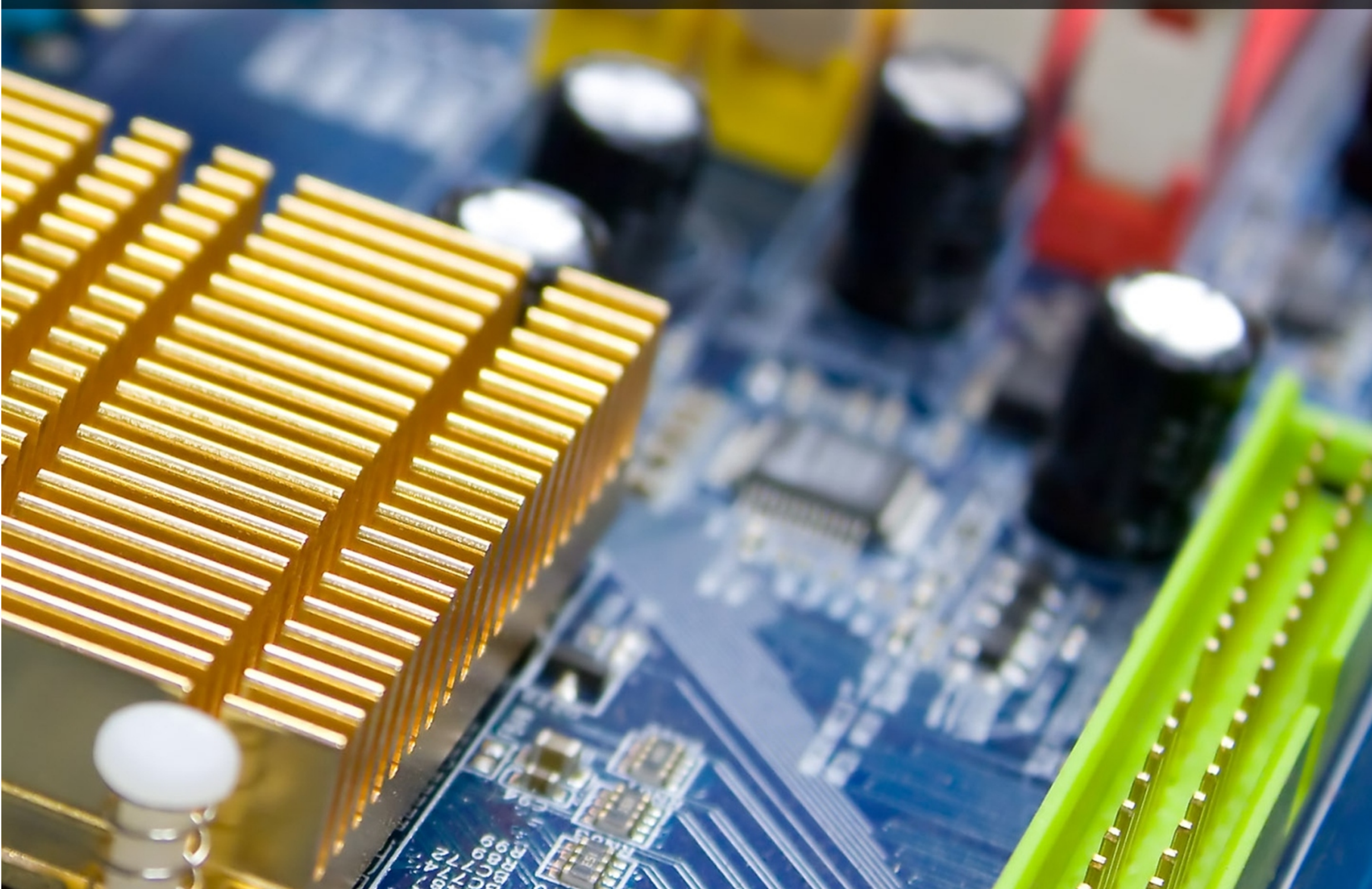
Online ISSN : 2249-4596
Print ISSN : 0975-5861

Global Journal

of Researches in Engineering: F

Electrical and Electronic Engineering



Highlights

- Analysis of MIMO Spatial
- Transitive and Chaotic Maps
- Current Control Mode
- Electricity Billing System

Discovering Thoughts, Inventing Future

VOLUME 14 ISSUE 5 VERSION 1.0

Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering

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Electrical and Electronics Engineering
Volume 14 Issue 5 (Ver. 1.0)

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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

Average Current Control Mode Boost Converter for the Tuning of Total Harmonic Distortion & Power Factor Correction using PSIM

By Kashif Habib, Aftab Alam & Shahbaz Khan
Northwestern Polytechnical University, China

Abstract- The aim of this paper is to investigate the power factor correction (PFC) of Boost Converter under an average current-mode control. Boost converter topology is used to accomplish this active power-factor correction in many discontinues/ continuous modes. The boost converter is used usually it is easy to implement and works well. In this paper comparative evaluation of different techniques for harmonic reduction in input current of ac-dc converter is presented. Converters employing as side switching and boost converter is simulated in PSIM Software. Average current tracks the current program with a high degree of accuracy. This is especially important in high power factor pre-regulators, enabling less than 5% harmonic distortion to be achieved with a relatively small inductor. In fact, average current mode control function works well even when the mode boundary is crossed into the discontinuous mode at low current levels. The outer voltage control loop is oblivious to this mode change. Firstly I have simulated only single bridge rectifier without any use of converter to find the THD (Total Harmonic Distortion) at input and then applied open loop converter with single bridge rectifier to see how it affects the input THD and at last applied a converter with current control and voltage control loops so that to improve the input THD. A step change at Load end is applied and the result is displayed so that to show the response of the system to be stable. All the results are shown below in the paper.

Keywords: PSIM; average current control; power factor correction; total harmonic distortion (THD).

GJRE-F Classification : FOR Code: 290903

AVERAGECURRENTCONTROLMODEBOOSTCONVERTERFORTHETUNINGOFTOTALHARMONICDISTORTIONPOWERFACTORCORRECTIONUSINGPSIM

Strictly as per the compliance and regulations of :

Average Current Control Mode Boost Converter for the Tuning of Total Harmonic Distortion & Power Factor Correction using PSIM

Kashif Habib [α], Aftab Alam [σ] & Shahbaz Khan [ρ]

Abstract- The aim of this paper is to investigate the power factor correction (PFC) of Boost Converter under an average current-mode control. Boost converter topology is used to accomplish this active power-factor correction in many discontinues/ continuous modes. The boost converter is used usually it is easy to implement and works well. In this paper comparative evaluation of different techniques for harmonic reduction in input current of ac-dc converter is presented. Converters employing as side switching and boost converter is simulated in PSIM Software. Average current tracks the current program with a high degree of accuracy. This is especially important in high power factor pre-regulators, enabling less than 5% harmonic distortion to be achieved with a relatively small inductor. In fact, average current mode control function works well even when the mode boundary is crossed into the discontinuous mode at low current levels. The outer voltage control loop is oblivious to this mode change. Firstly I have simulated only single bridge rectifier without any use of converter to find the THD (Total Harmonic Distortion) at input and then applied open loop converter with single bridge rectifier to see how it affects the input THD and at last applied a converter with current control and voltage control loops so that to improve the input THD. A step change at Load end is applied and the result is displayed so that to show the response of the system to be stable. All the results are shown below in the paper.

Keywords: PSIM; average current control; power factor correction; total harmonic distortion (THD).

I. Introduction

AC-DC converters are used in adjustable speed drives, SMPS, UPS etc. Most of power Electronics (PE) system which get connected to AC utility mains use diode rectifier at the input. The non-linear nature of diode rectifier causes significant line current harmonic generation, thus, they degrade power quality, increases losses, failure of some crucial medical equipment and so on. Therefore, stringent international standard are imposed. Hence, harmonic reduction circuits are incorporated in PE system [1].

Earlier expensive bulky inductor and capacitor were installed [2] but they effectively eliminated certain harmonic. Active power line conditioners (APLC) used for harmonic reduction are generally hard switched, which result in low efficiency, low EMI, high component stress etc. Soft switched resonant converter are also used and are usually operated in variable frequency mode and thus component are required to be designed at lowest operating frequency. Active clamped technique is well known for zero voltage switching (ZVS) operation in various converters. Boost converter topology in continues conduction mode (CCM) is used in medium power AC/DC converter, as it gives near unity power factor at ac input [3, 4].

Power-factor-correction (PFC) converters are widely used in power supplies for pre -regulating of power factor. Generally speaking, any type of switching converters can be the candidate for PFC purpose [5-8]. But in practical the Boost converter has been the favorable and popular choice when taking into account the factor of current stress and efficiency. As a typical nonlinear circuit system, PFC Boost converters are recently revealed to exhibit fast-scale instability, such as bifurcation and chaos operation, over the time of line cycle. These complex behaviors implying instability should be avoided from the viewpoint of traditional design principles, which can be realized by the changing of circuit parameters, or enclosing the accessional control method when the circuit parameters are fixed. The basic practical requirement for power supplies is to regulate output voltage. Moreover, this requirement has to be combined with that of power-factor-correction (PFC) in the design of most practical power supplies. Defined as the ratio of the active power to the apparent power, the power factor represents a useful measure of the overall quality level of satisfaction of power supplies and systems in such areas of performance as harmonic distortion and electromagnetic interference. Generally speaking, any type of switching converters can be chosen as a PFC stage. In practice, taking into account the current stress and efficiency, the boost converter has been a favorable and popular choice. The discontinuous conduction mode of operation has the obvious advantage of simplicity since no additional control is required [9].

