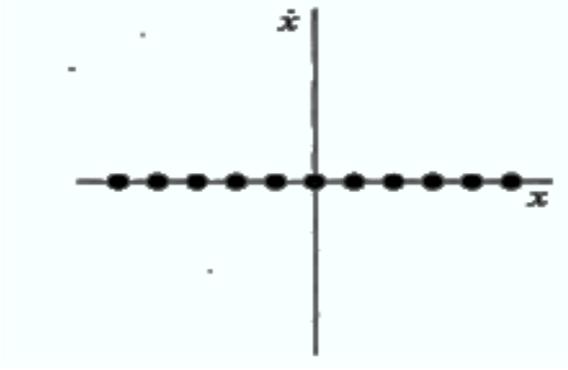


Fig. 4 when  $\omega_0 = 0$

When value of parameter is zero there is a whole line of fixed points; perturbations neither grow nor decay.

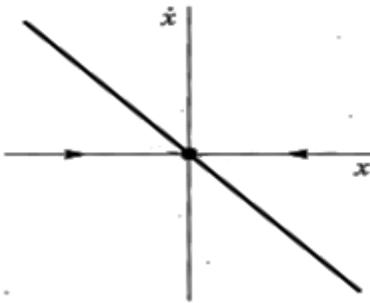


Fig.5 For  $\omega_0 > 0$  &  $\omega_0 < 0$

Resonance parameter is greater or less than zero then the fixed point is stable or attracting fixed point.

#### IV. Transfer Function

Transfer function of LC circuit is complex voltage divider.

$$\text{Transfer Function} = \frac{1}{sL + \frac{1}{sC}} = \frac{1}{s^2LC + 1} = \frac{1}{1 - \omega^2LC} \quad (12)$$

For large values of L, C and  $\omega$  the transfer function becomes negative. In this case the signal is 180 degrees out of phase with the input. At  $\omega = 0$  the value of transfer function is one.

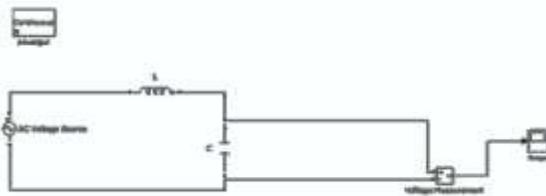


Fig.6. MATLAB Simulink Model

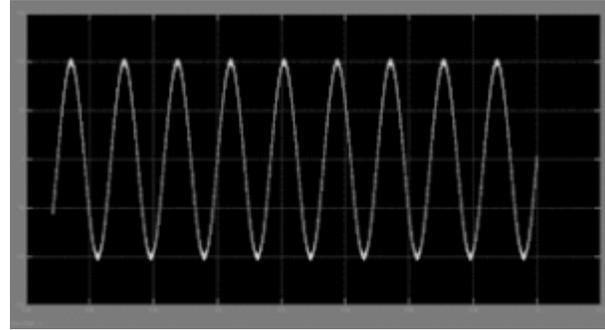


Fig. 7. Output Waveform

Simulation of LC circuit gives the realistic approach towards output voltage by setting the initial value zero of capacitor voltage and inductor current. Also input signal of 100 volts peak to peak to analyze the output waveform across the capacitor with 60 Hertz supply frequency. The circuit forms a harmonic oscillator. Introducing the resistance increases the decay of these oscillations. Output waveform corresponds to zero damping because amplitude doesn't change with time. Damping factor is also zero  $\zeta = 0$  which indicates that the system is undamped.

Now  $Q = \frac{\omega_0 LC}{R} = \infty$  because  $R=0$  and quality factor is very large so the circuit has very low damping and it will vibrate longer. Higher Q indicates a lower rate of energy loss relative to stored energy [15], [16] and [17].

#### V. Step Response

If an ideal DC battery gets connected to ideal de-energized LC circuit, transient is an ideal sine current. Since there's no damping, it will oscillate forever [18], [19] and [20].

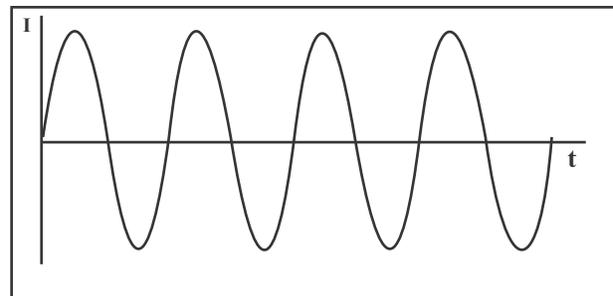


Fig. 8. LC Network Response

#### VI. Result Discussion

Due to absence of resistor the circuit is in the domain of superconductivity and there is no energy dissipation. When  $\omega = 0$  and  $\omega > 0$  or  $\omega < 0$  then oscillations are stable and undamped. Quality factor is high in this circuit which indicates that the ratio of energy loss is very low. Simulation of basic tank circuit indicates that the oscillations are undamped.

## VII. Conclusion

When resonance frequency is greater or less than zero then the fixed point is stable which means oscillations are stable and amplitude does not increase. At zero value of resonance frequency perturbations do not affect stability of oscillations. Output voltage waveform corresponds to zero damping because amplitude doesn't change with time. The polarity of the voltage varies as the energy is passed from side to side between the capacitor and inductor generating an AC type sinusoidal voltage.

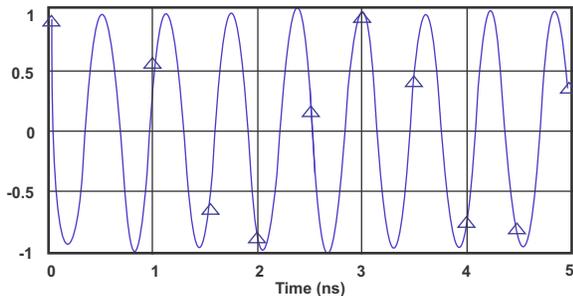


Fig. 9. Stable Oscillation

When we tune a radio to a specific station, the LC circuits are fixed at resonance for that specific carrier frequency. It is used for giving the essential positive feedback for supporting the oscillations.

## VIII. Future Work

The voltage magnification that takes place at resonance is given the image Q and the "Q Factor" (the voltage magnification) of LC Band Pass and Band Stop filter circuits as an example, controls the "rejection", the ratio of the desired to the undesirable frequencies that may be accomplished through the circuit. The results of voltage magnification are particularly beneficial as they are able to offer magnification of AC sign voltages the use of simplest passive components, i.e. without the demand for any external power supply.

## IX. References

- [Vanassche et al., 2002] Vanassche, P., Gielen, G., and Sansen, W. (2002). On the difference between two widely publicized methods for analyzing oscillator phase behavior. In IEEE/ACM International Conference on Computer-Aided Design, pages 229–233.
- [van Staveren et al., 2001] van Staveren, A., Verhoeven, C. J. M., and van Roermund, A. H. M. (2001). Structured Electronic Design: High Performance Harmonic Oscillators and Bandgap References. Kluwer Academic Publishers.
- [Vanassche et al., 2004] Vanassche, P., Gielen, G., and Sansen, W. (2004). Efficient analysis of slow-varying oscillator dynamics. IEEE Transactions on Circuits and Systems–I: Regular Papers, 51 (8):1457–1467.
- [Verhoeven et al., 2003] Verhoeven, C. J. M., van Staveren, A., Monna, G. L. E., Kouwenhoven, M. H. L., and Yildiz, E. (2003). Structured Electronic Design: Negative-Feedback Amplifiers. Kluwer Academic Publishers.
- [Vittoz et al., 1988] Vittoz, E. A., Degrauwe, M. G. R., and Bitz, S. (1988). High-performance crystal oscillator circuits: Theory and application. IEEE Journal of Solid-State Circuits, 23(3):774–783.
- [Westra et al., 1999] Westra, J. R., Verhoeven, C. J. M., and van Roermund, A. H. M. (1999). Oscillators and Oscillator Systems: Classification, Analysis and Synthesis. Kluwer Academic Publishers.
- [Yoon et al., 2005] Yoon, S.-W., Pinel, S., and Laskar, J. (2005). A 0.35- $\mu\text{m}$  CMOS 2-GHz VCO in wafer-level package. IEEE Microwave and Wireless Components Letters, 15(4):229–231.
- [Zanchi et al., 2001] Zanchi, A., Samori, C., Levantino, S., and Lacaíta, A. L. (2001). A 2-V 2.5-GHz -104-dBc/Hz at 100 kHz fully integrated VCO with wide-band low-noise automatic amplitude control loop. IEEE Journal of Solid-State Circuits, 36(4):611–619.
- [Rael and Abidi, 2000] Rael, J. J. and Abidi, A. A. (2000). Physical processes of phase noise in differential LC oscillators. In IEEE Custom Integrated Circuits Conference, pages 569–572. [Rogers et al., 2000]
- [Rogers et al., 2000] Rogers, J. W. M., Macedo, J. A., and Plett, C. (2000). The effect of varactor nonlinearity on the phase noise of completely integrated VCOs. IEEE Journal of Solid-State Circuits, 35(9):1360–1367.
- J. Petrzela, "Multi-state memory cell with resonant tunnelling diodes: Circuit tool for chaos generation," 2018 28th International Conference Radioelektronika (RADIOELEKTRONIKA), Prague, 2018, pp. 1-5.
- A. P. Cerrada, J. L. J. Martín and V. G. Posadas, "NDF method for linear oscillator design," 2015 International Symposium on Consumer Electronics (ISCE), Madrid, 2015, pp. 1-2.
- [Samori et al., 2000] Samori, C., Lacaíta, A. L., Zanchi, A., Levantino, S., and Cal'í, G. (2000). Phase noise degradation at high oscillation amplitudes in LC-tuned VCO's. IEEE Journal of Solid-State Circuits, 35(1):96–99.
- [Stover, 1966] Stover, H. L. (1966). Theoretical explanation for the output spectra of unlocked driven oscillators. Proceedings of the IEEE, 54(2):310–311.

15. [Atherton and Dorrah, 1980] Atherton, D. P. and Dorrah, H. T. (1980). A survey on non-linear oscillations. *International Journal of Control*, 31(6):1041–1105.
16. [Atherton, 1975] Atherton, D. P. (1975). *Nonlinear Control Engineering*. Van Nostrand Reinhold Company.
17. [Andreani and Mattisson, 2000] Andreani, P. and Mattisson, S. (2000). On the use of mos varactors in RF VCO's. *IEEE Journal of Solid-State Circuits*, 35(6):905–910.
18. [Coram et al., 2000] Coram, G. J., Anderson, B. D. O., and Wyatt, Jr., J. L. (2000). Limits to the fluctuation-dissipation theorem for nonlinear circuits. *IEEE Transactions on Circuits and Systems–I: Fundamental Theory and Applications*, 47(9):1323–1329.
19. [Falk and Schwarz, 2003] Falk, T. and Schwarz, W. (2003). An explicit formulation of the sensitivity function of two-dimensional oscillators. In *International IEEE Workshop on Nonlinear Dynamics of Electronic Systems*, pages 81–84.
20. C. Rogers, N. Ahmed, "Implementation of a VHF broad-band FIR adaptive filter", *Instrumentation and Measurement IEEE Transactions on*, vol. 38, pp. 1074-1079, 1989, ISSN 0018-9456.



# Recognition of Faulty Modules in a Photovoltaic Array Using Image Processing Techniques

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## Abstract:

*Visual techniques are very helpful in recognizing the condition of photovoltaic panels which are extensively used for power generation. Being clean source of energy and having zero fuel cost, solar industry has developed in no time. In order to seek maximum power from a photovoltaic, the modules installed in a PV array should be in good health. However, studies show that, direct exposure to sunlight and other faults within a PV array may damage some modules, which in turn may lead to overall efficiency reduction. This research work aims to present a visual technique to recognize faulty module in a PV array by optical image analysis. In addition to imaging techniques, the proposed framework implements mathematical modelling to correctly determine a faulty cell within a PV module. In past, thermal imaging has been used for this purpose but almost negligible work has been done by employing an optimal camera, in this regard, the proposed technique could prove to be a cost effective and efficient alternate solution to the stated problem.*

**Keywords**—Visual techniques, image recognition, solar panels

## I. Introduction

Photovoltaic systems are very common nowadays for power production. As, solar energy is clean and free, solar power systems are considered perfect for urban installations. Furthermore, the maintenance cost of photovoltaic (PV) systems is almost negligible. All these attributes of solar photovoltaics have made them most popular among renewable energy sources.

In past few years, the demand of solar photovoltaics has been increased. Consequently, some PV modules available in the market are often unhealthy or not in good condition. Sometimes, the manufacturing of PV modules is not up to the mark, as a result PV modules become degraded with time. Environmental factors play a pivotal role towards the performance and health of PV systems. Studies have shown that atmospheric heat and humidity directly affects the health of PV modules [1]. Prolonged exposure of PV modules to heat and humidity may lead to module degradation or discoloration, which is reported as a permanent fault in a PV module. A degraded module calls for the need of a proper cooling mechanism to cope with extreme environmental conditions. It has been reported in literature that every degraded module may cause a 0.8% decrease in efficiency annually [2].

Choi [3] has reported non-linearities or irregularities in

the characteristics of degraded PV modules. Phinikarides [4] has presented performance degradation analysis on the basis of PV technology. Moreover, [4] has also listed effects of weathering conditions on PV performance. Also, various degradation rate ( $R_d$ ) calculating methodologies have been presented in this work, it is shown that the value of  $R_d$  varies with methodology Cornaro [5] has presented a case study by discussing a performance analysis of PV modules of various technologies after one year of outdoor exposure in Rome. This work has reported that polycrystalline silicon photovoltaics are more stable as compared to double junction amorphous silicon modules which were prone to degradation in the initial months of installation. However, if the annual performance ratio (PR) is considered, it is almost similar for both technologies. In addition, it is reported in this work that the phenomenon of module degradation is different for PV modules of same models but from different manufacturers.

Various thermographic studies have been done so far in order to diagnose the health of an operational PV module. Also, thermographic analysis is commercially done in PV industries before their installment. Quarter [6] has proposed a light Unmanned Aerial Vehicle (UAV) based thermographic technique in order to monitor and diagnose faulty modules in a PV array. A visual approach has been utilized in this work on the basis of thermal and optical camera together, for the diagnosis of a degraded PV module. The suggested technique is good in fault diagnosis of PV module, but as this technique employs an IR and an optical camera together, this no more remains a cost effective solution to the problem.

Similarly Aghaei [7] has presented another thermography based digital image processing technique to detect a degraded module within a PV array. The author has further employed advanced imaging techniques in the thermal image of a faulty PV array in order to make fault more important and recognizable.

Yinhua Hu [8] has presented a thermography based approach to detect partial shading that is a temporary fault in a PV array. The author has detected the faulty portion of the module on the basis of temperature distribution in the thermal image obtained from an infrared (IR) camera. On the other hand, Karakose [9] has presented an image processing based analysis of moving shadow effects for reconfiguration in PV arrays. The later technique is a cost effective solution as it utilizes an optical camera which is cheaper as

compared to a thermal camera. A comparison of prices of thermal and optical cameras have been presented in Table 1.

In recent past, very less or no work has been done on health diagnosis of PV utilizing solely a simple optical camera. In this research work, an optical camera based image processing technique has been presented in order to diagnose health of a PV module. This technique employs a simple Nikon camera in order to capture images of healthy and unhealthy modules of PV array. An algorithm is proposed to detect and recognize unhealthy or faulty cells/ modules in the PV array. The proposed algorithm is tested on an array of size  $1 \times 3$  ( $N_s \times N_p$ ). The performance of proposed technique is discussed and compared with existing techniques in the last section of the paper.

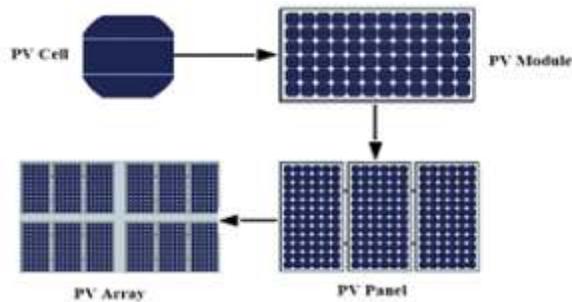


Fig. 1 Cell to array structure of photovoltaic

## II. Proposed Image Processing Technique

Existing visual techniques for recognition of faulty or unhealthy module in PV either use thermal camera or they are implemented with thermal and optical camera together. Thus, increasing the complexity and processing time of the overall algorithm. Also, employing a thermal or infrared (IR) camera in addition with an optical camera signifies an exponential rise towards the overall cost of the setup. However, the proposed technique only requires an optical camera (Model: Coolpix L820V1.0) for capturing the images of the PV modules. It is to be noted that the images can be captured from camera of any model with a recommended resolution of 4 mega pixel (MP). The camera resolution of 4 MP has been selected after performing number of experiments with several camera resolution settings, e.g. 640x480 pixels, 2 MP, 4MP, 8 MP, 16 MP etc. During experimentation, it was observed that the resolution of 640x480 pixels, some useful information of the image is gone when it is processed. However, in case of resolution greater than 4MP, it was observed that the processing time of the algorithm is considerably increased, as the algorithm has to scan the pixels of whole image. So, the camera resolution of 4 MP is better in terms of image results and processing time of the algorithm. Later, the images are processed in MATLAB to recognize unhealthy module within a PV array. The algorithm of the proposed technique is shown in Fig.2.

According to the suggested algorithm, the captured image

is called in MATLAB and is converted to the inverted image to make the faulty cells more prominent as compared to the rest of healthy cells in a module of the PV array. Later, the image is converted into a binary or black and white image in order to convert faulty cells in black, whereas, the healthy cells of the module are converted into white during this image conversion. It is to be noted that a gray scale image contains values from 0 to 255 whereas, a binary or black and white image contains only two values i.e. 0 for black and 1 for white [10]. So, in the proposed algorithm, pixel level analysis of the binary image is done in order to determine whether a cell/module is healthy or unhealthy. As, an image is actually a matrix having x and y co-ordinates, so it is imperative to design a mathematical model to correctly conduct cell-wise health analysis of a particular module on the basis of pixel values of the image. In that regard, the proposed algorithm calculates area of each cell within a PV module on the basis of x and y coordinates in the image. After that, number of healthy and unhealthy pixels are determined within a cell of the PV module. Later, this count is compared with the calculated area of the cell. If, the count of unhealthy pixels is greater than 50% of the area of cell, that cell is declared as unhealthy cell, otherwise healthy. A threshold of 50% has been defined on the basis of taking into account the effect of interconnections of cells that also appear in the image of module as black. It is pertinent to note that the author of [9] has performed moving shadow analysis using imaging techniques. In that regard, five image conversions have been done to calculate the percentage of shade, i.e. image erosion, dilation, blurring, canny edge detection and contour drawing operations. These image operations altogether contribute towards increased processing time of the algorithm. Whereas, the proposed algorithm has to go through only two image conversions in order to detect the faulty module. Later, mathematical operations are done in order to exactly determine the location of faulty cell which are described in following section.

TABLE 1. Model-wise price comparison of thermal and optical camera

Optical Camera Model (Sony)	Price in \$	Thermal Camera Model	Price in \$
LCSEB/B	38	FLIR-E4	980
DSCH300/BM	179.95	FLIR-I40	2800
Alpha a6000	698	63902-0202 NIST	2895
DSC-HX200V	1130.6	PS24	4353.88
A7 Full Frame	1130.6	T200	7500

### A. Mathematical Modelling

A PV module consists of number of cells in series and parallel. Further, number of modules in series make a PV string, whereas, number of series strings in parallel make up a PV array. Fig.1 describes the structure of a PV array from cellular to array level. The mathematical model of the problem is described in equations 1-5.  $A$  represents the area of particular cell that is being scanned by the algorithm at an instant.  $I(x, y)$  represents the x, y coordinates of a particular pixel of an image that is being

processed by the MATLAB code.  $H$  represents number of healthy pixels present in the image at cellular level. Similarly,  $U$  represents count of unhealthy pixels within a cell. Further, if the count of unhealthy pixels is greater than half of the area of cell, that cell is declared as unhealthy and vice versa.

