Online ISSN : 2249-4596
Print ISSN : 0975-5861

# Global Journal

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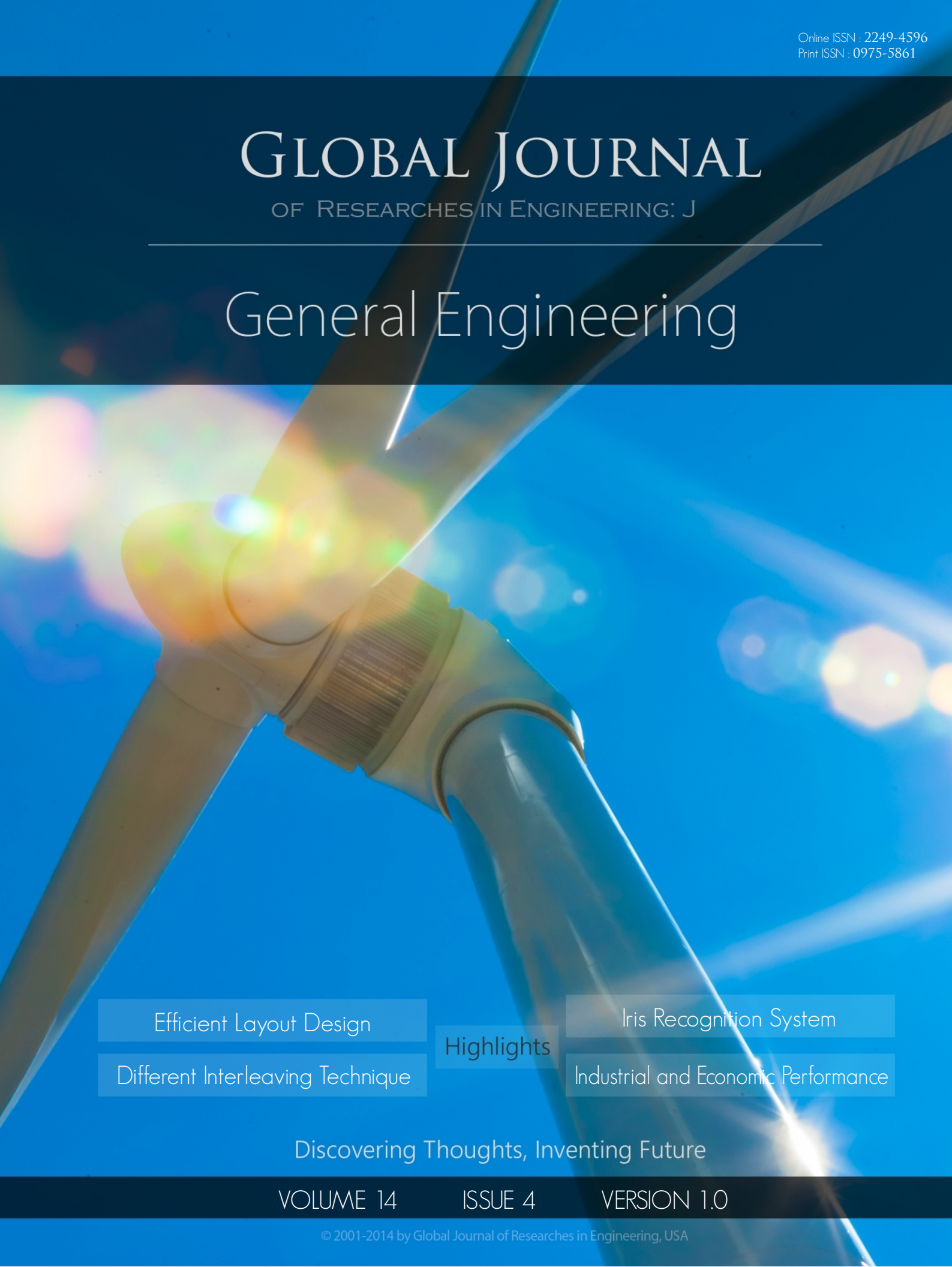

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Global Journal of Researches in Engineering: J
General Engineering

Global Journal of Researches in Engineering: J
General Engineering
Volume 14 Issue 4 (Ver. 1.0)

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Global Journal of Researches in Engineering: J
General Engineering
Volume 14 Issue 4 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

# Performance Analysis of different Interleaving Technique for M-QAM Modulation over Rayleigh Fading Channel in an Outdoor Environment with different Equalizers

By Md. Anam Mahmud, Md. Rakibul Islam, Selim Zahan, Tanvir Ahmed & Shuva Paul

*Rajshahi University of Engineering and Technology, Bangladesh*

*Abstract-* In this paper we investigate the impact of using different block interleaving techniques with different equalizers for a digital communication system which uses MQAM (M=16) modulation technique to transmit information over Rayleigh faded AWGN channel in an outdoor environment. Interleaving technique which are considered here are Algebraic interleaver, Random interleaver, Matrix interleaver and Helical scan interleaver. Performance is analyzed in terms of bit error rate by MATLAB simulation. The different property values that is path delay, average path gain, maximum Doppler shifts, Doppler spectrum parameters etc are chosen carefully for the simulation of Rayleigh fading channel to show a realistic fading channel. Stepsize, forget factor etc for different adaptive algorithms used by decision feedback equalizer (DFE), linear equalizer (LE) are also chosen properly. All the analysis shows the use of interleaving technique increases the performance of communication system. Algebraic and Random interleaver have shown better performance for this considered communication system. Maximum likelihood sequence estimate (MLSE) equalizer provides best equalization for limiting signal dispersion and ISI.

*Keywords:* *rayleigh fading, MQAM modulation, equalizer, interleaving.*

*GJRE-J Classification :* *FOR Code: 091599*


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*Keywords: rayleigh fading, MQAM modulation, equalizer, interleaving.*

## I. Introduction

Mobile communications and wireless network have experienced massive growth and commercial success in the recent years. However, the radio channels in mobile radio systems are usually not amiable as the wired one. Unlike wired channels that are stationary and predictable, wireless channels are extremely random and time variant [1]. It causes multipath propagation. Multipath propagation in wireless communication system is a challenge. This phenomenon, caused by the arrival of multiple delayed copies of the transmitted signal at the receiver, results in intersymbol interference (ISI), severely distorting the transmitted signal at the receiver. This also causes time dispersion, attenuation, and phase shift, know as fading, in the received signal [2] . To transmit data from one location to another through wireless communication channel a lot of things have to consider such as modulation, encoding, filtering, equalization etc. For an effective communication all these things have to be done carefully. So appropriate technique choosing is very vital. M-ary signaling schemes are preferred over binary signaling schemes for transmitting digital information over band pass channels when the requirement is to conserve bandwidth at the expense of increased power [3]. This schemes are one of most efficient digital data transmission systems as it achieves better bandwidth efficiency than other modulation techniques and have higher data rate [4]. M ary modulation can enhance the power saving, especially in power-saving applications. There are many types of modulation techniques which are used for the transmission of information [5]. Different kinds of M-ary modulation techniques like MPSK, MDPSK, MQAM etc each of which offers benefits of its own [6]. The number of signals or number of M increases (M≥0, 1, 2,….,M) the error probability or more clearly the probability of Symbol error rate is increased [7].

In this paper MQAM modulation scheme is considered. BER performance using different interleaving techniques and equalizers over Rayleigh fading channel in an outdoor environment is analyzed by MATLAB simulation. These equalizers are maximum likelihood sequence estimate (MLSE) equalizer, decision feedback equalizer (DFE) and linear equalizer (LE). And the interleaving techniques we use are Algebraic interleaver, Random interleaver, Matrix interleaver and Helical scan interleaver. LE is used mainly for linear cases, DFE is used for non linear cases. But MLSE equalizer can be used for both cases [8]. For outdoor environments, path delays after the first are typically between 100 ns and 10 $\mu$s (i. e. between 1e-7 s and 1e 5 s) [25]. Here we have taken two paths of delay 1e-7s and 1e-5s. In practice, an average path gain value is a large negative dB value. However, computer models typically use average path gains between -20 dB and 0 dB. Here in this analysis the path gain is chosen -9dB and Doppler shift is taken 4HZ where The source moves

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at a speed 2.4 m/s and the carrier frequency is 500MHZ.

The rest of the paper is organized as follows. The communication system model is described in Section II. Section III describes the fading channel. Section IV Rayleigh fading channel. Section V discuss about Equalizers. Interleavers are discussed in SectionVI. Results are discussed in Section VII. Finally, Section VIII provides the concluding remarks of this work.

## II. The Communication System Model

Communication system under consideration is shown In fig.1. Here a random signal using random bit generator is generated first. Then the generated binary data is encoded by a convolutional encoder of rate 1/2. After that the signal is interleaved by different interleavers and then converted into M-ary signal. This M-ary signal is modulated by M-ary modulation (16 QAM) scheme and transmitted through Rayleigh faded AWGN channel. At the receiver side the signal is equalized by equalizer (LQ, DFE & MLSE). After that, it is demodulated by a QAM demodulator. The demodulated symbols are converted into bits. The bit stream is de-interleaved. After that convolutional decoding is done to this signal. And the decoded signal is the desired output signal. The performance and characteristics of a channel depends on the choice of digital modulation schemes. Moreover, one scheme is said to be better than other depending on the channel, required levels of performance and the target hardware trade-offs [9].

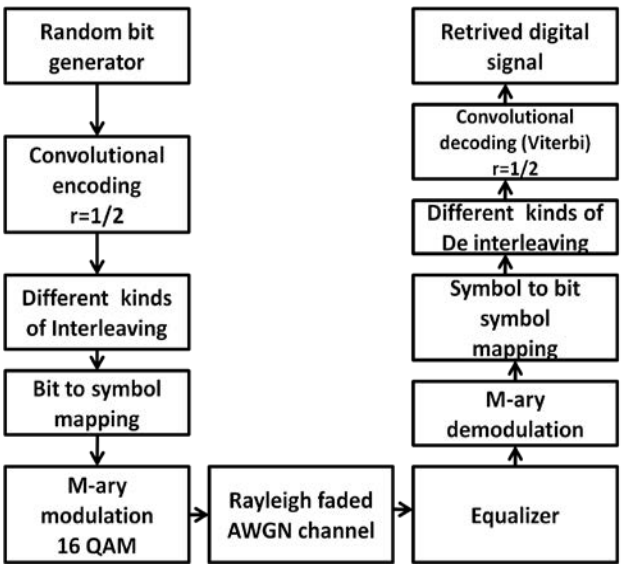


*Figure 1 :* Block diagram of digital communication system based on M-ary modulation scheme

## III. Fading Channel

Fading is the deviation of the attenuation affecting a signal over certain propagation media. The fading may vary with time, geographical position or radio frequency, and is often modeled as a random process. A fading channel arises from the movement of the transmitter and receiver, commonly referred to as the time-varying effect or Doppler effect [12]. In a multipath fading channel, the transmitted signal arrives at the receiver via multiple paths. These paths generally arise via signal reflection from the ground, hills, buildings, and any other large structures. They also arise from signal diffraction via bending around the corners of buildings or sliding across rooftops. They also can arise via signal scattering from small objects. Each signal path results in a randomly delayed, attenuated, and phase- shifted copy of the transmitted signal. Examples of fading models for the distribution of the attenuation are Nakagami fading, Log-normal shadow fading, Rayleigh fading, Rician fading, Weibull fading etc. Here we will discuss about Rayleigh fading.

## IV. Rayleigh Fading

The delays change in an unpredictable manner associated with different signal paths in a multipath fading channel and can only be characterized statistically. When there are a large number of paths, the central limit theorem can be applied to model the time-variant impulse response of the channel as a complex-valued Gaussian random process. When the impulse response is modeled as a zero mean complex-valued Gaussian process, the channel is said to be a Rayleigh fading channel. Rayleigh fading models assume that the magnitude of a signal that has passed through such a communications channel will vary randomly, or fade, according to a Rayleigh distribution. Rayleigh fading is viewed as a reasonable model for tropospheric and ionospheric signal propagation as well as the effect of heavily built-up urban environments on radio signals [13],[14].

Rayleigh fading is a reasonable model when there are many objects in the environment that scatter the radio signal before it arrives at the receiver. The central limit theorem holds that, if there is sufficiently much scatter, the channel impulse response will be well-modeled as a Gaussian process irrespective of the distribution of the individual components. If there is no dominant component to the scatter, then such a process will have zero mean and phase evenly distributed between 0 and $2\pi$ radians. The envelope of the channel response will therefore be Rayleigh distributed.

Calling this random variable R, it will have a probability density function:

$$PR(r) = \frac{2r}{\Omega} e^{-r^2/\Omega} \quad , r \geq 0 \qquad (1)$$

Where, $\Omega = E(R^2)$

Often, a complex number is convenient to represent the gain and phase elements of a channel's distortion. In this case, Rayleigh fading is exhibited by the assumption that the real and imaginary parts of the response are modeled by independent and identically distributed zero-mean Gaussian processes so that the amplitude of the response is the sum of two such processes. In this analysis, Jakes Doppler power spectrum has been considered. This spectrum model is actually due to Gans [20], who analyzed the Clarke-Gilbert model ([21], [22]). The Clarke-Gilbert model is also called the classical model. Jakes Doppler power spectrum applies to a mobile receiver. It derives from the following assumptions [23]: (i) The radio waves propagate horizontally. (ii) At the mobile receiver, the angles of arrival of the radio waves are uniformly distributed over [ $\pi$, -$\pi$ ] [24]. At the mobile receiver, the antenna is omnidirectional (i.e. the antenna pattern is circular-symmetric).

## V. Equalizer

Equalizer is a kind of filter which is used to control dispersion of received signal. It has a frequency characteristics that is inverse of that of transmission medium. This will restore higher frequency component and eliminate pulse dispersion [10]. There are three types of equalization methods commonly used :Maximum Likelihood Sequence (MLSE)- Detection - Optimal, but Impractical. The MLSE Equalizer uses the Viterbi algorithm to equalize a linearly modulated signal through a dispersive channel [11]. Linear Equalization - suboptimal, but simple. Non-Linear Equalization (DFE)- for severe ISI channels. Linear equalizers are simple to implement and are highly effective in channels where is the ISI is not severe (like the wired line telephone channel) [15]. Linear Equalizers are further classified into two types based on weight adaptation: Preset Equalizers, Adaptive Equalizers. DFE consists of a forward filter and a feedback filter formed. Once the receiver RX decisions on the received signal, the signal after its impact can immediately calculate and deduct. DFE using feedback system, so there is error propagation phenomena [16]. MLSE: In a single-carrier frequency-selective Rayleigh fading environment, assuming a time-invariant channel impulse response (CIR), the received symbols are described by [18, 19].

$$r_k = \sum_{j=0}^{L-1} h_j \, S_{k-j} + n_k \qquad (2)$$

Where Sk denotes the kth complex symbol in the transmitted sequence of N symbols chosen from an alphabet D containing M complex symbols, $r_k$ is the kth received symbol, $n_k$ is the kth Gaussian noise sample N (0, σ2 ) and hj is the jth coefficient of the estimated CIR [17]. The equalizer is responsible for reversing the effect of the channel on the transmitted symbols in order to produce the sequence of transmitted symbols with maximum confidence.

## VI. Interleaver and Deinterleaver

Interleaving is the reordering of data that is to be transmitted so that consecutive bytes of data are distributed over a larger sequence of data to reduce the effect of burst errors. The use of interleaving greatly increases the ability of error protection codes to correct for burst errors. Many of the error protection coding processes can correct for small numbers of errors, but cannot correct for errors that occur in groups [26]. Interleavers consider in this paper are

*Algebraic interleaver (algintrlv):* Derives a permutation table algebraically, using the Takeshita-Costello or Welch-Costas method. Here Takeshita-Costello method is used.

*Random interleaver (randintrlv):* Chooses a permutation table randomly using the initial state input that you provide.

*Matrix interleaver (matintrlv):* Fills a matrix with data elements row by row and then sends the matrix contents to the output column by column.

*Helical scan interleaver (helscanintrlv):* Fills a matrix with data row by row and then sends the matrix contents to the output in a helical fashion. [27].

## VII. Results & Performance Comparison

Performance analysis of different interleavers with different equalizer for MQAM modulation techniques under Rayleigh fading channel in outdoor environment implies in a FEC encoded digital communication system are shown through figure 2 to 6.

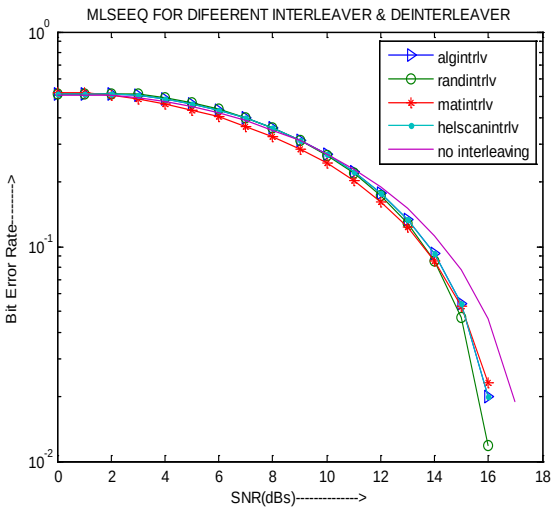


*Figure 2 :* Performance analysis for 16QAM signal with MLSE equalizer passing through multipath Rayleigh fading channel

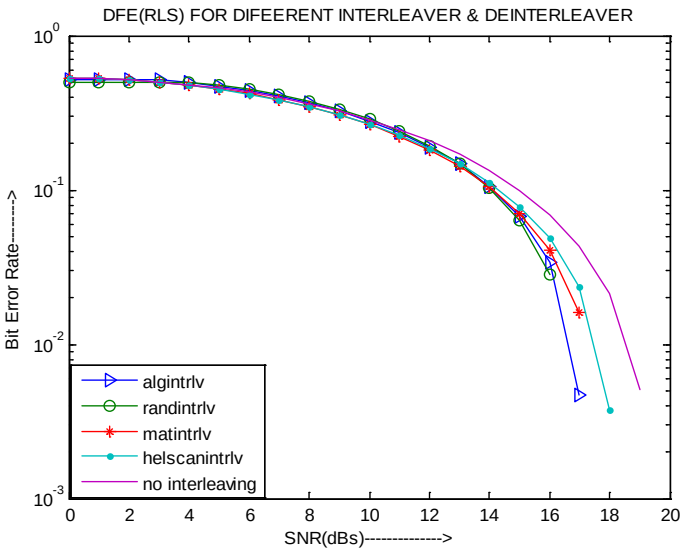


*Figure 3 :* Performance analysis for 16QAM signal with DFE(RLS) equalizer passing through multipath Rayleigh fading channel

Figure 2 shows performance analysis for MLSE equalizer with different interleaving technique. At $10^{-1.5}$ BER the required SNR for algebraic, random, matrix, helical scan interleaver and the system without interleaver are 15.5dB, 15.2dB, 15.8dB, 16.1dB and 16.5dB respectively. It can be observed that for MLSE equalizer the BER for random interleaver and the system without interleaver are 0.0465 and 0.0776 at 15dB SNR. Thus BER performance using random interleaver is improved by 2.23dB compared to the system without interleaver.