In a conventional switching power supply employing a buck derived topology, the inductor is in the output. Current mode control then is actually output current control, resulting in many performance advantages [10-12]. On the other hand, in a high power factor pre-regulator using the boost topology, the

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inductor is in the input. Current mode control then controls input current, allowing it to be easily conformed to the desired sinusoidal wave shape. In high power factor boost pre-regulators the peak/average error is very serious because it causes distortion of the input current waveform. While the peak current follows the desired sine wave current program, the average current does not. The peak/average error becomes much worse at lower current levels, especially when the inductor current becomes discontinuous as the sine wave approaches zero every half cycle. To achieve low distortion, the peak/average error must be small. This requires a large inductor to make the ripple current small. The resulting shallow inductor current ramp makes the already poor noise immunity much worse. The average current mode method can be used to sense and control the current in any circuit branch. Thus it can control input current accurately with buck and fly back topologies, and can control output current with boost and fly back topologies.

II. Design of System

I have used average current control Boost Converter for the improvement of power factor and total harmonic distortion. The boost converter is a high efficiency step-up DC/DC switching converter. The converter uses a transistor switch, typically a MOSFET, to pulse width modulate the voltage into an inductor. Rectangular pulses of voltage into an inductor result in a triangular current waveform. For this discussion we assume that the converter is in the continuous mode, meaning that the inductor's current never goes to zero.

Some formulas and mathematical notations of Boost Converter are shown below in table 1.

Table 1 : Basic Formulas of Boost Converter

Components/ Parameters	Formulas
Peak inductor current	i_{pk}
Min inductor current	i_o
Ripple Current	$\Delta i = \left(i_{pk} - i_o\right)$
Ripple Current Ratio to Average Current	$r = \Delta i / i_{ave}$
Off Duty Cycle	$1 - D = T_{off} / T$
Switch Off Time	$T_{off} = (1-D)/f$
Average and Load Current	$i\_ave = \Delta i / 2 = i\_load$
RMS Current for a Triangular Wave	$i_{rms} = \sqrt{i_o^2 + \left(\Delta i^2\right) / I^2}$

The boost converter has two conduction states, continuous conduction mode and discontinuous conduction mode. The block diagram of boost converter is shown in figure (1).

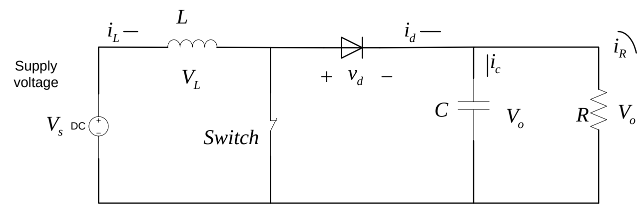

Figure 1 : Basic Diagram of Boost Converter

The average current mode control method is feedback control for current. I have used two PI controllers to stabilize the system. After using this average current control method, I have taken good results.

III. Simulation & Results using PSIM Software

I have selected the PSIM software for simulation. Firstly I have explained only the bridge rectifier. Then calculate its THD, which is good because no energy using equipments in the circuit so it's THD is very good. Then I have shown the bridge rectifier using boost converter. The results show that its THD is very high so I have to improve this THD. For this purpose I have selected the average current controlled method.

The circuit diagram of PSIM software are shown below.

a) Simple Bridge Rectifier

The circuit diagram of simple bridge rectifier is shown in figure (2).

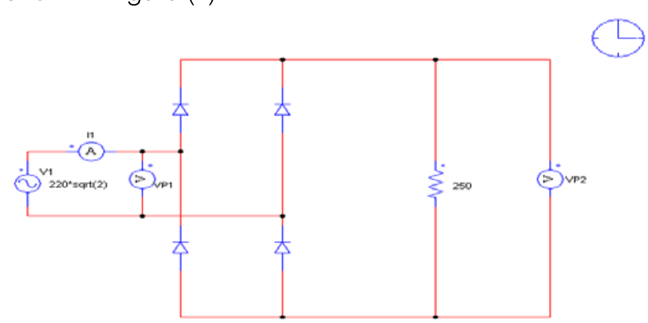

Figure 2 : Bridge Rectifier

The results are as given below

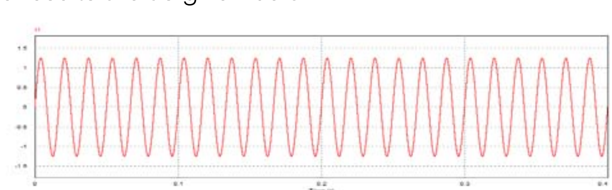

Figure 2 : Input Current

The THD of bridge rectifier is shown below in figure (3). It shows that if the circuit is simple BRIDGE

RECTIFIER then its THD will be very low, because no any complex circuit is attached in the diagram.

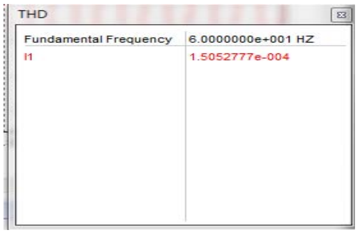

Figure 3 : Total Harmonic Distortion of Simple Brigde

b) Bridge RectifierUsing Boost Converter

The circuit diagram of Boost Converter is shown in figure (4).

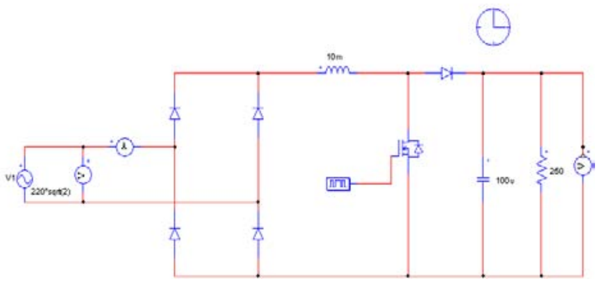

Figure 4 : Boost Converter

The results of input current are shown in figure (5).

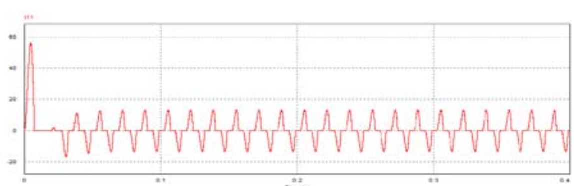

Figure 5 : Input Current of Boost Converter

The result shows clearly that a lot of ripples in the waveform. So it must be sure that its THD must be very high. The THD data is shown below in figure (6).

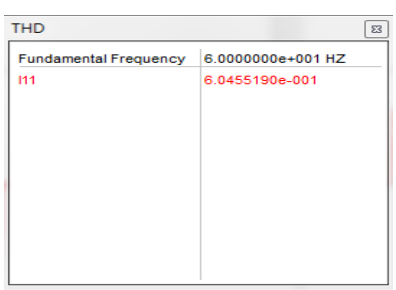

Figure 6 : Total Harmonic Distortion of Boost Converter

We can see clearly that its THD is more than 60% and we see a lot of ripples in the input current so our task is to reduce the ripples and make the THD around 5%. So for this we have to design a controller that gives us good results and improved power factor.

c) Average Current Control Method using Boost Converter

The circuit diagram of Average Current Control method using Boost Converter is shown below in figure (7). I have worked on PSIM Software. The value of each component is shown in the circuit. I am using 220 RMS in the input and getting 400V in the output. I have arranged the values according to the circuit like duty cycle of 0.4 and the values of PI controller are set according to the circuit requirement.

Table 2 : Circuit Parameters Used In Simulation

Components/ Parameters	Values
Input Voltage	220V RMS
Duty cycle	0.4
Inductor	10 mH
Capacitor	100 uF
Resistor	250 Ω
Switching Frequency	100 KHz
Reference Voltage	400 V

The table shows the basic components of the circuit Diagram.

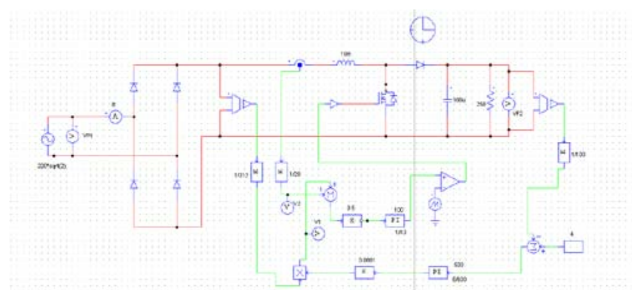

Figure 7 : Average Current Control Method

The results of the simulation are shown below. Here the input voltage is shown in figure (8), which I set 220V RMS.

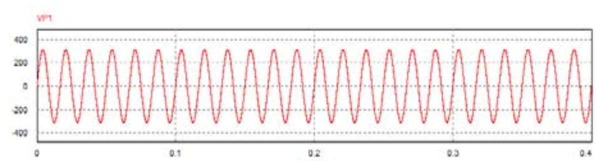

Figure 8 : Input Voltage

Because it is Boost Converter, its output must b higher than the original one. So we can see that its output is 400V DC. Because it is Boost Converter, the output waveform is shown in figure (9).