First of all, area of cell is calculated as;

$$A = (x_2 - x_1) * (y_2 - y_1) \quad (1)$$

$$\begin{aligned} &\text{If} \\ &I(x,y) = 1, \\ &H = H + 1 \end{aligned} \quad (2)$$

$$\begin{aligned} &\text{If} \\ &I(x,y) = 0, \\ &U = U + 1 \end{aligned} \quad (3)$$

$$\begin{aligned} &\text{Cell is healthy if;} \\ &H \geq 0.5A \end{aligned} \quad (4)$$

$$\begin{aligned} &\text{Cell is unhealthy if;} \\ &U \geq 0.5A \end{aligned} \quad (5)$$

### B. Extension from module to array

The proposed model can be extended to full PV panel in a way that the algorithm, searches for the unhealthy module in a PV array, once it searches the faulty module/s, the above mentioned model can be utilized to further recognize the fault at cellular level. The mathematical model to detect a faulty module within a PV array is described in equations 6-10.

$A_{hl}$  symbolizes the area of upper half of the module. Similarly,  $H_{hl}$  represents the count of healthy pixels in upper half of the module, while  $U_{hl}$  represents number of unhealthy pixels in that part.

$$A_{hl} = (x_2 - x_1) * (y_2 - y_1) \quad (6)$$

$$\begin{aligned} &\text{If} \\ &I(x,y) = 1, \\ &H_{hl} = H_{hl} + 1 \end{aligned} \quad (7)$$

$$\begin{aligned} &\text{If;} \\ &I(x,y) = 0, \\ &H_{hl} = H_{hl} + 1 \end{aligned} \quad (8)$$

$$\begin{aligned} &\text{First half of module is healthy if;} \\ &H_{hl} \geq 4 + A_{hl} \end{aligned} \quad (9)$$

Here, a multiplying factor of 4 has been taken on the basis of number of cells present in one row of the PV module. In this case, there are four cells in each row of the module.

First half of module is healthy if;

$$U_{hl} \geq 4 + A_{hl} \quad (10)$$

Similarly, the model will check for second half of the same module. The module will be healthy if and only if both halves of the module are recognized as healthy, otherwise the module will be unhealthy even if only one half of it is recognized as unhealthy. This is because, any

of the unhealthy part of the module will affect the overall performance of the PV array, thus contributing towards power loss.

### III. Experimental Setup

An experimental setup has been established in order to test the performance of proposed algorithm. For this purpose a 1x3 ( $N_s \times N_p$ ) monocrystalline PV array, model 7SPM 85 has been utilized. A dataset of images have been obtained from a Nikon camera, model Coolpix L820V1.0 with a resolution of 4 MP.

Experimentation has been done under two weather scenarios in order to test the efficiency of the proposed algorithm. For this purpose, images of the PV array are captured under diffused irradiation conditions in weather scenario 1 [Fig.3]. Moreover, similar dataset of images has been obtained under sunny weather as well [Fig.4]. Later, the algorithm was simulated for both scenarios and the health of PV cells was clearly exhibited as healthy or unhealthy in results of the algorithm in TABLE 3.

TABLE 2: Data sheet of PV model 7SPM 85

Parameters	Value
Cells per module	32
Maximum power ( $P_{mpp}$ )	86W
Voltage at maximum power ( $V_{mpp}$ )	16.5V
Current at maximum power ( $I_{mpp}$ )	5.25 A
Open circuit voltage ( $V_{oc}$ )	20.2 V
Short circuit current ( $I_{sc}$ )	6.5 A

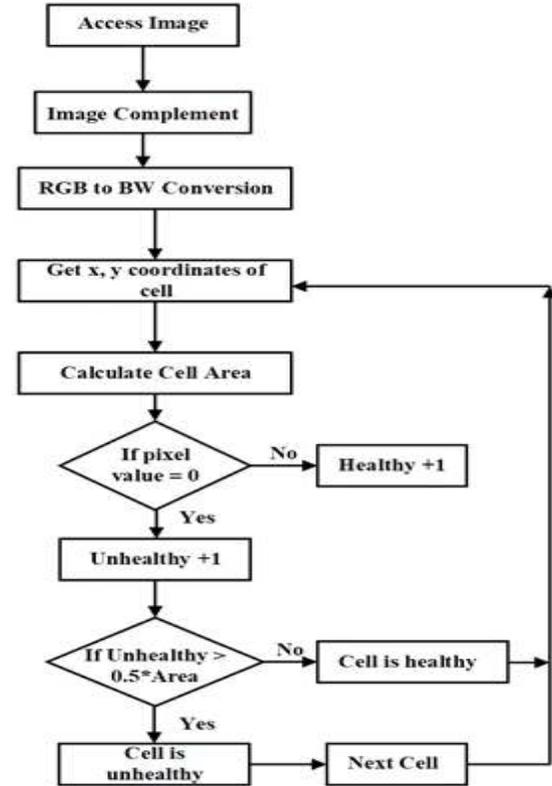


Fig. 2 Flow chart of proposed image processing technique

### IV. Simulation Results and Discussion

This section describes the simulation results of the proposed algorithm. In order to prove the effectiveness of

the proposed algorithm, the algorithm is run for two weather scenarios.

**Weather Scenario 1:**

Under this scenario, images were captured under diffused irradiation conditions during sun hours 13:00-14:00. Fig. 3(a) shows the actual image, whereas Fig. 3(b) shows the inverted image and Fig. 3(c) shows the processed image. It can be seen clearly that the processed image is showing the faulty part of the image as black. The algorithm results for this image have been shown in TABLE 3. Cell wise analysis of the module is done in order to precisely recognize faulty cells within a PV module. Next, on the basis of these results, some cooling mechanism of PV modules can be suggested in order to avoid further degradation. As, the degradation can spread to neighboring cells, which may lead to complete degradation of the whole module in the long run. In that regard, it is imperative to design cooling mechanism, so that pre-mature degradation owing to extreme hot weather conditions may be dealt with.

**Weather Scenario 2:**

Similarly, the images were captured for another weather scenario in order to test the validity and robustness of the

proposed algorithm. In this scenario, the weather was sunny and the images were captured during peak sun hours (13:00-14:00). The actual image, inverted image and processed image for weather scenario 2 has been shown in Fig.4 (a), (b), (c) respectively. The simulation results are given in TABLE 3. It can be seen that the algorithm results for this scenario are identical to those in weather scenario 1, while accurately recognizing faulty cells. So, it is verified that the algorithm works well irrespective of the weathering condition.

In past, thermography based visual techniques have been used in order to determine failure within a particular module of a PV array. However, these techniques suffer the challenges of processing time of the algorithm and cost of the camera setup. Moreover, interpretation of IR images is a real challenge owing to weather conditions, reflection and partial shading issues.

On the basis of extent of degradation within a PV module, cooling mechanism for a PV array can be suggested in the future work of this technique. Furthermore, the MPPT of the PV system can be updated according to the health status of the modules that is obtained by the proposed technique.



Fig 3. (a) Scenario 1: Actual image of faulty module

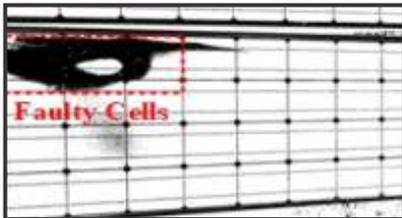


Fig.3 ( C ) Black and white image



Fig.4.(b) Inverted image



Fig.5. (a) Actual image of full 1x3 (NsxNp)PV array



Fig. 3 (b) Inverted image



Fig.4.(a) Scenario 2:Actual image of faulty module



Fig.4 ( C ) Inverted image

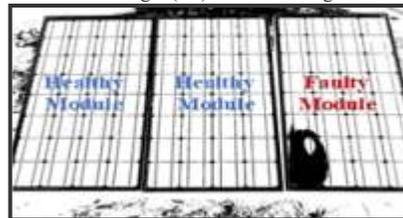


Fig.5.(b) Black & image of full 1x3 (NsxNp) PV array with faulty module indicated

Fig.5. Actual & black & white image of full 1x3 (NsxNp) PV array

TABLE 3. Simulation results of proposed algorithm under weather scenario 1 & 2

Weather Scenario	Area of Cell (A)	Healthy	Unhealthy	Result on LCD	
Scenario 1	1.	44544	43526	1443	cell1 is healthy
	2.	43424	42498	1347	cell2 is healthy
	3.	45312	44338	1403	cell3 is healthy
	4.	46848	45777	1508	cell4 is healthy
	5.	46400	45336	1497	cell5 is healthy
	6.	48000	46951	1490	cell6 is healthy
	7.	50592	49363	1682	cell7 is healthy
	8.	51408	49970	1895	cell8 is healthy
	9.	52704	51520	1645	cell9 is healthy
	10.	52416	51282	1595	cell10 is healthy
	11.	53456	52260	1662	cell11 is healthy
	12.	54912	52863	2522	cell12 is healthy
	13.	54560	53000	2029	cell13 is healthy
	14.	57120	55728	1872	cell14 is healthy
	15.	59136	57610	2015	cell15 is healthy
	16.	60032	58021	2504	cell16 is healthy
	17.	59280	51218	8551	cell17 is healthy
	18.	60088	58559	2021	cell18 is healthy
	19.	62176	60593	2084	cell19 is healthy
	20.	66368	64189	2696	cell20 is healthy
	21.	67584	28462	39643	cell21 is unhealthy
	22.	68544	66375	2694	cell22 is healthy
	23.	68544	65728	3341	cell23 is healthy
	24.	70656	68232	2957	cell24 is healthy
	25.	72864	20433	52972	cell25 is unhealthy
	26.	72800	55894	17447	cell26 is healthy
	27.	73920	64541	9924	cell27 is healthy
	28.	77380	74119	3819	cell28 is healthy
	29.	81792	9725	72640	cell29 is unhealthy
	30.	81760	74944	7389	cell30 is healthy
	31.	81792	79393	2972	cell31 is healthy
	32.	86336	82817	4108	cell32 is healthy
Scenario 2	1.	23184	22508	983	cell1 is healthy
	2.	24534	23877	973	cell2 is healthy
	3.	25803	25051	1077	cell3 is healthy
	4.	27342	25870	1806	cell4 is healthy
	5.	25578	24944	956	cell5 is healthy
	6.	26352	25798	882	cell6 is healthy
	7.	28224	27441	1123	cell7 is healthy
	8.	28917	27996	1264	cell8 is healthy
	9.	27612	26969	977	cell9 is healthy
	10.	30051	29187	1213	cell10 is healthy
	11.	31005	30294	1066	cell11 is healthy
	12.	31482	30380	1460	cell12 is healthy
	13.	33108	31897	1576	cell13 is healthy
	14.	33345	32130	1582	cell14 is healthy
	15.	34974	33838	1512	cell15 is healthy
	16.	34272	33447	1198	cell16 is healthy
	17.	35685	33927	2137	cell17 is healthy
	18.	40803	39068	2140	cell18 is healthy
	19.	37260	36086	1562	cell19 is healthy
	20.	39528	37929	1999	cell20 is healthy
	21.	38610	13223	25781	cell21 is unhealthy
	22.	39780	38574	1606	cell22 is healthy
	23.	41535	40362	1582	cell23 is healthy
	24.	44019	42268	2172	cell24 is healthy
	25.	41256	13806	27858	cell25 is unhealthy
	26.	46008	40068	6370	cell26 is healthy
	27.	45333	43954	1806	cell27 is healthy
	28.	48438	46505	2375	cell28 is healthy
	29.	46575	83	46925	cell29 is unhealthy
	30.	50616	40026	11041	cell30 is healthy
	31.	51984	49583	2858	cell31 is healthy
	32.	53352	51427	2388	cell32 is healthy

#### IV. Conclusion

The guaranteed life time of PV module is 20 years but in order to achieve this life time, appropriate maintenance is required as these modules are directly exposed to internal and external stresses. Consequently, effective real time diagnostics and inspection techniques are very essential to prolong lifetime of PV module. Nevertheless, in recent years there has been an increasing growth in monitoring methods for PV systems.

In proposed research, the purpose was to suggest an algorithm of digital image processing technique which was designed in MATLAB environment in order to recognize the health of PV module. For this purpose, images of a  $1 \times 3$  ( $N_s \times N_p$ ) PV were captured from Nikon Coolpix camera. Proposed technique is cost effective in a way that it employs a simple optical camera to capture images. Moreover, as there are only two image conversions taking place in the algorithm, the processing time of the algorithm is considerably less as compared to existing imaging techniques owing to have four image conversions in their algorithms. The images in suggested technique were processed in MATLAB in order to determine health of the modules in a PV array. Moreover, a particular cell within a module was identified as healthy or unhealthy. The proposed algorithm is tested under two weather conditions i.e. under sunny weather and under diffused irradiation scenario. The results obtained in both scenarios were alike and the faulty cells within a module were clearly recognized as unhealthy in simulation results.

#### References

- [1] Bouraiou, Ahmed, et al. "Experimental investigation of observed defects in crystalline silicon PV modules under outdoor hot dry climatic conditions in Algeria." *Solar Energy* 159 (2018): 475-487.
- [2] Jordan, Dirk C., and Sarah R. Kurtz. "Photovoltaic degradation rates—an analytical review." *Progress in photovoltaics: Research and Applications* 21.1 (2013): 12-29.
- [3] Choi, Sungwoo, et al. "Performance degradation due to outdoor exposure and seasonal variation in amorphous silicon photovoltaic modules." *Thin Solid Films* 661 (2018): 116-121
- [4] Phinikarides, Alexander, et al. "Review of photovoltaic degradation rate methodologies." *Renewable and Sustainable Energy Reviews* 40 (2014): 143-152.
- [5] Cornaro, Cristina, and Davide Musella. "Performance analysis of PV modules of various technologies after more than one year of outdoor exposure in Rome." *International Conference on Applied Energy (ICAE2011)*. Tree, 2011.
- [6] Quater, Paolo Bellezza, et al. "Light Unmanned

Aerial Vehicles (UAVs) for cooperative inspection of PV plants." *IEEE Journal of Photovoltaics* 4.4 (2014): 1107-1113.

- [7] Aghaei, M., et al. "IR real-time analyses for PV system monitoring by digital image processing techniques." *Event-based Control, Communication, and Signal Processing (EBCCSP), 2015 International Conference on*. IEEE, 2015.
- [8] Hu, Yihua, et al. "Thermography-based virtual MPPT scheme for improving PV energy efficiency under partial shading conditions." *Power Electronics, IEEE Transactions on* 29.11 (2014): 5667-5672.
- [9] Karakose, Mehmet, and Mehmet Baygin. "Image processing based analysis of moving shadow effects for reconfiguration in PV arrays." *Energy Conference (ENERGYCON), 2014 IEEE International*. IEEE, 2014.
- [10] Longacre Jr, Andrew. "Image data binarization methods enabling optical reader to read fine print indicia." U.S. Patent No. 6,575,367. 10 Jun. 2003.



# Development of WDM System using Fiber Nonlinearities via Four Wave Mixing and Cross Phase Modulation

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## Abstract:

*In the optical fiber communication systems, when the power is high, the impact of nonlinear effects become significantly important for transmission. In the Nonlinear effects, the Refractive index (RI) provides the significant information in multi-channel optical systems. There are various techniques have been proposed for multi-channel optical system using fiber nonlinearities. However, the proposed system offers the development and design of Wavelength Division Multiplexing (WDM) system designing using fiber nonlinearities effects for extraordinary data rate, extended transmission distance and low BER. These fiber nonlinearities are classified as Cross Phase Modulation (C/XPM) and Four Wave Mixing (FWM). In the designed system, the low BER using both these fiber nonlinearities effect compared to existing work. The paper demonstrates the generation of multiple signals due to nonlinearities effects between two or more wavelengths interact each other. It is defined that using the FWM for WDM system, the BER of  $1.13e-33$  is achieved and XPM for WDM system produces BER of  $1.5e-12$ . It is also demonstrated that WDM via FWM offers less BER compare to WDM system via XPM.*

**Keywords**— Bit Error Rate (BER), Fiber Nonlinearity, Wavelength interaction, Nonlinear effects.

## I. Overview

In optical fiber communication system, during the transmission, high optical power will produce various effects on signals [1]. These effects are mainly categorized in Linear and Nonlinear effects [2]. In the long haul communication, nonlinear effects are becoming more prominent for WDM System because of higher demand of bit-rates used [3]. The fiber nonlinearities are categorized in Stimulated Scattering (Raman or Brillouin), and Optical Kerr effect. This Kerr effect produces the (Self and Cross) Phase Modulation along with Wave Mixing terms as (FWM). In this study, the principle behind fiber nonlinearities of FWM and XPM system will be discussed to come out with a valuable results and conclusions for a long haul communication system of wavelength division multiplexing (WDM).

In optical communication, the high data rates traffic is transported across communication networks. This huge data transportation issue is compensated using an effect

of fiber nonlinearities of FWM and XPM system to produce a various signals of different wavelengths as coherent sources in WDM system. In this paper, the two channel WDM system is designed using via FWM and XPM. The performance of the designed 2-Channel WDM is compared for FWM and XPM design models. The designed system also provides the determination of allowable dispersion of fiber and Gpbs bit rate for the designed 2-Channel WDM FWM and XPM design models.

## II. Background and Literature Review

In fiber nonlinearities, the FWM demonstrates the interaction between two closely spaced wavelengths of laser light to conserve the energy [4]. In Multi-Channel optical systems, the thrashing of two or more channels offers generation of multiple new frequencies with expend of power in depletion region of fiber. The two continuous waves of wavelengths  $\omega_1$  and  $\omega_2$  are inserted into the fiber that generates the side band due to FWM [5]. The XPM in fiber nonlinearities creates the phase changes due to one wavelength of light interact with other. XPM system offer the accumulation of light by adapting the phases of the optical beams with another beam via collaborations in the non-linear medium. In XPM effective refractive index along a fiber will increase caused by some intense beam from others a beam which is twice large from another [6].

### A. Previous Studies

Q. Li in [7] discussed the extremely effectual generation of broadband FWM products that are investigated using a low dispersion value of fiber experimentally. The issue with this study is of low dispersion and low data rate.

A. Cerquira [8] studied the FWM technique for inserting the 2 strong pump waves near the 0 dispersion. The system was designed using two external cavity lasers that are integrated using a 3 dB coupler and is enlarged by two cascaded Erbium Doped Amplifiers (EDFAs). Both the EDFAs have different configurations. The first one has nominal power of 12mW and second one is used as booster that is configure using 250mW. The peak power measured at fiber input was about 10W. This power was indulge at each laser. The output power was measured using optical spectrum analyzer. after the fiber under test. A conventional fiber (single mode fiber) with photonic crystal fiber were determined in terms of their efficiency and the generation products. Yu, J in [9] and Costa, A in [10] investigated the impact of XPM on optical AM-PSK

modulation formats in WDM system. The study defines that AM-PSK modulation format in the XPM system will rapidly increase the capacity required in order to make wavelength spacing narrow to enhance the channel space. The high channel space will provide the intense XPM effect. The aim on their research also is to demonstrate the numerical and simulation of XPM in WDM system using amplitude modulation and m-phase shifting scheme and decode signals in single span of link. The XPM system designed form two channels, one referred as probe (CW laser) with high power 10 dBm and another one will carry the binary data and is referred to low power pump channels at 0 dBm.