In order to achieve $10^{-1.5}$ BER for DFE (rls) 16.1dB, 15.8dB 16.3dB ,16.5dB 17.5dB SNR are required by algebraic, random, matrix, helical scan interleaver and the system without interleaver respectively which is shown in Figure 3.

At 15dB SNR for DFE (rls) equalizer the BER are 0.0648 and 0.0996 for random interleaver and the system without interleaver respectively. Thus BER performance using random interleaver is improved by 1.93dB compared to the system without interleaver.

Figure-4 shows that LE (rls) equalizer could not achieve $10^{-1.5}$ BER for any of these interleaving technique considered SNR.

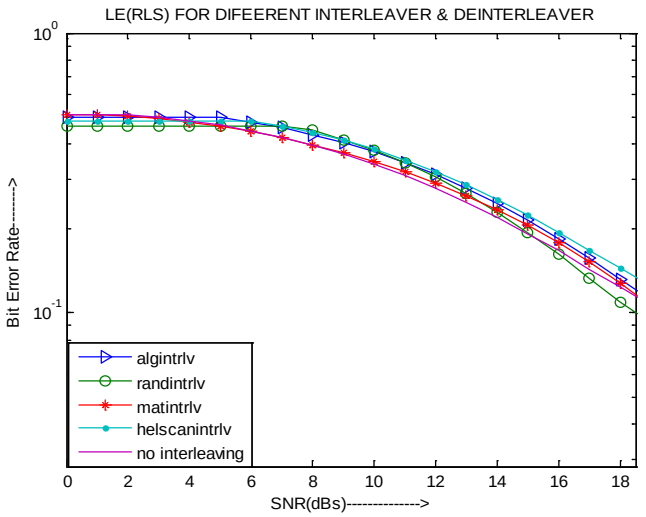


*Figure 4 :* Performance analysis for 16QAM signal with LE(RLS) equalizer passing through multipath Rayleigh fading channel

Figure 5 shows the performance of algebraic interleaver for MLSE, DFE (rls) and LE (rls) equalizer. At $10^{-1.5}$ BER the SNR of MLSE and DFE (rls) are 15.6dB and 16.2dB respectively. On the other hand Figure-6 shows performance analysis of random interleaver. 15.25dB and 15.8dB SNR are required by MLSE and DFE (rls) equalizer in order to achieve $10^{-1.5}$ BER. LE (rls) equalizer could not achieve $10^{-1.5}$ BER, it is mentioned above and also can be seen from the figures. It can be observed from figure 5 & 6 that MLSE equalizer is the best equalizer among these three that is MLSE, DFE (rls) and LE (rls).

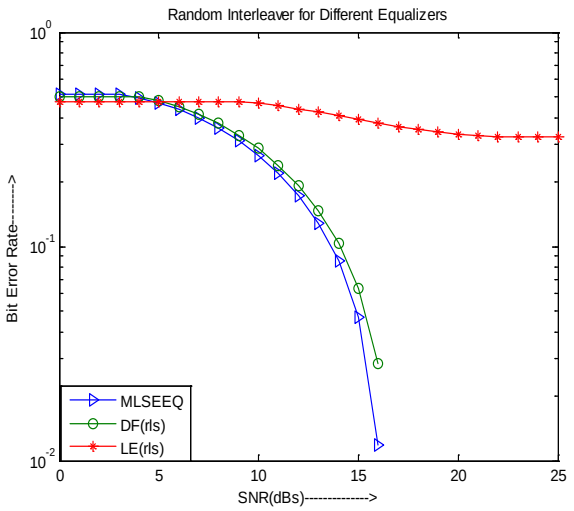


*Figure 5 :* Performance analysis of algebraic interleaver for different equalizers

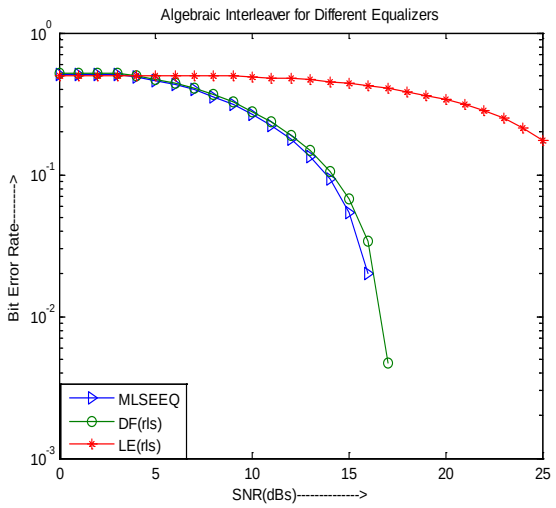


*Figure 6 :* Performance analysis of random interleaver for different equalizers

## VIII. Conclusion

In this paper we have analyzed the performance of different types of interleaving techniques and equalizers for 16QAM modulation technique over a multipath Rayleigh fading channel in an outdoor environment. It is found that random interleaver shows better performance. The performance shown by algebraic interleaver is also good. And among the equalizers MLSE equalizer has shown the better performance than all.

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Global Journal of Researches in Engineering: J
General Engineering
Volume 14 Issue 4 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

# Area Efficient Layout Design of Multiply Complements Logic (MCL) Gate using QCA Technology

By Syeda Sharmin Islam, Sharmin Farzana & Ali Newaz Bahar
*Mawlana Bhashani Science and Technology University, Bangladesh*

*Abstract-* Quantum dot Cellular Automata (QCA) is one of now popular technology for its highly scalable feature and ultra low power consumption that made its one of the promising alternatives to CMOS technology. This paper present a new layout design of Multiply Complements Logic (MCL) gate based on QCA inverter (INV), QCA wire and QCA majority voter (MV) gates. To verify and simulate the proposed gate QCA Designer and Microwindlite tools are employed. The simulation result confirmed the correctness of the proposed circuits and comparison shows the area efficiency of QCA over CMOS technology. This proposed design layout has a promising future in constructing ultra low power exhausting information processing system and can stimulate higher digital applications in QCA.

*Keywords: QCA inverter (INV), QCA wire, QCA majority voter (MV) gate, QCA Designer and MICROWIND.*

*GJRE-J Classification : FOR Code: 291899*


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# Area Efficient Layout Design of Multiply Complements Logic (MCL) Gate using QCA Technology

Syeda Sharmin Islam [α], Sharmin Farzana [σ] & Ali Newaz Bahar [ρ]

*Abstract-* Quantum dot Cellular Automata (QCA) is one of now popular technology for its highly scalable feature and ultra low power consumption that made its one of the promising alternatives to CMOS technology. This paper present a new layout design of Multiply Complements Logic (MCL) gate based on QCA inverter (INV), QCA wire and QCA majority voter (MV) gates. To verify and simulate the proposed gate QCA Designer and Microwindlite tools are employed. The simulation result confirmed the correctness of the proposed circuits and comparison shows the area efficiency of QCA over CMOS technology. This proposed design layout has a promising future in constructing ultra low power exhausting information processing system and can stimulate higher digital applications in QCA.

*Keywords: QCA inverter (INV), QCA wire, QCA majority voter (MV) gate, QCA Designer and MICROWIND.*

## I. Introduction

Nanotechnology provides new possibilities for computing due to the unique properties that arise at such reduced feature sizes. Among this new devices, Quantum-dot Cellular Automata (QCA) [1, 2] relies on new physical phenomena (such as Coulombic interactions), and innovative techniques that radically depart from a CMOS-based model. QCA not only gives a solution at nano-scale, but it also offers a new method of computation and information [3, 4]. Consider the processing features of QCA technology, the basic element is cell that can be used as an information processing unit (perform logical operation), while others (i.e. wires) are used for information transfer and communication. In information processing reversible logic circuit made a great attention in recent years. It is addressed that the reversible logic gates are promising computing paradigm with applications in emerging technologies such as quantum computing, quantum dot cellular automata, optical computing, etc. [5-8]. In Quantum computing we found there are many proposals on Reversible Logic Gate (RLG) design like Feynman Gate [9], Toffili Gate [10], Fredkin Gate [11], NFT Gate [12] but very few of them are being designed in QCA [13, 14].

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## II. Materials and Methods

The QCA cell is the basic building block of QCA. Four quantum dots that consist of a QCA arranged in a square pattern. These quantum-dots are sites in which electrons are able to tunnel between them but cannot leave the cell. The basic cell constructed from four quantum dots with two mobile electrons which can move to different quantum dots by means of electron tunneling. Columbic repulsion will cause the electrons to always occupy diagonally opposite dots. The two stable polarization of electrons *P= +1.00* and *P= -1.00* of a QCA cell represents logic '1' and logic '0' respectively, shown in figure 1.

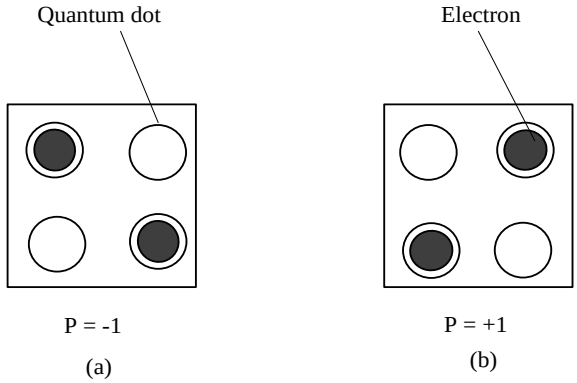
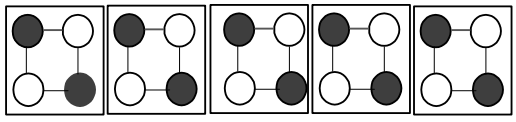


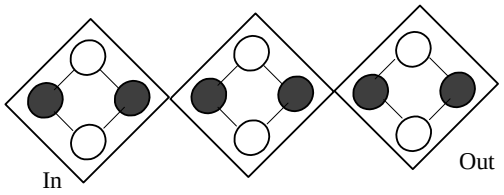

*Figure 1 :* Basic QCA cell and binary encoding (a) polarization=-1 and (b) polarization=+1

### *a) QCA Wire*

QCA wires can be either made up of $90^0$ cells or $45^0$ cells. $45^0$ cells are used for coplanar wire crossings (Figure 2). In case of Inverter, if place two cells at $45^0$ with respect to each other they interact inversely. An array of QCA cells acts as a wire and is able to transmit information from one end to another, i.e., all the cells in the wire will switch their polarizations to follow that of the input or driver cell.




(a)

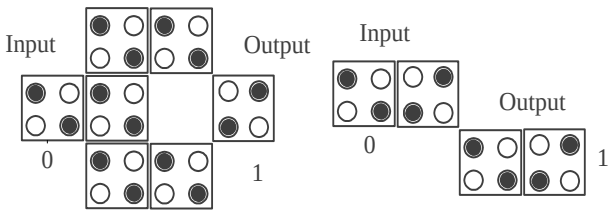



(b)

*Figure 2 :* QCA (a) $90^0$ wire (b) $45^0$ wire

*b) QCA Inverter*

QCA Inverter returns the opposite value of input value. This inverter is made of eight cell or four QCA wires. The input polarization is split into two polarizations and in the end, two wires join and make the reverse polarization shown in figure 3.

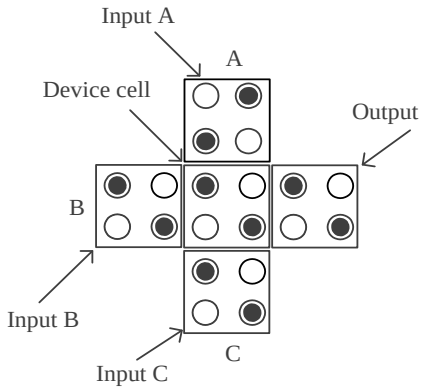



(a) (b)

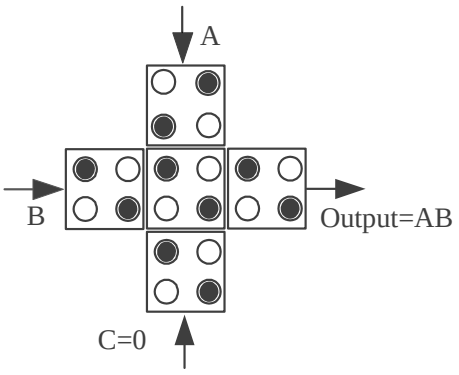
*Figure 3 :* QCA inverter

*c) Majority Voter*

Majority Voter [15] (MV) is described as logic function MV (A, B, C) = AB + BC + CA. MV can be realized by 5 QCA cells, as shown in Figure 4 (a). Using QCA majority voter two basic gates "AND" and "OR" can be implemented by setting one of the input fixed to 0 or 1 value. Figure 4 (b) Shows when C=0 then Output is AB that indicates the AND operation and when C=1 then Output is A+B that means OR operation shown in figure 4(c).




(a)

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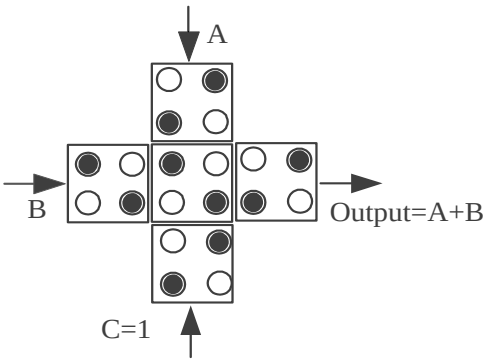


(c)

*Figure 4 :* (a) Majority Voter Gate (b) perform AND operation (c=0) and (c) OR operation(c=1)

## III. MCL Gate

In this section describe the 3 × 3 MCL (Multiply Complements Logic) Gate. Reversible Logic gate is defined as input vector and output vector must be with one to one correspondences. The MCL gate maps the inputs A, B, C to P= (B+C)', Q= (A+B)', R=A. Table 1 represents the truth table of this gate and figure 5 shows the QCA block diagram of MCL gate.

*Table 1 :* Truth Table of the MCL gate

| A | B | C | P=B'C' | Q=A'B' | R=A |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |

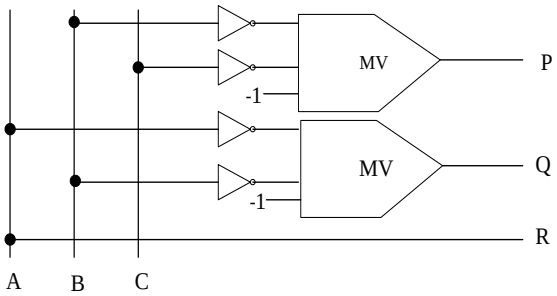


*Figure 5 :* QCA block diagram of MCL gate

*a) Characterization of MCL Gate*

As MCL gate is a reversible gate so it has equal number of inputs A, B, C and outputs P, Q, R. QCA block diagram of MCL gate shows that two majority gates and four not gates are used to perform logical operation. Output P obtained from the AND operation of B NOT and C NOT. Output Q obtained from the AND operation of A NOT and B NOT. Output R obtained from the input A.

*b) Simulated Design Layout Of MCL Gate In QCA And CMOS*

i. *QCA simulation*

QCA Designer [16, 17] is the product of an ongoing effort to create a rapid and accurate simulation and layout tools for quantum-dot cellular automata (QCA). Figure 6 shows the simulated gate design of MCL gate, where A, B, C and P, Q, R are the input and output cell respectively.

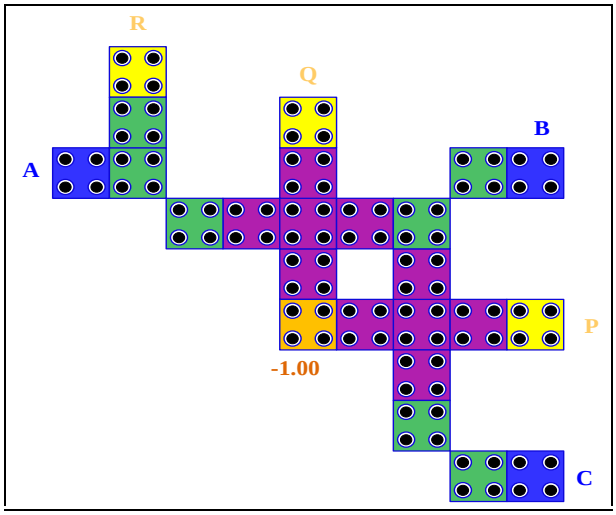


*Figure 6 :* Simulation of MCL Gate using QCA Designer

In figure 7, the simulated input output waveforms of MCL gate using QCA Designer is shown. In the output P has pass-through two clock zone, it indicates that P has a time delay of 0.5 (clock cycle) and on the other Q and R has no time delay. In figure 7 circle indicate the time delay in the output signal.

*Figure 7 :* Simulated input output waveforms of MCL gate with 0.5 clock cycle delay

ii. *CMOS simulation*

For design and simulation the MCL gate in CMOS we used PC tools MICROWIND [18]. This tool is very user-friendly to design and find out the covered area of any logic gate.