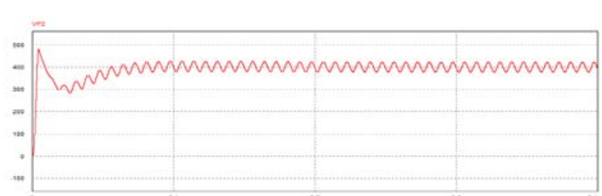

Figure 9 : Output Voltage

The Input Current is shown below in figure (10)

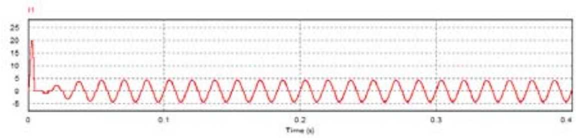

Figure 10 : Input Current

It can be seen that there is no ripple in the input current, so its THD must be very good. The THD of input current is shown below in figure (11).

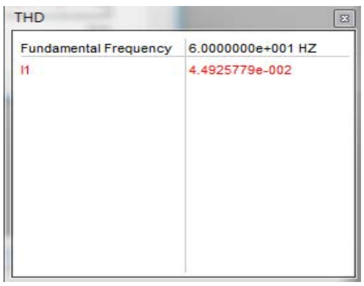

Figure 11 : Total Harmonic Distortion

So now THD is around 4.5%. It means that its THD is very good. So our results are improved by applying the average current control method to the Boost Converter.

In the average current control method, we use a feedback circuit diagram as we can see in figure (7). In the feedback circuit diagram, we have the comparison analysis of Inductor Current and Reference Current as shown in figure (12).

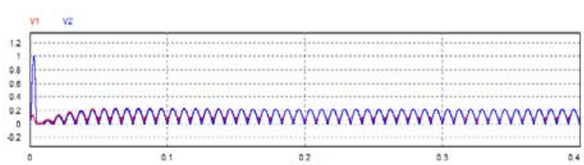

Figure 12 : Comparison of Inductor Current and Reference Current

So it is clear from the diagram that both have same waveform and same periodic cycle.

d) Average Current Control Method Boost Converter using Variable Load

The circuit diagram shown in Figure (13), it shows the Average Current Control Method using variable load. I have selected a step of 0.2 sec and with parallel resistance of 500 OHM. You can see clearly that after 0.2 sec step output voltage, input current and input voltage goes down on 0.2 and then comes to the original position. The Block Diagram of the circuit is shown in figure (13).

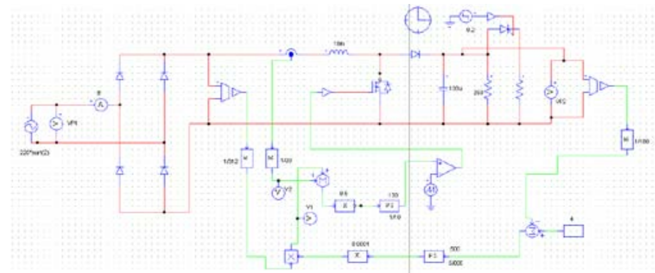

Figure 13 : Average Current Control Method with Variable Laod

It is the output voltage, which clearly shows that at 0.2 steps it goes down and then come to its original position. The diagram of the output Voltage is shown in Figure (14).

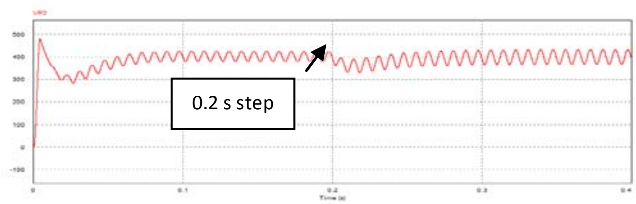

Figure 14 : Output Voltage with Variable Load

The input current shown below in figure (15) shows the change at 0.2 sec.

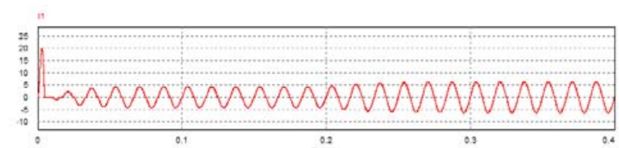

Figure 15 : Input Current with Variable Load

After applying the variable load, the THD is shown in figure (16) this is good around 4%.

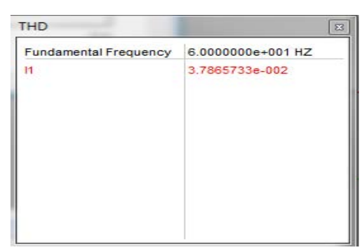

Figure 16 : Total Harmonics Distortion with Variable Load

It is the comparison of Inductor Current and Reference Current shown below in Figure (17).

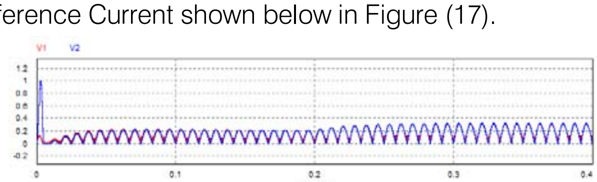

Figure 17 : Comparison of Inductor Current and Reference Current with Variable Load

It can be seen clearly that both have same waveforms.

IV. Conclusion

I have used the Software PSIM, which helped me for the measurement of THD and Power Factor. Firstly I show the results of open loop uncontrolled rectifier and then shows the average current control method. The average current control method improves the results (THD and Power Factor). In the results of uncontrolled rectifier, we can see that harmonics are very high so our task is to reduce the harmonics. I used the close loop controlled rectification and arranging the PI controllers to get the good results. I have also shown the comparison of Inductor current and the reference current which is the comparison of rectified scaled voltage and the output DC voltage. I have also shown the transient analysis of average current control method, which also shows good results. So I got the good THD which is 4.45%.

V. Acknowledgment

I will take this opportunity to express my deepest regards and thanks to my professor, without his guidance I would not be able to complete this paper. His attitude and guidelines during this paper is very valuable and helpful for me. During this paper I have explore new horizon of this field and I am confident that with the guidance of my professor I will excel in this field.

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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

Radar Based Lie Detection Technique

By Kedar Nath Sahu, Dr. Challa Dhanunjay Naidu & Dr. K Jaya Sankar
Stanley College of Engineering and Technology for Women, India

Abstract- The need for lie detection is to resolve disputes that arise over inheritance, forgery, impersonation as well as in forensic science which deals with application of science to law aiding to deliver justice by eliciting truth, scientific evaluation of physical evidence usually encountered in many civil, criminal regulatory and statutory cases. All the methods for lie detection including the most popular polygraph testing depend on the measurement of variation of physiological conditions like heart beat rate, respiratory rate (breath rate), etc. by establishing physical contact of some medical device with the person's body and thus are invasive and obtrusive. But these physiological conditions vary due to the effect on the autonomic nervous system (ANS) for any reason irrespective of whether the person tells a lie or the person is innocent but feels nervous for being under test. This leads to an ambiguous and/or inaccurate decision about the person telling lies. A radar based lie detector proposed recently can be a remote, non-contact, non-invasive and unobtrusive method. This review paper summarizes the common signs of deceptive behavior, major non-radar based methods used earlier and finally, the radar based technique for lie detection that has emerged as a technical breakthrough in lie detection.

Keywords: lie detection, EEG, ECG, polygraph testing, f-MRI, brain fingerprinting, ultra-wideband (UWB) radar, stealthy etc.

GJRE-F Classification : FOR Code: 090699

RADARBASEDLIEDETECTIONTECHNIQUE

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Radar Based Lie Detection Technique

Kedar Nath Sahu α, Dr. Challa Dhanunjay Naidu σ & Dr. K Jaya Sankar ρ

Abstract- The need for lie detection is to resolve disputes that arise over inheritance, forgery, impersonation as well as in forensic science which deals with application of science to law aiding to deliver justice by eliciting truth, scientific evaluation of physical evidence usually encountered in many civil, criminal regulatory and statutory cases. All the methods for lie detection including the most popular polygraph testing depend on the measurement of variation of physiological conditions like heart beat rate, respiratory rate (breath rate), etc. by establishing physical contact of some medical device with the person's body and thus are invasive and obtrusive. But these physiological conditions vary due to the effect on the autonomic nervous system (ANS) for any reason irrespective of whether the person tells a lie or the person is innocent but feels nervous for being under test. This leads to an ambiguous and/or inaccurate decision about the person telling lies. A radar based lie detector proposed recently can be a remote, non-contact, non-invasive and unobtrusive method. This review paper summarizes the common signs of deceptive behavior, major non-radar based methods used earlier and finally, the radar based technique for lie detection that has emerged as a technical breakthrough in lie detection.

Keywords: lie detection, EEG, ECG, polygraph testing, f-MRI, brain fingerprinting, ultra-wideband (UWB) radar, stealthy etc.