Sharda, A. K in [11] designed multiple user FWM based DWDM system that include 1, 2, 4, and 8 user configurations. This user are configured at the bit rate of 2.5Gbps. The designed system utilizes FWM technique to generate the multiple wavelengths. These multiple wavelengths are generated to provide the multiple laser inputs. The performance of the designed system using Bit Error Rate, Q-factor at received power for different long transmission distance varied from 20km to 110km for optical fiber cable. As it was already discussed that system include 1, 2, 4, and 8 user configure at 2.5Gbps bit rate. The total output wavelengths have been created through FWM setups. The CW laser is configured at 10dbm each laser that is used an input power. The output wavelengths are rectified and filtered one by one and are amplified at the similar level of -15dbm. These wavelengths are modulated. The modulation have been achieved using Mach-Zender modulator. These wavelengths then are multiplexed and are transferred and transmitted in to optical fiber. In the end, the receiver is configured with optical characteristics that has photodiode and a low pass filter.

In this paper, the 2-Chaneel WDM system is designed using FWM and XPM for high bit rate of Gbps and wide transmission length. The appropriate power and component characteristics value were selected based on the literature review and previous studies. This is to ensure that the system was able to support at realistic parameters of optical transmission communication. In the next, the methodology of designed 2-Chaneel WDM system is designed using FWM and XPM for high bit rate of Gbps and wide transmission length is discussed in detail. The system models are developed and discussed and results attained from the developed models are also discussed.

### III. Methodology

In this work, 2-Chaneel WDM system is designed using FWM and XPM for high bit rate of Gbps and wide transmission length is developed. A conceptual block diagram of FWM and XPM system combine with WDM model was developed in order to have a better visualization of the whole structure and the component to be used. The system models are developed using RSoft OptSim design software whereby the eye diagrams, Q values, and the BER results were obtained. All the

simulation results were analyzed and compared with the conclusions drawn from the theory and for the further recommendation development.

#### A. System Design of FWM

The design of FWM effect is as shown in Figure 1. The system is developed from two channels and 3-dB coupler is used to modulate the signal for transmission at fiber length.

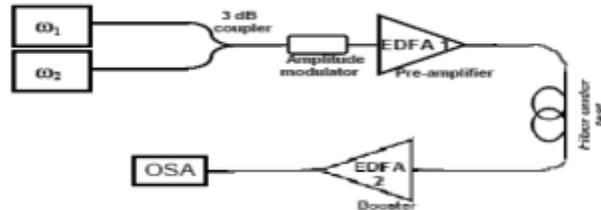


Fig. 1. WDM System Design using FWM

The two channel are created as shown in Figure 1. length of fiber 100 km is set to get a coherent generation of output signal. The system is developed by configuration of the two EDFA. The simulation of FWM is shown in Figure 2.

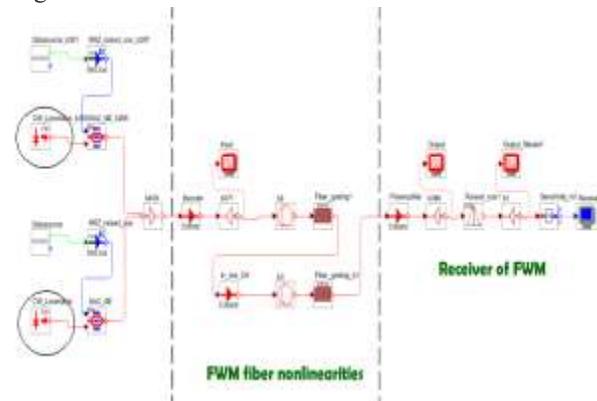


Fig. 2. Simulation Design of FWM using RSoft OptSim

#### B. System Design of XPM

The system design of XPM is same as of the FWM configuration as shown in Figure 3. The major differences between both design systems are their input power on both CW lasers. In XPM design system, the input power at one CW laser must higher than the other one which is 10 dBm and 0 dBm.

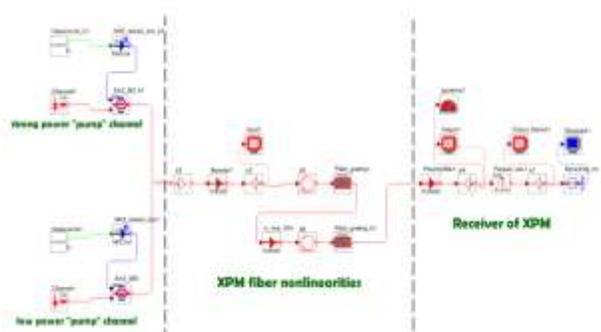


Fig. 3. Simulation Design of XPM using RSoft OptSim

### C. WDM System Design via FWM and XPM

In this section, the WDM system is designed for transmission system of FWM/XPM as shown in Figure 4. The configuration of WDM system is developed by design the Multiplexing (Mux), Single Mode Fiber, Demultiplexing (DeMux).

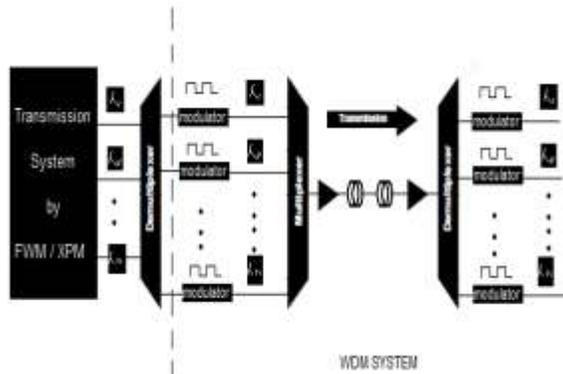


Fig. 4. FWM / XPM Transmission System in WDM System

In the designed system more than one signals are input to the fiber transmission. A multiple signals produces from FWM or XPM system will combined together through Mux as shown in Figure 5 and Figure 6 respectively.

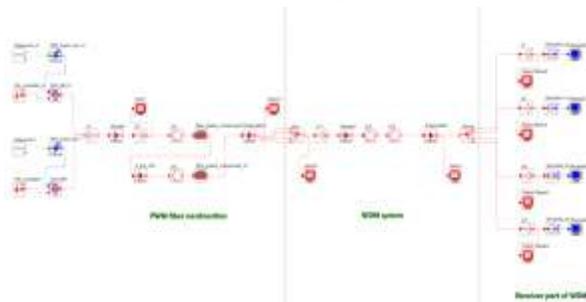


Fig. 5. Simulation design of XPM with WDM system

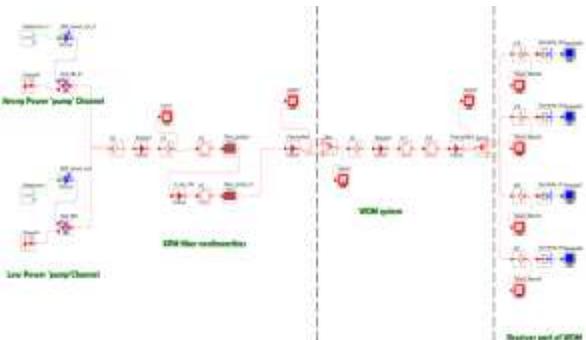


Fig. 6. Simulation design of XPM with WDM system

Those signals being amplified by EDFA booster over dispersion shift fiber of transmission distance of 100 km. A fiber spans with opposite dispersion sign ( $\pm 2.6$  ps/nm/km) resulting in ideal dispersion compensation at the center of the simulated bandwidth. The other EDFA is used in the receiver section as a preamplifier in order to amplified backs the weak signals. The simulation design of FWM and XPM with WDM system is shown in Figure 5 and Figure 6 respectively. In the next section, the results attained for the designed system is discussed.

### IV. Results and Discussions

In this section, the results attained for the designed WDM system using FWM and XPM are discussed. The performance of the designed WDM system using FWM and XPM is compared. The performance of the designed system is compared based on the number of output signals produced, BER, Q measurement, and the eye diagram. The critical parameters to be considered in this section are the dispersion of fiber (ps/nm/km), laser input power (dBm), length of fiber (km) and supported bit rate (Gbps). The output of the designed WDM system using FWM and XPM is discussed in different sections such as; the effect of dispersion fiber on output signal, the effect of input power on Q measurement, the effect of fiber length on BER, the effect of bit rate on BER and Implementation fiber nonlinearities system in WDM system.

#### A. The Effect of Dispersion Fiber on Output Signals

The numbers of output signals produced by FWM and XPM system is varied from 1 ps/nm/km to 4 ps/nm/km. The resulting output signals from FWM and XPM is shown in Figure 7 and Figure 8 respectively.

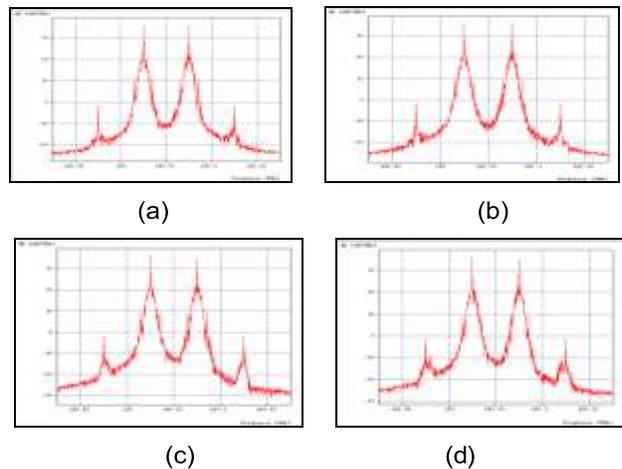


Fig. 7. Output signal from XPM system with different dispersion value (a) 1 ps/nm/km (b) 2 ps/nm/km (c) 3 ps/nm/km (d) 4 ps/nm/km

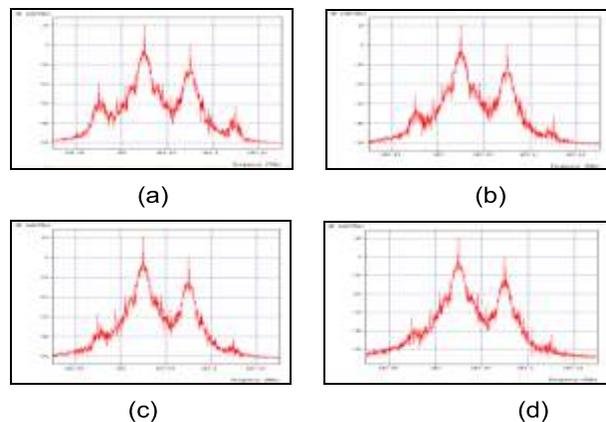


Fig. 8. Output signal from XPM system with different dispersion value (a) 1 ps/nm/km (b) 2 ps/nm/km (c) 3 ps/nm/km (d) 4 ps/nm/km

From the results, a higher dispersion value will cause a weaker output power then will lead in reducing the number of output signals. It is clearly shown in Figure 8, since the reduction on the number of output signals from XPM is due to the higher dispersion of fiber. Therefore the suitable dispersion fiber in both systems must below than 4 ps/nm/km. In the next, the effect if input power on Q-factor is discussed.

### B. The Effect of input Power on Q measurement.

The graph of input power versus Q measurement between FWM and XPM system are shown in Figure 9. The input power is varied from -20 dBm to 0 dBm with spacing of -5 dBm such as; -15 dBm, -10 dBm, -5 dBm and -0 dBm. The results obtained are shown in Table 1.

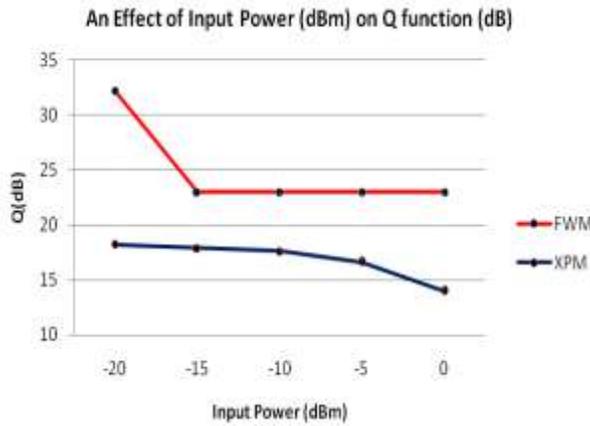


Fig.9. An effect of input power (dBm) on Q function (dBm)

For FWM system, the Q measurement decreased as the input power increased. The same output observation is being obtained for XPM system.

TABLE I. INPUT POWER (DBM) VERSES Q (DBM) OF FWM AND XPM

Input Power (dBm)	FWM (dBm)	XPM (dBm)
-20	32.188721	18.240697
-15	22.964364	17.905387
-10	22.964364	17.617287
-5	22.964364	16.605979
0	22.967061	13.96817

Practically the requirement for Q measurement must be more than 6dBm [12]. The results show that, both of the systems are suitable operating at -20 dB input power. In the next, the effect of fiber length on BER is discussed.

### C. The effect of fiber length on BER

The effect of fiber length on BER for FWM and XPM system is shown in Figure 10.

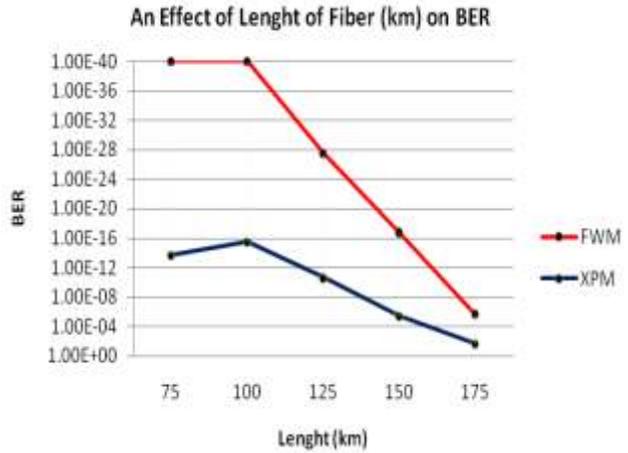


Fig.10 An effect of fiber length (km) on BER

The length in this study is varied from 75 km to 150 km as stated in Table 2.

TABLE II. Length of Fiber (KM) Versus BER of F

Length (km)	FWM	XPM
75	1.00E-40	2.07E-14
100	1.00E-40	3.52E-16
125	3.15E-28	2.49E-11
150	1.88E-17	4.30E-06
175	2.23E-06	0.0227501

The result shows that BER increased proportionally with distance. This is due to the attenuation (loss) from the fiber and receiver noise. As the distance increase the bit interval becomes longer. The longer the bit interval means fewer bit can be transmitted per unit of time. Thus, as the higher distance increase will lead to a lower bit rate [12]. The simulated result shows that maximum suitable distance for both systems is less than 100km. In the next, the effect of bit rate on BER is discussed.

### D. The effect of bit rate on BER

The range of bit rate that is been used in this simulation are from 1.25 Gbps to 40 Gbps as shown in Table 3.

TABLE III. Bit Rate (Gbps) verses BER of FWM and XPM

Bit Rate (Gbps)	FWM	XPM
1.25	5.83E-05	6.20E-04
1.8	5.50E-05	3.40E-09
2.5	7.30E-07	6.90E-24
10	1.00E-40	1.90E-08
40	2.28E-02	0.0227501

The fiber length is fixed at 75 km for FWM system and 100 km for XPM system with dispersion 1 ps/nm/km. The input power for both systems is being set at -20 dBm as shown in Figure 11.

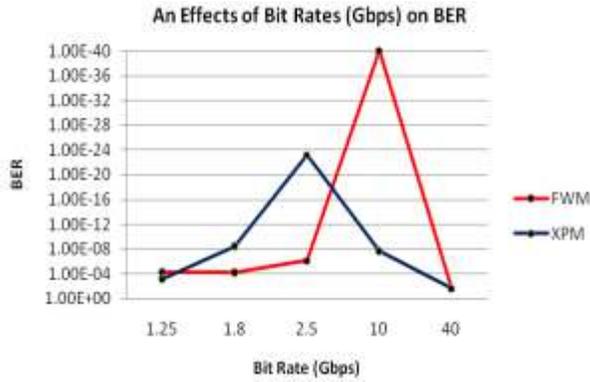


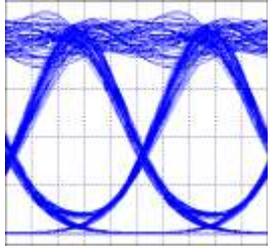
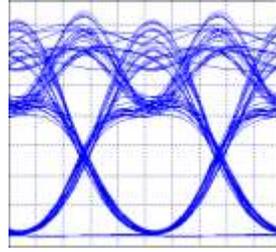
Fig. 11. An effect of bit rate (Gbps) on BER

It can be illustrated from Figure 11 that at bit rate 10 Gbps, the BER value for FWM system is  $1.00\text{e-}40$  while XPM system is  $1.0\text{e-}8$ . Based on the result, it is known that XPM system is inefficient to transmit in transmitting high data rate. Therefore, the best BER for nonlinearities technique must around  $1.0\text{e-}50$  to  $1.0\text{e-}30$  [2]. In the next, the implementation of fiber nonlinearities in WDM system is discussed.

#### E. Implementation fiber nonlinearities in WDM system

Table 4 compares the eye diagram between FWM and XPM technique.

TABLE IV. Comparison Eye Diagram with BER value

FWM	XPM
1.13e33	1.5e12
	

Based on the table, BER increased as the eye openings become closer. Thus as the BER decrease will lead to eye open very well. From the results, it is known that FWM is the best technique to be implemented in WDM. Since the BER for FWM is  $1.13\text{e-}33$  which is less than  $1.5\text{e-}12$  from XPM system.

It has been demonstrated that noise and dispersion affect the signals along a fiber. Dispersion on fiber causes a phase shift between the two sidebands around the optical signals and affected to the XPM technique [13]. Since XPM used a differential phase shifts due to its input power (CM laser). Therefore XPM is more sensitive to of phase noise. Due to the disadvantages discussed in the

previous section, XPM has not been considered as a good transmission system in WDM rather than FWM.

#### I. Conclusion

In this paper, the WDM system is developed using fiber nonlinearities for high data rate, long transmission distance. The system is designed using Four Wave Mixing (FWM) and Cross Phase Modulation system (XPM) for single mode optical fiber as their transmission medium. The system's performance is also compared with the existing technique. It has been concluded that developed WDM system using fiber nonlinearities is more efficient for high data rate transmission at high fiber length with low BER. Noise and dispersion will affect the signals along a fiber. Therefore XPM is more sensitive to of phase noise. Due to the disadvantages discussed in the previous section, XPM has not been considered as a good transmission system in WDM rather than FWM. For future work, recommended input signals are being to be 4 channels up to 64 channels. This is allowing FWM and XPM techniques to be applied in large bandwidth capacity of optical fiber. Therefore Wavelength Division Multiplexing (WDM) system will be replaced by Dense Wavelength Division Multiplexing (DWDM) system and Ultra Dense Wavelength Division Multiplexing (U-DWDM) system.

#### Acknowledgment

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#### References

- [1] A. Newell, Nonlinear optics: CRC Press, 2018
- [2] C. Guo, F.Liu, S.Chen, C.Feng, and Z.Zeng, "Advances on exploiting polarization in wireless communications: Channels, technologies, and applications," IEEE Communications Surveys & Tutorials, vol.19, pp. 125-166, 2017.
- [3] B. Mukherjee, "WDM optical communication networks: progress and challenges," IEEE Journal on Selected Areas in communications, vol.18, pp. 1810-1824, 2000.
- [4] S. Boscolo, Shaping Light in Nonlinear Optical Fibers: John Wiley & Sons, 2017.
- [5] P.C. Debnath, S. Uddin, and Y.-W. Song, "Ultrafast All-Optical Switching Incorporating in Situ Graphene Grown along an Optical Fiber by the Evanescent Field of a Laser," ACS Photonics, 2017.