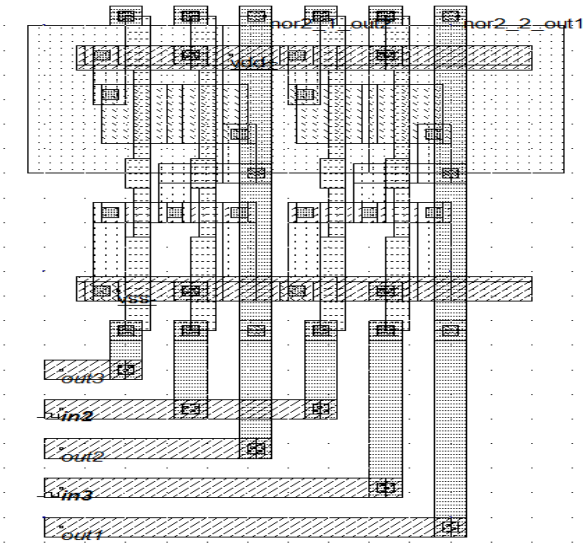


*Figure 8 :* Simulated gate layout of MCL gate in CMOS

## IV. Result Comparison

In this section show that, designed MCL gate in QCA, how much area efficient than CMOS. Here show the comparisons that have calculated area using QCA Designer and MICROWIND [18]. Table 2 shows the designing parameter Figure 9 shows the covered area comparison between CMOS technology and QCA technology. For this comparison different designing technology are employed in MICROWIND.

*Table 2 :* Designing Summary of MCL gate in QCA and CMOS technology

| Parameters | MCL Gate |
|---|---|
| Number of cells | 24 |
| Number of Majority Voter gate | 2 |
| Time delay (clock cycle) | 0.5 |
| Covered area (size) in QCA ($\mu m^2$) | 0.038 |
| Covered area (size) in CMOS ($\mu m^2$) | 4.5 |
| Improvement (in times) | 118.42 times |

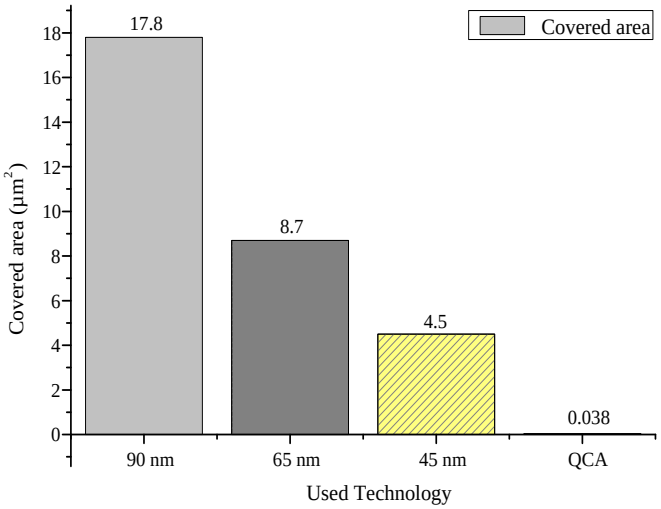


*Figure 9 :* Area in different versions of CMOS technology and QCA

## V. Conclusions

QCA is one of the emerging nano-technologies in computing paradigm which is capable to design highly saleable logic device also suitable for implementing reversible logic gates. This paper presented an area efficient layout design of Multiply Complements Logic (MCL) gate in QCA which is 118 times smaller in size than 45 nm CMOS technology. The simulation has done using QCA Designer and MICROWIND.

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Global Journal of Researches in Engineering: J
General Engineering
Volume 14 Issue 4 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

# A Dimensionality Reduced Iris Recognition System with Aid of AI Techniques

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*Keywords: feed forward back propagation neural network (FFBNN), adaptive median filter, unbalanced haar wavelet, modified multi text on histogram (MMTH), iris recognition, artificial bee colony algorithm (ABC), principle component analysis (PCA), modified fuzzy c-means (MFCM).*

*GJRE-J Classification : FOR Code: 280213p*

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## I. Introduction

Today, many countries are considering or even announced procurement of bio-metrically enabled national identity (ID) card schemes, one of whose purposes will be to detect and prevent multiple IDs [1]. Applications such as passenger control in airports, access control in restricted areas, border control, database access and financial services are some of the examples where the biometric technology has been applied for more reliable identification and verification [6]. Biometric is unique to each individual and is reliable [16]. Iris recognition is the most reliable biometric system available because of iris uniqueness [19], stability, permanency and easily taking [3]. Iris based recognition has been gaining popularity in recent years, and it has several advantages compared to other traditional biometrics such as finger prints and facial features [13]. Also, the probability of finding two people with identical iris pattern is almost zero [7]. That's why iris recognition technology is becoming an important biometric solution for people identification in access control [14].

More technically, the iris is part of the unveil, or middle, coat of the eye. It is a thin diaphragm stretching across the interior portion of the eye and supported by the lens [4]. Iris recognition is a method of biometric authentication that uses pattern-recognition techniques based on high-resolution images of the irises of an individual's eyes [2]. There are four main techniques in Iris Recognition System Namely: Segmentation, Normalization, Feature Extraction And Matching [12]. Iris recognition begins with finding an iris in an image, demarcating its inner and outer boundaries at the pupil and sclera, detecting the upper and lower eyelid boundaries if they occlude and detecting and excluding any superimposed eyelashes or reflections from the cornea or eyeglasses. These processes may collectively be called segmentation [1]. Iris normalization mainly involves two basic operations, one is to detect eye lids and the other is boundary detection. The first step involves extraction of circular shaped iris rim by removing the noisy regions. The second step is to detect the inner and outer boundaries of iris. [5]. The matching module generates a match score by comparing the feature sets of two iris images [11].

The great advantage of the authentication using iris recognition is the irreplaceable nature. It has various applications to high-security facilities, but it is now being widespread developed in information systems such as network, e-commerce, and retail applications [3]. Although, a number of iris recognition methods have been proposed, it has been found that several accurate iris recognition algorithms use multiscale techniques, which provide well-suited representation for iris recognition [10]. The main difficulty of human iris recognition is that it is hard to find the apparent feature points in the image and to keep their represent ability high in an efficient way [17]. The data are unique to the individual and remain so throughout one's life [8]. The performance of iris recognition systems highly depends on the segmentation process [9] which is a challenging problem [20].

The rest of the paper is organized as follows: Section 2 reviews the related works with respect to the

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proposed method. Section 3 discusses about the proposed technique. Section 4 shows the experimental result of the proposed technique and section 5 concludes the paper.

## II. Related Works

Fernando *et al.* [21] have used a modular neural network architectures as systems for recognizing persons based on the iris biometric measurement of humans. In that system, the human iris database was enhanced with image processing methods, and the coordinates of the center and radius of the iris were obtained to make a cut of the area of interest by removing the noise around the iris. The input to the modular neural networks was the processed iris images and the output was the number of the person identified. The integration of the modules was done with a gating network method results demonstrate that the use of the human iris biometric measurement worked with modular artificial neural networks and favorable results of person identification were obtained.

Kodituwakku *et al.* [22] have attempted to develop an algorithm for iris recognition based on Fuzzy logic incorporated with the visible properties of the human iris function. They were considered the visible features of the human iris such as pigment related features, features controlling the size of the pupil, visible rare anomalies and pigment frill. First they extracted the important and essential feature of a human iris image. Secondly, as an AI technique, Fuzzy logic was applied for iris recognition and person identification. The final system was a very successful at a rate of 98.6% accuracy in recognition with small mistakes.

Hariprasath *et al.* [23] have presented an iris recognition system based on Wavelet Packet Analysis. With an adaptive threshold, WPT sub images coefficients were quantized into 1, 0 as iris signature. Those signatures presented the local information of different irises. By using wavelet packets, the size of the iris signature of code attained was 1280 bits. The signature of the iris pattern was compared against the stored pattern after computing the signature of iris pattern Identification was performed by computing the hamming distance. The accuracy of the proposed system varied when different feature vector was chosen.

Naresh Babu *et al.* [24] have proposed an efficient Fuzzy based Iris Recognition Scheme (FIRS). That scheme has four stages namely Segmentation, Normalization, Feature extraction and classification using fuzzy logic. Hough transforms used for detection of Region of Interest (ROI), and combination of Discrete Wavelet Transform (DWT) and Independent Component Analysis (ICA) was used for feature extraction. Using mean and standard deviation as parameters a fuzzy classifier was used to classify the IRIS images. The results were quite convincing and encouraging.

Pushpalatha *et al.* [25] have proposed an iris recognition system with iris localization to segment and recognize cooler iris with highest speed and accuracy. Frequency domain magnitude and phase features were used for image feature representation. For classification process, support vector machines with "winner takes it all" configuration were used. Tests have shown 97% accuracy with average time of 31 milliseconds seconds for classifying each test image. They developed the iris recognition system using C#.Net (.Net 3.5).

## III. Proposed Iris Recognition System using AI Techniques

In the proposed methodology, the given input image is preprocessed using adaptive median filter for removing salt and pepper noise at the first stage. Following that, by adjusting the contrast and applying active contour technique on the preprocessed eye image, iris is localized. Then Unbalanced Wavelet Packet coefficients and MMTH features are extracted from the localized iris image and the extracted features are clustered using MFCM. Following that the dimension of the features are condensed using PCA. The Unbalanced Wavelet Packet coefficients and the dimension reduced MMTH features are given to train FFBNN. While training the parameters of the FFBNN are optimized using ABC. During the testing process the same procedure is done here till the feature extraction process. Then the output obtained from the feature extraction process is given to well-trained FFBNN-ABC to validate whether the given input iris image is recognized or not. The architecture diagram of the proposed Iris Recognition System is shown in Fig.1.

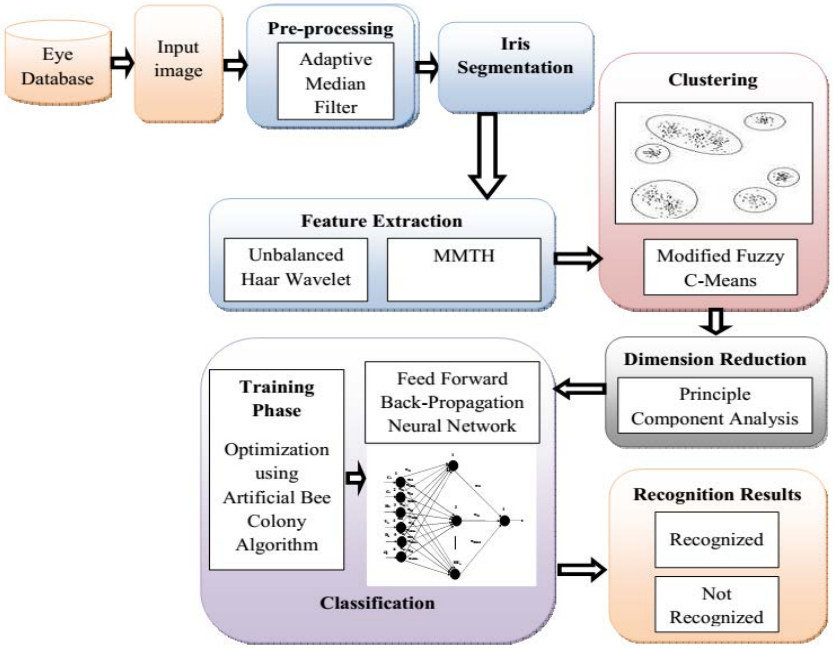



*Figure 1 :* Architecture of Our proposed Iris Recognition System

*a) Preprocessing*

The input eye image is initially changed into grey level format. After that using Adaptive median filter, the grey level eye image is preprocessed to take away salt and pepper noise. The input image may have noises which destroy the good pixels in the image. The noise must be eradicated from the input image in order to attain good precision. We are applying adaptive median filter to salt and pepper noise in our suggested work. It identifies the impulse by calculating the difference between the standard deviation of the pixels inside the filter window and the concerned current pixel. Let the iris database $(I)$ contains many eye images and let $x_{i,j}$ be one of the grey level images taken from the database. The lower and upper bounds $x$ are $s_{\min}, s_{\max}$ correspondingly. The grey level of image $x$ is specified by probability

$$y_{i,j} = \begin{cases} s_{\min}, \ probability\ p \\ s_{\max}, \ probability\ q \\ x_{i,j}, \ 1-a-b \end{cases} \quad (1)$$

The noise level is described as $ns = a + b$ .

The functioning procedure of Adaptive median filtering is explained below,

- Initialize the window size $ws = 3$.
- Work out maximum $\left(s_{i,j}^{\min,ws}\right)$, minimum $\left(s_{i,j}^{\max,ws}\right)$ and median $\left(s_{i,j}^{med,ws}\right)$ of the pixel values in $S_{i,j}^{ws}$ .
- If $s_{i,j}^{\min,ws} < s_{i,j}^{med,ws} < s_{i,j}^{\max,ws}$, then go to step 5. Or else increase the window size $ws$ by 2.
- If $ws \le ws_{\max}$ go to 2. Or else substitute $y_{i,j}$ by $s_{i,j}^{med,ws_{\max}}$ .
- If $s_{i,j}^{\min,ws} < y_{i,j} < s_{i,j}^{\max,ws}$, then $y_{i,j}$ is not a noise candidate or else substitute $y_{i,j}$ by $s_{i,j}^{med,ws}$ .

$$S_{i,j}^{w} = \{(k,l): |k-i| \le ws \ and \ |j-l| \le ws\}.$$

At this point $S_{i,j}^{ws}$ is window of size $ws \times ws$ centered at $(i,j)$. $ws_{\max} \times ws_{\max}$ Be the maximum window size.

$s_{\min}, s_{\max}$ are computed as follow:

$$su(i,j) = \sum_{m=i-k}^{i+k} \sum_{n=i-k}^{j+k} S_{m,n} \quad (2)$$

$$WS(i,j) = (2l+1)^2 \quad (3)$$

Using equiv. (4) and (5), Local mean value $\mu(i,j)$ and local standard deviation $\sigma(i,j)$ are computed as below.

$$\mu(i,j) = \frac{su(i,j)}{WS(i,j)} \quad (4)$$

$$\sigma(i,j)=\sqrt{\frac{\left(\sum_{m=i-k}^{i+k}\sum_{n=i-k}^{i+k}\left(s_{i,j}-\mu(i,j)\right)\right)}{WS(i,j)}} \quad (5)$$

Next by means of these local mean, standard deviation and as well a user defined multiplier upper and lower bounds are computed.

Lower bound $(s_{\min})$ and upper bound $(s_{\max})$ are computed as

$$s_{\min}=\mu 1(i,j)-m\times\sigma(i,j) \quad (6)$$

$$s_{\max}=\mu 1(i,j)+m\times\sigma(i,j) \quad (7)$$

The noise candidates only substituted by the median $s_{i,j}^{med,ws}$ in the above adaptive median filter algorithm, while staying behind are unaltered. By means of the above adaptive median filter algorithm the salt and pepper noise is eliminated from the specified input eye image and the preprocessed eye image is indicated as $x'$. This preprocessed eye image $(x')$ is subsequently subjected to iris localization process.

*b) Iris Segmentation and Normalization*

Iris segmentation is the main part in the process of iris recognition. In order to segment the iris from the eye image, here enhanced iris segmentation technique by considering the adaptive thresholding is utilized. The proposed iris segmentation technique has four phases namely,

- Removing Holes
- Pupil Detection
- Iris Detection
- Adaptive Normalization

i. *Hole Filling*

The eye image has holes in the pupil region which is the darkest region in the eye with nearly circular shape. In order to remove the holes from the pupil, binarized image is obtained by applying adaptive thresholding technique. The range of the threshold value ($\varsigma$) is between 0.1to 0.5. The binary images are obtained by adaptive thresholding technique. The maximum pixel value in the preprocessed image $(x')$ is multiplied with the threshold value ($\varsigma$). Then by considering the value obtained after the multiplication, the preprocessed image $(x')$ is binarized. The process of removing the hole from the pupil is detailed in the below steps:

*Step 1:* Set the threshold value ($\varsigma$) as 0.1.

*Step 2:* Obtain the binary image ($Bx'$).

*Step 3:* Take the complement image ($Cx'$) of the binarized image ($Bx'$).

*Step 4:* Take the binary image ($Bx'$) with all zeros and consider it as hole.

$$Hx'_q, where \quad q=0$$

*Step 5:* Catch a point (*po*) inside the hole.

*Step 6:* Check whether $Bx'_q \neq Bx'_{q-1}$ then go to step 7

*Step 7:* $B_q=(Bx'_{q-1}\oplus\Gamma)\cap Cx'$ where $\Gamma$ is the structuring element defined as $\begin{bmatrix}0&1&0\\1&1&1\\0&1&0\end{bmatrix}$

*Step 8:* If $Bx'_q=Bx'_{q-1}$,then discover the hole filled image ($Hx'$) where $Hx'=Bx'_k\cup Bx'$

*Step 9:* Find the number of connected components ($\hbar$) from the hole filled image ($Hx'$).

*Step 10:* Increment the threshold value ($\varsigma$) as $\varsigma+=0.05$ and go to step 2, Repeat the same until $\varsigma=0.5$.

*Step 12:* Find the index of minimum non zero ($\mathrm{A}$) for each threshold ($\varsigma$).

*Step 13:* If the index of minimum non zero occurs for more than one threshold ($\varsigma$) value, select the highest threshold value ($\varsigma$) among them.

By doing the above steps, the largest filled circle ($L_c$) which indicates the pupil ($Ppl$) without having the hole is obtained. Then the radius of the pupil ($RPpl$) and the centre of the pupil ($CPpl$) are obtained from the largest filled circle ($L_c$).

ii. *Pupil detection*

In order to detect the center of the pupil ($CPpl$) and radius of the pupil ($RPpl$), maximum distance ($md(L_c)$) in the largest filled circle ($L_c$) is computed by traversing both horizontally and vertically. Following that, center ($CPpl$) and radius of the pupil ($RPpl$) is identified by dividing the maximum distance ($md(L_c)$) by 2. By using the obtained center ($CPpl$) and the radius ($RPpl$), pupil ($Ppl$) is detected.

iii. *Iris detection*

For iris identification, the preprocessed iris image is upgraded to have sharp variety at the image limits utilizing histogram evening out. This difference upgraded image is utilized for discovering the external iris range by drawing concentric loops of diverse radii from the understudy focus and the intensities lying over the border of the loop are summed up. Among the applicant iris loops, the loop having most extreme

change in power as for the long ago drawn round is the iris external limit. The sweep of the iris location steps is itemized in the accompanying steps.