I. Introduction

In recent times, need for lie detection has enormously increased to combat tremendous growth rate of crimes in the society. The lie detection procedure adopted by various investigating agencies may be simple or rigorous depending on the intensity of the crime under investigation. The procedural steps of a particular lie detection method are executed either in complete or in part based on the order of the crime. In ancient Hindu and Chinese civilization as reported in [1], lie detection was done by asking the suspect to chew a grain of rice and spit it out. In China, a dry grain of rice indicates the dry mouth of a liar. In India, rice stuck to the mouth was the sign of guilt. Astrology, tea-leaf readings etc. were also some of the primitive methods used for lie detection. All these primitive and non-scientific methods highlight the psychological state of lying. Cardiovascular activity represent the physiological sign of lying as documented first by Lombroso, an Italian criminologist in late 19th century[1]. The blood pressure and heart rate increases noticeably while lying.

As technology advanced more powerful lie detection techniques have emerged. They include Polygraph testing, Facial Thermal Imaging, Electroencephalograph (EEG), functional-Magnetic Resonance Imaging (f-MRI), Event Related Potentials (ERP), Brain fingerprinting etc. DNA profile test, dactylography, cheiloscopy have been followed by the investigators since long. [3-6]. Of all the other existing methods for lie detection viz. examining documents, analytical fingerprints, DNA profiling, authenticating audio and video records, investigating a crime scene, screening a suspect from a psychological perspective etc., polygraph testing has been very popularly used since long. Later more advanced technique like functional-magnetic resonance imaging (f-MRI) was developed [7]. This method studies the change of brain metabolism that takes place when a person tells a lie. Event related potential (ERP) was yet another method [8] to study the changes during information processing of the brain but suffered from the limitation that led to the development of another method called as multifaceted electroencephalograph response analysis (MERA) as reported in [9]. Brain fingerprinting, a computer based technology was Dr. Lawrence A. Farwell's invention [10] and exploits the brainwave response characteristics when the criminal is subjected to crime related images. As EEG has undergone tremendous advancement in the recent years, its ability to read the brain activity simultaneously from all parts of the head has increased.

As a technological breakthrough of radar applications, medical uses of ultra-wideband (UWB) radars were presented in 2002 [11]. The UWB radar pulse passes through the human thorax and gets echoed back by the cardiac structure i.e. the heart wall. Using this principle an ultra-wideband (UWB) radar based lie detector was reported in [2].

II. Common Signs of Deception

The common signs of deceptive behavior have been reported in the literature [12] such as body language, emotional gestures and contradiction, interactions and reactions, verbal context and content, facial micro-expressions, statement analysis, change of topic etc. These deception techniques are used by

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police, forensic psychologists, security experts and other investigators to help prevent them from being victim of fraud or scams and other deceptions.

Of course, these signs don't strictly indicate that someone is lying, but that they are more likely to be lying. Just because some exhibits one or more of these sign does not make them a liar. The above behaviors should be carefully observed and compared to a person's base or normal behavior (the behavior that precedes the instant of lying) whenever possible. Some of the very common signs of deceptive behavior are discussed below.

a) Body Language

Liars have a typical body language as they avoid making eye contacts, move the hands on their face, throat, mouth, touch or scratch the nose or behind the ear, take up less space by having hand, arm and leg movements toward their own body.

b) Emotional Gestures and Contradiction

It is found that the gestures or expressions of a liar do not match the verbal statement. There is no timing and duration between emotional gestures and words of expressions. Expressions are limited to mouth movements and not the whole face.

c) Reactions During Interactions

It is not uncommon that an innocent person goes on offensive whereas the guilty behaves defensive. Mostly it is found that a person telling a lie feels uncomfortable to face the investigator and often turns the head or body away while being interrogated. Another peculiar behavior is that the guilty might unconsciously keep some object like a water bottle, a note book between him and the interrogator.

d) Verbal Context and Content

The liars use the words of the interrogator to make the answer of the question asked to them, speak more than natural, and add unnecessarily more details to convince the questioner as they are uncomfortable with silence or pauses in the conversation. They speak in a monotonous tone and the pronouns of their statements are not emphasized. The words may be garbled and spoken softly with no usage of grammar. Sentences will be muddled instead of having emphasized. One of the verbal signs of lying is that the liar tries to invent the answer and hence spends more time for searching a right word while speaking, doesn't use contractions and takes long time to provide an answer.

e) Facial Micro-expressions

Sometimes a momentary involuntary facial expressions such as anger, disgust, fear, sadness, surprise and contempt known as micro expressions are unconsciously displayed when the person attempts to hide an emotion. These actions are quick (even sometimes not easily noticeable), intense expressions of concealed emotion, appear and suddenly disappear off the face in a fraction of second. This theory of micro expressions was discovered first by Haggard and Isaacs in 1966 [13]. These micro expressions betray the person while lying as the one will be trying to cover his feelings with fake smiles, but involuntary face muscles reveal the hidden emotions.

Like micro-expressions, forced smile (that involves only the muscles of the mouth and not the rest of the face), increased blinking, scratching the face or nose, placing the hand over the mouth while speaking are also other good indicators of change of a person's normal behavior and known as the non-verbal signs of lying [14].

f) Statement Analysis

This is also known as linguistic text analysis and detecting anomalies and was developed in 1970s [15]. The method involves studying the language, grammar and syntax of a person's event description. Text analysis represents the subject's verbal behavior i.e. usage of words (written and oral statements). Text analysis or statement analysis is a two-part process according to Susan Adams, senior instructor at FBI Academy [15].

Sometimes police and other investigators adopt this technique to indicate the presence of lies by analyzing the subject's words, because, people always phrase a statement according to their knowledge and therefore their statement may even include the information which they really did not intend to share. It is nearly impossible to give a long deceptive statement with an idea of protecting it from revealing it as a lie.

g) Change of Topic

When someone is guessed for lying, then the theme of the conversation should be changed quickly. By doing so, it is found that the liar follows the change and feels more relaxed. In contrast, an innocent subject gets confused by such a sudden change of topic under interrogation and may try to go back to the previous topic. The liar may try to use humor or sarcasm to avoid the subject of issue.

h) Other General Signs

The possible deception in oral and written statements can also be detected in the following various ways also as reported in [16].

Truthful people frequently use the pronoun 'I' to describe their actions whereas deceptive people are lack of self references as they describe the events in passive voice. Truthful people use past tense in order to describe a past event whereas the deceptive people describe the past events using the present tense. A deceptive person usually tries to avoid answering the question and prefers not to lie. The liar responds with a question and tries to dodge. By using non-committal verbs such as think, believe, guess, suppose, assume

Global Journal of Researches in Engineering (F) Volume XIV Issue V Version I Year 2014

etc., equivocating adjectives and adverbs: sort of, almost, mainly, perhaps, may be, about etc. and vague statements like you might say, more or less etc. the subject avoids answering the interrogator. Liars usually try to convince the interrogators that what they say is true by using mild oaths such as I swear, as God is my witness so that their statements sound more convincing.

Also a guilty person uses mild or vague words which are explicit synonyms or euphemistic terms such as missing instead of stolen, warned instead of threatened etc. Liars speak fabricated stories to make up a detailed description and hence are lack of details. “I try to”, “I decided to”, “I also needed” etc. are the statements used by liars to allude to all these actions with talking anything definitively. As described in [16], Mean Length of Utterance (MLU) of the suspect is defined to be the total number of words in a statement divided by the number of sentences. When people become anxious to speak about an issue they speak in sentences much longer or much shorter than the MLU.

Laser detector also can detect muscular, circulatory and other physiological changes during the anxiety of lying. The voice and tone can be analyzed by using computer programs as the vocal cords produce a distorted sound wave caused by an involuntary interference of the nerves while lying. In another method called as the lie detecting keyboard, when a person types into a computer the change in the typing pattern is observed, moistures in finger tips is sensed, body heat is recorded and how fast the fingers move on the keyboard is monitored.

According to Aldert Vrij, Professor of Applied Social psychology at University of Portsmouth, UK [17] there is no verbal and non-verbal cues that can be completely relied upon because the assumption that liars are more nervous than truth-tellers is incorrect. Thus any machine may be accurate in measuring nervousness but that doesn’t mean someone is lying. With technological advancements, humans will be able to better correlate the psychological state of lying with physiological responses.

According to some lie detection experts, a combination of body language, micro expressions, eye movement and direction as well as other cues must also be used to make an educated guess on whether someone tells a lie. But in order to reveal the truth or lies of a person, the interrogator should first establish and understand the base behavior of a person by having sufficient conversation before applying any or all of the above signs of lying.

III. Lie Detection Technologies

The lie detection methods can be broadly categorized as (i) invasive and (ii) non-invasive from the subject’s privacy view point.

a) *Invasive Methods*

i. *Polygraph Theory*

Ratio of inhaling and exhaling time during breathing change when someone lies. The first polygraph was invented [1] by John Larson, medical student working for the Berkeley police department. The use of polygraph for lie detection emerged in late nineteenth century. Irregularities in blood pressure and breathing patterns indicate the liar. Also a person while lying sweats more than a truth-telling person which reduces the skin resistance due to higher concentration of negative charged chloride ions on the surface of ion. Leonarde Keeler included “skin resistance” as the third polygraph channel [1]. Measurement of three physiological vectors: cardio logical, respiratory and perspiratory activities are still used by modern polygraphs.