- [6] P. Guan, F. Da Ros, M. Lillieholm, N.-K. Kjølner, H. Hu, K. M. Røge, et al., "Scalable WDM phase regeneration in a single phase-sensitive amplifier through optical time lenses," *Nature communications*, vol.9, pp. 1049, 2018.
- [7] Q. Li, Y. Huang, Z. Jia, C. Yao, G. Qin, Y. Ohishi, et al., "Design of fluorotellurite microstructured fibers with near zero flattened dispersion profiles for optical frequency comb generation," *Journal of Lightwave Technology*, Vol. 36(11), pp. 2211 – 2215, 2018.
- [8] S Jr, Arismar Cerqueira, JM Chavez Boggio, A. A. Rieznik, H. E. Hernandez-Figueroa, H. L. Fragnito, and J. C. Knight. "Highly efficient generation of broadband cascaded four-wave mixing products." *Optics Express*, Vol. 6(4), pp. 2816-2828, 2008.
- [9] Yu, J., & Jeppesen, P. Investigation of cross-phase modulation in WDM systems with NRZ and RZ modulation formats. *Optics communications*, Vo.184(5-6), pp. 367-373, 2000.
- [10] Costa, A., Alves, A., & O'Reilly, J. Investigation of cross-phase modulation in WDM systems with AM-PSK modulation formats. In *London Communications Symposium*, London, 2001.
- [11] A. K. Sharda, G. Kaur, and N. Gupta, "Performance comparison of 2.5 Gbps FWM based DWDM system for enhanced number of users," in *Advanced Optoelectronics and Lasers*, 2008. CAOL 2008. 4th International Conference on, pp. 137-139, 2008.
- [12] Charles K. Kao. "Optical fiber Technologies" Vol 2. IEEE press reprint selected series. pp. 1981 – 343, 2000.
- [13] A. Costa, A. Alves and J. O'Reilly "Investigation of Cross-Phase Modulation in WDM Systems with AM-PSK Modulation Formats" *IEEE Photonics Technology Letters*, vol. 10(12), pp.2414-2421, 2000.



# Using L2TP Protocol in Cloud Infrastructure with IoT for Secure and Robust Communication

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## **Abstract:**

*Security is the major issue in networking world and it is extremely critical for business continuity. In this paper, VPN is deployed between virtual Cloud and physical IoT devices to obtain faster communication with security allowing transferring of data proficiently and safely. L2TP technology is used to achieve VPN connectivity with two phase authentication and encryption of data, which results as a secure and fast tunnel for data transfer minimizing time from 240ms to 140ms. This will provide a new way to transmit data securely and in less time. Other VPN technologies such as IPsec and SSL can be incorporated with this technique, which can further enhance the data rate and make the connection more secure.*

## **I. Introduction**

Internet of Things and Cloud computing are new technologies that are growing rapidly in the field of telecommunications. As the world is advancing in technology, the risks of security breaches are becoming more common in the field of information technology [1]. In this paper we are discussing the method of securing the IoT data with the help of Cloud infrastructure and L2TP protocol. We focus on the privacy of data transferred by IoT to the servers through Cloud, the servers as well as the firewall are virtual machines deployed on Cloud infrastructure.

Data or information is the most important aspect for any human or any organization. Data security should be to the utmost level so to secure the unauthorized use of the data [2]. IoT is comprised of multiple devices, software's operating systems which can send out kilobytes of data a minute to complex things comprising of multiple sensors churning out gigabytes of data in a continuous data stream. As per RFC 4949, the security breaches by entity to evade established measures can be classified in terms of intent, origination and delivery method. Depending on the intent of attacker, as active (resources / operations) or passive (put information to use without affecting system resources). If referenced to the point of initiation, "inside attack" versus "outside attack" are the known types Using the method of delivery, direct and indirect attacks are well referenced. These includes "smurf attacks" as well "reflection attacks"(replay by intrusion). Use of IoT results in improved efficiency and reduced human error.

L2TP protocol will be used in this experiment to further secure the layer of data and find out the impacts of this

protocol. The layer 2 tunneling protocol is utilized to help virtual private systems (VPNs), depending on an encryption protocol that it goes inside the passage to give security. L2TP does not give secrecy or solid validation independent of alternate sources. Other algorithms such as 3DES and AES128 (Figure 4 & 5) are described as they provide encryption.

Due to the universal appeal IoT is incorporated with Cloud computing, because of the amount of data IoTs could generate and their requirement to have the freedom of virtualization and storage capacity. Ability to create smart applications is balanced by security as it is the main concern in Cloud computing [1]. In this paper was present a novel solution paradigm for secure communication links between IoT devices and application servers in the cloud.

In Section II we present literature review of existing security techniques. In Section III we introduce the paradigm of IoT Security using L2TP as the initial protocol and we present the base architecture. In Section IV we present the results and analysis present a way of integrating components; Cloud platforms, Cloud infrastructure and IoT middleware. We identify the future work and finally conclude in the last two sections.

## **II. Literature Review**

Users expect that their data is protected from external sources from malice. In [2] notion of Probabilistic Yoking Proofs (PYP) performance metrics of cost, security, and fairness are stressed. The proposal combines the message format with incremental sampling process dictated by Poisson where there is rate of change of metrics. Further in other work, IoT devices gathered data from different instruments and send the data to the controller in plain format. We hence prefer star topology as used in traditional ISP server. In [3], IoT and Cloud Computing is integrated using COTS to enable privacy preservation. Here proxying IoT using VPN is considered effective and we further extend the concept of simple cryptographic techniques using two authentication techniques and adapt L2TP parameters to enable a cost effective as well as time effective implementation.

The Cloud environment is based on virtual machines and virtual infrastructure, it can be provided by standard internet protocols. The communication leads data transfer and applications work between the users and Cloud. Communication with in VMs are also taking place on logical network which is places on physical network. Single physical machine is hosting multiple VMs and using different ports to distinguish traffic among them.

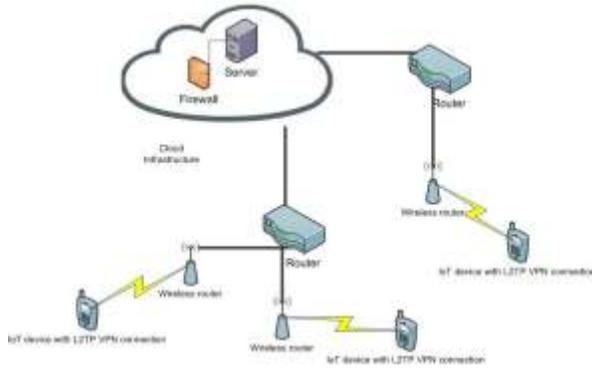


Figure 1 Cloud and TWO IoT Device based Framework to enable security protocols over VPN.

The physical layer cannot determine the threats present in the virtual network, thus it becomes extremely challenging to inspect and detect abnormal activities of the virtual machines. Firewalls and antiviruses deployed on virtual networks help overcome such situations and observe traffic patterns to find anomalies in the system. Traffic flooding and Denial of Service (DoS), spoofing and sniffing of virtual network. The traffic rates are monitored for the detection of malicious content [4].

### a. Security in IoT via Cloud service

The records within the Cloud is a good deal extra liable to danger in terms of confidentiality, integrity, and accessibility in comparison to the conventional computing version [5]. The growing numbers and users are indication towards greater risk and security breaches. To secure data for IoT and Cloud, VPN technology is becoming more and more popular as it isolates the infrastructure that is already in Cloud from unknown attackers.

To protect the correspondence and system, the CSA (Cloud Security Alliance) rules prescribe the utilization of mixture of virtual LANs, IDS, IPS, and firewalls to ensure the information in travel. The rules additionally center around spillage of client's information because of a virtual system and the utilization of same fundamental foundation. The CSA suggests the utilization of previously mentioned devices with strict access administration approaches. The CSA has permitted utilization of virtual gadgets and traditional physical gadgets with snug coordination with the hypervisor to guarantee perceivability and checking of movement over the virtual system [6].

## III. System Model

The star topology system architecture is shown in Figure 1. Here the services rendered are as described in RFC 2661. Specifically we use authentication and encryption without the use of IPsec. Connection oriented architecture assume a remote smart phone which established a PPP connection across the PSTN Cloud to an LAC. The LAC then tunnels the PPP connection across the Cloud server to an Node Server which provides authentication, and access as well as accounting by home

smart phone's Management Domain.

We configure the Cloud firewall, and configure L2TP VPN, to measure our success using various time instances as our metric. In today's world, three of the most important things in networking are security, time and business continuity; we looked at three of those metrics to implement this experiment.

### a. Configuring Devices:

In this experiment following devices/machines are used.

#### i. Firewall:

A firewall is deployed on the Cloud, with three interfaces. We used two of them.

One is LAN interface Port A, which we would be able to ping

Other is port B for WAN IP masking.

With interface Port A, we have connected a virtual machine that is communicating with the IoT devices for testing purpose.

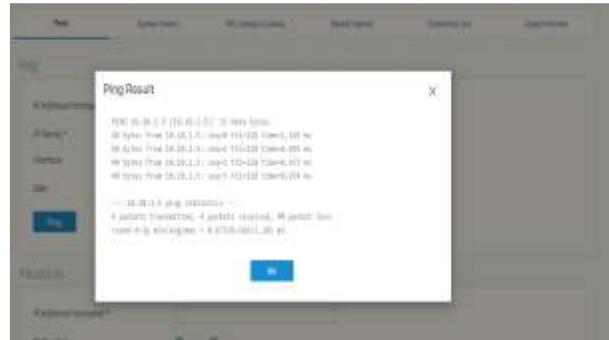


Figure 2 Ping response from firewall to machine (cloud)

The ping response is shown in Figure 2. The simple technique is sufficient to quantify the effect of the slow L2TP implementation.

### b. Encryption Techniques:

During the authentication, there are two phases and in both phases encryption and authentication takes place with given algorithms:

**Table 1 Configuring Authentication - Phase I**

Phase I configuration parameters		
DH Group	Encryption	Authentication
DH1024	3DES	SHA1
DH1024	3DES	MD5
DH1024	AES128	MD5

**Table 2 Configuring Authentication - Phase II**

Phase II configuration parameters		
DH Group	Encryption	Authentication
DH1024	3DES	SHA1
Dh1024	3DES	MD5
DH1024	AES128	MD5

### 3DES:

Triple information encryption algorithm turned into DES make it tougher to decrypt, 3DES increases the important thing length of DES i.e fifty six-bit by using algorithm 3 times with 3 exclusive keys. The combined key size now emerged as 168-bit.

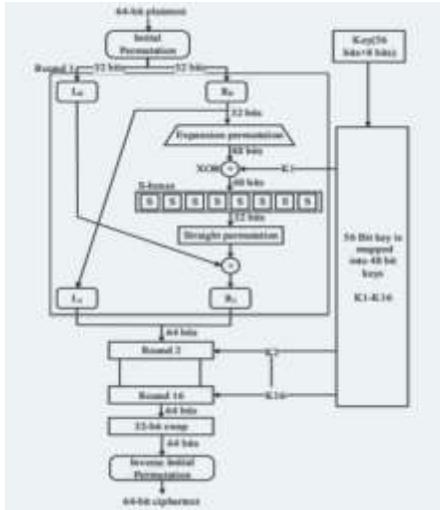


Figure 3 The working of 3DES logical [7]

### AES128:

Any combination of data (128 bits) will be supported by AES algorithm. Key length of 128, 192, and 256 bits used. This is referred to as AES-128, AES-192, or AES-256 (depending on the key length). During the process of encryption decryption, AES system goes through 10 rounds for 128-bit keys, 12 rounds for 192-bit keys, and 14 rounds for 256-bit keys to deliver final cipher-text or to retrieve the original plain-text [8].

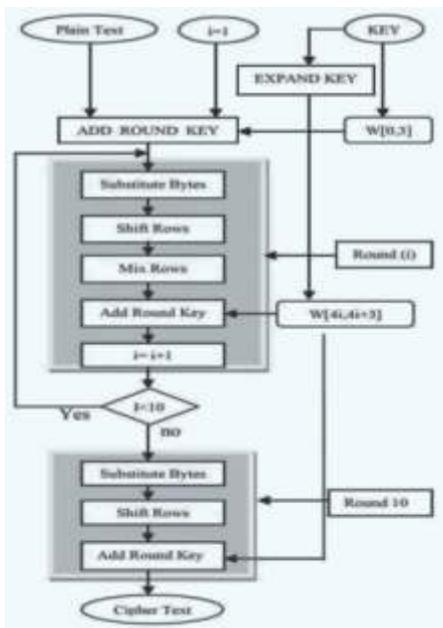


Figure 4 Working principle of AES logical flow

Figure 3 and Figure 4 show the key generation authentication is a flow based process which is fed back to the iterative loop encrypting and decrypting alternatively for asymmetric networks like those based on IoTs.

### IV. Results and Analysis

To measure time in this experiment we used Packet internet groper (PING), verifying that no firewalls were implanted and by going directly to the server we were getting the mean time of PING 252 ms. But after the VPN configuration, the mean time reduced to 140 ms. So, by using VPN we are saving 112 ms or nearly 45% and the data is encrypted and secured with the help of L2TP protocols. This method helps the data to be secure as well as fast using known technique (3DES, VPN).

We also initiated the speed test and use trace route to detect that no external intrusions were traced during the time of deployment.

After deployment Figure 5 shows the logical diagram resulting from this experiment,

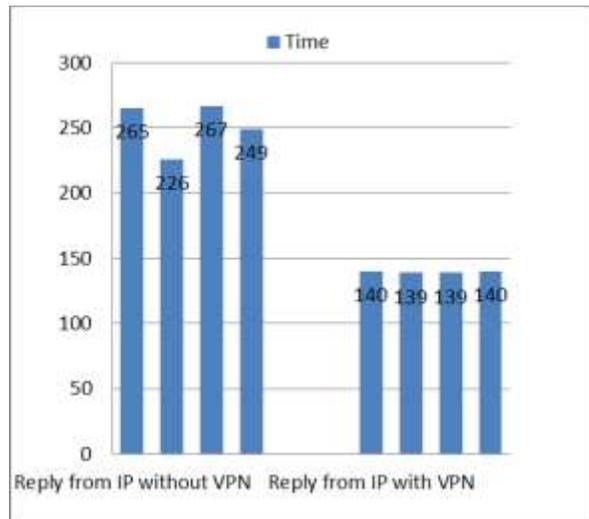


Figure 5 Comparison of the reply from IP with and without VPN, demonstrating the stability of VPN.

#### a. Analyses:

L2TP protocol is an open source connection oriented protocol which does not require third party application to implement. Additional algorithms are used with the implementation to make the connection secure such as 3DES. The old version protocols such as PPTP (Point to Point Tunneling protocol) were proprietary and now obsolete to work on. This method can be used in the service sector organization and business continuity is required such as the banking sector can use this method in its day to day services which can lower the time frame of data communication and enhance the security for their customers. The L2TP makes fewer nodes which results the packets to transfer towards the destination in less time than usual. This also makes the data transfer secure as the tunnel is single way process and no outer interference can occur.

## b. Future Works

Apart from the L2TP protocol, the IPSec technology can also be used in the connectivity between the Cloud firewall and the devices, which may further enhance the results. The results however are not very different from the expected. We used Apple Iphone, which only supports L2TP for VPN technology. Other 3<sup>rd</sup> party applications can also be used in the process to perform the same experiment with different protocols.

## V. Conclusion

The geographical spread of the Cloud technology has raised many security issues to all users individual or organizational. A novel method for authentication and accountability to prevent IDS (Intrusion Detection System) was presented which has enhanced the outcome to a greater extent. Irrespective of the fast data rate acceleration of each technology the security issue must be solved or decreased to a minimal to attain a better integration model. A model is proposed which saves time, and makes data secure by using the L2TP protocol via Cloud to serve IoT devices. The financial sector, commercial markets and other service industries can take advantage to this service. It is expected to see multiple L2TP and integration with IPSec as future work. With the proposed changes, belief between customer and the organization can again be enhanced.

## References

- [1] D. AB. Fernandes, Security issues in Cloud environments: a survey, *Int. J. Inform. Sec.* 13 (2) 2014, pp. 113–170.
- [2] Christos Stergiou, *Secure integration of IoT and Cloud Computing*, Elsevier, 2016
- [3] MR. Schurgot, “Experiments with security and privacy in IoT networks”, *IEEE*, 2015, pp. 4.
- [4] N. Gonzalez, A quantitative analysis of current security concerns and solutions for Cloud computing, *J. Cloud Comput.*, 2012, pp. 1–18.
- [5] R. Latif, *Cloud computing risk assessment: a systematic literature review*, in: *Future Information Technology*, Springer, Berlin, Heidelberg, 2014, pp. 285–295.
- [6] Cloud security alliance, *security guidelines for critical areas of focus in Cloud computing v3.0*, 2011
- [7] Ajay Kakkar, M. L. Singh and P.K. Bansal, "Comparison of Various Encryption Algorithms and Techniques for Secured Data Communication in Multinode Network", *International Journal of Engineering and Technology*, Volume 2 No. 1, pp. 87-92, January 2012.
- [8] Mr. Gurjeevan Singh, Mr. Ashwani Singla and Mr. K S Sandha, "Cryptography Algorithm Comparison for Security Enhancement in Wireless Intrusion Detection System", *International Journal of Multidisciplinary Research*, Vol.1 Issue 4, pp. 143-151, August 2011.
- [9] Akash Kumar Mandal, Chandra Parakash and Mrs. Archana Tiwari, “Performance Evaluation of Cryptographic Algorithms: DES and AES”, *IEEE Students' Conference on Electrical, Electronics and Computer Science*, pp. 1-5, 2012.



# Internet of Things over LTE/LTE-A Network

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## Abstract:

In these days Long Term Evolution (LTE) and Long Term Evolution Advance (LTE-A) both are prominent technologies in respect of Internet of Things (IoT). As far as power saving requirement for IoT devices LTE, LTE-A also provide mechanism to turn off receptions and go to sleep when no data need to be received or transmitted. LTE and LTE-A also provide Quality of Services and perfect robustness. Internet of Things (IoT) might be joined in straightforwardly and consistently an extensive number of various and heterogeneous end framework while giving open access to choose information for improvement of digital services.

**Keywords-** IoT, LTE, LTE-A, Services

## I. Introduction

The Internet of Things is the network of objects or “physical things” which are fixed to a network or with any electronic device, computerized software, antennas/sensors and connectivity to enable it to perform big service by communicating each other (with other connected devices). Everything which is identifiable uniquely in internet communication system and each thing is able to communicate to another thing within Internet infrastructure.

Current performance along with history is described in below diagram clearly.

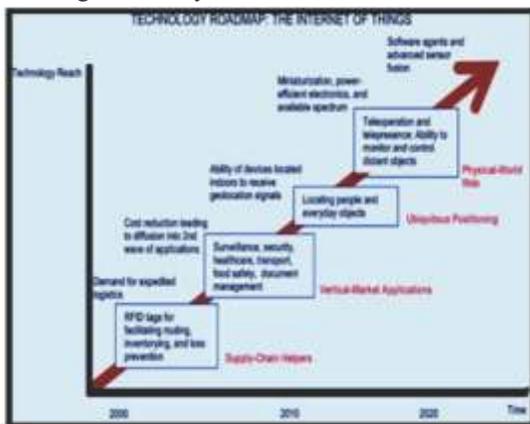


Figure.1: Roadmap of Internet of Things (IoT) [1]

The term “IOT” or Internet of things was first documented in 1999 by a British visionary, Kevin Ashton. Initially, Internet of Things is supposed to offer communicating

connectivity of different systems and devices. Which is somehow we say it is more than machine-to-machine communications (M2M). [2][3]

Wireless system can be classified in two as far as high speed mobile wireless access services are concerned. LTE- A is anticipated that would target considerable change in gashly productivity and lessening in latency.<sup>[12]</sup> Now in the IoT prototype, lots of objects that are present with us continuously on the network in form or other. In the result bulky amount of data are generated which is obviously required to stored, then process and present in uninterested efficient form. The evolution towards information and communication is evident for the demand of Wi-Fi and 4 G-LTE wireless internet accesses. The achievement for continuous connectivity is succeeded with the help of Internet of Things (IoT)[4].