*Input:* radius of the pupil ( $RPpl$ ), center of the pupil ( $CPpl$ ), preprocessed image $(x')$

*Output:* Radius of the iris (*IR*)

*Step 1:* Obtain the preprocessed image $(x')$.

*Step 2:* Find the histogram equalized image $HE(x')$

*Step 3:* Compute the size of the preprocessed image $(x' \in R \times C)$

*Step 4:* Calculate the radius of the iris as $IR = Rppl \times 1.5$

*Step 5:* Check whether, $IR \le R/2$, then go to step 6. Otherwise go to step 10

*Step 6:* Set the angle $\vartheta = 0$, and set the summation of the radius of the Iris as $Sum(I_r) = 0$

*Step 7:* Find the coordinates $(i, j)$ of the image

$$i = (Rpp\ l_i) + IR \times \cos(\vartheta)$$

$$j = Rppl_j + IR \times \sin(\vartheta)$$

$$Sum(IR) += HE(x')$$

*Step 8:* Increment the angle $(\vartheta)$ by 10

*Step 9:* If $\varphi \le 360$ go to step 7 otherwise go to step 5

*Step 10:* Change the intensity over circumference

*Step 11:* For i=1 to $IR$ , do the following,

$$differnce_i = |S_i - S_{i+1}|$$

*Step 12:* Find the maximum change in the intensity

*Step 13:* Obtain the radius of the iris $(IR)$

From the radius $(IR)$ which is obtained in the above process is used to segment the iris from the eye image. Thus finally we obtained the iris $(I)$ separately and the obtained iris part $(I)$ passed to the normalization process.

iv. *Adaptive Normalization*

Here, scale based normalization approach [29] is utilized to normalize the iris image $(I)$ in order to preserve the texture property of the features in the iris region $(I)$. In the normalization process, the obtained iris part $(I)$ is converted into Cartesian space to non-uniform polar space. After that, the points lying on the perimeter of the iris $(P(I))$ and pupil circle $(P(ppl))$ are obtained. Subsequently, the range of radius between the pupil and iris boundaries is obtained and it is mapped to a rectangle by considering the distance between the pupil and iris boundaries [29]. Finally, the obtained normalized iris image $(N(I))$ is subjected to feature extraction.

*c) Feature Extraction*

i. *Applying Unbalanced Haar Wavelet*

By passing the localized iris image through the uneven haar wavelet filter coefficients are computed and are applied as attributes. The separate uneven haar wavelet is a decay of one dimensional data concerning an orthonormal haar like basis where jumps vectors do not essentially happen in the middle of their support. At this point, we employ the UH wavelets to incarcerate the texture attributes from the preprocessed image. Not like the traditional wavelet transform, the uneven haar wavelet works as follows:

- Take the transform of the data with respect to an uneven haar basis
- Threshold the coefficients
- Take the opposite transform

We acquire three texture attributes such as starting point ( $(s)$ ), ending point ( $(e)$ ), and break point ( $(b)$ ) which is detailed in by employing the UH wavelet [28]. A fundamental problem in non-parametric regression is the estimation of a one dimensional function $f : [0,1 \to R]$ from noisy measurements $X_i$ observed on an equispaced grid:

$$X_i = f(i/n) + \varepsilon_i, i = 1,...,n, \qquad (8)$$

Where $\varepsilon_i's$ are random variables with $E(\varepsilon_i) = 0.$ We first give a description of the construction of the UH vectors. Suppose that our domain is indexed by $i = 1,...,n,$ as is the case in $(8),$ and that $n \ge 2.$ We first construct a vector $\psi^{0,1},$ which is constant and positive for $i = 1,...,b^{0,1},$ and constant and negative for $i = b^{0,1} + {}^{-}1,.,n.$ The breakpoint $b^{0,1} < n$ is to be chosen by the analyst. The positive and negative values taken by $\psi^{0,1}$ are chosen in such a way that $(a)$ the elements of $\psi^{0,1}$ sum to zero, and $(b)$ the squared elements of $\psi^{0,1}$ sum to one.

We then recursively repeat this construction on the two parts of the domain determined by $\psi^{0,1}$ :that is provided that $b^{0,1} \ge 2,$ we construct (in a similar fashion) a vector $\psi^{1,1}$ supported on $i = 1,...,b^{0,1},$ with a breakpoint $b^{1,1}.$ Also, provided that $n - b^{0,1} \ge 2,$ we

construct a vector $\psi^{1,2}$ supported on $i = b^{0,1}+1,...n$ with a breakpoint $b^{1,2}$. The recursion then continues in the same manner for as long as feasible, with each vector $\psi^{j,k}$ having at most two "children" vectors $\psi^{j+1,2k-1}$ and $\psi^{j+1,2k.}$ For each vector $\psi^{j,k}$ ,their start, breakpoint and end indices are denoted by $s^{j,k}, b^{j,k}$ and $e^{j,k}$, respectively. Additionally, we define a vector $\psi^{-1,1}$ with elements $\psi^{-1,1}(l) = n^{-1/2}\mathrm{I}(1 \le l \le n),$ where $\mathrm{I}(.)$ is the indicator function. Note that to shorten notation, we do not explicitly emphasis the dependence of $\psi^{j,k}$ on $(s^{j,k}, b^{j,k}, e^{j,k})$. The indices $j,k$ are scale and location parameters, respectively.

*Steps in DUHT*

- Take the input domain $X_{i,} i = 1,...n, n \ge 2.$
- Fix $p_o$ between the range of $1/2$ , 1 which is independent of n.
- Define the unbalanced Haar Mother Vector $\psi_{s,b,e}$ where the s,b and c are the start, breakpoint and end with elements

$$= \left\{\frac{1}{b-s+1} - \frac{1}{e-s+1}\right\}^{1/2} \Pi(s \le l < b) - \left\{\frac{1}{e-b} - \frac{1}{e-s+1}\right\}^{1/2} \Pi(b+1 \le l < e). \quad (9)$$

The inner product between $X$ and $\psi 1, b^{0,1}, n$ is maximized in absolute value. More formally, $b^{0,1} = \arg\max |< X, \psi, B, n >|$, the range of $b$ is such that assumption 3.1 holds with $p = p_o$ choose $b^{j+1,l} = \arg\max |< X, \Psi_{s^{j+1,l}}, b, e^{j+1,l>}|$, where $l = 2k-1, 2k$ again the range of $b$ is such that assumption 3.1 holds with $p = p_{o.}$

*a. Assumption*

Let $|\psi^{j,k}|, |\psi^{j,k}|^{+} and |\psi^{j,k}|^{-}$ denote the number of non-zero, positive and negative components of the vector $\psi_{j,k,}$ respectively. There exists a fixed constant $p \in [1/2, 1]$ such that for all n, we have

$$\max\left\{\frac{|\psi^{j,k}|^{+}}{|\psi^{j,k}|}, \frac{|\psi^{j,k}|^{-}}{|\psi^{j,k}|}\right\} \le p, \quad (10)$$

Uniformly over $j \ge 0$ and $k$ .The condition that both rations should both be bounded away from 1 can be interpreted as the requirement that the UH basis should not be "too unbalanced".

*b. Assumption*

Let $b = \{b^{j,k}\}_{j,k}$ be a set of breakpoints which determines a UH basis defined on $\{1,....n\}$. Let the total numbers of scales $j$ and $b$ be denoted by $J(n)$. If Assumption 3.1 holds, then

$$J(n) \le \left[\log_{1/p} n\right]. \quad (11)$$

Let the $i^{th}$ component of the vector $\psi_{j,k,}$ The inverse DUHT is performed via direct multiplication and addition, using the Parseval identity

$$X_i = \sum_{j,k} DUHT(X)^{J,K} \psi^{J,K}(i). \quad (12)$$

1. Perform Discreet Unbalanced Haar Wavelet Transform of the vector $X = \{X_i\}_{i=1}^{n}$ with respect to the basis $b$. Let $Y_{j,k} = DUHT(X)^{J,K}$. After the transformation the regression problem $(8)$ can be written as,

$$Y_{j,k} = d_{j,k} + \varepsilon_{j,k.} \quad (13)$$

Where $d_{j,k} = DUHT(f)^{j,k}$ with $f = \{f(i/n)\}_{i=1}^{n}$ and $\varepsilon_{j,k} = DUHT(\varepsilon)^{J,K}$ with $\varepsilon = \{\varepsilon_i\}_{i=1}^{n}$. The $d_{j,k}$'s are the true UH coefficients of **f** which are known and need to be estimated.

- Estimate each $d_{j,k}$ by means of a suitable "universal" shrinkage rule $d_{j,k} = h(Y_{j,k}, \lambda)$, where the function $h$ has the property that $h(y, \lambda) = 0$ if and only if $|y| \le \lambda,$ and the "threshold" parameter $\lambda$ is set equal to $\sigma(2\log n)^{1/2}$.

The localized iris image is subjected to attain modified multi text on histogram feature after finding the UH wavelet features.

ii. *Modified Multi Text on Histogram Feature Extraction $(H(V_2))$*

To remove the attributes from the images, MTH (Liu, *et al.*, 2010) [26] is a dominant device which extorts the feature from the iris image by combining the benefits of co-occurrence matrix and histogram. Besides with these benefits, mean and variance measures are applied to develop the feature extraction process.

By using the sobel operator on the iris image along both the horizontal and the vertical directions, the gradient images $(gx'x, gx'y)$ is computed in order to locate the modified multi Texton histogram feature

(MMTH). After that, gradient map $(gx'(x,y))$ is erected by means of the gradient magnitude $(mag)$ and the orientation $(ori)$. The gradient magnitude $(mag)$ and the orientation $(ori)$ are worked out as give

$$mag = \sqrt{(gx'x^2 + gx'y^2)} \quad (14)$$

$$ori = \tan^{-1}\left(gx'y \Big/ gx'x\right) \quad (15)$$

The MMTH feature extraction process consists of following three steps:

- Computing Original Image Feature ( $H(V_1)$ )
- Computing Orientation Image Feature ( $H(V_2)$ )
- Modified Histogram Features ( $H(V)$ )

*a. Computing Original Image Feature ( $H(V_1)$ )*

Initially, the unique iris image is fragmented in to a number of grids where the grid may have the size of 3x3, 5x5 and so on. Subsequently for every grid, mean ( $m$ ) and variance ( $v$ ) are computed and by means of those calculated mean ( $mean$ ) and variance ( $\mathrm{var}$ ), threshold value ( $t_v$ ) is calculated.

$$t_v = \{ mean + \mathrm{var}, mean - \mathrm{var} \} \quad (16)$$

Then for each grid, the center pixel value is compared with the threshold value ($t_v$).

$$C_p(i) = \begin{cases} mean & , t_v = \{(mean(i) + \mathrm{var}(i)) \geq t_v \geq (mean(i) - \mathrm{var}(i)\} \\ Unchanged, & otherwise \end{cases} \quad (17)$$

But the center pixel value lies in between the threshold value ( $t_v$ ), it is substituted with the mean value of the grid or else not as shown in equiv. (11). The grids are partly covered and this process is used for all the grids. The histogram vector ( $H(V_1)$ ) is attained after completing the interchanging process, by finding the frequency of grids (not pixels) based on every grey levels only from the recognized areas.

*b. Computing Orientation Image Feature $(c)$*

After obtaining the orientation image i.e. the gradient image as mentioned above using equiv. (8) & (9), the same process done for the original image as explained in section 3.2.1. is repeated for the orientation image. Finally, the histogram vector is obtained, denoted as $H(V_2)$ only from the identified regions.

*c. Modified Histogram Features ( $H(V)$ )*

The determined vectors achieved such as ( $H(V_1)$ ) and ( $H(V_2)$ ) are concatenated to acquire the MMTH feature ( $H(V)$ ). The attained MMTH features are subsequently focused to clustering process.

*d) Modified Fuzzy C means Algorithm*

To attain the cluster, the resultant MMTH features are subsequently passed to the MFCM. Fuzzy c-means (FCM) is a technique of clustering which permits one piece of data to belong to two or more clusters. This technique is often applied in pattern recognition. To develop the clustering result adapted FCM is applied based on minimization of the objective function specified in equiv. (12): In our suggested method, the texture attributes computed are clustered in to 2 clusters by means of MFCM.

$$O = \sum_{r=1}^{N}\sum_{j=1}^{c}\left[(1-\alpha)\mu^{m}{}_{ij}(x_i - c_j)^2\right] \quad (18)$$

Where, $m$ is any real number greater than 1, $u_{ij}$ is the degree of membership of $x_i$ in the cluster $j$, $x_i$ is the $i$th of d-dimensional measured data, $c_j$ is the d-dimension center of the cluster, and $||*||$ is any norm conveying the resemblance between any calculated data and the center. Fuzzy partitioning is executed through an iterative optimization of the objective function shown above, with the revise of membership $u_{ij}$ and the cluster centers $c_j$ by:

$$\mu_{ij} = \frac{1}{\sum_{k=1}^{c}\left(\frac{\| x_i - c_j \|}{\| x_i - c_k \|}\right)^{2/m-1}} \quad (19)$$

$$c_j = \frac{\sum_{i=1}^{N}\mu_{ij}^{m} x_j}{\sum_{i=1}^{N}\mu_{ij}^{m}} \quad (20)$$

This iteration will end when $\max_{ij}\left\{\left|\mu_{ij}^{k+1} - \mu_{ij}^{k}\right|\right\} < \tau$ , where $\tau$ a termination criterion between 0 and 1, whilek isthe iteration step. This process unites to a local minimum or a saddle point of O. The collected attributes are subsequently passed to the next process that is dimensionality reduction.

*e) Dimensionality Reduction using Principle Component Analysis*

For reaching this overview, Principal component analysis is a quantitatively hard method. The method

assesses a novel set of variables, called principal components. Each principal component is a linear mixture of the real values. The entire principal components are orthogonal to each other, so there is no unnecessary information. The principal components as a total form an orthogonal basis for the space of the information. Principal component analysis is a changeable reduction process. It is constructive when you have attained data on a number of variables and consider that there is some idleness in those variables. In this case, redundancy represents that some of the variables are linked with one another, probably because they are measuring the similar construct. As of this redundancy, you consider that it should be probable to decrease the observed variables into a smaller number of principal components that will report for most of the variance in the examined variables. For analyzing information, PCA is a dominant device. This will obtain you through the steps you required to execute a Principle Components Analysis on a set of data. At this point, attributes in each cluster are decreased and as a result the reduced cluster features are employed for additional process.

i. *Steps for Reducing the Dimensionality of the Features:*

*Step 1:* Obtain a set of features from a cluster

*Step 2:* Discover the difference between the features

*Step 3:* Compute the covariance matrix

*Step 4:* Compute the Eigen vectors and Eigen values of a matrix

*Step 5:* Arrange eigenvectors in descending order of eigen values

*Step 6:* Create the reduced set of features.

Thus the dimension reduced features are then passed in to FFBNN to continue the recognition process. The obtained feature vector has the length of 6.

*f) Recognition*

Feed Forward neural Network (FFBNN) is applied to identify the iris. In the training phase, uneven wavelet coefficients and the dimension reduced features are specified as the input to the FFBNN. Using these texture features, the neural network is well educated in order to identify the iris. The neural network contains n number of input units, $h$ hidden units and one output unit. The structure of the FFBNN is specified as below:

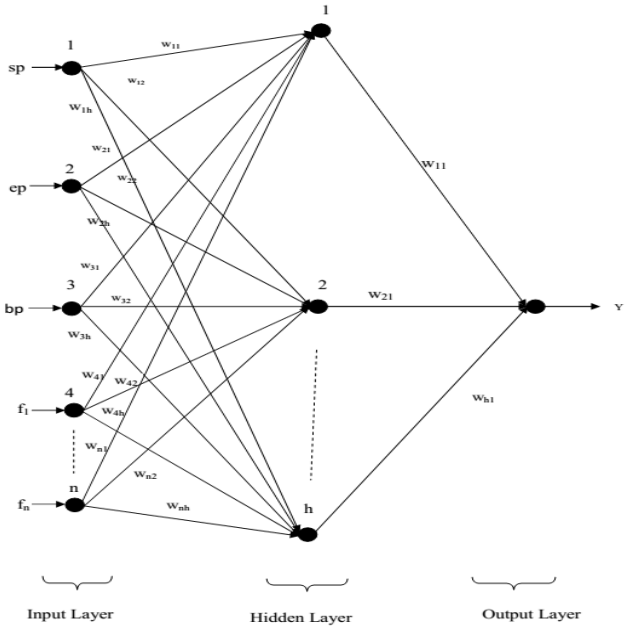



*Figure 2 :* Diagram of the FFBNN

- For all the neurons, assign weights randomly except for input neurons.
- The bias function and activation function for the neural network is explained beneath.

$$x(t) = \beta + \sum_{n=1}^{H} \left( w_{tn} sp_{tn} + w_{tn} bp_{tn} + w_{tn} ep_{tn} + w_{tn} f_{t1} \ldots, + w_{tn} f_{tn} \right) \quad (21)$$

$$x(a) = \frac{1}{1 + e^{-x(t)}} \quad (22)$$

In bias function $sp_{tn}, bp_{tn}, ep_{tn}, f_{t1}, f_{t2} \ldots f_{tn}$ are the uneven coefficients such as starting point, break point, ending point and features attained after dimension reduction correspondingly. The activation function for the output layer is specified in Eq. (16).