The underlying theory of the polygraph is that when people lie they also get measurably nervous about lying. The heartbeat increases, blood pressure goes up, breathing rhythms change, perspiration increases, etc. A baseline for these physiological characteristics is established by asking the subject questions whose answers the investigator knows. Deviation from the baseline for truthfulness is taken as sign of lying. Hence, deliberate lying produces bodily reactions reflected in blood pressure, breath and heart rates, skin sensitivity (Galvanic Skin Resistance) etc. A Polygraph (“Lie-Detector”) testing instrument simultaneously measures and records physiological changes caused by the sympathetic nervous system through the couplings to the body of the person while the subject is asked a series of questions for which he has to answer ‘yes’ or ‘no’. The machine measures changes in blood pressure, breath rate, and respiration rate. From these a trained expert detects whether the person is lying. But these can also be caused by many causal factors like nervousness, anger, sadness, embarrassment, fear and number of medical conditions such as colds, headaches, constipation, or neurological and muscular problems. For many, the phrase "lie detection" brings to mind an image of a polygraph machine and an intimidating movie-style interrogation. But the method does not have scientific validity as there is no scientific evidence that polygraph experts can detect lies using their machine at a significantly better rate than non-experts using other methods. There is no evidence that the polygraph is really able to detect lies.

The method suffers from the problem of countermeasures. The effectiveness or better accuracy of polygraph test could be guessed if it would have been stealthiest. But since polygraph examination requires the consent of the person to be examined and nobody can undergo the test without their willingness the method suffers from having no stealthiness. As heart and breath rates along with blood pressure and electro dermal activity are important measurement parameters in a polygraph procedure, the person undergoing polygraph analysis should necessarily be in a calm and healthy condition. But subject's emotional state is a serious cause of interference. Though high blood pressure does not affect the accuracy of the Polygraph test, it is necessary to ensure medical fitness of the subject prior to examination. It usually takes from 2 to 3 hours to administer a Polygraph test for each individual. The polygraph is an admirable but not impermeable tool.

Due to advances in computer programming in 1990s, polygraph could be administered through computers unlike the analog polygraph of 1970-80s [1]. Physiological irregularities of the examinee could be identified by the examiner more efficiently.

Commonly used polygraphs have error rates of 40% or more. Since polygraphs rely heavily on interpretation by polygraph examiners, human error and bias can create inaccurate results.

ii. *Facial Thermal Imaging*

Whenever someone during anxious states tries to make something up e.g. someone starts lying, the changes in the brain activity makes the temperature of the periorbital areas i.e. areas around his eyes and the cheeks rise because of the blood flow redistribution during the states of anxiousness. Detecting and monitoring of this temperature on face can be used as an indicator of someone lying. Researchers in UK are using at airports this novel method of lie detection based on thermal imaging technology to spot the liars [17]. University of Bradford, North England has conducted experiments on this lie detection technology which yielded promising results, according to Professor Hassan Ugail, Director for Center for Visual Computing, University of Bradford in North England [17]. In [18], thermal image analysis is described as a novel method with the anticipation that it will play an important role in scoring polygraph testing. Thermal image analysis consists of three stages: image acquisition (acquiring facial thermal imaging by means of mid-infrared camera), physiological correlation (transforming the raw thermal data to blood flow rate through heat transfer modeling) and pattern classification (classifying the subject as deceptive or non-deceptive on the basis of nearest-neighbor classification method).

Thus the traditional invasive 1D physiological measurement in conjunction with normal non-invasive 2D physiological measurement might increase the accuracy and reliability of polygraph testing.

iii. *Electroencephalograph (EEG)*

By means of the electrodes attached to the subject's head this method measures the brain waves and detects brain processing related patterns while making the subject recognize a scene or a person during the course of questioning. The perceived trustworthiness interpreted by the individual from looking at the face of the subject decreases when someone is lying.

iv. *Functional MRI*

Lying causes a conflict between lie and the truth within the brain. The increased activity can be detected by fMRI which records brain activity by identifying changes in brain blood flow and the metabolic rate. This discovery is a step closer to developing a lie detector which doesn't depend on nonspecific physiological vectors that can be induced by conditions other than lying.

This technique maps the brain activity by means of powerful magnets. This measures the usage of oxygen throughout the brain. Different parts of the brain of a person are activated while telling a lie than telling the truth. As active parts of the brain involve increased blood flow, more oxygen usage than the inactive parts this increases the intensity of magnetic resonance signal. This feature is exploited in the functional MRI technique. Though this technology has tremendous potential for lie detection but still not trustworthy due to its own drawbacks such as invasiveness, inaccuracy etc. Moreover this technology finds it tough for the real time application as the f-MRI machines are bulky, highly expensive and sensitive to motion. The responses of multiple voxels in the brain are evoked by stimulus and then detected by fMRI in order to decode the original stimulus during brain-reading.

v. *Event Related Potentials*

This method involves the measurement of positive and negative change of potentials corresponding to information processing of brain but suffers from the disadvantage that the signal averaging eliminates all the complex patterns which lead to loss of meaningful signals. This led to the development of another lie detection technique known as multifaceted EEG response analysis (MERA).

vi. *Brain Fingerprinting*

In the event of a crime, a lot of physical evidences related to the crime may be unavailable but the sequence of the events is silently recorded by the subject's brain. This makes a difference between a criminal and an innocent person that the criminal has the details of the crime stored in his brain whereas the innocent does not possess any such record. Brain fingerprinting or uses EEG to determine if the subject is familiar to an image.

In this technique three types of stimuli viz. targets, irrelevant and probes are attached to the subject's headband to measure electrical brain responses.

For any reason if the techniques mentioned above do match with the crime scene evidences then even innocent will be proved guilty. Moreover, all of the above lie detection techniques to some or all extent whether justifiable or not but, invade the privacy of someone's mind and thus are invasive. Hence, this gave rise to the need for some non-invasive, non-obtrusive method of lie-detection that takes care of the subject's privacy.

vii. *Cognitive Chronometry*

This refers to the systematic measurement of response time either to perform mental operations or time of mental associations and can be used to distinguish lying from truth-telling. Two measuring instruments relying on cognitive chronometry are the implicit association test (IAT) and the Timed Antagonistic response alethiometer (TARA).

a. *Non-invasive Method*

Radar Principle: Radio Detection and Ranging (RADAR) is an electromagnetic device used to detect (i.e. to confirm the presence) and locate (to measure the distance or range) an object (the target). In principle, as explained in [19], radar transmits a modulated signal aimed at the target and detects the echoed signal. It consists of a transmitting antenna that radiates the electromagnetic energy, a receiving antenna and a receiver. A part of the transmitted energy is intercepted by a reflecting object or the target and is reradiated in all directions. But the fractional energy reradiated in the backward direction toward the radar location is collected by the receiver via the receiving antenna. The signal returned is processed to extract the desired information about the target. The range to the target is determined by measuring the two-way propagation time for the radar signal. For moving objects there exists a relative motion between the radar and the object and hence there is a shift in the carrier frequency of the returned signal. This shift of frequency is due to the Doppler effect on the carrier signal that is also a measure of the relative velocity.

- *Definition of UWB*

According to the revision of part 15 of the governing rules and regulations laid by the Federal Communications Commission (FCC), Washington, D.C. 20554, ultra-wideband (UWB) is defined as the frequency band for which fractional bandwidth $=2(f_H-f_L)/(f_H+f_L) \geq 20\%$ or has a UWB bandwidth equal to or greater than 500 MHz regardless of the fractional bandwidth. UWB medical systems must be operated in the frequency band 3.1 to 10.6 GHz.

- *Issue of Safety*

As reported in [2], the emission limit of medical UWB radars is 2 to 3 orders of magnitude less than a cell phone and hence talking over a cell phone for more than 5 minutes is equivalent to UWB monitoring of 10 hours. The power level and electric field intensity of the UWB radar based stealthy lie detector described in [2] are 7 to 9 order lesser. This explains the safety concern of UWB radar based heart rate monitoring that it is less dangerous and safer than the cell phones.

- *Heart-rate-variability (HRV)*

This is the physiological phenomenon of variation in the time interval between heartbeats i.e. the variation in the beat-to-beat interval. HRV is also an indicator of the emotional arousal. The main inputs received by the sinoatrial node (SA node) viz. the sympathetic nervous system (SNS), parasympathetic nervous system (PSNS) and humoral factors are affected due to thermoregulation, hormones, sleep-wake cycle, meals, physical activity, stress etc. HRV reduces due to decreased PSNS activity or increased SNS activity.

- *Radar based lie detection*

The radar based procedure which could perform remote, unobtrusive, non-invasive and stealthy lie detection is when an UWB radar pulse passes through the human thorax it gets echoed back by the cardiac structure i.e. the heart wall. This characteristic was exploited to design and build the UWB radar based lie detector. The most incredible feature is that it is a stealth detecting device as it is not physically connected and is invisible to the subject under test. Hence it bears no physiological and psychological discomforts, prevents the breathing and cardio countermeasures of the subject unlike the polygraph lie detector. In its experimental setup comprising of a UWB radar device and an ECG amplifier heartbeat rate could be detected from a distance of 15 to 20 cm from the heart. Both ECG and UWB radar methods yield the same heartbeat related data from the heart-rate-variability (HRV) characteristics.