There are lots of merits of IoT but many hurdles are available in aforementioned topic point. IoT is similar to a heterogeneous end framework. Such a heterogeneous field of utilization makes the recognizable proof of arrangements satisfying the specific difficulties[5][6].

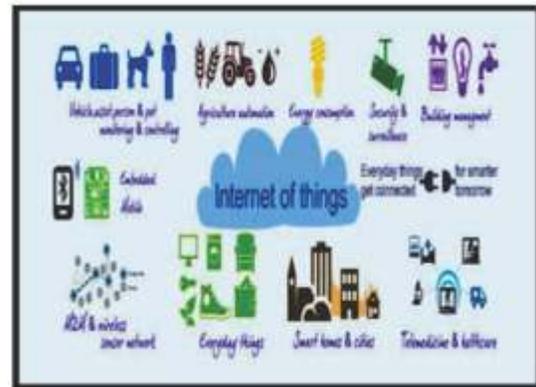


Figure.2. Internet of Things (IoT)[7]

## a. Objective

Give a review of network architecture that will bolster LTE-and LTE advanced air interface.

## II. Background

### A. IOT Data Handling

In traditional data management system, the system manage the storage, retrieval and update of data items, files and others elementary records. As far as IoT is concerned data handling must concise and data online while provide storage. This increases the idea of data handling from offline storage, query processing[8].



Figure.3. Internet of Things (IoT) [10]

### B. IoT Data Lifecycle

The lifecycle of data within an Internet of things, the information continues from information generation to aggregation, optional filtering, exchange and pre-processing, and then at long last to capacity and filing. Examination and questioning are both the end focuses that start and expend information generation, however creation of information can be set to be pushed to the Internet of things administrations of consuming. Accumulation, Production, total, separating the information and some other essential preparatory and questioning handling usefulness are viewed as online in IoT framework. A portion of the operations goalmouth at level of making information accessible one for steady get to the long haul, while authentic is worried with read just information. Since some Internet of Things frameworks may produce, store and process the information in system for constant [11][12][13].

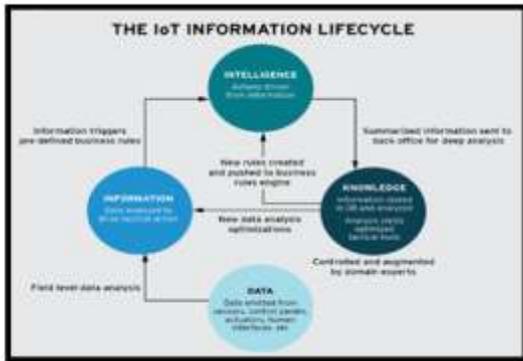


Fig. 4. Internet of Things (IoT) information life cycle [14]

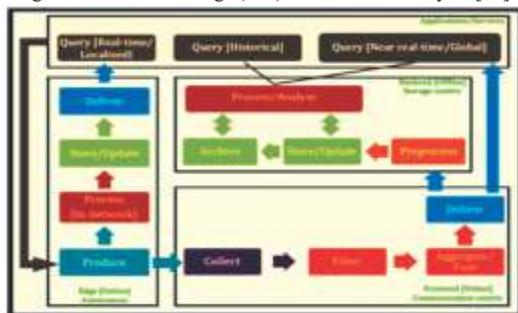


Figure.5. IoT purposed data lifecycle and data management system [14]

### C. Querying

As querying is the core process to access any kind of data in a system. It is also used for querying as well for retrieving the data and simply data intensive systems are relied on querying [15].

### D. Production

Data production process in IoT's system is exchanging or trading the information from one node another or any sort of machine to machine (M2M) correspondence and detecting. As time is most important factor correspondence. So information is normally time stamped and at some point conceivably geo-stamped [16][17].

### E. Aggregation

Data aggregation process in IoT's framework is, transmission of the all raw data in real time out of the network.<sup>19</sup>

Which is always sanctioned expensive? Especially when the given data are so huge and the available bandwidth are so limited. Fusion & aggregation are both techniques which are deploy to merge operations in real time. These both techniques perform the compress to the data volume for storage and transmission purposes [18].

### F. Delivery

Finally at the delivery point after fusion & aggregation data filtered and this possibly can either on at the autonomous virtual channel/units or at the any concentration points within the Internet of Things systems. For transferring of data for permanent data stores, there can be used any kind of broadband communication connectivity either Wired or wireless [17].

### III. Literature And Review

The next generation network (NGN) could be another build and changing into progressively and a considerable measure of fundamental for future telecommunication network in this paper indicates five performs layer of NGN plan and talk about some end to end QOS (quality of administration) Issues for NGN (Called NGNQOS). As far as possible layers are 1) Application layer that support SIP (Session Initiation convention) and SIP can be depicted is a convention for correspondence and overwhelming multimedia system communication sessions. In this manner most regular uses of SIP range unit in web media transmission for voice and video calls, further as moment electronic informing wherever web Protocol (IP) systems.

2) Network Management Layer that goes for beating the bottlenecks issues at edge hubs or servers for end to end affirmation control.

3) Adaption layer that supports totally extraordinary system designs and system quality

4) Network Transmission Layer that offers end-to-end

QoS organization for period exchanges through mix Differentiated Service (DiffServ) and Multi-Protocol Label change (MPLS).

(5) Management Layer that gives Web-based GUI program to information presentation, checking, modification and higher subjective process in NGN. [18].

In 1998 Telecomm configuration started to concentrate on a coming era of a system that could be change the present phone arranges. The future in telecomm association move towards a break between the system supplier and specialist co-op [18].

This development is less cost and propels the capacity of system to bolster current administrations and applications and edge of media issue and communication network.

The essential development which is required to appear at noteworthy change in the correspondence market is the modification from circuit change media transmission system to package based framework using the web protocol. The general Plan behind the NGN is wherever in which one framework sends all information besides associations (voice, information, Video) by exemplifying these into parcels the NGN is a package based Network which can make organizations including Telecommunication Services and Can Produce of Multiple Broadband Quality of organization allowed send propels which advantage related Purposed are autonomous. [19]

The client hope to utilize at least one administrations that give by administration verification (i.e who is utilizing) Authorization (i.e. the client would have an authorization to utilize the administration or not). The hardest Challenges in the NGN will give validation and Authorization administrations when wandering is need so the client would be confirmed or approved to change the system on the fly.

The next section defines and briefly the need for information and the communication innovation (ICT) administrations, that is determine above. This paper gives a backdrop for determining the predict market tendency and their implication for the regulator. The final section finishes with guidance and submission for the future research.

Of a particular salient to for the next generation network are the proceed topics in the area of software described network (SDN), network, virtualization, security, application, cloud, services also the numerous important issues are accomplish next generation [20].

NGN conference at IEEE ICC 2015 important to combine and upgrade the new improvement and development rising center ranges. This conference also participation and invites for both academic and industry research doing in the area of next generation network technologies such as services, Architecture, protocols. This paper gives inside and out read on the innovations being considered for Long Term Evolution-Advanced (LTE-Advanced). In the first place, the movement from third era (3G) to fourth

era (4G) is delineating as far as execution needs and fundamental attributes.

The new determination created by the Third Generation Partnership Project (3GPP), that supports the mixing of present and future radio get to technologies, is highlighted. At that point, the most innovations for LTE-Advanced area unit clarified, next to potential improvements, their related difficulties, and some methodologies that are contemplated to handle that difficulty [21].

Relaying is one more of the climate that is acquainted in LTE-Advanced with support the execution of LTE, regarding scope and out-turn with regards to 3GPP the utilization of transfers can allow the resulting upgrades.

- Offer coverage in new areas.
- Temporary network preparation.
- Cell-edge outturn.
- Coverage of high rate.
- Cluster quality.

These improvements will be delegated "cover age expansion" and "throughput upgrade". Also to the past upgrades, the work of transfers brings the following blessings:

- Cost reduction: the cost of a transfer, independent from anyone else, ought to be not exactly the cost of an eNB, forward that the complexness of a hand-off is a littler sum than the many-sided quality of an eNB. Because of the shortage of a wired backhaul, the arrangement esteem and time should even be decreased, contrasted with an eNB.
- Power utilization lessening: The single-bounce separation between the eNB and therefore the UE is split into 2 distances: the separation from the eNB to the transfer, and the separation from the relay to the UE [22].

Types: Sorts the meaning of a ""sort"" of hand-off, in venture with 3GPP, is done by joining a collection of attributes that a transfer relay should have. The first basic qualities wont to order transfers range unit their duplexing subject, layers, and level of coordination into the RAN. On high of those orders, transfers will contain "additional items" like overhauled MIMO limits, joint effort capacities, etc. the resulting area gives an outline of the groupings of relays [22].

Third Generation Partnership Project (3GPP) a gaggle of telecommunication transmission affiliations working towards the change and support of a global System for Mobile communication (GSM) and also created radio get to advances, has started dealing with long-run Evolution progressed (LTE-Advanced) to accomplish the essentials of bleeding edge improvement. The key destinations for this advancement development square measure raised rate, enhanced range strength, enhanced scope and diminished inactivity. The top comes about of those objectives square measure significantly up administration

provisioning and lessening of administrator costs for different activity circumstance[23]

LTE-A helps in integration the present networks, of cutting edge innovation. The key objectives for this development the escalating user demands. The technical options of LTE-A could likewise be outlined with the word reconciliation. LTE-Advanced are standardized inside the 3GPP determination unharnessed ten (Release ten LTE-An) and can be intended to satisfy the 4G requirements as outlined by ITU. LTE-An as a framework needs to take a few choices into concerns in light of enhancements at each level that includes different quality and difficult execution. Different changes on the physical layer might be relied upon to support larger bandwidths with a great deal of adaptable distributions and to shape utilization of further expanded receiving wire innovations. Coordinated base stations, booking, MIMO, obstruction administration and concealment likewise will require changes on the particular[24].

In this Paper offers a summary of the long term Evolution (LTE) of the Universal Mobile Telecommunication System (UMTS), that is being produced by the third Generation Partnership Project (3GPP). LTE constitutes them obstruct step towards the fourth era (4G) of radio advances proposed to grow the limit and speed of versatile correspondences. Particular thought is given to the requirements and centers of LTE, its use of various radio wire strategies, and to the one Carrier Frequency Division Multiple Access (SC-FDMA) regulation utilized as a part of the LTE transmission. Likewise new future examination square measure as are arranged here[25][26].

A diagram of the LTE and LTE-An is given. The summary focused on the LTE needs and targets, course of events for the LTE preparing, various get to innovation in LTE, MIMO, furthermore the anticipated examination ranges. The paper furthermore examines couple of potential new investigation zones covering cloud radio get to arrange, Multi bounce remote systems, and Resilience and dependableness of LTE with MPLS[27].

The third generation partnership project has been developed (3GPP) standards based on advanced Long Term Evolution (LTE), and the potential for 3 GPP 4G, organize and change the expected wireless technologies and the advancement of the transcendent system. This article provides an overview of the review dedicated to 4G to meet the requirements of the job. The technology elements such as broadband and exchange distances which are being multi-acceptance cables, transmit / separate collection (companies), and exchange, and know the needs of the evolving LTE systems[28].

LTE-Advanced meets the execution needs set by ITU-R for IMT-Advanced and absolute it is an improvement of LTE and not is position structure in itself. Keeping obvious the possibility of in turn around similitude, LTE-Advanced terminals are proposed to have the ability to get to frameworks planned as per the fundamental unleash of

the LTE particulars; furthermore, terminals from the basic LTE unleash will be prepared to get to LTE advanced networks[29].

#### IV. Methodology

The research methodology its addresses several important points, including topic selection research purposes, and previous research on the subject also through collection of information and data by use tools of questionnaires, survey and statistics tables that help in obtaining information and data in find solutions and ways to treat Phenomenon. In this research analyze the 10years previous research papers and articles read and take some main points.

Through the use of quantitative research in the Independence study of the important use of appropriate tools in quantitative research through Mathematical Statistics, data and surveys that give the figures and ratios help to know the extent of the phenomenon and opinions slice search and responders.

The advancement of 3GPP's third era Universal Mobile Telecommunication System (UMTS), the essential broadband CDMA development, starting from its basic unleash in 1999/2000. There are groupings of different landings of UMTS, besides the development of High Speed Down connection Packet Access (HSDPA) in unleash five presented in the casually named three .5G. The resulting extension of the improved Dedicated Channel (E-DCH), higher famous as High Speed transmission Packet Access (HSUPA), completed three. 5G. the mix of HSDPA and HSUPA is at present alluded to as High Speed Packet Access (HSPA). LTE connected with the circulation of the discharge eight judgments in 2008 and LTE-Advanced is being introduced as a bit of unleashed ten. The LTE-Advanced radio get to arrange (RAN) sensibility is needed to be for all intents and purposes cemented by December 2010.

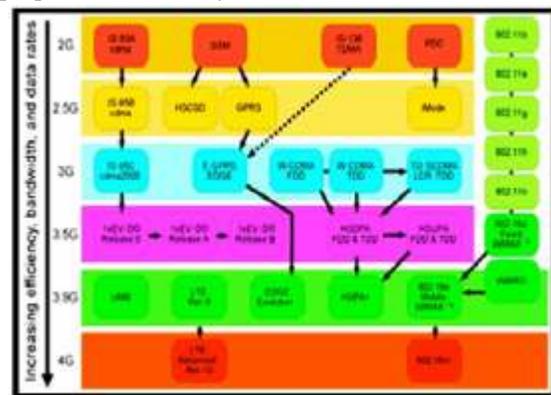


Figure.6. Efficiency of bandwidth with data sets

#### V. Sampling

Researcher tries to access to research samples close to him such as software houses, universities franchise communications offices , academics and different views on the subject of research and the extent of the

phenomenon in the country and within the means available. In order to overcome the negative results and focus on the positive results, may lead to the development of the telecommunications industry in the country and encourage investors in the field of telecommunications and software and inventors that can have an important role in reducing unemployment and improving the technological industries, especially telecommunications and software application. The sample size is 15; they filled the questionnaires I have been given. So mostly they are in telecommunication companies such as Mobilink, Zong, Telenor, Warid etc. samples representative collect the largest amount of information through statements and interviews and survey research taking information that contribute to the development of a hypothesis and theory research in terms of potential impact of Next Generation Network (NGN) in the field of telecommunications and the extent of social acceptance of such researcher trying to collect information on the research sample representative valid and appropriate that can be broader representation of all the people and the development of the theory of searching through information derived.

**A. Primary Research**

At the stage of primary data collection research using data collection methods through tools of Statistics such as questionnaires respondents samples that are filled questionnaires then return it, researcher to obtain private data and the original distribution of the research and also by conducting press interviews that contribute to obtain information and data, and through Find used in the surveys that are more stresses of interviews and are typically used to collect the large number of population responses.

**B. Secondary Research**

Secondary Research depends on the qualitative approach in the search through the collection of the above information for research in similar research from books, documents, magazines, research articles and internet for previous data contribute to the reinforcement Research and get the comparisons with Search, Secondary research relied on Google Universal site for the enormous scientific wealth through previous theories in the same search, and that has credibility and stability, as well as a Institute Of business and technology library and to ensure that wrote the value of such Business laws information management system computer sciences.

**Q1. General**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Male	15	100.0	100.0	100.0

**Q2. Occupation**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Telecommunication	10	66.7	66.7	66.7
Software	3	20.0	20.0	86.7
Engineer	2	13.3	13.3	100.0
Total	15	100.0	100.0	

**Q3. LTE standard is developed by**

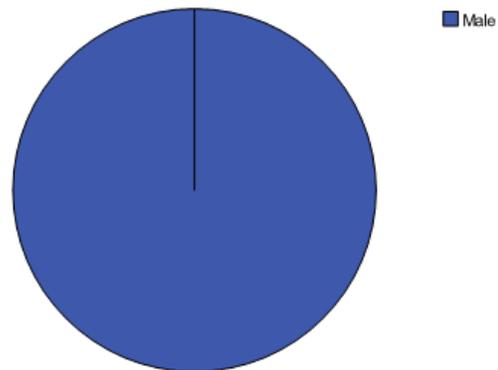
	Frequency	Percent	Valid Percent	Cumulative Percent
Valid ITU	1	6.7	6.7	6.7
IEEE	2	13.3	13.3	20.0
3GPP	12	80.0	80.0	100.0
Total	15	100.0	100.0	

**Q10. The radio interface is switched**

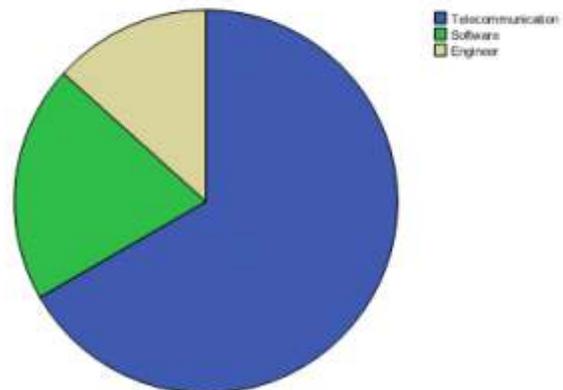
	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Packet Switch	14	93.3	93.3	93.3
Both	1	6.7	6.7	100.0
Total	15	100.0	100.0	

**Pie Chart**

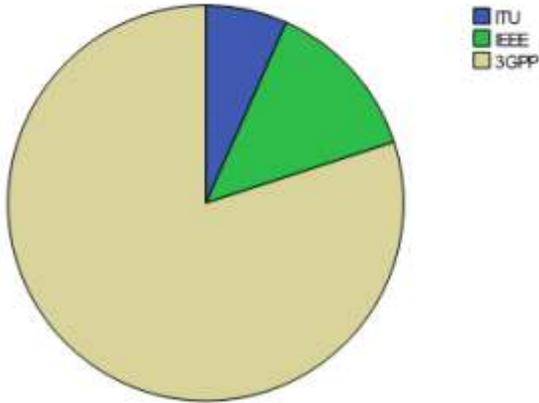
**Q1.General**



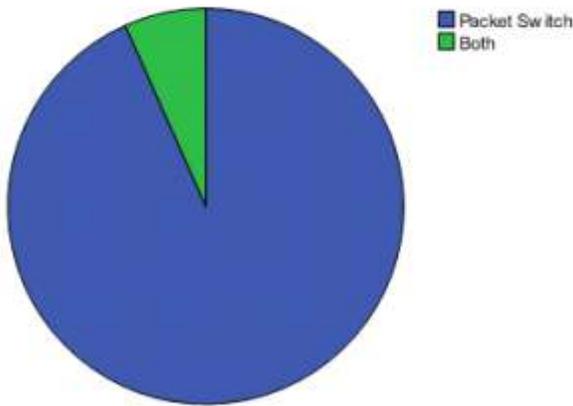
**Q2.Occupation**



Q3.LTEstandard.is.developed.by



Q.10.The.radio.Interface.is.switched



## Regression Table and Hypothesis

### C. Nominal Regression

Case Processing Summary

		N	Marginal Percentage
Q2. Occupation	Telecommunication	10	66.7%
	Software	3	20.0%
	Engineer	2	13.3%
Q10. The radio interface switched	Packet Switch	14	93.3%
	Both	1	6.7%
Valid		15	100.0%
Missing		0	
Total		15	
Subpopulation		2 <sup>a</sup>	

The dependent variable has only one value observed in 1 (500%) subpopulations

### Model Fitting Information

Model	Model Fitting Criteria -2Log Likelihood	Likelihood Ratio Tests		
		Chi-Square	Df	Sig-
Intercept Only	6.017			
Fuel	5.170	-846	2	-.655

Parameter Estimates

	B	Std. Error	Wald	df	Sig.	Exp (B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Q2.Occupation <sup>a</sup>								
Telecommunication Intercept	17.278	3572.253	.000	1	.996			
[Q.10.The.radio.Interface.is.switched=2]	-.774	3572.253	.000	1	.996	1.41E-7	.000	-
[Q.10.The.radio.Interface.is.switched=3]	0 <sup>c</sup>	-	-	0	-	-	-	-
Software								
Intercept	.405	.913	.197	1	.657			
[Q.10.The.radio.Interface.is.switched=2]	.000	.000		1		1.000	1.000	1.000
[Q.10.The.radio.Interface.is.switched=3]	0 <sup>c</sup>	-	-	0	-	-	-	-

3. The reference category is: Engineer.

b. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

c. This parameter is set to zero because is redundant.