- Get the learning error.

$$Er = \frac{1}{h} \sum_{n=0}^{h-1} D_n - A_n \quad (23)$$

$Er$ is the FFBNN network output, $D_n$ *and* $A_n$ are the preferred and actual outputs and $h$ is the total number of neurons in the unseen layer.

i. *Error Minimization*

Weights are assigned to the unseen layer and output layer neurons by arbitrarily selected weights. The input layer neurons have a stable weight.

- Find out the bias function and the activation function.

- Compute BP mistake for every node and revise the weights as follows:

$$w_{(tn)} = w_{(tn)} + \Delta w_{(tn)} \quad (24)$$

$\Delta w_{(tn)}$ is attained as,

$$\Delta w_{(tn)} = \delta . x(t_n) . B \quad (25)$$

Where $\delta$ is the learning rate, which usually ranges from 0.2 to 0.5, and $Be$ is the Back Propagation fault.

- Next do again the steps (2) and (3) until the Back propagation error gets minimized. The process is continued till it satisfies $B < 0.1$.
- The error gets minimized to a minimum value the FFBNN is well trained for executing the testing phase.

The result of the neural network $(y)$ is compared with the threshold value $(\tau)$ after that. If it pleases the threshold value, the iris is known or else not.

$$result = \begin{cases} iris, & y \geq \tau, \\ non\,iris, & y < \tau \end{cases} \quad (26)$$

Using ABC, the FFBNN parameters $(w_{tn}, \beta)$ are optimized in order to get higher precision and successful presentation in the recognition of iris. White testing more number of input images specified to the well instructed FFBNN-ABC to authenticate whether it makes out the iris images suitably or not.

ii. *Optimization of FFBNN parameters by ABC*

Now we are applying the ABC algorithm for optimizing the parameters of FFBNN while training to acquire competent iris recognition result. ABC algorithm is a swarm based meta-heuristic algorithm which was motivated by the sharp foraging behavior of the honey bees. It contains three components namely, employed bees, onlooker bees and scout bees. The employed bees are combined with the food sources in the region of the hive and they shift the data to the onlookers about the nectar quality of the food sources they are utilizing. Onlooker bees are looking the dance of the employed bees within the hive to pick one food source to use according to the data offered by the employed bees. The employed bees whose food source is discarded turn into Scout and look for novel food source randomly. The number of food sources indicates the location of probable solutions of optimization problem and the nectar amount of a food source represents the quality of the solution. The FFBNN parameters $(w_{tn}, \beta)$ are optimized by means of ABC. The fitness function desired here is eqn. (15). This optimization of FFBNN parameters by ABC gives higher recognition result and efficient concert.

*a. Initial Phase*

Initially the population of the food sources $x_i$ $(i = 1,2,....N)$ are produced randomly. $N$ Indicates the size of the population. This food sources encloses the FFBNN parameters $(w_{tn}, \beta)$. This generation process is called as initialization process. The fitness value of the produced food sources is computed by equation (15) to assess the best food source.

*b. Employed Bee Phase*

Using the beneath equation, novel population parameters are produced in the employed bee phase,

$$V_{i,j} = x_{i,j} + \phi_{ij}(x_{i,j} - x_{k,j}) \quad (27)$$

Where, $k$ and $j$ is an arbitrary chosen index, $\phi$ is randomly produced number in the range [-1, 1] and $V_{i,j}$ is the novel value of the $j^{th}$ position. Next the fitness value is calculated for every novel generated population parameters of food sources. From the calculated fitness value of the population, best population parameter is chosen i.e. the population parameter, which has the highest fitness value by using greedy selection process. Probability of the chosen parameter is calculated by the equation (22) after choosing the best population parameter.

$$P_j = \frac{F_j}{\sum_{j=1}^{d} F_j} \quad (28)$$

Where, $P_j$ is the probability of the $j^{th}$ parameter.

*c. Onlooker Bee Phase*

Number of onlooker bees is calculated approximately after computing the possibility of the chosen parameter. Next, generate novel solutions $(V_{i,j})$ for the onlooker bees from the solutions $(x_{i,j})$ based on the probability value $(P_j)$. After that the fitness function is computed for the novel solution. In order to choose the best parameter, use the greedy selection process later.

*d. Scout Bee Phase*

Find out the abandoned parameters for the scout bees. If any abandoned parameter is present, after that substitute that with the novel parameters found out by scouts by means of the equation (28) and assesses the fitness value. After that memorize the best parameters accomplished so far. Afterward the iteration is increased and the process is prolonged till the stopping criterion is arrived.

## IV. Experimental Results

Our proposed iris recognition system with FFBNN-ABC is implemented in the working platform of MATLAB (version 7.13).Our proposed iris recognition

system is the combination of FFBNN and ABC. In order to reduce the computation complexity and get higher performance, the dimensionality of features is reduced with the help of the well-known optimization algorithm PCA. Then the dimensionality reduced features are given to the FFBNN to achieve the training process. So as to get more accuracy in the process of recognition, the FFBNN parameters are optimized using ABC algorithm. In the testing process, more data are given to the well trained FFBNN-ABC to validate the performance of the proposed technique. The performance of the proposed iris recognition system is evaluated using CASIA database and the proposed technique's performance is compared with the existing iris recognition systems given in [21], [23] and [24].

*a) Performance Analysis*

By applying the statistical measures which is specified in [27], the concert of our suggested iris recognition system is examined. We employ CASIA iris thousand –NG database which has 788 number of iris images to complete the performance analysis process. For one dataset, our proposed technique takes 0.3225 seconds for training and 0.0054 seconds for testing. Totally our database consists of 51 dataset. The performance of the proposed technique is compared with other classifiers such as FFBN, FFBN_GA, Fuzzy, ANFIS&KNN and the corresponding statistical measures are given in Table 1(i). Then the performance of the proposed technique is analyzed by using Unbalanced Haar Wavelet and it is compared with other wavelets such as Haar, Coif let, Symlet & Bi-orthogonal wavelet and the corresponding statistical measures are given in Table 1(ii). Also our suggested iris recognition system performance is assessed and compared with the conventional iris recognition system given in [21], [23] & [24] and the corresponding statistical measures are given in Table 1(iii). Figure 3, 4 and 5illustrate the sample of iris images, preprocessed images and iris segmented images correspondingly.

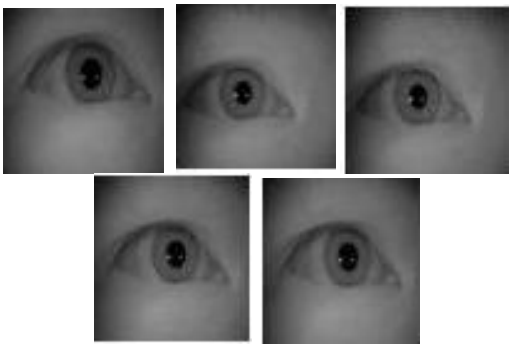


*Figure 3 :* Sample eye images

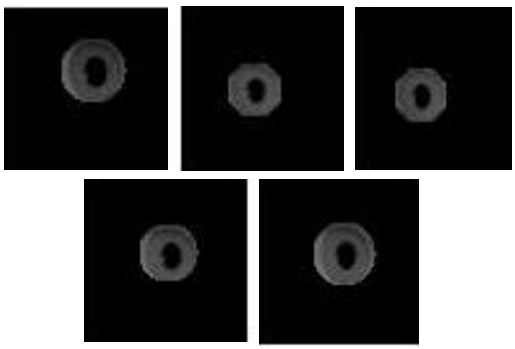


*Figure 4 :* Preprocessed eye images

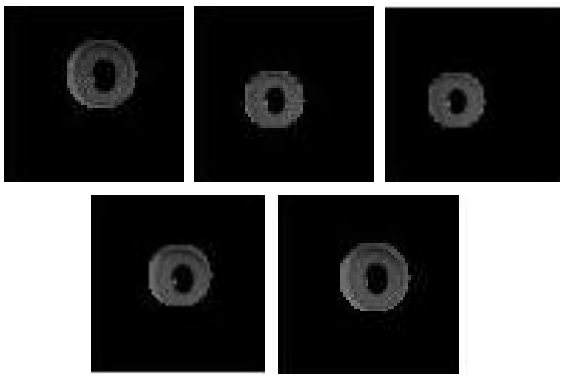


*Figure 5 :* Segmented iris image

| Measures | Proposed Technique | FFBNN | FFBNN-GA | FUZZY | ANFIS | KNN |
|---|---|---|---|---|---|---|
| Accuracy | 98.8317757 | 96.95431472 | 96.95431472 | 96.44670051 | 96.57360406 | 97.20812183 |
| Sensitivity | 98.69451697 | 97.07446809 | 97.32620321 | 96.79144385 | 97.30458221 | 97.34042553 |
| Specificity | 100 | 96.84466019 | 96.61835749 | 96.1352657 | 95.92326139 | 97.08737864 |
| FPR | 0 | 3.155339806 | 3.381642512 | 3.8647343 | 4.076738609 | 2.912621359 |
| PPV | 100 | 96.56084656 | 96.2962963 | 95.76719577 | 95.5026455 | 96.82539683 |
| NPV | 90 | 97.31707317 | 97.56097561 | 97.07317073 | 97.56097561 | 97.56097561 |
| FDR | 0 | 3.439153439 | 3.703703704 | 4.232804233 | 4.497354497 | 3.174603175 |
| MCC | 94.2470505 | 93.89852174 | 93.90090616 | 92.88352799 | 93.14569616 | 94.40708603 |
| FAR | 0 | 3.155339806 | 3.381642512 | 3.8647343 | 4.076738609 | 2.912621359 |
| FRR | 1.305483029 | 2.925531915 | 2.673796791 | 3.20855615 | 2.69541779 | 2.659574468 |

(i)

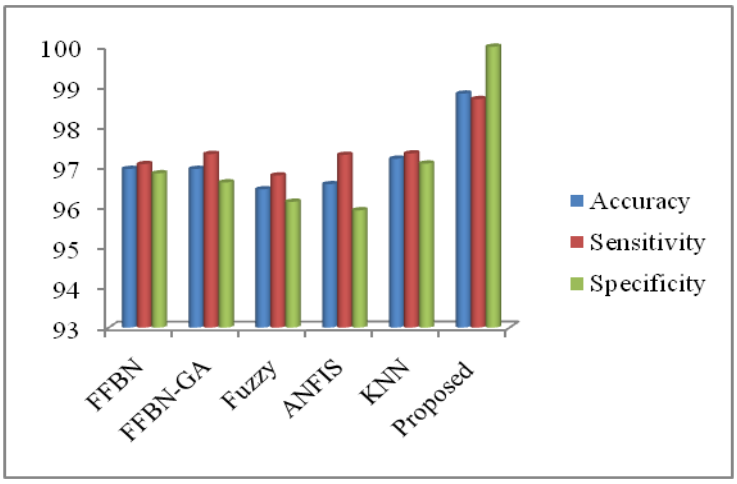
| Measures | Proposed Technique (UH) | Haar | Coiflet | Symlet | Bi-orthogonal |
|---|---|---|---|---|---|
| Accuracy | 98.8317757 | 97.96954315 | 97.71573604 | 97.84263959 | 97.46192893 |
| Sensitivity | 98.69451697 | 97.38219895 | 97.36842105 | 97.37532808 | 97.35449735 |
| Specificity | 100 | 98.52216749 | 98.03921569 | 98.28009828 | 97.56097561 |
| FPR | 0 | 1.477832512 | 1.960784314 | 1.71990172 | 2.43902439 |
| PPV | 100 | 98.41269841 | 97.88359788 | 98.14814815 | 97.35449735 |
| NPV | 90 | 97.56097561 | 97.56097561 | 97.56097561 | 97.56097561 |
| FDR | 0 | 1.587301587 | 2.116402116 | 1.851851852 | 2.645502646 |
| MCC | 94.2470505 | 95.93901397 | 95.42610333 | 95.68227129 | 94.91547296 |
| FAR | 0 | 1.477832512 | 1.960784314 | 1.71990172 | 2.43902439 |
| FRR | 1.305483029 | 2.617801047 | 2.631578947 | 2.624671916 | 2.645502646 |

(ii)

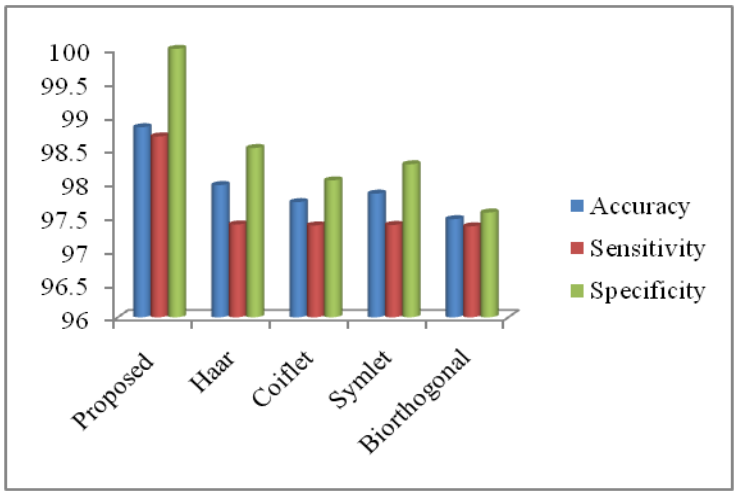
| Measures | Proposed Technique | Existing[21] | Existing[24] | Existing[23] |
|---|---|---|---|---|
| Accuracy | 98.8317757 | 97.84263959 | 98.0964467 | 97.20812183 |
| Sensitivity | 98.69451697 | 97.37532808 | 98.65951743 | 97.34042553 |
| Specificity | 100 | 98.28009828 | 97.59036145 | 97.08737864 |
| FPR | 0 | 1.71990172 | 2.409638554 | 2.912621359 |
| PPV | 100 | 98.14814815 | 97.35449735 | 96.82539683 |
| NPV | 90 | 97.56097561 | 98.7804878 | 97.56097561 |
| FDR | 0 | 1.851851852 | 2.645502646 | 3.174603175 |
| MCC | 94.2470505 | 95.68227129 | 96.19241486 | 94.40708603 |
| FAR | 0 | 1.71990172 | 2.409638554 | 0 |
| FRR | 1.305483029 | 2.624671916 | 1.340482574 | 2.659574468 |

(iii)

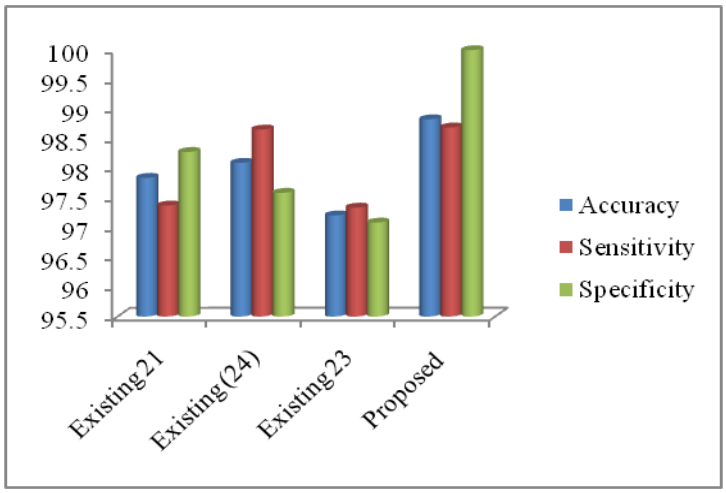
*Table 1 :* Performance measures of Proposed FFBNN-ABC-PCA technique with other (i) other classifiers (ii) other wavelets (iii) existing techniques




(i)




(ii)




(iii)

*Figure 6 :* Graphical Representation for comparison of the performance measures of Proposed FFBNN-ABC-PCA technique with other (i) other classifiers (ii) other wavelets (iii) existing techniques in terms of accuracy, sensitivity and specificity

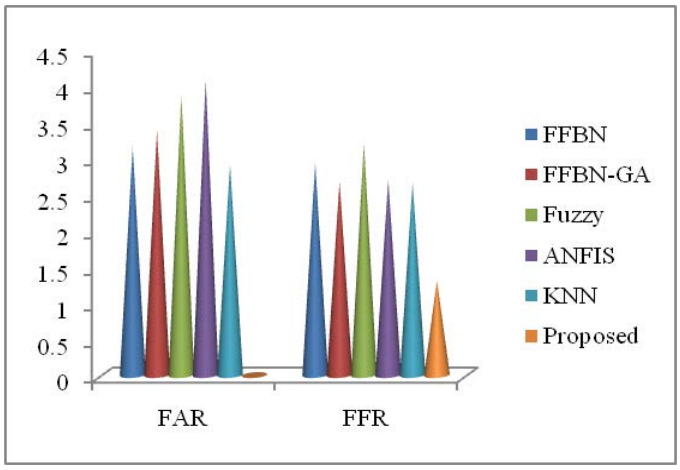
*Discussion:* Comparison of the performance of the proposed technique with different classifiers.

In Table.1(i) and Figure 6.(i), the performance of the proposed technique is compared with various classifiers such as FFBNN, FFBNN-GA, Fuzzy, ANFIS and KNN. By seeing both table and graph, we can say that the proposed technique yields higher rate of accuracy than the proposed technique. From the measurement of the accuracy, we can say that our proposed technique recognize the iris images effectively. In addition to that, the sensitivity and specificity are the two measurements which can provide the additional details about the performance of a technique. On looking at the sensitivity and specificity measures, our proposed technique has given better rate than the other classifiers. In specificity measure, our proposed technique is yielded 100% specificity. Also, when looking at the other measurements such as FPR and FDR, the proposed technique obtained 0% FPR and FDR which indirectly indicates that the proposed technique recognize the iris images accurately.