In the event of human heartbeat detection, the parasympathetic and sympathetic sections of the autonomic nervous system play a major role and hence the time interval between successive heartbeats known as the Heart Rate Variability (HRV) is measured. The heart rhythm fluctuates around the mean heart beat rate due to continuous alteration in sympathetic-parasympathetic balance of the autonomic nervous system. The heartbeat rate decreases due to parasympathetic activity and increases due to sympathetic activation.

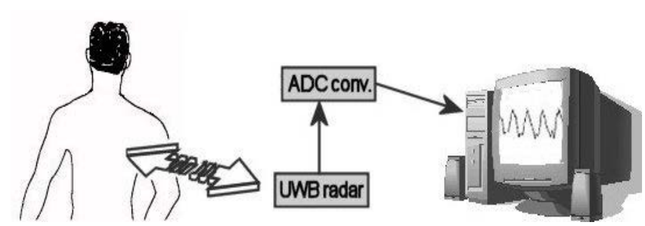

Figure 1 : Schematic of the stealthy vital parameters monitor mounted on the back of a chair [10]

As reported in [2], the subject was asked to sit on a chair and the radar was placed on the back of a chair as shown in figure 1. Two different detectors were

Global Journal of Researches in Engineering (F) Volume XIV Issue V Version I Year 2014

implemented to obtain heartbeat period from an electrocardiograph (ECG) signal and an UWB echo signal. The ECG signal comprising of P, Q, R waves was passed through a high pass filter and only the R waves were detected in successive beats. Then the peaks and valleys of the signal were obtained from the UWB echo tracings and the time lag between the two consecutive valleys was considered as the heart beat period. The heart-cycle period simultaneously estimated from both ECG and UWB radar are depicted in Fig.2 and Fig.3 respectively during five minutes (400 heart beats) considering the subject in a rest condition.

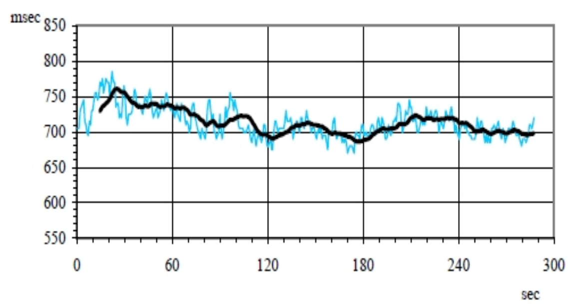

Figure 2 : ECG based heart-beat period detection estimated during five minutes (400 heart beats) [2]

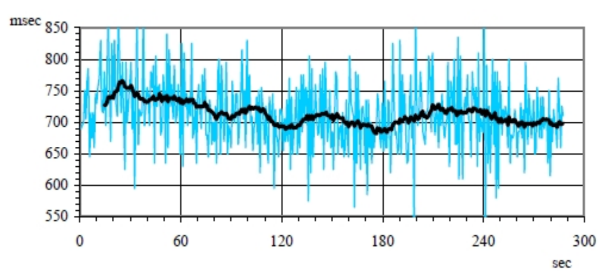

Figure 3 : UWB radar based heart-beat period detection estimated during five minutes (400 heart beats) [10]

It was seen that both UWB radar and ECG derived HRV signals are equivalent. The heartbeat period for both UWB detected beats and ECG detected was found to be 713 ms and hence a sampling rate equal to inverse of mean heartbeat period i.e. 1/0.713 Hz or 1.4 Hz was used for further signal processing. The heartbeat rate, respiration rate provided by the radar can be compared with those of a normal human being. Discrepancies if any infers about the person lying.

IV. Conclusion

A recent study by the author of [2] has proved that ECG results (invasive) were in confirmation with UWB radar (non-invasive) based results.

Radar based technology seems to have tremendous potential for lie detection but still a lot of work has to be done for trustworthiness. There exists no true and scientific lie detector or can be developed within the present state of the art, nevertheless HRV detected by means of an UWB based radar seems to be a viable method.

The strength of UWB radar based lie detection is that the subject under test can be maintained unaware of being monitored and thus psychological discomfort can be avoided. Moreover the operation of this lie detector machine in a stealthy mode is a bonus of avoiding countermeasures. This factor adds to the strength to the legal aspects in delivering justice.

However from a practical viewpoint it is clear that any kind of criminal investigation accounts for the act of determination of innocence or guilt and this act is more a legal entity than just a scientific determination. Hence, for the best detection result, the investigating agencies should take the results of any of the methods in conjunction with the common signs of deception discussed as above before they announce a final verdict.

Most of the lie detection experts view that a combination of body language and other cues must be used to make an educated guess on whether someone is telling the truth or a lie.

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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

Using the Effect of Mechanical Stress on Doped Silicon as an Angular Movement Sensor for MOEMS/MEMS Micro Mirrors

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Abstract- The effect of elastic strain of moderate magnitude using high doped silicon substrate can change the conductivity of the substrate. The commonly used metal (strain) gage has a magnitude factor of between 2 ÷ 4 while high doped silicon (strain) gage factor magnitude is between 150 ÷ 200, thus improving the substrate sensitivity considerably. Using those physical attributes allow us to create a MOEMS sensor resolving accuracy issues and saving space in any future MOEMS device design. Those devices will be able to measure any mechanical movement connected to the high doped silicon substrate by converting the physical strain created from the movement stress to current/voltage change in the substrate device. The simplicity of the device is that the device could measure movement without any need to implement an outer sensor to it. By measuring the device's strain change it would "feel" the movement and convert it to an analog value, thus creating a strain gage built in the MOEMS device surface.

GJRE-F Classification : FOR Code: 290901p

USINGTHEEFFECTOFMECHANICALSTRESSONDOPEDSILICONASANANGULARMOVEMENTSENSORFORMOEMSMEMSMICROMIRRORS

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Using the Effect of Mechanical Stress on Doped Silicon as an Angular Movement Sensor for MOEMS/MEMS Micro Mirrors

D. Berko [α] & Y. S. Diamand [σ]

Abstract- The effect of elastic strain of moderate magnitude using high doped silicon substrate can change the conductivity of the substrate. The commonly used metal (strain) gage has a magnitude factor of between 2 ÷ 4 while high doped silicon (strain) gage factor magnitude is between 150 ÷ 200, thus improving the substrate sensitivity considerably. Using those physical attributes allow us to create a MOEMS sensor resolving accuracy issues and saving space in any future MOEMS device design. Those devices will be able to measure any mechanical movement connected to the high doped silicon substrate by converting the physical strain created from the movement stress to current/voltage change in the substrate device. The simplicity of the device is that the device could measure movement without any need to implement an outer sensor to it. By measuring the device's strain change it would "feel" the movement and convert it to an analog value, thus creating a strain gage built in the MOEMS device surface.

I. Introduction

Many of the MOEMS (Micro Optic Electric Mechanical System) development is micro mirrors devices that display an image or a video signal on a screen. Those devices usually use small sensors such as PSD (Position Sensitive Diode). Many of those devices encounter difficulties due to sometime pour image focus that derives from the difficulty to close the closed control loop between the mirror movements to the actual mirror position. Also those sensors are relatively quite big in the mirror device.

We wanted to create a "built in" sensor implemented in the mirror base rod substrate, thus simplifying the device and improving the sensor's reading and the image quality.

In order to measure angular movement of a micro mirror placed on a micro rod a mechanical stress conversion is needed. The stress resulting angular movement is torque stress, and in order to easily measure small strain change in the substrate we needed to convert it to a linear torsion or compression stress.

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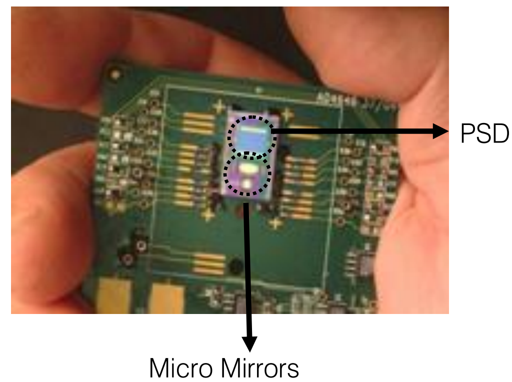
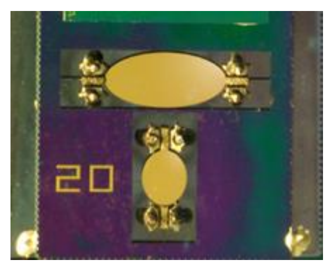


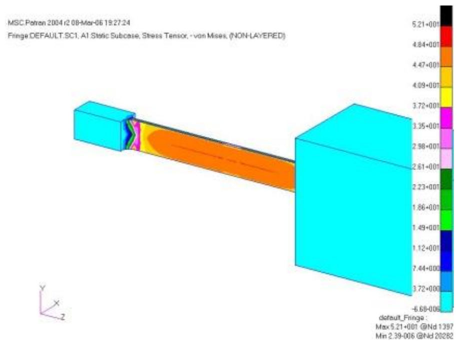


II. Mechanical Stress Transformation of Torsion to Tensile and Compression

Converting the torsion stresses to tensile and compression stresses was done by using new mechanical connection between the main beam of the mirror and its end connection. The new structures at the end connection were shaped as "H" for the micro mirror main beam. This solution is an originally development we invented and proved as very useful.