Hypothesis: According the analysis the result shows that the technology is showing a better impact as peri scribe

### D. Data Management Framework for IoT

In working scenario proposal for data handlings are preferred to WNS, the more sophisticated characteristics of Internet of Things is not to explicitly address. It is also one of the main functionality of the global IoT space. Therefore the proposed framework has a layer approach that sources centric middleware and centres on data

### VI. Result and Discussion

Proposed IoT data handling consists of some basic stacked layers namely as Data layer, Things layer, The Communication Layer, Source layer Federation Layer, Query Layer and Transactions Layer.<sup>18</sup>

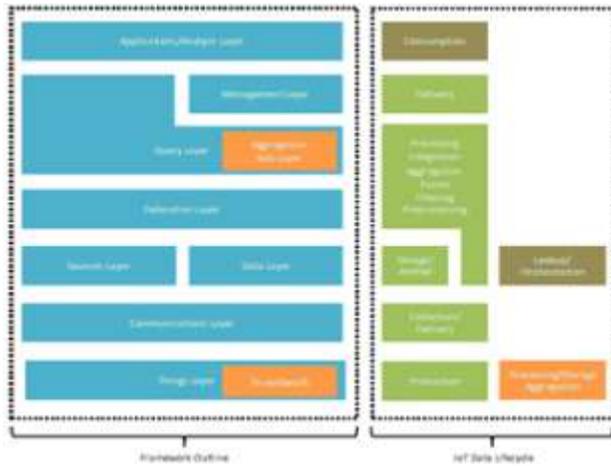


Figure.6. Outline of the proposed IoT data management framework and mapping of its layers to the IoT data lifecycle[29]

### A. Data Layer

Data layer is the main and core layer of system of IoT data handling. This layer has all Data handling responsibility. During the procedure of data handling there are some problems to be addressed in IoT handling.

### B. Things layer

Things layer can be any device i.e. cell phone/mobile phones, computer laptop, or any sensor device that has capacity of communication to other devices.

### C. The Communication Layer

The communication layer functionality is to connect data sources and distributed data sources to more concentrated data storage and to processing unit.

### D. Source Layer

The source layer is the system which is design to show data systems that metadata store the locations of data fragments beforehand for purposes of querying or update.

### E. Federation Layer

As federation layer is middle or central framework of IoT's structure. The main function of federation layer is to provide the structure that joins broadcast Internet of Things sub-systems and data sources together to form a globalized view of the IoT systems.

### F. Query Layer

The obligation of question layer is to exemplify the components of important for producing the inquiries, streamlining the current inquiries and executing inquiries of the Internet of Things (IoT's) database. It is sent both at the nearby and united levels. To being administering the subsystems conveyed by individual associations.

### G. Transaction Layer

The transaction layer deals with all the execution of questions and information that are identified with IoT system and IoT services. Depending upon the kind of inquiries and information execution handle given by IoT

system to exchange layer, it can send either a solitary source/established execution technique, or it can convey disseminated or worldwide execution instrument.

## VII. Conclusion

LTE-Advance touches the execution requirements set by IMT-Advance and inside and out. It is a development of LTE and not another framework in itself. In above cited subject we discussed about something about IoT and information data handling of system for the Internet of Things. LTE-Advance terminals are intended to have the capacity to get to systems worked by first arrival of the determinations. To compensate for storage, the comprehensive IoT components i.e. data handling framework with core data & support for federation layer and source layers.

## References

- [1] Iotjournal.weebly.com/upload/1/8/8/0/188809834/ieee\_iot\_journal\_si\_iot\_over\_lte\_cfp\_final.pdf
- [2] AnuradhaBasu Bharti Vidyapeeth's College of Engineering Delhi, India "LTE Advance: The 4G Mobile Broadband Technology"S
- [3] UpkarVarshney and Radhika Jain "Issues in Emerging 4 G Wirless 4G Wireless Networks"
- [4] Mervat Abu-Elkheir, Mohammad Hayajneh and Najah Abu Ali " Data Management for the Internet of Things: Design Primitives and Solution.
- [5] Figure # 2, <https://datasciencebe.files.wordpress.com/2014/11/internet-of-things.jpg>
- [6] Chae-Sub Lee, Dick Knight, "Realization of the Next-Generation Network," IEEE Communications Magazine, pp. 34-41, Oct. 2005.
- [7] Figure # 1, [http://en.wikipedia.org/wiki/Internet\\_of\\_Things#/media/File:Internet\\_of\\_Things.png](http://en.wikipedia.org/wiki/Internet_of_Things#/media/File:Internet_of_Things.png)
- [8] Figure # 4, <https://gigaom.com/2014/10/28/the-information-life-cycle-for-the-internet-of-things/>
- [9] Review- Data Management for the Internet of Things: Design Primitives and Solution, © 2013 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license
- [10] Review- Data Management for the Internet of Things: Design Primitives and Solution, © 2013 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license
- [11] Wu, G.; Talwar, S.; Johnsson, K.; Himayat, N.; Johnson, K.D. M2M: From mobile to embedded

- internet. *IEEE Commun. Mag.* 2011, 49, 36–43.
- [12] Cooper, J.; James, A. Challenges for database management in the internet of things. *IETE Tech. Rev.* 2009, 26, 320–329.
- [13] Kopetz, H. *Real-Time Systems: Design Principles for Distributed Embedded Applications*, 2nd ed.; Springer: Berlin, Germany, 2011.
- [14] Kopetz, H. *Real-Time Systems: Design Principles for Distributed Embedded Applications*, 2nd ed.; Springer: Berlin, Germany, 2011.
- [15] Han, S.H.; Kim, Y.K. An Architecture of Real-Time, Historical Database System for Industrial Process Control and Monitoring. In *Proceedings of First ACIS/JNU International Conference on Computers, Networks, Systems and Industrial Engineering (CNSI 2011)*, Jeju, Korea, 23–25 May 2011; pp. 31–34.
- [16] Zheng, Q.; Bi, X. An Improved Concurrency Control Algorithm for Distributed Real-Time Database. In *Proceedings of IEEE International Conference on Advanced Management Science (ICAMS)*, Chengdu, China, 9–11 July 2010; pp. 364–367.
- [17] -Crétaux, J.F.; Jelinski, W.; Calmant, S.; Kouraev, A.; Vuglinski, V.; Bergé-Nguyen, M.; Gennero, M.C.; Nino, F.; Rio, R.A.D.; Cazenave, A.; Maisongrande, P. SOLS: A lake database to monitor in the near real time water level and storage variations from remote sensing data. *Adv. Space Res.* 2011, 47, 1497–1507.
- [18] Liu, Z.; Lin, D. Embedded Real-Time Database System Concurrency Control Protocol A-Based FDA. In *Recent Advances in Computer Science and Information Engineering*; Qian, Z., Cao, L., Su, W., Wang, T., Yang, H., Eds.; Springer: Berlin/Heidelberg, Germany, 2012; pp. 461–466.
- [19] Barker, K.; Askari, M.; Banerjee, M.; Ghazinoor, K.; Mackas, B.; Majedi, M.; Pun, S.; Williams, A. A Data Privacy Taxonomy. In *Lecture Notes in Computer Science: Dataspace: The Final Frontier*; Sexton, A., Ed.; Springer: Berlin/Heidelberg, Germany, 2009; pp. 42–54.
- [20] Atzori, L.; Iera, A.; Morabito, G. The Internet of Things: A survey. *Comput. Netw.* 2010, 54, 2787–2805.
- [21] A. Mihovska, F. Meucci, N.R. Prasad, F.J. Velez, O. Cabral, Multioperator resource sharing scenario in the context of IMT-Advanced systems, in: *Proc. Second Int. Workshop Cognitive Radio and Advanced Spectrum Management CogART 2009*, 2009, pp. 12–16.
- [22] I.H. Kim, K. Lee, J. Chun, A MIMO antenna structure that combines transmit beamforming and spatial multiplexing, *IEEE Trans. Wireless Commun.* 6(3)(2007)775–779.
- [23] S. Songsong, F. Chunyan, G. Caili, A resource scheduling algorithm based on user grouping for LTE-Advanced system with carrier aggregation, in: *Proc. Int. Symp. Computer Network and Multimedia Technology CNMT 2009*, 2009, pp. 1–4.
- [24] S. Parkvall et al. “Evolving 3G Mobile Systems —Broadband and Broadcast Services in WCDMA”, *IEEE Communications Magazine*, February 2006.
- [25] E. Mino Diaz, et al., “The WINNER project: Research for new Radio Interfaces for better Mobile Services”, *IEICE Transactions*, Japan, Vol. E87-A, No. 10, October 2004
- [26] Hyung G. Myung, Junsung Lim, and David J. Goodman, “Single Carrier FDMA for Uplink Wireless Transmission”, *IEEE Vehicular Technology Magazine*, vol. 1, no. 3, Sep. 2006, pp. 30–38
- [27] H. Ekström, A. Furuskär, J. Karlsson, M. Meyer, S. Parkvall, J. Torsner, and M. Wahlqvist, “Technical Solutions for the 3G Long-Term Evolution,” *IEEE Commun. Mag.*, vol. 44, no. 3, March 2006, pp. 38–45
- [28] Y. Yang, H. Hu and J. Xu, G. Mao, 2009, “Relay Technologies for WiMAX and LTE-Advanced Mobile Systems,” *IEEE Comm. Mag.*, vol. 47, no. 10. Pp. 100-105, Oct. 2009
- [29] S. Parkvall, E. Dahlman, A. Furuskär, Y. Jading, M. Olsson, S. Wanstedt, K. Zangi, 2008, “LTE Advanced – Evolving LTE towards IMT-Advanced”, *Vehicular Technology Conference, VTC 2008-Fall*. pp. 1-5, Oct. 2008.



# Social Network YouTube a Source of Earning

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## Abstract:

When people arrive on the internet world the lots of opportunities to earn online money are waiting for them some of them are Freelancing, Affiliate marketing, Blogging, Youtubing and so on. The outstanding and investment free option to earn online money is from YouTube. It is the simplest process to be got paid by sitting at home. This paper presents the complete procedure to earn money from world's second largest social networking site YouTube, I will explain that how I started my YouTube career and after one and a half year how much amount I earned from YouTube, the complete analytics report will be shown in the results section. Results show that peoples can use YouTube as a full-time job.

**Keywords**—Social Network, Online Earning, Youtube.

## I. Introduction

Social Networks helps social actors to share their ideas, knowledge information and other activities on virtual communities. By these networks, millions of users connect with other user's profiles or with global communities [1].

Social Networking Sites are the most powerful and progressive part of the digital world. An enormous amount of users daily search different kind of content over the internet so how can we take advantage of these Social Networking Sites and what are the finest procedure to make money from these sites. In this paper, I will serve the complete procedure to make a massive amount of money from the second world's largest social networking site YouTube. Networking sites are the backbone of the World Wide Web, these sites enable billions of users to link with each other. On the internet there are many opportunities are available to make online money but this paper mainly focuses on YouTube.

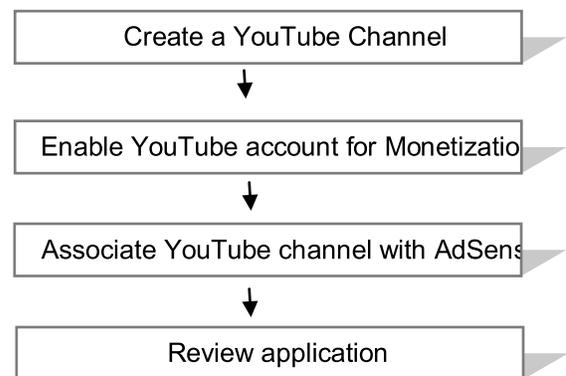
YouTube is one of the world's largest video sharing platforms, where videos are uploading continuously by the millions of users [2]. You will be surprised to know that top YouTube celebrities use their channels as a full-time job because from their youtube account they generate a huge amount of money. A world's famous youtuber PewDiePie earn million dollars per year, likewise countless Pakistani content creators' upload their content videos o social network site YouTube and generate revenue. YouTube provides a platform to their creators to monetize their videos by YouTube Partnership Program. Video producers can generate a handsome amount of revenue from advertisements served on their video content [3]. Even every person can earn money

online without investment by publishing videos on their YouTube channel account. This paper presents the complete guide that how can anyone use YouTube as a source of earning and how he or she get paid by sitting at home.

## II. Youtube a Source of Earning

### A. Setup YouTube and AdSense account

When you start a career on YouTube as a fundamental theme of earning or as a source of business income one thing that comes in your mind is "when my earning will start". After enabling your YouTube channel account for monetization and associate it with AdSense and bringing audience traffic to your content videos, once your channel earning score elapse Google payment threshold your channel's earning will start.



1) *Create a YouTube Channel*: Signup with Youtube by adding your personal information, you can also use your Gmail account. Sign in to your Youtube account and from right top corner click on your profile icon and create a channel, fill out all the information and verify it by your mobile number, congratulations you have done now add channel profile picture and channel art.

2) *Enable YouTube Account for Monetization*: The next step is to enable your channel for displaying Ads and it will be possible by enabling the monetization option, and this option is available in status and features option, go to the creator studio and click on the channel tab here you will find option of monetization and you have to enable it. It will require an AdSense account so signup with AdSense.

3) *Associate YouTube Channel with AdSense*: AdSense account is mandatory for receiving the payment and generates revenue from YouTube videos. After enabling monetization it is necessary to connect your AdSense account with your channel because AdSense keeps the

track of your channel's earning that you can withdraw when your revenue passes payment threshold.

4) *Review Application:* YouTube team reviews your application when your channel reaches up to 1,000 subscribers and 4,000 watch hours in order to check that either your channel follows YouTube terms and conditions or not and when the process completes they will inform you through an email that now your videos are eligible to generate revenue from suitable Ads.

## B. Publishing Your Content on YouTube

The process of video publishing might seem a difficult task but when you did it once, you will observe that, it is a very easiest process. Every month more than 1.5 billion peoples watch YouTube videos; this is the reason that publishing videos can give you a rewarding experience [4]. Video uploading requires a few steps.

- Log in to your YouTube account
- At the top right click the Upload button
- Choose the privacy option for your video

Video Characteristics	Privacy	Public	Unlisted	Private
URL sharing		Yes	Yes	No
Added to the channel section		Yes	Yes	No
Shows in recommendation		Yes	No	No
Uploaded on your channel		Yes	No	No
Go notification to subscribers		Yes	No	No

Table.1. Types of Video Privacy

- Select video from your laptop or mobile that you want to upload.
- Add basic information like title, tags, and description.
- When uploading is done click on publish
- Share your videos on multiple networking sites to create backlinks.

## C. Follow YouTube Partnership Terms and Conditions

Here is the list of YouTube community guidelines that will help you to save from trouble, follow these guidelines seriously.

- Don't upload nudity content
- It's not good to upload abusive videos
- Don't upload harmful or dangerous content
- YouTube doesn't allow hateful and violent content
- Everyone hates spam so avoid spam content videos
- Only upload authorized videos, don't use other's content

## D. Follow AdSense Terms and Conditions

It is necessary for all creators to adhere to AdSense program policies if you do not follow these rules your AdSense account will disable by Google.

- To maximize the number of clicks do not click on your own video ads.
- To get more Ad clicks do not ask your friends to click on ads.
- Do not use the violent and adult content.
- Do not put ads on copyright content.
- Do not get traffic from paid to click programs.
- Do not make changes on AdSense ad code.
- Do not use AdSense code in software or emails
- Do not publish hateful, violent, nudity, spam and copyrighted content.

## E. Techniques for Channel Growth

I get a tremendous amount of success on my YouTube channel within one and a half year. Although this success is not outrageous, it really justifies my effort. Applying these techniques will definitely support you to achieve your target.

1) *Videos Planning:* If you fail to plan then you plan to fail. The first step is to decide what your expertise are, Do what you love and choose a niche according to your skills, pinpoint your target and start making videos based on your targeted audience.

2) *Create High-Quality Content:* Publish content that highly engages your audience, make videos that are entreating and informative and try to make burst and evergreen content that will remain relevant with respect to time.

3) *Be Consistent:* Consistency helps you to build a strong connection with your subscribers. Try to maximize your uploading speed. Usually, subscribers ignore those channels that are not serious to publish their content regularly.

4) *Use Top Search Keywords in Title and Description:* Do proper SEO (Search Engine Optimization) of videos and use those keywords in title, tags, and description that have high search and high CPC (Cost per Click) rate.

5) *Make Eye-Catching Thumbnail for Videos:* For each video create an attractive thumbnail with a small explanatory note that helps your audience to understand what your video is all about.

6) *Add Channel trailer:* YouTube offers to their creators to make most of the customization to their channels one of them is adding a channel trailer that shows in channel's home section. It's a video that automatically plays when the new audience comes to your channel and this video tells your traffic what you offer them.

7) *Use Appropriate Tool:* Lots of enormous tools are available over the internet that helps you to promote your channel one of them is Tube Buddy, It is a best friend for all YouTube creators. I have been used Tube Buddy since last one month and it really helps me to find more

audience.

8) *Add Social Links*: YouTube offers the privilege to their creators to build their social circle by adding social links in About section. In channel settings, you can add your various social media links. Moreover, you can also add subscribe button on your channel art.

9) *Add Intro and Outro*: It is like starting theme song that helps you to make a brand, with intros and outros your video will become more interesting and gives the sense of professionalism.

10) *End Video with a Big Thank you and Ask for Subscribe*: The answer will always be no until you never ask. Try to end the video with a high note of confidence and tell your viewers that you are really thankful to them.

11) *Collaboration is Important*: Connect with your subscribers and audience, interact with them, reply to their comments, listen to their requests and all time make them feel connected.

#### F. Withdraw Finalized YouTube Earning

Every month from 10 to 14, finalize earning shows into your AdSense account and from 21 to 29 finalized earning receipt shows in your AdSense Payment section you can withdraw it by the easiest method that is Western Union.

Western Union is a worldwide money transfer service that allows you to get your earning cash within two months, it is the fastest method to get payment. Yours earning made in US dollar but you get it in your local currency from western union agents.

### III. Results

I have been using Youtube since October 2016 I started an interior design channel. Within six months, this channel becomes my full-time job with a few thousand subscribers. Now after one and a half year, my channel reputation is as follows.