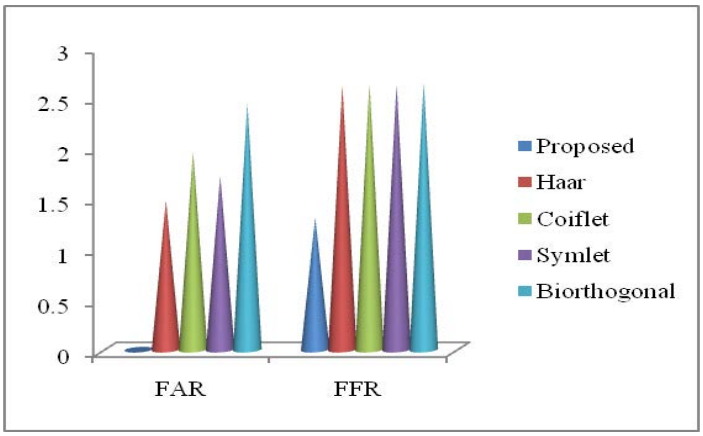
*Discussion:* Comparison of the performance of the proposed technique by changing wavelets and existing techniques.

In Table.1 (ii) and Figure (ii), the performance of the proposed technique is compared by changing wavelets such as Haar, Coif let, Symlet and Bi-Orthogonal. In our proposed technique, Unbalanced Haar Wavelet is utilized. On looking at both table and graph, we can say that the proposed technique yields higher rate of accuracy, sensitivity and specificity when compared to the other wavelet techniques. All the performance measures are showed that our proposed technique recognize the iris images efficiently. Similarly, the performance of the proposed technique is compared with the existing techniques such as [21], [23] and [24] and it is given in Table1.(iii) and figure 6. (iii). As discussed above, our proposed technique

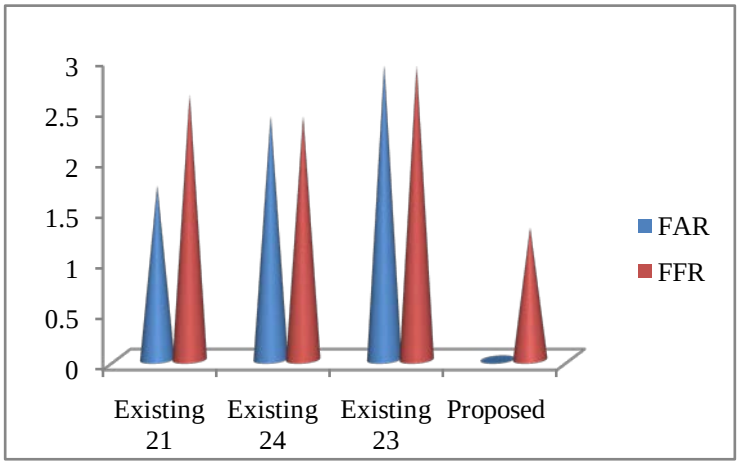
overcomes the existing techniques by offering higher performance rate. Thus it has shown that, it can be used in real time applications




(i)




(ii)




(iii)

*Figure 7 :* Graphical Representation for comparison of the performance measures of Proposed FFBNN-ABC-PCA technique with other (i) other classifiers (ii) other wavelets (iii) existing techniques in terms of FAR and FRR

*Discussion:* Comparison of the performance of the proposed technique with the other techniques in terms of FAR and FRR.

In Figure.7, the performance of the proposed technique is compared with other techniques in terms of FAR and FRR. Our proposed technique has less FRR rate when compared to the other techniques. While seeing the value of FAR, our proposed technique offers 0% of FAR. It adds additional strength to our proposed technique in its performance. Thus our proposed technique proved its efficiency in the recognition of iris.

## V. Conclusion

We have suggested an iris recognition system based on FFBNN and ABC at this point. The suggested system was executed and CASIA iris thousand –NG database is employed to examine the results of the suggested iris recognition system. The presentation study confirmed that the suggested iris recognition system in iris recognition process presents an incredible rate of accuracy (98.8317757), sensitivity, (98.69451697), specificity (100), FAR (0) and FRR (1.305483029). The high value of these measures illustrates that our suggested technique more precisely identifies the iris images from the specified test images. Based on FFBNN-ABC, the comparison result illustrates that our suggested iris recognition system has specified high accuracy than existing methods. Hence our suggested iris recognition system competently identifies the iris imaged by applying the FFBNN and ABC techniques.

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Global Journal of Researches in Engineering: J
General Engineering
Volume 14 Issue 4 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

# The Epileptic Nature of Electricity Supply and its Consequences on Industrial and Economic Performance in Nigeria

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*Abstract-* Nigeria industrial development over the years has been bedevilled by myriads of problems top among which is the erratic nature of electricity supply in the energy or power sector. Every successive government had promised to do something drastic to stabilize the sector in other to drive growth in the industrial sector. However, more than hundred years of amalgamation of northern and southern protectorate and 54 years after the attainment of independent in Nigeria, the Nation is plagued with chronic under development in every area of lives including poor, unreliable and epileptic electricity supply. This has no doubt affected the performance of industrial sector as an engine of growth in Nigeria and as such this paper was premised on testing empirically the impact of electricity supply on industrial and economic development in Nigeria from 1972 – 2010. To achieve this, the paper employed the Granger Causality test and the ARDL bounds test approach to cointegration proposed by Pesaran et al (2001). In order to determine the time series characteristics of variables used in the regression, the paper adopted the approach of NG and Perron (2001) modified unit root test. The Granger Causality results showed that there is a feedback causal relationship between GDP per capita and electricity supply. Unidirectional relationship is seen between capital employed and GDP per capita without a feedback effect, running from capital to GDP per capita.

*Keywords: industrial performance, electricity supply, economic development, error correction.*

*GJRE-J Classification : FOR Code: 660301, 091599*


*Strictly as per the compliance and regulations of:*

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## I. Introduction

Industrialization, which is a deliberate and sustained application and combination of an appropriate technology, infrastructure, managerial expertise, and other important resources, has attracted considerable interest in development economics in recent times. This is because of the critical role industrialization plays in economic development. Industrialization acts as a catalyst that accelerates the pace of structural transformation and diversification of economies; enables a country to fully utilize its or endowment and to depend less on foreign supply of finished goods or raw materials for its economic growth, development and sustenance.

In recognition of the importance of industrialization to economic growth and development, Nigeria since independence has adopted various policies, incentives and schemes to promote industrialization. Some of these policies include the import substitution, indigenisation policy (1972) structural adjustment programme (SAP) of the late 1980s. In 2000, Bank of industry, and small and medium equity investment schemes was established to reduce credit constraints faced by entrepreneurs. And recently in 2007, the Federal Government adopted the National Integrated Industrial Development (NIID) blueprint.

Despite these policies and incentives, available statistics indicate that the industrial sector seems to be experiencing sluggish growth. The survey by Manufacturing Association of Nigerian the first quarter of 2006 paint a gloomy picture of the Nigerian crisis industrial sector. For instance, the survey showed that only 10 per cent of manufacturing concerns in Nigeria operate at 48.8 per cent of installed capacity. The survey also notes that about 60 per cent of the companies operating were barely able to cover their average variable costs, while 30 per cent had completely closed down. According to that report, most of the industrial areas around the country suffered an average of 14.5 hours of power outage per day as against 9.5 hours of supply, and the cost generating power supply by firms for production constitute about 36 per cent of total cost of production (Okafor, 2008; Adegbamigbe, 2007 and Udaejah, 2006). Indeed, Nigeria's electricity sector is in crisis.

The supply of e1ecricity supply of in Nigeria is bedevilled with consistent crisis as exemplified by such indicators as electricity blackouts and persistent on self generating electricity. Indeed as noted by Ekpo (2009), Nigeria is running a generator economy with its adverse

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effect on cost of production. The country's electricity market is dominated on supply side by a state owned monopoly — Nigeria Electricity Distribution Company (NEDC) , the private and current owner of the former Power Holding Company of Nigeria (PHCN) and the National Electrical Power Authority (NEPA) — has been incapable of providing minimum acceptable international standards of electricity service that is reliable, accessible and available for the past decades.

Available statistics indicating the percentage utilization of the installed capacity of electricity and index of industrial production lends further credence to the nature of the electricity crisis. Example, in the decades of the 1970s, the installed capacity of electricity generation in megawatts is 1,097.79, while the average capacity utilization was 35.58 per cent. Installed capacity improved marginally to about 3,318.83 and only an average of 33.43 per cent was actually utilized in 1980s. The period from 1990 to 2003, saw average installed electricity generating capacity of about 6000MW, whereas the utilization rate was on the average below 40 per cent. In the 2007, installed electricity generation capacity was about 7,011MW, while actual utilization rate was 37.4 per cent (Okafor, 2008).

The low and unstable capacity utilization, evident in the average capacity utilization of less40 per cent in more than three decades, shows the large gap between installed and actual operational capacity. This large gap clearly indicates the level of technical inefficiency in the power system. Nigeria's persistent electricity crises have weakened the industrialization process, resulting to production stoppages and high operational cost, and significantly undermined the efforts of government of Nigeria to achieve sustained economic growth and development.

The objective of this paper therefore, is to investigate the joint interaction of industrialization, electricity supply, and economic development in Nigeria from 1972 to 2010, within the framework of autoregressive distributed lag (ARDL) bounds testing approach to co-integration proposed by Pesaranet (2001). The significance of this study is to demonstrate empirically that however novel policies on incentives to drive the industrial sector are, if the electricity supply problem is not fixed, the policy objective, accelerating the growth of the industrial sector may not be realized.

Following the introduction, the rest of the paper is organized into six sections. Section two discussed the relevant literature and the theoretical underpinnings of the paper. In section three the paper attempts to examine the industrial development policies, incentives and institutions put place in Nigeria since independence to stimulate industrial development. The model and methodology of the study is presented in section four, and in section five empirical results are discussed while the paper concluding remarks was examined in section six.

## II. Literature Review and Theoretical Framework

They are plethora of literature on the interaction of electricity crisis, industrial growth and economic development. Odell (1995) argued that for Columbia to industrialize, electricity supply and demand are important elements of the process. Iwayemi (1988) argued for the importance of energy Sector in the socio-economic development of Nigeria. He submitted that strong demand and increased supply would stimulate increased income and higher living standards. Okafor (2008) used descriptive analysis to corroborate the views of these authors by arguing that poor and inefficient electricity supply has adverse implication for industrial development in Nigeria.

Oke (2006) attributed the non-competitiveness of Nigeria's export goods to poor infrastructure especially electricity supply, which drives the running cost of firms. Archibong (1997) argued that the positive side of SAP could not be fully established due to administrative bottlenecks, rigidities and poor infrastructure, especially electricity supply. This undermined the effectiveness of fiscal and other incentives designed to stimulate the growth and diversification of the economy.

Ndebbio (2006) argued that electricity supply drives industrialization process. He submitted that one important indicator whether a country is industrialized or not is the megawatt of electricity consumed. He further argued that a country's electricity consumption per-capita in kilowatt hours (KWH) is proportional to the state of industrialization of that country. Ukpong (1976) established the existence of a positive relationship between electricity consumption and economic development. In addition, he submitted that the expansion of energy sector on the demand side is important factor in accelerating the growth of the industrial sector. Ekpo (2009) elaborated on the folly of running a generator economy and its adverse effects on investment. He strongly argued that for Nigeria to jump start and accelerate the pace of economic growth and development, the country should fix power supply problem. Aigbokan (1999) argued in his paper that fixing the energy sector is tantamount to shifting the production possibility curve of the country's economy.

Adenikinju (2005) provided a strong argument to support the importance of energy supply. The poor nature of electricity supply in Nigeria, he argued, has imposed significant cost on the industrial sector of the economy. This result corroborates the survey of the Manufacturers Association of Nigeria (MAN) 2005. In that survey MAN indicated that the costs of generating power constitute about 36 percent of production.

Most of the empirical literature focused on the demand side, and studies that were supply biased were mostly descriptive in nature. To the best of the author's

knowledge, no study in Nigeria has attempted to test empirically the causal and long-run relationship between economic developments, industrialization and electricity supply using the ARDL bounds test approach to cointegration from the supply side. The gap this paper intends to fill.

There are a range of competing theories to the study of economic development. Each approach has its strength and weaknesses with different ideological, theoretical and empirical analysis. The theories include the classic theories of economic development and the endogenous growth model. The Classic theories have four approaches:

a) The Linear-stages theories: This includes the Rostow's stages of growth and the Harrod-Domar Growth Model.
b) Structural Change Models: The Lewis theory of development and structural change.
c) The international dependency revolution: This includes the Neoclassical Dependence Model, false paradigm model and the Dualistic-Development Thesis.
d) The traditional neoclassical growth model

This study is anchored on the endogenous growth model. The motivation for the endogenous growth model stems from the failure of the neoclassical theories to explain the sources of long-run economic growth. The neoclassical theory does not explain the intrinsic characteristic of economies that causes them to grow over extended period of time. The neoclassical theory focuses on the dynamic process through which capital-labour ratios approach long-run equilibrium. In the absence of external technological change, which is not clearly explained in the neoclassical model, all economies will converge to zero growth.

The neoclassical theory see rising GDP as a temporary phenomenon resulting from technological change or a short-term equilibrating process in which an economy approaches its long- run equilibrium. The neoclassical theory credits the bulk of economic growth to a completely independent process of technological progress.

According to neoclassical theory, the low capital-labour ratios of developing countries promise exceptionally high rates of return on investment. Based on this premise, it was expected that the free- market reforms imposed on highly indebted countries by the World Bank and the International Monetary Fund should have prompted higher investment, rising productivity, and improved standards of living. Yet even after the prescribed liberalization of trade and domestic markets, many LDCs experienced little or no growth and failed to attract new foreign investment or to halt the flight of domestic capital. The anomalous behavior of developing-world capital flows (from poor to rich nations) helped provide the impetus for the development of the concept of endogenous growth or, more simply, the new growth theory. The new growth theory represents a key component of the emerging development theory.

The new growth theory provides a theoretical framework for analyzing endogenous growth, persistent GNP growth that is determined by the system governing the production process rather than by forces outside that system. In contrast to traditional neoclassical theory, these models hold GNP growth to be a natural consequence of long-run equilibrium. The principal motivations of the new growth theory are to explain both growth rate differentials across countries and a greater proportion of the growth observed. In particular, endogenous growth theorists seek to explain the factors that determine the rate of growth of GDP that is left unexplained and exogenously determined in the Solow neoclassical growth equation (that is, the Solow residual).

Models of endogenous growth bear some structural resemblance to their neoclassical counterparts, but they differ considerably in their underlying assumptions and the conclusions drawn. The most significant theoretical differences stem from discarding the neoclassical assumption of diminishing marginal returns to capital investments, permitting increasing returns to scale in aggregate production, and frequently focusing on the role of externalities in determining the rate of return on capital investments. By assuming that public and private investments in human capital generate external economies and productivity improvements that offset the natural tendency for diminishing returns, endogenous growth theory seeks to explain the existence of increasing returns to scale and the divergent long-term growth patterns among countries. And whereas technology still plays an important role in these models, it is no longer necessary to explain long-term growth.

A useful way to contrast the new (endogenous) growth with traditional neoclassical theory is to recognize that many endogenous growth theories can be expressed by the simple equation Y=AK, as in the Harrod-Domar model. In this formulation, A is intended to represent any factor that affects technology, and K again includes both physical and human capital. And there are no diminishing returns to capital in this formula, so the possibility exists that investments in physical and human capital can generate external economies and productivity improvements that exceed private gains by an amount sufficient to offset diminishing returns. The net result is sustained long-term growth -an outcome prohibited by traditional neoclassical growth theory.

Thus even though the new growth theory reemphasizes the importance of savings and human capital' investments for .achieving rapid growth, it also leads to several implications for growth that are in direct

conflict with traditional theory. First, there is no force leading to the equilibration of growth rates across closed economies; national growth rates remain constant and differ across countries depending on national savings rates and technology levels. Furthermore, there is no tendency for per capita income levels in capital-poor countries to catch up with those in rich countries with similar savings and population growth rates. A serious consequence of these facts is that a temporary or prolonged recession in one country can lead to a permanent increase in the income gap between itself and wealthier countries.

Perhaps the most interesting aspect of endogenous growth models is that they help explain anomalous international flows of capital that exacerbate wealth disparities between developed and developing countries. The potentially high rates of return on investment offered by developing economies with low capital-labour ratios are greatly eroded by lower levels of complementary investments in human capital (education), infrastructure, research and development (R&D). In turn, poor countries benefit less from the broader social gains associated with each of these alternative forms of capital expenditure. Because individuals receive no personal gain from the positive externalities created by their own investments, the free market leads to the accumulation of less than the optimal level of complementary capital.

Where complementary investments produce social as well as private benefits, governments may improve the efficiency of resource allocation. They can do this by providing public goods (infrastructure) or encouraging private investment in knowledge-intensive industries where human capital can be accumulated and subsequent increasing returns to scale generated. Unlike the Solow model, new growth theory models explain technological change as an endogenous outcome of public and private investments in human capital and knowledge-intensive industries. Thus in contrast to the neoclassical counterrevolution theories, models of endogenous growth suggest an active role for public policy in promoting economic development through direct and indirect investments in human capital formation and the encouragement of foreign private investment in knowledge-intensive industries such as computer software and telecommunications (Stern, 1991; Sala-i-Martin, 1990; Romer, 1986; Helpman, 1986; Lucas, 1988; Barro, 1990; Todaro and Smith, 2003).

## III. Overview of Industrial Policies Incentives and Institutional Support

Given the importance and relevance of industrialization (industrial sector) to economic growth and development, Nigeria since independence has put in place various policies, incentives and institutions to drive industrial development. These policies and strategies embarked upon in Nigeria since independence are summarized and presented in this section.

Import Substitution Industrialization policy was the first industrial strategy embarked upon by the Nigeria government immediately after attaining independence. It objectives of this policy among others include to lessen overdependence on foreign trade and to save foreign exchange by producing those items that were formerly imported. For example detergents, food, textiles, household appliances etc.

In 1972, the Nigerian Indigenization policy was adopted following the obvious failure of the import substitution strategy. The major objective of this policy was to strengthen Nigeria economy. others include the transfer of ownership and control to Nigerians in respect of those enterprises formally wholly or mainly owned and controlled by foreigners, fostering widespread ownership of enterprises among Nigerian citizens, the creation of opportunities for Nigeria indigenous businessmen, the encouragement of foreign businessmen and investors to move from the unsophisticated area of economy to the area where large investments are more needed.