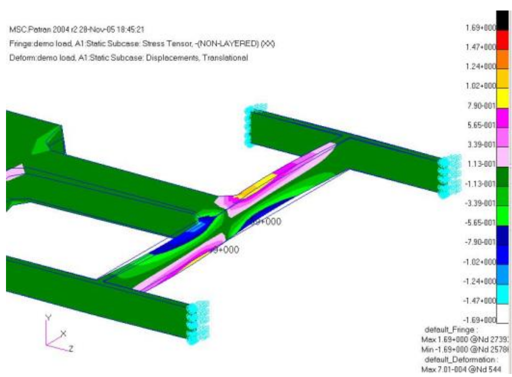
Getting a linear stresses distribution on a large surface made it easy to measure without limiting the micro mirror movement requirements. The constraint design of main mirror beam was very basic. The cube shaped connection gave no room for implanting any sensors or to create big surface to measure stresses.

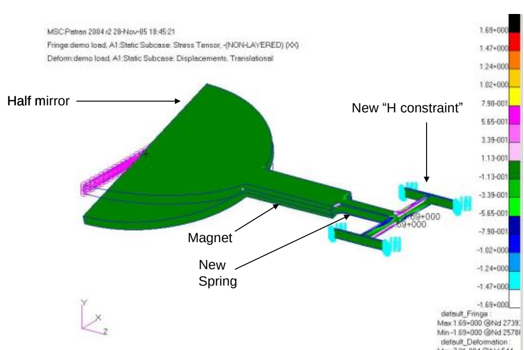
The first mirror beam design



Finite elements analysis showing that the stress concentrates on a small and difficult area to monitor

The new "H" design constraint





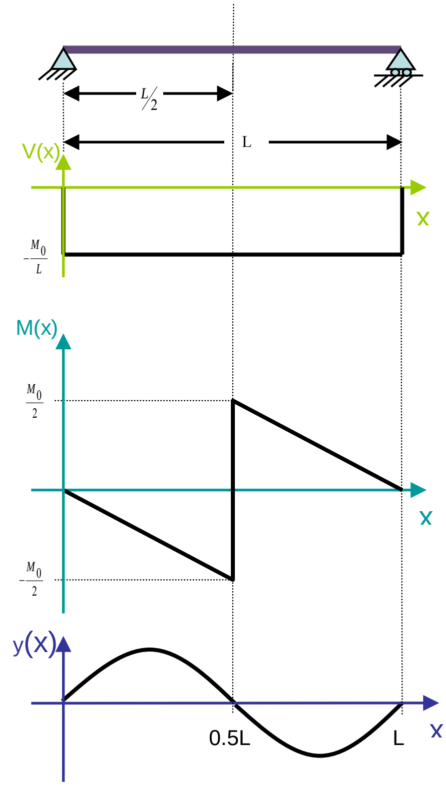
Finite elements analysis shows that changing the constraint design of the mirror main beam end connection to "H", converted the torsion stress to a uniformed compression and tensile stress area which is easier to monitor.

Mechanical analysis of the main beam mirror

Beam Shear Force Diagram

Bending Moment Diagram

Beam Deflection Diagram



Maximum calculated moment

$$M(x) = -\frac{M_0}{L} \cdot x$$

Maximum calculated beam stress

$$\sigma(x) = \frac{M \cdot C}{I} = \frac{\left(-\frac{M_0}{L} \cdot x\right)\frac{h}{2}}{\frac{b \cdot h^3}{12}} = -\frac{6 M_0 \cdot x}{b \cdot h^2 \cdot L}$$

The strain-displacement relation is

$$\varepsilon_{xx} = \frac{du}{dx}$$

In the case when the stain is x-dependent, the elongation of the gauge is:

$$u = \int_0^{L/2} -\frac{6 M_0 \cdot x}{E \cdot b \cdot h^2 \cdot L} dx = \left(-\frac{6 M_0}{E \cdot b \cdot h^2 \cdot L} \cdot \frac{x^2}{2}\right)_0^{L/2}$$

$$u = -\frac{6 M_0}{E \cdot b \cdot h^2 \cdot L} \cdot \left(\frac{L^2}{8} - 0\right) = -\frac{3 M_0 \cdot L}{4 E \cdot b \cdot h^2}$$

$$u = \frac{3 \cdot 2.697 \cdot 10^{-4} \cdot 0.78}{4 \cdot 17.23 \cdot 10^{3} \cdot 10 \cdot 10^{-3} \cdot (70 \cdot 10^{-3})^2} = -0.013 mm$$

Maximum elongation of the beam is 0.013mm

Calculation shows the same maximum elongation for the other half of the beam.

$$u = \int_{L/2}^{L} -\frac{6M_0}{E\cdot b\cdot h^2}\left(\frac{x}{L}-1\right)dx = -\frac{6M_0}{E\cdot b\cdot h^2}\cdot\left(\frac{x^2}{2L}-x\right)\Bigg|_{L/2}^{L}$$

$$u = -\left[\frac{6M_0}{E\cdot b\cdot h^2}\left(\frac{L}{2}-L\right)-\frac{6M_0}{E\cdot b\cdot h^2}\left(\frac{L}{8}-\frac{L}{2}\right)\right] = -\frac{6M_0}{E\cdot b\cdot h^2}\left(-\frac{L}{2}+\frac{3L}{8}\right)$$

$$u = \frac{6M_0}{E\cdot b\cdot h^2}\cdot\frac{L}{8} = \frac{3\cdot 2.697\cdot 10^{-4}\cdot 0.78}{4\cdot 17.23\cdot 10^3\cdot 10\cdot 10^{-3}\cdot(70\cdot 10^{-3})^2} = 0.013mm$$

Both half beams are symmetric up to a sign difference.

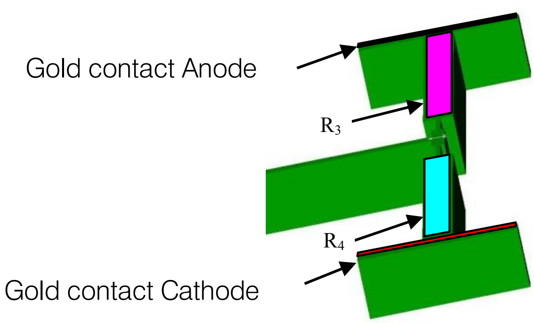
The elongation is big enough to be effective and measurable by our sensor application.

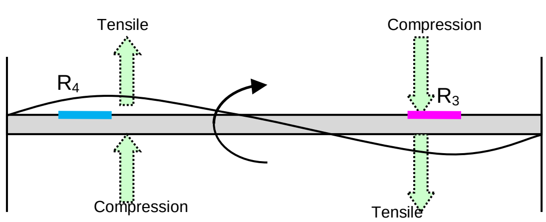
The maximum strain of half a beam is:

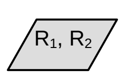
$$\varepsilon_{max} = \frac{\Delta L_{max}}{L/2} = \frac{0.013}{0.78/2} = 0.033$$

III. Electronic Design

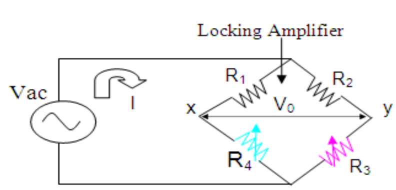
"H" surfaces will get opposite tensile and compression stresses. Those surfaces are the variable resistors of the Wheatstone bridge. The surfaces are already doped thus have better sensitivity. Ref. resistors are doped surfaces with no stresses applied on them.







Silicon n – doped
Not stressed reference Resistor



$$\varepsilon = 2\cdot\frac{V_0}{V_S}\cdot\frac{1}{S} \qquad \varepsilon = 2\cdot\frac{V_0}{V_S}\cdot\frac{1}{S}$$

$$S = \frac{\Delta R/R}{\varepsilon} \qquad \frac{d\rho}{\rho} >> \varepsilon(1+\upsilon) \Rightarrow \frac{dR}{R} \approx \frac{d\rho}{\rho}$$

$$GF = S \qquad GF = S = \frac{\Delta R/R}{\Delta L/L} = \frac{\Delta R/R}{\varepsilon}$$

IV. High Doped Silicon as a Strain Gage

The Electrical Principle of operation in order to create the built in sensor was first of all adding beams for the "H" constraint, thus adding big surfaces that are easier to implant MEMS sensors on. Secondly using high doped silicon to increase the conductivity of the substrate, thus enhancing the sensitivity of the built in sensor in the substrate. The gage factor of metal is between 2 ÷ 4 while the high doped silicon gage factor is between 150 ÷ 200. Thirdly using Wheatstone bridge to precisely measure the small changes in the resistance of the material due to applied stresses derived from angular movement. Another use of the Wheatstone bridge is to compensate temperature interferences and noises.

$$R = \rho\frac{L}{A} = \frac{\rho}{h}\cdot\frac{L}{b} = R_S\cdot\frac{L}{b} \qquad \frac{\rho}{h} \equiv R_S$$

For high doped silicon $\rho = 10^{-2} \div 10^{-1}\ \Omega\cdot cm$

New added beam dimensions: L=780μm=0.078cm, but our elongation measurements were done for half beam so we shall use L/2= 0.039cm in our calculations.