My YouTube Channel Analytics Report from Oct 2016 to Jan 2018	
Number of Uploaded Videos	More than 400 videos
Total Subscribers	More than 44,000
Total Views	More than 11 Million
Total Watch time	More than 15,890,000 minutes
Average View Duration in Min	1:2 minutes
Channel Location	Pakistan
Channel Type	Interior Designs
Account created	October 8, 2016
Estimated Monthly Earning	500 US dollars
Estimated Yearly Earning	6000 US dollars
Total Number of Likes	More than 37,591
Total Number of Dislikes	4,100
Number of Comments	900+
Number of Shares	78700+

Table 2. My One Year Channel report

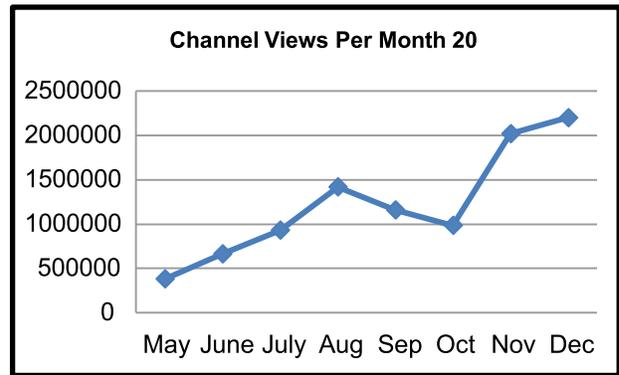


Fig.1. Monthly views

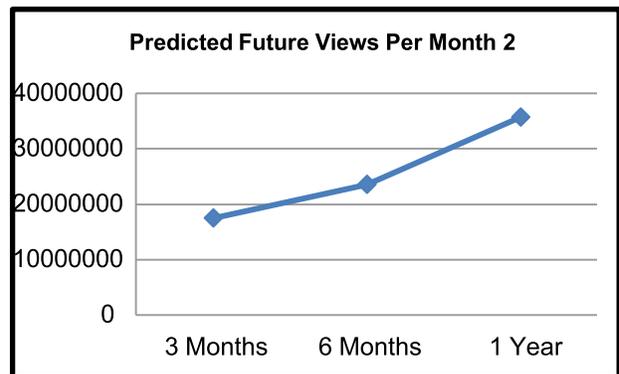


Fig.2. Predicted views

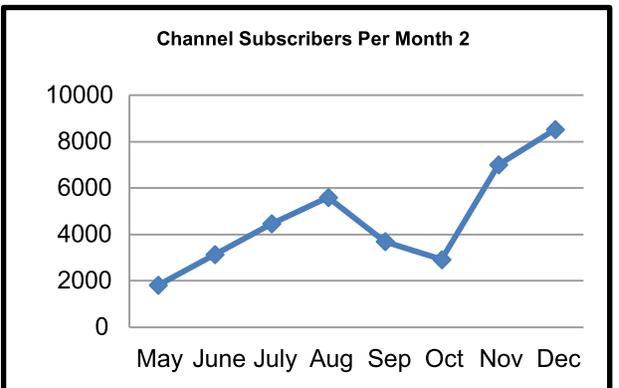


Fig.3. Monthly Subscribers

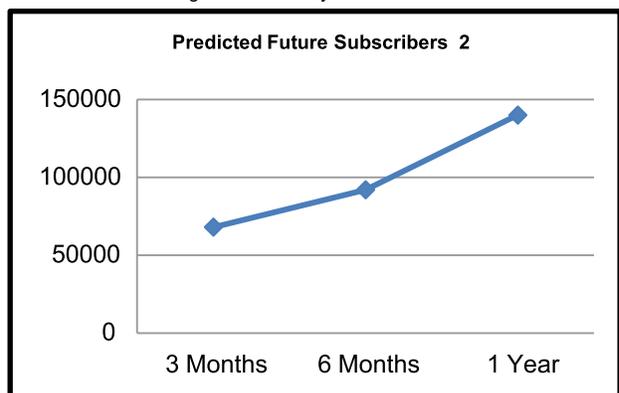


Fig.4. Predicted Subscribers

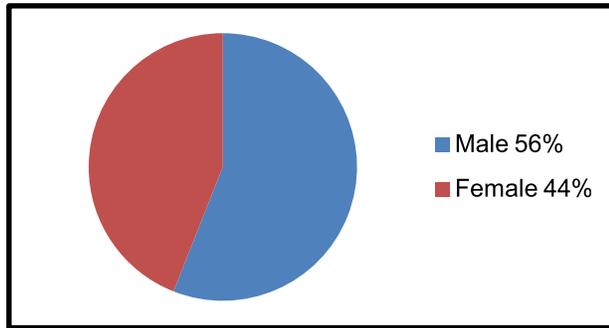


Fig.5. Gender views

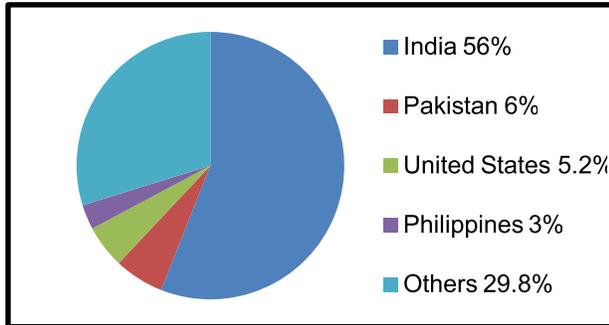


Fig.6. Top Geographies Watch Time

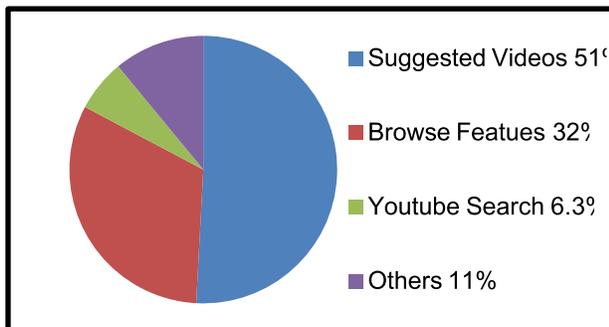


Fig.7. Traffic Sources Watch Time

Top 10 Videos (Oct 2016-Jan 2018)	Watchtime (Minutes)	Video Views	Estimated Revenue
1	1,882,767+	1,530,250+	\$ 561.75
2	1,898,044+	2,268,70+	\$ 516.85
3	1,380,302+	383,385+	\$ 978.28
4	1,298,141+	990,903+	\$ 419.64
5	795,289+	388,161+	\$ 189.33
6	584,193+	561,550+	\$ 149.28
7	492,278+	393,899+	\$ 130.11
8	309,072+	79,697+	\$ 169.48
9	274,784+	129,184+	\$ 69.21
10	296,999+	259,513+	\$ 64.72

Table3. Earnings of Top Videos

#### IV. Conclusion

The actual illusion behind handsome YouTube earning is being consistent in uploading videos. In today's world, thousands of peoples use YouTube as a full-time job and get the handsome amount from it. The results show that after one and a half year effort the channel is in the position that it can be used as a full-time job and can bear the expenses of a complete family.

#### V. References

- [1] Obar, Jonathan A.; Wildman, Steve (2015). "Social media definition and the governance challenge: An introduction to the special issue".
- [2] A. Severyn, A. Moschitti, O. Uryupina, B. Plank and K. Filippova, "Multi-lingual opinion mining on youtube," Information Processing & Management, 52(1), 2016, pp. 46-60
- [3] YouTube Help, "Introduction to YouTube Partner Program" Jan 9, 2018. Available <https://support.google.com/youtube/answer/72857?hl=en>. online document [Accessed: January 15, 2018]
- [4] Shaun Cronin, "How to Upload a Video from Start to Finish" Available <https://blogs.constantcontact.com/how-to-upload-video-to-youtube/> [Accessed: January 16, 2018].
- [5] Ngonmang, B., Sean, S., & Kirche, R. (2013), "Monetization and Services on a Real Online Social Network Using Social Network Analysis", 2013 IEEE 13th International Conference on Data Mining Workshops.
- [6] Mitra, P., & Baid, K. (2009). Targeted advertising for online social networks. 2009 First International Conference on Networked Digital Technologies.
- [7] Nagarajan, M., Baid, K., Sheth, A., & Wang, S. (2009). Monetizing User Activity on Social Networks - Challenges and Experiences. 2009 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology.
- [8] Casas, P., Fiadino, P., Sackl, A., & D'Alconzo, A. (2014). YouTube in the move: Understanding the performance of YouTube in cellular networks. 2014 IFIP Wireless Days (WD).



# Analysis of World's Top YouTube Channels 2017

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## Abstract:

Top content creators of YouTube have a huge size of the audience that rivals the size of the traditional television audience. This paper presents the world's highest-paid Youtubers who generates million dollars revenue per year by uploading videos on YouTube. A survey of top channels is conducted in order to collect the data then the results of the data is compared among all those channels to discover that what strategies are being followed by top Youtubers to become a millionaire.

**Keywords**—World's top YouTube channels, YouTube channels, Social media YouTube.

## I. Introduction

YouTube is a world's largest video sharing social networking website launched in Feb 2005 by PayPal workers, in Nov 2006 Google bought it for 1.65 billion US dollars. YouTube offers a variety of content videos, allow its users to watch, share, publish, rate, comment and follow other user's channels. YouTube contains several kinds of stuff like trailers, documentaries, entertainment shows, music clips, training videos, and other short clips. Mostly videos are published by individuals. The unregistered users are only able to watch the content videos whereas the registered users are able to publish an unlimited content on the video sharing site, add comments, like videos and share videos on other social networking websites [1].

Registered users monetize their videos with the help of the YouTube Partner Program, after enabling monetization YouTube placed advertisements on videos and subscribers watched their videos in this way creators generate their revenue. Advertisements are placed through Google AdSense. Creators generate their earning based on ads revenue generated when users watch their content. Channel's earning depends upon from which country your channel gets more views and which types of ads are shown on your videos.

Online earning is the most convenient and simplest way to make money by monetizing your talent or skills. Monetization of talent is something like converting someone's talent into money. When YouTube launch in 2006, the owners only wanted to launch such a place of activity where they could stream news, they did not conceive that YouTube will become the world's second largest search engine and will become a perfect site to generate online money by creating and uploading content videos by sitting at home [2].

The Internet is a main source of information and getting more popular every day [3]. The main purpose of this paper is to analyze the world's top highest paid YouTube

creators who generate their revenue in million dollars per year by publishing their content videos on YouTube. In addition, the main objective is to examine the strategies that top Youtubers followed. We gather data by surveying top YouTube channels, results show that most of the top channels belong to the United States and mostly entertainment channels are more popular over the internet.

The management of the complete paper is as follows: The Section II presents the methodology of the research, Section III presents the results section in which we have shown some tables in order to show different parameters, the Section IV presents the conclusion and finally, Section V presents the references.

## II. Methodology

We conduct an online survey to collect analytics of top channels and analyze the best practices and strategies that top channels followed after statistical analysis results evaluated and show in the form of tables. We categorize our survey paper into two parts, the first part is about the analytics report such as content type, number of subscribers, number of views, from which country that channel belongs and the second part is about best practices or strategies as shown in figure 1. For data collection, we have used social blade site that tracks user statistics for Youtube, twitter, instagram, twitch and other social media sites [5], by utilizing social blade site we get a deeper understanding of user growth and collect analytics data report that usually includes the number of videos, number of subscribers, number of views and other parameters as well. In order to examine the next part of data collection that what strategies are being followed by top YouTube channels we first take the list of top 100 youtube channels from the same site that is social blade and then we pick up the top 10 Youtube channels and by visiting their channel profile, we analyze their regular activities moreover, we also analyze that what are their common practices on their channels by which they became the world's top channels.



By surveying each channel one by one, we collect all the analytics report which and then perform statistical analysis over that data in order to examine results. Analytics report contains the following parameters:

- Which types of videos are upload on the channel?
- A total number of videos those are available.
- Total number of subscribers
- Total number of views
- Date on which the channel was created.
- Country location from which that channel belongs.
- How much amount channel generates monthly?
- How much amount channel generates yearly?

The next part is to examine that what strategies are being followed by these top YouTube channels. The different factors can lead the channel to reach the highest of success. Patience plays a very important role in the success of every channel. The remaining top strategies will be a list in the results section.

### III. Results

A successful creator always embodies their viewers, he keeps his audience engaged for a long time, He carefully understands that what their customer actually want and then create content accordingly.

Table 1, lists analytics report of world’s top 10 highest paid YouTube channels, it is clear from table 2 that a top YouTube creator can earn up to million-dollar revenue from YouTube.

Table 2, lists the top strategies and best practices that are followed by top Youtubers, by following those strategies

anyone can grow their channel on YouTube and can earn million-dollar revenue by uploading content. Table 2 shows that almost all channels produce high-resolution content and 90% channels create high-resolution thumbnails. All channels do proper SEO means they properly add title, tags, and description for each video. 90% of channels create backlinks for getting more views, 40% of the channels add captions, 90% channels add cards, 80% channels add end screens at the end of each video, 60% channels maintain consistency in their uploads, 80% of the channels collaborate with their audience and 100% of the channels create entertaining videos to entertain their audience. Successful YouTube channels always follow a realistic schedule and based on that schedule they regularly upload content [4].

Table 3, lists the use of content type that which type of videos are more popular on YouTube table results shows that there is 40% of channels which creates entertainment videos, 20% channels are popular based on music tracks, 10% sports and 10% sports channels are more popular over the YouTube.

Similarly, Table 4, lists the location that from which country these channels belong to, results describe that most of the channels belong to the United States and its percentage is 50%, 30% of the channels belong to India and rest of the channels belongs to other countries. With results, it can be easily determined that YouTube is more popular in the United States and usually most of the highest paid YouTube creators belong to the US.

### IV. Conclusion

To maximize the revenue world’s top YouTube channels

Table 1: Analytics of World’s TopYouTubeChannel

Channel No:	Content Type	No: of Videos	Subscribers	Views in Billion	Created on	Country	Estimated Monthly Earning	Estimated Yearly Earning
1	Games	1900+	11 M+	36 B+	Feb, 2011	US	\$930,000	\$11 Million
2	Music	11,900+	34 M+	306 B+	Mar, 2006	IN	\$450,000	\$5.5 M
3	Entertainment	2820+	5 M+	64 B+	June, 2012	US	\$88,500	\$1.1 M
4	Entertainment	45+	3 M+	3 B+	May, 2012	US	\$58,900	\$706,900
5	Sports	33,120+	21 M+	201 B+	May, 2007	US	\$200,700	\$2.4 M
6	Shows	22,190+	19 M+	142B+	Sep, 2006	IN	\$217,600	\$2.6 M
7	Music	635+	26 M+	133 B+	Mar,2012	BR	\$204,200	\$2.5M
8	Entertainment	165+	700,000	8 B+	Jan, 2007	AT	\$47,800	\$574,000
9	Entertainment	940+	12 M+	187 B+	Mar, 2015	US	\$229,200	\$2.7 M
10	Shows	72500+	10 M+	132 B+	Dec, 2005	IN	\$170,300	\$2 M

Table2: Best Practices Followed by Top Channels

Strategies/ Best Practices	1	2	3	4	5	6	7	8	9	10	%
High-resolutionvideo quality	V	V	V	V	V	V	V	V	V	V	100
High-resolutionthumbnail	V	V	V	V	V	V	V	V	V	U	90
SEO	V	V	V	V	V	V	V	V	V	V	100
Backlinks	V	V	V	V	V	U	V	V	V	V	90
Caption added	V	U	V	U	U	U	U	V	U	V	40
Cards added	U	V	V	V	V	V	V	V	V	V	90
End screens added	U	V	V	V	V	V	V	V	V	U	80
Consistency	V	V	V	U	V	V	U	U	U	V	60
Collaborate withtheaudience	V	V	V	U	V	V	V	U	V	V	80
Entertaining Videos	V	V	V	V	V	V	V	V	V	V	100
Regularity	V	V	V	V	V	V	V	V	V	V	100

Table3: Use of Content Type

Content Type	Number of Channels	Percentage (%)
Entertainment	4	40
Music	2	20
Sports	1	10
Shows	2	20
Games	1	10
Total	10	100

Table4: Channel'sLocation

Location	Number of Channels	Percentage (%)
United States	5	50
India	3	30
Other	2	20
Total	10	100

upload such type of content videos that attracts a huge amount of traffic because they generate revenue when the large audience watches their content. Therefore, in order to grow your channels on YouTube try to target the audience of the United States, select an entertaining and trending niche. In addition, follow all those best practices that top YouTube channels follow.

## V. References

- [1] En.wikipedia.org.(2018). YouTube [online] Available at: <https://en.wikipedia.org/wiki/YouTube> [Accessed on 6 Feb, 2018].
- [2] Common Characteristics of Successful YouTubers – Buy Views Review, [online] Available at <http://buyviewsreview.com/commoncharacteristics-successful-YouTubers/> [Accessed on 6 Feb 2018].
- [3] Alghamdi, K.M., Moussa, N.A., Internet use by the public to search for health-related information, International Journal of Medical Informatics, Volume 81, Issue 6, June 2012, Pages 363-373R.
- [4] ReelNReel (2018). 50 Common Characteristics of Successful YouTuber. [online] Available at : <https://www.reelnreel.com/successful-YouTuber/> [Accessed on 7 Feb, 2018].
- [5] <https://socialblade.com/>
- [6] Fen Zhou, Florian Dransart, “Online Statistics of Keyword-Indexed Youtube Videos”, Sixth International Conference on Communication Systems and Networks (COMSNETS) 2014.
- [7] Lakshmi Kaushik, Abhijeet Sangwan, John H.L. Hansen, “automatic sentiment extraction from youtube videos”, 2013 IEEE Workshop on Automatic Speech Recognition and Understanding
- [8] Jebabli, M., Cherifi, H., Cherifi, C., & Hamouda, A. (2015). User and group networks on YouTube: A comparative analysis. 2015 IEEE/ACS 12th International Conference of Computer Systems and Applications (AICCSA).
- [9] Wang, Y., Kitayama, D., Lee, R., & Sumiya, K. (2009). Automatic Generation of Learning Channels by Using Semantic Relations among Lecture Slides and Recorded Videos for Self-Learning Systems. 2009 11th IEEE International Symposium on Multimedia

# ATM PIN Verification via Smartphones: Securing the Future of Digital Banking in Pakistan

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## Abstract:

*Plastic money has become the most favored way of conducting monetary transactions in most developed countries, partly due to the ubiquity and ease of access of Automated Teller Machines, but its use in Pakistan still lags largely behind. While Teller machines offer a great deal of ease when it comes to accessing personal bank accounts, checking balance, paying utility bills or performing Inter/Intra Bank Fund Transfers. However, they also pose numerous critical security challenges. For example, skimming devices only require a 4-digit Personal Identification Number to steal an individual's private information and a teller machine's hardware especially vulnerable to such tactics. This might even lead to identity theft where someone might steal a customer's account by way of recording their PIN after a valid debit/credit card transaction. This paper identifies such security concerns and suggests a method to make transactions safer and more secure by bypassing the Teller's own vulnerable hardware by way of entering the PIN from the keypad of a user's Smartphone or handheld device via a bank's digital banking app.*

**Keywords**—Security; Automated Teller Machine; Smartphone; Authentication; ISO 8583; PIN Verification.

## I. Introduction

Modes of carrying cash have evolved rapidly together with technology since the beginning of the 21st Century, and now people use Automatic Teller Machines (ATM) to perform tasks such as withdrawing cash, transferring funds and paying utility bills, all of which can be done with extreme ease and speed by inserting a personalized piece of plastic, called a debit/credit card, and entering a four-digit Personal Identification Number (PIN). Many countries, China being a notable example, are also adopting and offering speed internet coupled with the card and mobile payment services through their national banks; e.g., mobile financial and banking services, greatly increasing the reach and efficiency of their banking systems [3].

While modern technology has undeniably transformed ways of carrying cash, increasing the speed and efficiency with which we conduct our day-to-day monetary transactions, it has simultaneously generated new modes of vulnerability such as identity-fraud, loss of sensitive or private information, and monetary theft. This vulnerability is especially pronounced in Pakistan, whose banking sector is not well-equipped to process such fraud claims, leading to the citizens lagging behind in the use of plastic money. ATMs are the most commonly used channel of monetary transfer in Pakistan, even compared

to mobile, internet, branch and Telephone banking. In the last few years, people have started gradually adopting digital banking in its myriad of forms, but ATMs are still poised to be the primary way of monetary transactions for the foreseeable future, and thus any gaps in their security have extensive consequences for the banking sector as a whole. This paper identifies one such gap in the security of the commonly used ATMs here and tries to propose a pragmatically sound solution that could be implemented with ease to this mode of banking. This will additionally allow us new opportunities to analyze transaction trends and build better systems to detect fraud in its various shapes [1].