The 1972 Act that resulted in the indigenization policy was amended, repealed and replaced bythe Nigerian Enterprises Promotion Act, in 1977. This Act gave birth to the indigenization policy of1977. The 1972 Act contained II schedules, while the 1977 Act contained III schedules. Schedule I of 1977 contained 40 Enterprises, Schedule II contained 57 and Schedule III contained 39. In l98l to beprecise, the number of Enterprises in each schedule was revised. By this, schedule I had 36 Enterprises. Schedule II, 576 Enterprises and Schedule III, 456 Enterprises respectively.

Structural Adjustment Programme (SAP) was adopted in June, 1986 and it received the blessings of Breton Wood institutions. SAP was regarded as the universal recipe that would bring the desired transformation of the economy from agrarian to industrial. In particular, this policy came up to improved the weaknesses, and ineffectiveness of earlier policies. Its aims and objectives include promoting investment, stimulating non-oil exports and providing a base for private sector led development, promote efficiency of Nigeria's industrial sector, privatization and commercialization of investment, develop and utilize local technology by encouraging accelerated development and of local raw materials and intermediate inputs rather than depend on imported ones. The SAP induced industrial policies include interest rate deregulation, debt conversion (equity) swap, privatization and commercialization policy and the new export policy incentive.

In 1989, Trade and Financial Liberalization Policy were enacted purposely to foster competition and efficiency in the financial sector. Its aims and objectives

include, to stimulate competition among the domestic firms and between the domestic imports competing firms and foreign firms in order to promote efficiency, reduction of levels of both tariff and non tariff barriers, the commodity marketing boards and market determination of exchange rate as well as deregulation of interest rates. The National Economic Reconstruction Fund (NERFUND) was established in the same year as complementary institution to the industrial policy. NERFUND seeks to address the medium and long-term financial constraints experienced by small and medium scale entrepreneurs, provide the required financial resources to participating merchant and commercial banks to lend to small and medium scale firms and provide or foreign denominated loans to participating firms for a period of five to ten years with a grace of one to three years.

Bank of Industry (BOI) established in 2000, was introduced as a development institution to accelerate industrial development through the provision of long-term loans, .equity finances and technical assistance to industrial enterprises. The bank has the combination of the following institutions, Nigerian Industrial Development Bank (NIDB), Nigerian Bank for Commerce and Industry (NBCI), Industrial and Insurance Brokers (IDIB), Leasing Company of Nigeria Limited (LECON). The objectives of these banks include providing long term loans, assist in employment generation and promote industrial dispersal indigenous entrepreneurship.

As a complement to the Bank of Industry, Small and Medium Industries Equity Investment Scheme (SMIEIS) was also set up in 2000. The objective was to assist in the coordination of the scheme with a guideline that 60 percent of the SMIEIS fund should go to core real sector. 30 percent to services, and 10 percent to micro enterprises through NGOs. The other objectives of SMIEIS include increased per capita income/output and initiating changes in the structure of business the society through growth, increased output and employment opportunities, enhanced regional economic balance through industrial dispersal, moderate rural/urban migration, easy adaptation to local technology and promote efficient resource utilization. As part of the efforts towards the implementation of Nigeria's Industrial Policy, which fuelled the competitiveness of the industrial sector, finance, technological advancement, incentives to industries, research and development, among others, the National Integrated Industrial Development (NIID) blueprint was adopted by the Federal Government in 2007. The NIID is a country service framework developed by the United Nations Industrial Development Organization (UNIDO) in collaboration with Federal Ministry of Industry and other stakeholders. The framework comprised four integrated programmes;

- Industrial governance and public/private sector partnership.
- Strengthening industry's institutional support base: a cluster development initiative to grow the Small and Medium Enterprises (SMEs) using common facilities.
- Environment and Energy: The challenge of low power generation and utilization to be addressed through rural renewable energy.
- Rural private sector agro-industrial development.

In addition, the Federal Government adopted the recommendation of the Presidential Committee on restructuring the moribund textile Industry in Nigeria with the approval of a N5Obillion loan to the subsector. Efforts to boost the development of SMEs through the construction of one industrial in each of the six geo-political zones of the country by the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) continued. The parks would provide industrial plots with regular power supply, potable water, and sewage system.

To support this initiative of the Federal Government of Nigeria, the Nigerian Electricity Regulatory Commission (NERC) issued 14 new licenses in 2007 to private operators for the establishment of independent power plants with varied capacities and expected total output of 6,010MW. All the licensed power generating plants were gas-based. This brought the total number of licenses issued by the commission to 23, with expected total output of 9,152.0MW. Two new distribution agencies were also granted licenses to commence operation. (Ndebbio and Ekpo. 1991, CBN Annual Report and Statement of Account, 2007)

In pursuance of these objectives, the government has experimented with a number of incentivesat positively influencing the performance and productivity of the industrial sector. Some of these incentives include tax holidays, tariff protection, outright ban on certain commodities to encourage domestic production, building of industrial estates (export processing zones) and Industrial Raw Material Research and Development Council (IRMRDC) etc.

## IV. The Model

The model adopted for this study is based on the endogenous growth theory used elsewhere by Stern (1991); Romer (1986, 1990); Sala-i-martin (1990); Ndiyo (2003); Help man (1992) and Barro (1990).(1986) departs from Solow by assuming that the economy-wide capital stock, positively affects at the industry level, so that there may be increasing returns to scale at the economy-wide level. Romer's model endogenizes the reason why growth might depend on the rate of investment (as in the Harrod-Domar mode1)simplified version presented in this study, we abstract from the

household sector, an important feature of the original endogenous growth model, in order to concentrate on issues concerning industrialization.

The general endogenuous production function

$$Gdppc = AK_i^a L_i 1^{-a} K^B \quad (1)$$

We assume symmetry across industries for simplicity, so that each industry will use the same capital and labour. Then, we have the aggregate production function as

$$Gdppc = AK^aL^B \quad (2)$$

Where Et is the white noise error term. The sign of all the elasticity coefficients are expected to positive.

$$Logindpr = b_0 + aLogkt + LogLt$$

The sign of the respective coefficients are expected to be positive.

## V. Methodology

This paper investigates the relationship between economic development, industrialization and electricity supply. Technology, capital and labour employed in the course of economic development included to investigate their relative impact on Nigeria's economic performance, using annual time data from 1972-2010. The data are all sourced from Central Bank of Nigeria statistical bulletin2007, 2008 and 2009. . In order to investigate the relationship that exists between the dependent variable, this paper adopts the following procedures.

First, the time series characteristics of the variable are investigated. The purpose is to determine order of integration. The paper conduct unit root test on the variables included in the regression by employing the Ng and Perron (2001) modified Unit Root tests. The objective here is to determine the underlying properties of the process that generate the present result and discussion of the analysis while conclusion is presented in the study time series variables employed. The choice of the Ng and Perron (2001) modified unit root test is

Where

Gdppc = real GDP per capita at time t

A = total factor productivity (3)

K = Capital stock

L = Labour

We assume that the impact of electricity supply and industrial output on economic performance possibly operates through total factor productivity (TFP). Moreover, any gains from increased electricity on TFP would depend on the rate of capacity utilization in industries. Since the paper intends to investigate the impact of electricity supply and industrialization on economic performance, we assume therefore, that TFP is a function of electricity supply (elects) and industrialization (proxy as index of industrial production) and technology (tech). Thus

$$A = f(elects, Indpr, tech) \quad (4)$$

Combining equations 2 and 3, we get

$$Gdppc = CtKt^{\alpha}L^{\beta} elects^{ø}, indpr^{d}, Tech^{a} \quad (5)$$

Where α., i, β, ø,d, and are elasticity coefficients. From equation 4 an explicit estimation function is specified, after taking the natural logs of both sides as follows

$$L0gGDPPC = a_0 + aLogkt + \beta LogLt + ø + Logelects + dLogindpr + \tilde{a}Logtech + Et \quad (6)$$

To investigate the determinants of industrial development the paper specilles equation 6 as follows:

$$\beta Logelects + {}^{a}Logtech + Et \quad (7)$$

based on the fact that the tests are more suitable for small samples than the traditional tests. In addition, as observed by Sinha (2007) the null hypothesis of a unitis not over-rejected when Ng and Perron (2001), modified unit root tests are employed.

Secondly, the paper examines the causal relationship between the dependent and explanatory variables by employing the Granger causality tests for co-integrating systems. Such an exercise will provide an understanding of the interactions among the variables in the system and will shed light on directions of the causality. Thirdly, the paper proceeds further to test the long-run (cointegration) relationship between the variables used in the model by employing the (ARLD) bounds testing approach to cointegration proposed by Pesaran et al (2001).

In this paper, the Autoregressive Distributed Lag (ARDL) bound test used extensively bysaran and Shin (1996); Pesaran and Pesaran (1997); Pesaran and Smith (1997) and Pesaranet al (2001) are employed. This technique has a number of advantages over Johansen cointegration techniques. Whereas the Johansen techniques require large data sample, a luxury that most developing economies do not have, the ARDL model is the most useful method of determining the existence of cointegration in small samples (Ghatak and Siddiki 2001). A second advantage of ARDL approach iswhile other cointegration techniques require all of the variables to b,e of the same order, the ARDL approach can be applied whether the variables in the regression are purely of 1(1) and/or purely 1(0) or a mixture of both. This implies that the ARDL approach avoids the pre testing problem associated with standard cointegration, which requires that the variables be already be classified into 1(1) (Pesaraiiet al2001).

A third advantage of the ARDL method is that if a researcher is not sure of the unit root properties of the

data, then applying the ARDL procedure is the most appropriate model for empirical work. As observed by Bahmanio-Skooee (2001), the first step in any cointegration technique is to determine the order of integration of each variable in the model. This however, would depend on which root one uses, and different unit root test could lead to contradictory results. For example, applying the conventional unit root test such as Augmented Dickey Fuller and Phillip Perron tests, one may incorrectly conclude that a unit root is present in a series that is actually stationary around a one-time structural break. This problem of testing for unit root is avoided with ARDL approach.

The ARDL approach requires two steps. In the first step, the existence of any long run relationship among the variables of interest is determined by using the F-test. The second stage requires the estimation of the long run relationship and to determine their values, thereafter the short run elasticity of the variables with the error correction representation of the ARDL model. The purpose of applying the ECM version of the ARDL is to determine the speed of adjustment to equilibrium. As argued by Pesaran and Pesaran (1997), the ARDL model is presented by equation 7

$$\Delta LGdppc_t = a_0 + \sum_{i=1}^{p} \alpha\Delta Gdppct-1 + \sum_{i=0}^{p} \theta LKt-1 + \sum_{i=1}^{p} \lambda u \sum_{i=0}^{p} \beta Allindprt-1 + \sum_{i=0}^{p} dAlelectst-1 + \sum_{i=0}^{p} \partial Techt-1 + \delta LLGPrt1 + + +U_t \quad (7)$$

Where

$\delta 1$ , i=1,2,3,4,5,6 are the long run multipliers

$\alpha, \theta, \lambda, \beta, d, \partial$ = are the short run dynamic coefficients of the ARDL model

$\Delta$ = is the first-difference operator

P = optimal lag length

The F-test is used to test the existence of long run relationship. When long run relationship exists, F- test indicates which variable should be normalized. The null hypothesis for no cointegration among variables in equation (7) is

$H_0$: $\Delta_1 = \Delta_2 = \Delta_3 = \Delta_4 = \Delta_5 = \Delta_6 = 0$ against

Against alternative

$H_1$: $\Delta_1 \neq \Delta_2 \neq \Delta_3 \neq \Delta_4 \neq 0\ \Delta_5 \neq \Delta_6 \neq$

*The F-test is used to test the existence of long run relationship. When long run relationship exists, F-test indicates which variable should be normalized. The null hypothesis for no cointegration among variables in equation (7) is*

*H0: $_1 = \Delta\ _2 = \Delta\ _3 = \Delta_4 = \Delta\ _5 = \Delta_6 = 0\ \Delta$ against*

*Against alternative*

*H1: $_1 \# \Delta\ _2 \# \Delta\ 3 \# \Delta\ _4 \# 0\ \Delta\ _5 \# \Delta\ _6 \Delta$*

The F-test has a non-standard distribution which depends on whether variables included in the model are 1(0) or 1(1); the number of variables and whether the model contains an intercept/or a trend. Given a relative small sample size in this study of 38 observations, the critical values are as reported by Pesaran et al (2001) which is based on small sample size.

If the F-test statistics exceeds their respective upper critical values, we can conclude that there is evidence of a long run relationship between the variables regardless of the order of integration of the variables. If the F-test statistics is below the upper critical value, we cannot reject the null hypothesis of no cointegration and if it lies between the bounds, a conclusive influence cannot be made without knowing the order of integration of the underlying variables.

If there is evidence of long run relationship (cointegration) of the variables, the following long run model is estimated.

$$LGDP_t = \alpha_1 + \sum_{i=1}^{p} QLogGDPt-1 + \sum_{i=0}^{p} \beta 1iLogKt-1 + \sum_{i=1}^{p} \theta 1iLogLt-1 + \sum_{i=1}^{p} \lambda 1iLogIndprt-1 + \sum_{i=1}^{p} d1ilogelectst-1 - \sum_{i=1}^{p} \partial 1ilogtecht-1 - Ut \quad (8)$$

The orders of the lags in the ARDL model are selected by either the Akaike Information Criteria (AIC) or the Scharz Bayesian Criteria (SBC), before the selected model is estimated by ordinary least squares, for annual data, Pesaran et al (2001) recommended choosing a maximum of 2 lags. The paper adopted a lag length of 2 because it minimizes SBC criteria.

The ARDL specification of the short run dynamics can be derived by constructing an error correction model (ECM) of the following form

$$\Delta LGDPR_t = \alpha_2 \sum_{i=1}^{p} Q2i\Delta LGDPRt-1 + \sum_{i=0}^{p} \theta 2iKt-1 + \sum_{i=1}^{p} \lambda 2iLt-1 + \sum_{i=1}^{p} Q2i\Delta Lindprt-1 + \sum_{i=1}^{p} d2i\Delta Lelectst-1 - \sum_{i=1}^{p} \partial 2iLTecht-1 + dECMt11 + Ut \quad (9)$$

Where d in $ECMt_{-1}$ is the speed of adjustment and the error term, defined as:

$$ECM_t = LGDP_t - \alpha_2 - \sum_{i=1}^{p} \theta 1iLGDPRt-1 - \sum_{i=0}^{p} \beta 1iLKt-1 - \sum_{i=1}^{p} \lambda 2iLt-1 + \sum_{i=1}^{p} Q2i\Delta Lindprt-1 + \sum_{i=1}^{p} d2i\Delta Lelectst-1 - \sum_{i=1}^{p} \partial 2iLTecht-1 \quad (10)$$

## VI. Empirical Result and Discussion

The results of the Ng and Perron (2001) modified unit root test is presented in table 5.0. Three of the variables under scrutiny namely GDP per capita, electricity supply (elects) and index of industrialoutput (indpr) are 1(1) process, which means that they are stationary at first difference. Capital (Kap) and Labour force (lab) are 1(0) process, implying that they are stationary at levels.

The purpose of testing for the stationarity properties of the variables in bounds approach to cointegration is because the (ARDL) bounds testing approach is applicable only in the presence of 1(1 and 1(0) variables or a mixture of both. This means that the assumption of bounds testing will collapse in the presence of 1(2) variable. The Ng and Perron (2001) modified unit root results presented in table 5.0, implies that the bounds testing approach is applicable in this study, as all the variables are a mixture of 1(1) or 1(0).

To investigate the causal relationship in the case of GDP growth rate, industrial output electricity supply, capital, labour, and technology variables, this paper adopts the Granger Causality test. As presented in table5.l, the results show that there is a feedback causal relationship between GDPPC and electricity supply. Unidirectional relationship is seen between Kap and GDP per capita without a feedback effect, running from Kap to GDP per capita. The same unidirectional relationship is observed between elects and Kap, the causality runs from Kap to elects. The causality result also revealed a unidirectional relationship without feedback effect between Lab and elects. The study found no causal link between indpr and GDP per capita.

The next task of the paper having established the order of integration and the causal link between the variables included in the model is to estimate equation 5. The purpose is to establish the long run relationship among the variables. Following Pesaran et al (2001), since the time series are annul, the paper adopt 2 as the maximum order of the lags in the ARDL and estimated equation 5 and if cointegration exists among the variables we proceed to estimate equation 6 and 8, for the period 1972-2010. The calculated F-statistics for the long run model and short run error correction model is presented in table55The critical values are reported in the same table and are based on critical values as reported in Pesaran et al (2001). The calculated F-statistics for the long run model is 12.21 and that of the short run model is 5.3. These values are higher than the upper and lower bound critical values at 5 per cent levels of significance. This implies that the null hypothesis of no cointegration cannot be accepted at 5 per cent and 10 per cent levels of significance and therefore, there is a long run relationship among the variables under scrutiny.

The long run result indicates that capital, technology, industrial output and electricity supply, are significant factors influencing GDP per capita. This is because the four variables do not only con form to a priori economic expectations; they are statistically significant at 5 and 10 per cent levels of significance. Their statistical significance strongly suggests that a 1 per cent increase in industrial output, capital, technology and electricity supply leads to about 3.8, 1.1, 4.1 and 4.5 per cent increase in real output respectively.

Following the estimation of the long run coefficients, the paper proceeds to estimate the error correction model. The paper adopts the general to specific approach to arrive at the parsimonious estimate by eliminating jointly insignificant variables. The error correction term shows the speed of adjustment to restore equilibrium in the dynamic model. In particular, the ECM coefficients show how quickly variables converge to equilibrium and the ECM coefficient is expected to have a negative sign. As observed by Banerjere et al (1998), a highly significant error correction term is a strong confirmation of the existence of a stable long run relationship.

The result of the bound testing cointegration shows that all the variables have the a priori sign and are statistically significant. This confirms the long run result that electricity supply, technology, industrial output and capital employed jointly determined economic development in Nigeria.