In Pakistan, the majority of people use two types of cards; Magstripe Cards and Chip Cards. In the former, a magnetic strip stores all your personal data, while in the latter a chip performs the same function. Coupled with the numbers embossed on the plastic of a card, of which the first six digits define the BIN (Bank Identification Number) and the following six digits contain the cardholder's details. As such while the card itself contains all of a user's information, you still need a PIN for verification before performing any electronic transactions. The banks in Pakistan which offer debit or credit card services only use a PIN verification system, which is inadequate when we compare it to the banks in Europe and a few other first world countries that require both a PIN and personal signature for verification purposes while in some countries both options are available [4].

The most common manner in which fraud is committed with regards to ATM banking is by stealing a person's PIN by using methods such as shoulder surfing or skimming devices. The security measures adopted by many banks are obsolete and are severely lacking in up-to-date guidelines and an adequate Standard Operating Procedure (SOP) in case someone's PIN is compromised [2]. The PIN is not embossed on a credit or debit cards but is physically entered by the cardholder during the transaction and set by the user during the activation of the card. The PIN is the only verification step which requires user input in order to make a transaction, and in our proposed model we allow users to input their PIN using a Smartphone bypassing the ATM's hardware entirely. In effect, this means that after *inserting* the card into the ATM a user will enter their 4-digit PIN using the keypad of the Smartphone via a banking application that will then send a request to the bank's server using the code specific to that particular device on which the user is performing the transaction, allowing them to not use the embedded keypad of the ATM, which is the most likely target of

skimming devices used to extract personal information.

## II. Background

In the existing system, every user has a 4-digit PIN for each ATM card and in order to withdraw money the user needs to verify their identity by entering a pin on the ATM interface. The PIN verification process is completed by inserting a card into the machine and entering your personal code. This pin is known only to the user and the bank. The latter uses it to get a matching code by the controller of the issuing bank using ISO 8583 standard message for transaction. After verification of the PIN, the controller sends back an approved matched response to the ATM which then allows the user to perform any further steps related to their transaction.

The debit or credit card, being a tangible entity can easily be lost or stolen and if the thief who steals the card can acquire the user's ATM PIN, then the user's bank account is severely compromised.

## III. Literature Review

Advancements in payment technologies have lead to an accelerated development of the ATM services in Pakistan, making them the primary site for banking purposes. Thus, financial institutions in Pakistan should concentrate their attention on ATM security to enhance consumer loyalty [8]. The payment industry as a whole has progressed towards becoming more customer-centric and technology-driven, significantly changing how the banking activities are conducted all over the world [9]. At the same time, there has been a rise in fraudulent activities revolving around the credit or debit card, as they are often stolen and the unauthorized owner of that card often tries to use it on an ATM by randomly guessing the PIN. Many skimmers can come up with correct credentials because many people choose PIN ranging from birthdays to phone codes [10].

There are many different approaches to overcoming such security challenges presented by an ATM's PIN verification process that are being adopting by numerous banks. An example of this is biometric verification of a user based on their finger prints, which studies have shown to minimize the rate of fraudulent activities on ATM machines [5]. Similarly, other modes of biometric verification such as Iris, Face, Handprint and Retina recognition are equally valid at curbing fraud, but their drawbacks are also restricting; simple dirt and dry skin easily hamper these techniques and they also require the installation and maintenance of specialized equipment in each and every ATM. For example, a camera for Face Recognition and a fingerprint reader for print recognition, which can be costly and time consuming [6]. Another method that has been previously proposed consists of a PIN verification technique relying on a numeric keypad with two shades of the keys as painted either black or white but the limitation of this system is it requires users to go multiple steps of color identification and if a video recording of the login is made the pattern can be found out because the system still uses an embedded keypad [11].



Fig. 1. PIN verification system image.

Another proposed system to prevent skimming attacks utilizes the technique of SMS verification. In this method, the user receives a temporary PIN generated by the bank's controller before each transaction. However, this approach involves complex interaction techniques and bypass the user's security as card holder requires to send clear card data information via SMS to the bank's server for verification and the limitation, thus becoming very drawn out and repetitive and breaching a customer's privacy [12].

The password/PIN-based authentication system that is already the norm here does not involve any complex pattern recognition techniques, such as those involved in biometric authentication, and its only requirement is that the given password must match the one already saved on the system. Thus, the PIN verification method is extremely cost and time effective since it requires no specialized hardware and only one input, and as such any improvements that we might propose should ideally capitalize on its strong-points without taking away any of its functionality [13].

Keeping all the aforementioned points in mind, this paper proposes a system that relies only on a simple, banksanctioned Smartphone application. This is an extremely viable method as according to the pilot survey conducted for this paper, 94% of people who own a debit or credit card also own a Smartphone. As such the user will only need an internet connection and a bank app through which they can access the PIN verification section. After the customer has inserted a card into the ATM and entered the PIN through their Smartphone, the server will then send an authentication request to the ATM on which the card was inserted. Thereafter the customer's Smartphone will display the same screen as the one on the window where they will select the nature of their transaction.

This method can also be applied to make monetary transactions on a single ATM using the credit or debit card of various different banks as well. All ATM transactions are based on response codes from 00 to 99, where the '00' code refers to a withdrawal notice. In terms of the controller, it means that approved transactions on an ATM are always routed through a bank's own secure server, handling all the various status checks and securing connectivity, while the point of sale (POS) only builds a connection when a user initiates a transaction. As such the entire communication between Bank-1 and Bank-2 can be done using a ISO 8583 in such a way that if a card holder of Bank-1 inserts a card into the ATM of Bank-2

the card can be used to initiate a request message using ISO standard message format to the controller of Bank-2 ATM which will further route to the controller of Bank-1 for verification. After receiving an approval or successful response from the controller of Bank-1 the user can expect to receive the desired cash which they requested from the ATM. Finally, Bank-2 will mark the transaction as successful and send a successful response back to the controller [7].

#### IV. Methodology

In order to calculate the impact of the proposed system a survey was conducted with a sample size of 50 participants in order to analyze the result and responses were conducted over the time period of one month. The results of the survey are presented in tables 1-2. Table 1 shows the nature of participants who took part in this survey and figure 1 shows their age range (from 19 to 41 years) and clearly demonstrates that most participants owned either a credit or debit card. Table 2 shows their comfort and confidence in using an ATM in Pakistan. According to question one, while 92 percent of the respondents do own a credit or debit card, 30 percent of them still fear for the security of their private information.

On the other hand, the other questions show that 54 percent of people have prior experience in internet banking, just not in conjunction with ATMs and 52 percent of people also have 4G internet continuously enabled on their Smartphone. As such, the security method suggested by this paper can be adopted quite easily. It has the potential to replace the existing transaction method which is quite risky and to overcome the security gap as represented in figure 2 which also validates the hypothesis of this study.

Table 1: Survey Participants Profile

No.	Profile	Details
1	Age	20 - 41 years old
2	Gender (Male/Female/NA)	36:13:1(NA)
3	Profile	The majority respondent owns multiple accounts in multiple banks and owns debit/credit cards.

Table 2: Questionnaire

No.	Question	Responses (Yes/ No)	Total	Percentage (Yes/No)
1	Do you have an ATM card?	46   4	50	92   8
2	Do you feel secure using ATM in Pakistan?	31   19	50	62   38

3	Do you have a Smartphone?	47	3	50	94	6
4	Have you ever used an internet banking App on your Smartphone?	27	23	50	54	46
5	Do you have a 4G speed internet data enabled on your phone?	26	24	50	52	48
6	Do you feel your information is secure while using ATM?	35	15	50	70	30
7	Have you previously used any other method of authentication on ATM such as Biometric?	13	37	50	26	74

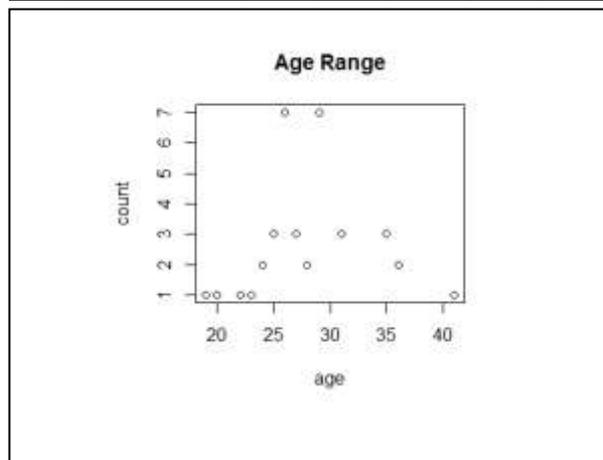


Fig. 2. Graph shows the age range of the participants.

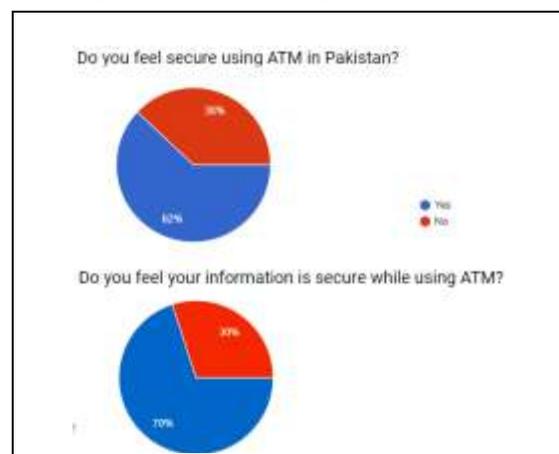


Fig. 3. The above figure show the percentage of question 2 and 6.

## A. Purposed System

This facilitates user to enter PIN using their Smartphone without using the embedded keypad of ATM device in order to minimize the risk of PIN getting skimmed by a skimmer device and this will enable the user to withdraw cash from the account after successful authentication of the corresponding PIN number which enters via Smartphone's keypad.

## B. Abbreviations and Acronyms

ATM, PIN, ISO, IBFT, CBS, EMV

## C. Server

The server manages the user account details and include details such as the user's account balance, account number and citizen ID and PIN code.

## D. ISO 8583

The ISO 8583 is an industry standard protocol for financial communication between the user and the bank which can be understood in terms of a sender and receiver. Each financial message then comprises of three parts; the header, application information, and the trailer.

The header and trailer encompass the application information and are utilized for directing and message integrity.

The application information comprises of ISO message including message type pointer.

Example: We have an ATM that can accept credit/debit card to withdraw money. This can be done through ISO 8583 using following steps:

x100 message sent to bank's server to authorize the PIN. After a successful match, it will initiate the transaction and verify the availability of amount and this done by the core banking system.

x200 The CBS will generate a response message to the server to withdraw the amount after checking the balance.

x220 The server will forward the same to the bank to complete the transaction, or x420 to the bank to cancel the authorization if the x200 failed.

## E. Transaction Routing

The controller, core-banking system, and switches make cash withdrawal possible from any ATM. Apart from cash withdrawal, people can perform multiple types of transactions on ATMs for instance fund transfers, utility bill payment, conduct account inquiries. The role of switches in this is to enable customers of Bank-1 to withdraw cash from an ATM of Bank-2 where they do not have an account.

All the user must do is insert their card in an ATM and open up the banking application on a mobile device with an enabled keypad. The user will then tap the ATM transaction window on the app, which will prompt the

ATM to connect to the application on your device. This will finally allow you to use your device's keypad to enter your security PIN, which the app will send as a verification request via mobile banking app to the bank's controller or modules which manage PIN verification and if matched it will send an 'approve' response to the ATM terminal. If you accidentally enter a wrong code or in case of a timeout, the transaction window will appear on the device's screen with a generated code explaining the reason for the declined transaction, simultaneously sending a signal to the ATM to eject your card and then you can simply try again. The entire communication can be done using the ISO 8583 message standards and thus require no new hardware or software upgrades on the ATM itself thus making this solution economical and easy to implement.

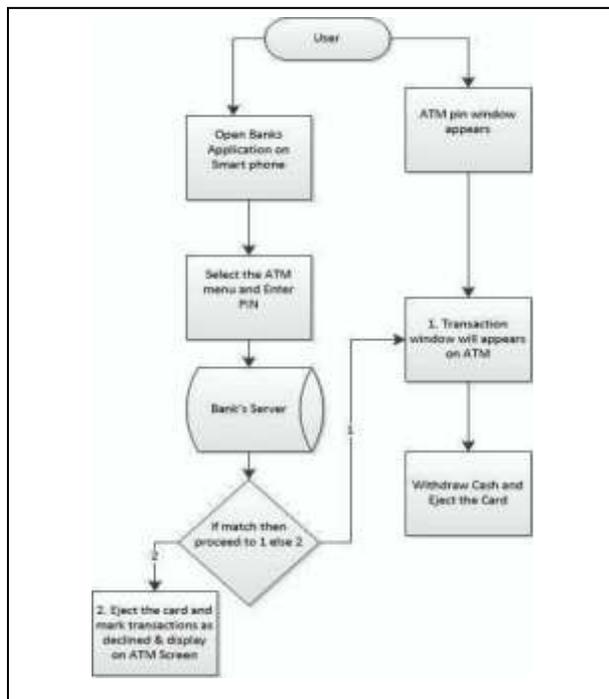


Fig. 3. DataFlow Diagram.

## F. Algorithm

- The user inserts a card into the ATM and PIN input window will appear.
- The user is then required to open the digital banking app on their smartphone, the user will then enter the PIN in the ATM transaction window on digital banking app after verifying the location of the ATM in which the user has inserted the card.
- The application will send a request to the server using ISO 8583 financial request message format and the PIN validation will be performed at server's end.
- The successful match of PIN the server will send an approved response to ATM response code "00" after a successful approval/completion PIN verification is valid.

e) In case of an unsuccessful match, ATM will eject the card and transaction will be marked as declined.

f) The ATM then send an acknowledgment message to the host and marks the transaction as completed. A new transaction window will appear on the ATM screen and in case of timeout or incorrectly matched the server will send a response to ATM to eject the card and generate a reason code of declined transaction.

## V. Advantages

a) Banks in Pakistan can introduce Smartphone technology with digital banking, which people are already familiar with thus no extensive training is required.

b) Security of the PIN code can be ensured by implementing algorithm based verification.

c) Data analytics techniques can be incorporated by using the proposed system to analyze transaction trends and to detect fraud and theft.

## Conclusion

This paper identifies security concerns regarding PIN verification methods used at ATMs and suggests a method to make transactions more safe and secure by bypassing the Teller's vulnerable hardware by entering the PIN from the keypad of a user's Smartphone or handheld device via bank's digital banking app.

The proposed system is designed to be more immune to hardware-based attacks such as PIN decoding, which is easily performed through illegally embedded keypads on the ATM device. Additionally, the given model has the capability to assemble user-generated data for further trend analytics. As such, adopting this method will undoubtedly enhance the security infrastructure of the banking system in Pakistan.

## Future Work

This study enables future research opportunities by integrating multiple bank cards on a single PIN and by enabling biometric verification using a Smartphone screen to avoid the installation of biometric devices on every ATM.

## References

- [1] J. Zhong, "A Comparison of Mobile Payment Procedures in Finnish and Chinese Markets," 22Nd Bled Econference-eEnablement Facil. an open, Eff. Represent. esociety, pp. 79–96, 2009.
- [2] K. Sridharan, "Multi bank atm family card : integration of multi bank multiple user in single card with user behavior monitoring using hmm & formula verification," Int. Res. J. Eng. Technol., vol. 4, no. 3, pp. 2391–2394, 2017.
- [3] R. Anderson and S. J. Murdoch, "Emv," Commun. ACM, vol. 57, no. 6, pp. 24–28, 2014.
- [4] M. Jacob, R. M. Jose, and N. Mathew, "QR based

Card-less ATM Transactions," vol. 2, no. 2, pp. 81–83, 2016.

- [5] V. M. Kumbhar, "Customers' Satisfaction in Atm Service: an Empirical Evidences from Public and Private Sector Banks in India," Manag. Res. Pract., vol. 3, no. 2, pp. 24–35, 2011.
- [6] N. Velankar Himani Saxena Devendra Sharma, Financial Matters In Global Perspective Financial Matters in Gloabal Perspective, Customers Perception towards ATM Services: A Study of Indian Banks Priyanka Sisodia, Roshni Gupta, Richa Dube, p-234-243, 2016.
- [7] M. Okechukwu and I. Majesty, "ATM Security Using Fingerprint Biometric Identifier: An Investigative Study," Int. J. Adv. Comput. Sci. Appl., vol. 3, no. 4, pp. 68–72, 2012.
- [8] V. Padmapriya and S. Prakasam, "Enhancing ATM Security using Fingerprint and GSM Technology," Int. J. Comput. Appl., vol. 80, no. 16, pp. 43–46, 2013.
- [9] D. Mahansaria, "Secure Password Entry Scheme in ATM Network which Is Resistant to Peeping Attacks," vol. 1, no. 2, pp. 142–145, 2009.
- [10] V. Roth, K. Richter, and R. Freidinger, "A PIN-entry method resilient against shoulder surfing," Proc. 11th ACM Conf. Comput. Commun. Secur. - CCS '04, p.236, 2004.
- [11] Anil K. Jain, Fellow, IEEE, Arun Ross, Member, IEEE, and Sharath Pankanti, Senior Member, IEEE, "Biometrics: a Tool for Information Security," IEEE transactions on information forensics and security, Vol. 1, no. 2, June 2006.
- [12] J. Zinman et al., "Auto Teller Machine (ATM) Fraud – Case Study of a Commercial Bank in Pakistan," J. Bank. Financ., vol. 2, no. 2, pp. 43–45, 2014.



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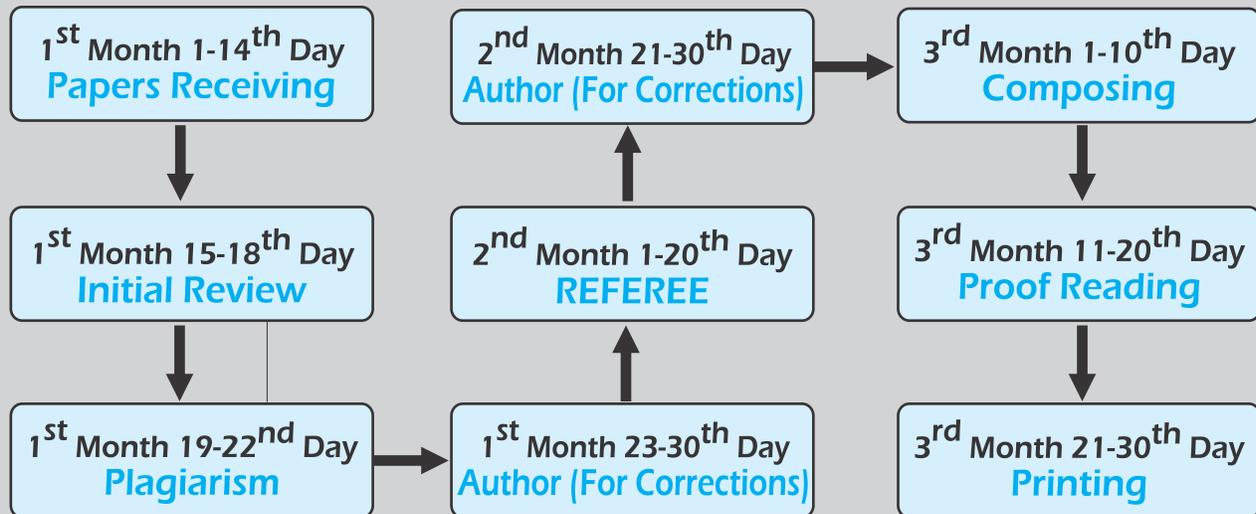
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