As previously discoursed, the error correction term indicates the speed of adjustment to restore equilibrium. The ECM variable has the correct a priori sign and is highly statistically significant. The speed of adjustment of 0.64 shows a high level of convergence. In particular, about 63 per cent of disequilibrium or deviation from long run growth rate of GDP in the previous period is corrected in the current year.

The diagnostic statistics are quite good. There is no evidence of serial autocorrelation as indicated by the value of the DW of 2.16. The normality test proved that the error term is normally distributed, as indicated in table 5:4. The paper conducted stability test of the long run and short run coefficients using the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ) and Jarque-I3era normality tests.

As observed by Bahmani-Okooee and Wing NG (2001), the stability of the regression coefficients is evaluated by stability tests and stability tests can show whether or not the regression equation is stable over time. This stability test is appropriate in time series data, especially when one is uncertain when change might have taken place. The null hypothesis is that the coefficient vector is the same in every period. CUSUM and CUSUMQ statistics are plotted against the critical bound of 5 per cent significance. As noted by Bahmani-Oskooee and Wing NG (2002), if the plot of these

statistics remains within the critical bound of 5 per cent significance level, the null hypothesis, which states that all coefficients in the error correction model are stable, cannot be rejected.

The plot of the Jarque-Bera and recursive residual is presented in figures 5.1 to 5.3 in the appendix. As shown in the graphs, the plot of CUSUM and CUSUMQ residuals are within the boundaries. This implies that the stability of the parameters of the model has remained within its critical bounds of parameter stability throughout the period of study. The result of the Jarque-Bera test lends credence to the stability of the parameters in the GDP per capita model. The results of these tests strongly suggest that the model is fairly well specified and robust for policy analysis.

## VII. Conclusion

This study attempted to investigate the impact of industrial development and electricity supply on economic development in Nigeria from l972 to 20l0. The study adopted the endogenous growth model because it approximates developing countries economic conditions better than other growth theories. In particular, this study investigated the impact of industrial output (indpr), capital (kap), labour force (lab), electricity supply in Mega Watt (elects) and technology (tech) on Nigeria's economic performance using the recently developed (ARDL) bounds testing approach to cointegration proposed by Pesaran et al (2001).

In order to determine the time series characteristics of variables used in the regression, the paper adopted the approach of NG and Perron (2001) modified unit root test. This approach was adopted because it is suitable for small samples than the traditional test such Dickey-Fuller and Phillip Perron tests. The result of the unit root test showed that the variables are either stationary at levels or at first difference, which clearly means that the bounds testing approach to cointegration can be adopted in this paper.

The paper adopted the Granger causality test to establish the causal link in the case of GDP per capita, electricity supply, industrial output, capital, labour force and technology. The results show that there is a feedback causal relationship between GDPPC and electricity supply. Unidirectional relationship is seen between Kap and GDP per capita without a feedback effect, running from Kap to GDP per capita. The same unidirectional relationship is observed between elects and Kap, the causality runs from Kap to elects. The causality result also revealed a unidirectional relationship without feedback effect between Lab and elects. The Granger causality test found no causal link in the case of industrial output and GDP per capita.

The result of the causality tests provides useful insight to policy formulation and implementation. It indicates that the contribution of the industrial sector to economic development was below the expected threshold given the gamut of industrial policies put in place since independence. This poor causality could be attributed to poor infrastructure especially electricity supply. This assertion agrees with submission of Ajanaku (2007), who argued that poor electricity supply and other factors have contributed to the dismal performance of the nation's industrial sector. For instance, the sector's contribution to GDP has continued to drop since 1990, from 4.7 per cent in 2003; 4.06 per cent in 2004 and 4.2 per cent in 2005. These figures represent the lowest contribution of the industrial sector to economic growth since independence in 1960. And according to Manufacturing Associationof Nigeria survey of small and medium term enterprises in 2007, small and medium term industries who are the drivers of the economy that should be growing is experiencing stunted growth. 1'he multinationals are not fairing any better. The major reason for their declining growth is poor infrastructure especially electricity supply. The causality result showed very strongly that electricity supply is crucial in stimulating economic growth and development rate.

The results of the long run and error correction model showed that the index of industrial development, electricity supply, technology and capital employed are important determinants of economic development. The paper tested for cointegration using the F-statistics as proposed by Pesaran et al (2001). The calculated F-statistics in the long run and short run models were well above the upper and lower bound critical values as provided for in Peseran et al (2001). The ECM variable was highly significant with the correct a priori sign, which showed the existence of long run relationship among the variables under consideration.

To test the importance of electricity supply and industrial development in economic development, the long run and short run equations were estimated first without the inclusion of electricity supply and industrial output, it was discovered that with the inclusion of electricity supply and industrial output, the overall results improved significantly. The diagnostic tests, the statistical significance and the a priori signs of the coefficients improved as well.

The important conclusion provided by findings of this study is that however novel an industrial policy may be, without fixing the electricity supply problem in Nigeria, the country may not be able to drive economic development to the desired threshold.

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## Appendices

*Table 5:0 :* Ng and Perron 2001 Modified Unit Root Tests

| Variables | MZa | MZt | MSB | MPT |
|---|---|---|---|---|
| log(gdppc) | -18.6301 | -3.02188 | 0.16220 | 1.42329 |
| 1% | -13.8000 | -2.5800 | 0.17400 | 1.7800 |
| 5% | -18.1000 | -1.9800 | 0.23300 | 3.1700 |
| 10% | -5.7000 | -1.6200 | 0.27500 | 4.4500 |
| log(elects) | -19.0489 | -3.08021 | 0.16170 | 1.30753 |
| 1% | -13.8000 | -2.5800 | 0.17400 | 1.7800 |
| 5% | -8.1000 | -1.9800 | 0.23300 | 3.1700 |
| 10% | -5.7000 | -1.6200 | 0.27500 | 4.4500 |
| dLog(gdplab) | 15.8456 | 2.81454 | 0.17762 | 1.54694 |
| 1% | -13.8000 | -2.5800 | 0.17400 | 1.7800 |
| 5% | -8.1000 | -1.9800 | 0.23300 | 3.1700 |
| 10% | -5.7000 | -1.6200 | 0.27500 | 4.4500 |
| log(indpr) | -15.0013 | -2.73862 | 0.18256 | 1.63362 |
| 1% | -13.8000 | -2.5800 | 0.17400 | 1.7800 |
| 5% | -8.1000 | -1.9800 | 0.23300 | 3.1700 |
| 10% | -5.7000 | -1.6200 | 0.27500 | 4.4500 |
| log(kap) | -16.1012 | -283271 | 0.17593 | 1.53888 |
| 1% | -13.8000 | -2.5800 | 0.17400 | 1.7800 |
| 5% | -8.1000 | -1.9800 | 0.23300 | 3.1700 |
| 10% | -5.7000 | -1.6200 | 0.27500 | 4.4500 |
| log(lab) | -7.49221 | -1.86393 | 0.24878 | 3.52739 |
| 1% | -13.8000 | -2.5800 | 0.17400 | 1.7800 |
| 5% | -8.1000 | -1.9800 | 0.23300 | 3.1700 |
| 10% | -5.7000 | -1.6200 | 0.27500 | 4.4500 |

*Table 1 :* Granger causality Result

| Null Hypothesis | F-statistics | Probability | Decision | Causality |
|---|---|---|---|---|
| Indr door nor Granger cause gdppc | 1.38502 | 0.2664 | Accept | Independent |
| Gppc does not Granger cause indpr | 0.66415 | 0.5224 | Accept | |
| Elects does not Granger cause gdppc | 6.22773 | 0.0055 | Reject | Feedback |
| Gdppc does not Granger cause elects | 3.00532 | 0.0646 | Reject | |
| Kap does not Granger cause gdppc | 600.530 | 7.E-22 | Reject | Unidirectional |
| Gdppc does not Granger cause kap | 0.09707 | 09078 | Accept | |
| Lab does not Granger cause elects | 3.53391 | 0.0419 | Reject | Unidirectional |
| Elects does not Granger cause lab | 0.32381 | 0.7259 | Accept | |
| Elects does not Granger cause indpr | 0.77603 | 0.4702 | Accept | Reject |
| Indpr does not Granger cause elects | 4.05848 | 0.0288 | Reject | |
| Kap does not Granger cause elects | 0.77603 | 0.4702. | Accept | Reject |
| Elects does not Granger cause kap | 4.05848 | 0.0288 | Reject | |

*Table 2 :* Long run Result (gdppc dependent variable)

| Variable | Coefficient | T-statistics | Probability |
|---|---|---|---|
| C | 5.757297 | 5.700311 | 0.0000 |
| Log(kap) | 0.111232 | 4.247550 | 0.0003 |
| Log(lab) | 0.224283 | 0.845585 | 0.4058 |
| Log(elects) | 0.452754 | 3.543821 | 0.0034 |
| Log(tech) | 0.405781 | 3.070092 | 0.0051 |
| Gdplab | 0.005991 | 2.555885 | 0.0171 |
| Log(indpr) | 0.378619 | 1.922852 | 0.0660 |

*R2 =0.65; F-statistics =12.21;D.W=1.6*

*Table 5.3 :* Overparametized Result

| Variable | Coefficient | T-statistics | Probability |
|---|---|---|---|
| Dlog(gdppc(-1) | 2.115872 | 0.411363 | 0.6881 |
| Dlog(indpr(-1)) | -0.517975 | -0.459591 | 0.6540 |
| Dlog(indpr(-2)) | 2.310543 | 2.263321 | 0.0430 |
| Dlog(elects(-1)) | 0.562072 | 0.921168 | 0.3751 |
| Dlog(elects(-2)) | -0.686395 | -1.221845 | 0.2452 |
| Dlog(elects(-3)) | 0.456381 | 2.126534 | 0.0234 |
| Log(kap(-1)) | 0.167257 | 0.341928 | 0.7383 |
| Log(kap(-2)) | 0.009117 | 3.219889 | 0.0032 |
| Log(lab(-1)) | 4.403576 | 1.466558 | 0.1682 |
| Log(lab(-2)) | -3.899951 | -1.189778 | 0.2571 |
| Dlog(gdplab(-1)) | 0.742241 | 0.561524 | 0.5848 |
| Dlog(gdplab(-2)) | -0.902594 | -0.743773 | 0.4713 |
| Log(tech(-1)) | 0.463572 | 3.247692 | 0.0035 |
| Ecm1(-1) | -0.562391 | -3.342341 | 0.0025 |

*R2=0.47; F-statistics =6.73; D.W=2.5*

*Table 5.4 :* Parsimonious Result

| Variable | Coefficient | T-statistics | Probability |
|---|---|---|---|
| C | 0.209360 | 1.935513 | 0.0254 |
| Dlog(indpr(-2) | 2.369628 | 3.258182 | 0.0044 |
| Dlog(elects(-2)) | 0.622652 | 2.673291 | 0.0265 |
| Log(kap(-2)) | 0.205177 | 1.859725 | 0.0354 |
| Log(tech(-1)) | 0.750557 | 2.053808 | 0.0548 |
| Ecm1(-1) | -0.637709 | -2.107843 | 0.0493 |

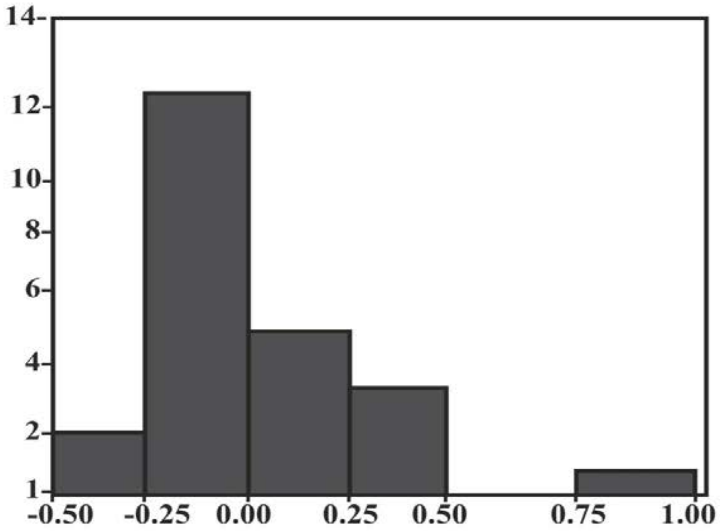
*R2=0.44; F-Statistics =5.2; D.W=2.16*

*Table 5.5 :* F-statistics for test for the existence of Long Run relationship

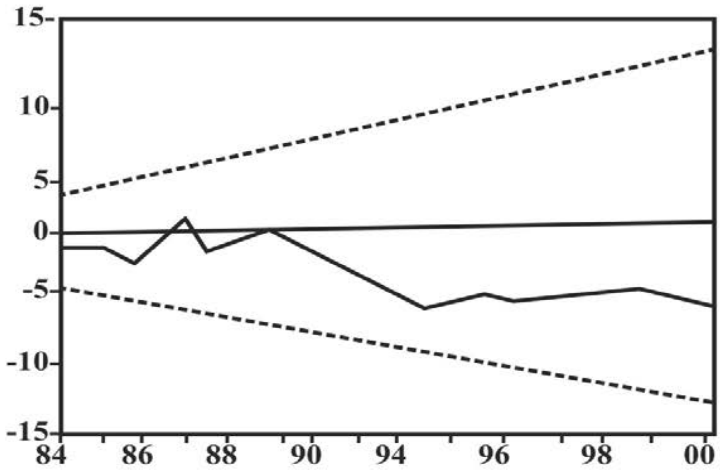
| | |
|---|---|
| Computed F-statistics (long run mode) | 12.21 |
| Computed F-statistics error correction model | 5.3 |
| Bound Testing Critical value | 5% lower (2.365); upper (3.553) |

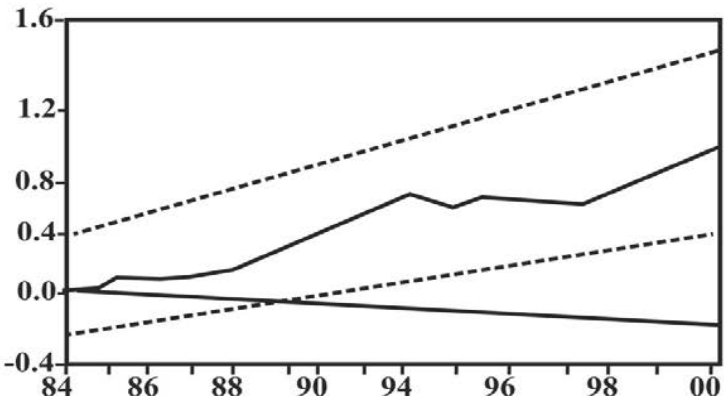
The critical values are taken from Pesaran et al (2001), unrestricted intercept and no trend with seven variables at 1 percent is 3.027 to 4.296; at 10 percent are 2.035 to 3.153.

## Stability Tests




| Series: Residuals | |
|---|---|
| Sample 1978 2001 | |
| Observation 24 | |
| Mean | 2.46e-16 |
| Median | -0.041366 |
| Maximum | 0.931583 |
| Minimum | -0.472045 |
| Std. Dev. | 0.282862 |
| Skewness | 1.499346 |
| Kurtosis | 6.091548 |
| Jarque-Bera | 18.54982 |
| Probability | 0.000094 |



# Global Journals Inc. (US) Guidelines Handbook 2014

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The MARSE member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

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The board can also take up the additional allied activities for betterment after our consultation.

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- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

**Note :**

"

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- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

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**(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.**

**(II) Choose corresponding Journal.**

**(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.**

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- Right Margin: 0.65
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- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
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2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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**Structure**

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

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

*Abstract, used in Original Papers and Reviews:*

Optimizing Abstract for Search Engines

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

Key Words

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

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

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

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

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

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

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

*Acknowledgements: Please make these as concise as possible.*

References

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

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

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

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

Tables, Figures and Figure Legends

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

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

Preparation of Electronic Figures for Publication

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

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

*Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.*

**6. AFTER ACCEPTANCE**

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

**6.1 Proof Corrections**

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

**6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)**

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

**6.3 Author Services**

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

**6.4 Author Material Archive Policy**

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

**6.5 Offprint and Extra Copies**

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

You must strictly follow above Author Guidelines before submitting your paper or else we will not at all be responsible for any corrections in future in any of the way.

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

## TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

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

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

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

**4. Make blueprints of paper:** The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

**5. Ask your Guides:** If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

**6. Use of computer is recommended:** As you are doing research in the field of Computer Science, then this point is quite obvious.

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

**8. Use the Internet for help:** An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

**9. Use and get big pictures:** Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## Informal Guidelines of Research Paper Writing

**Key points to remember:**

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

**Final Points:**

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

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

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

**General style:**

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

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

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

In every sections of your document

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

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

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

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

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

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

**Title Page:**

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

**Abstract:**

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

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

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

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

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

**Introduction:**

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

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

Approach:

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

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

**Procedures (Methods and Materials):**

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

Materials:

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

Methods:

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

Approach:

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

What to keep away from

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

**Results:**

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

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

Content

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

What to stay away from

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

Approach

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

Figures and tables

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

**Discussion:**

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

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

## Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

**Segment Draft and Final Research Paper:** You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

## Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

**Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).**

| Topics | Grades | | |
|---|---|---|---|
| | **A-B** | **C-D** | **E-F** |
| ***Abstract*** | Clear and concise with appropriate content, Correct format. 200 words or below | Unclear summary and no specific data, Incorrect form<br><br>Above 200 words | No specific data with ambiguous information<br><br>Above 250 words |
| ***Introduction*** | Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited | Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter | Out of place depth and content, hazy format |
| ***Methods and Procedures*** | Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads | Difficult to comprehend with embarrassed text, too much explanation but completed | Incorrect and unorganized structure with hazy meaning |
| ***Result*** | Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake | Complete and embarrassed text, difficult to comprehend | Irregular format with wrong facts and figures |
| ***Discussion*** | Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited | Wordy, unclear conclusion, spurious | Conclusion is not cited, unorganized, difficult to comprehend |
| ***References*** | Complete and correct format, well organized | Beside the point, Incomplete | Wrong format and structuring |

# INDEX


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ISSN 9755861