$$b = 20\mu m = 2\cdot 10^{-3}\,cm,\quad h = 70\mu m = 7\cdot 10^{-3}\,cm$$

$$R = \frac{\rho}{h}\cdot\frac{L}{b} = \frac{10^{-2}}{7\cdot 10^{-3}}\cdot\frac{3.9\cdot 10^{-2}}{2\cdot 10^{-3}} = 278.5\Omega$$

For gage factor 150 we get resistance delta of:

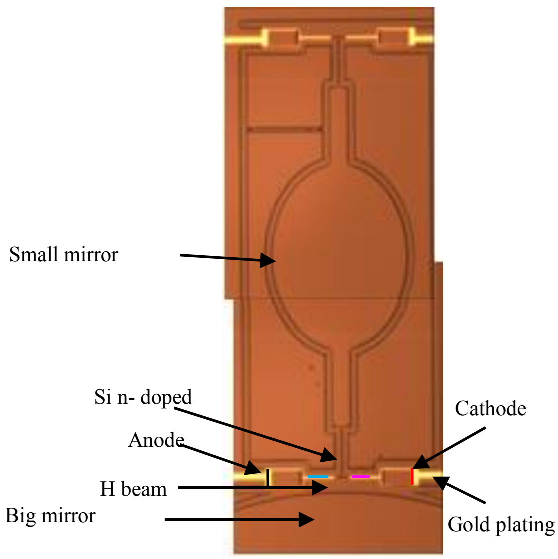
$$GF = \frac{\Delta R/R}{\varepsilon}$$

$$\Delta R = GF\cdot\varepsilon_{max}\cdot R = 150\cdot 0.033\cdot 278.5 = 1392\Omega$$

V. Fabricating a Prototype Model

In this project the device was designed, masks were fabricated and manufacturing process flow was created for this specific model. Masks were fabricated in micro fabrication labs of Tel Aviv University, lithography, Dry Etch, Wet Etch and the production process was done in the labs. The process was unique and included complicated design and fabrication with Critical Dimensions as small as 10μm with depth of 70μm. The highly doped silicon substrate amplified the sensitivity of the measurement areas, thus enabling easier way to measure small angular movements of the micro mirror. The new device is simpler and takes smaller space then the old one (with the PSD).

New mirror design with "H" beam after fabrication



VI. Conclusion

The new design of built in sensor on silicon substrate as a strain gauge is new and innovative. It can change the method of MEMS measurements for micro mirrors and other applications. Those measurements are essential for closed loop control systems used in micro moving system applications. We hope this project will make it easier to develop devices for scanning images on small screens such as glasses, small projectors etc or any other MEMS designs it might have an effect on.

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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

Low Power Conditional Sum Adder using Modified Ripple Carry Adder

By Anjana R., Vicky Kanoji & Ajay Somkumar
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Abstract- Carry select adder (CSeLA) is mainly used to alleviate the propagation delay caused by carry bit and upon which sum bit is generated. It produces n+1 sum from n bits. In this Paper, a simple Gate level implementation of regular Carry Select Adder is compared with our proposed work. Based on the comparison made in terms of power, delay and area, it is found that there is considerable reduction in area and power with delay overhead. Both regular and proposed methods are modeled using 180nm CMOS technology. From the results obtained, it is clear that proposed CSeLA is better than regular CSeLA.

Keywords: CMOS, delay efficient, CSeLA, low power, Propagation delay.

GJRE-F Classification : FOR Code: 290903p, 090607

LOWPOWERCONDITIONALSUMADDERUSINGMODIFIEDRIPPLECARRYADDER

Strictly as per the compliance and regulations of :

Low Power Conditional Sum Adder Using Modified Ripple Carry Adder

Anjana R. [α], Vicky Kanoji [σ] & Ajay Somkumar [ρ]

Abstract- Carry select adder (CSeLA) is mainly used to alleviate the propagation delay caused by carry bit and upon which sum bit is generated. It produces n+1 sum from n bits. In this Paper, a simple Gate level implementation of regular Carry Select Adder is compared with our proposed work. Based on the comparison made in terms of power, delay and area, it is found that there is considerable reduction in area and power with delay overhead. Both regular and proposed methods are modeled using 180nm CMOS technology. From the results obtained, it is clear that proposed CSeLA is better than regular CSeLA.

Keywords: CMOS, delay efficient, CSeLA, low power, Propagation delay.

I. Introduction

Designing power efficient, high performance adder is one of the major concerns as far as VLSI Sub system is considered. Speed is usually limited due carry propagation bit of an adder. The sum of final bit is generated by the carry propagation from the previous bit to next stage. The CSeLA consists of two multiplexed ripple carry adder and performs operation in parallel with carry Cin=0 and Cin=1, then final sum is selected through multiplexer (mux). Due to multiplexed RCA, there is considerable increase in area, which reveals that there is scope for reduction in area [2].

The main idea behind this work is to compare regular carry select adder with modified carry select adder. The modified carry select adder uses Boolean function based RCA along with modified XOR gate. The main advantage of this modified RCA comes with reduced gate count than the n-bit Full adder circuit.

This paper is organized as follows. Section II deals with the delay and area measurement of conventional full adder. Section III explains the Boolean function based RCA design. Section IV shows the comparison between proposed methods with regular CSeLA. Section V shows the power and delay evaluation of regular CSeLA and modified CSeLA. The implementation method and results obtained are analyzed in Section VI. The work is finally concluded in Section VII.

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II. Delay and Area Evaluation of Conventional Adder

The XOR gate is implemented using conventional AOI logic. The delay and area is found from this AOI logic, with the assumption that each gate having delay equal to one and the gate with the longest path contribute critical path delay. The total number of gate in AOI logic contributes to total area of logic block. Based on this method, 2:1 Mux, full adder, half adder, XOR are evaluated.

Table 1 : Delay and area evaluation of CSeLA

1-Bit Adder	Delay	Area
Full adder	6	13
Half adder	3	6
2:1 MUX	3	4
XOR	3	5
AND	1	1

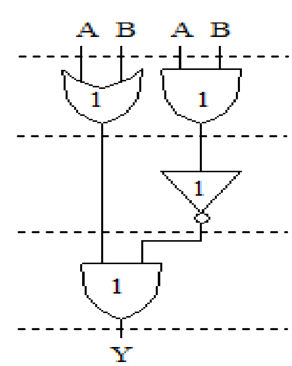

Figure 1 : Modified Ex-OR Gate

a) Boolean function based CSeLA

i. *RCA – I*

The main idea is to use modified RCA instead of RCA with Cin=0 to reduce area and power consumption of regular CSeLA. The AOI implementation of full adder requires 14 gates, while the modified full adder CSeLA has two ripple carry adder with Cin=0 and Cin=1 and multiplexer to choose data one among them. One of two RCA is replaced with Boolean function (BF), which has reduced number of gate count. From the truth table of full adder its evident that sum is obtained from

XOR/XNOR function. Mux is used to select either XOR or XNOR outputs. Carry is obtained from AND and OR inputs. This method replaces Conventional RCA with Boolean logic function. This Boolean logic function comes up with reduced area compared to regular carry save adder.

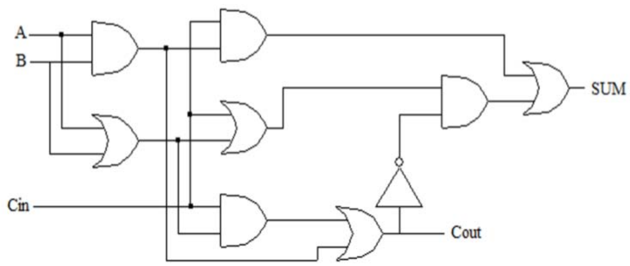

Figure 2 : Modified Full Adder Using 9 Logic Gates

ii. *Modified BEC-1*

The main idea is to use modified BEC-1 instead of RCA with Cin=1. The M-BEC 1 uses XOR gate based on Boolean function. The AOI logic of XOR gate has in total 5 gates, while the modified XOR gate has 4 gates, which reduces the total gate count. The modified XOR gate uses the following Boolean logic function.

$$Y = (a+b)(\sim ab)$$

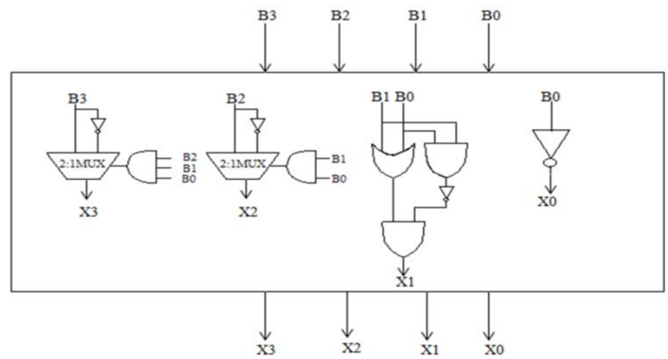

Figure 3 : Modified 4-bit BEC

III. Delay and Area Evaluation of Regular 16-b CSeLA

The regular 16-B CSeLA is shown in the Fig. It uses variable RCA and they are grouped into five groups with variable word length. The delay and area of these five groups are evaluated. The steps involved are detailed below.

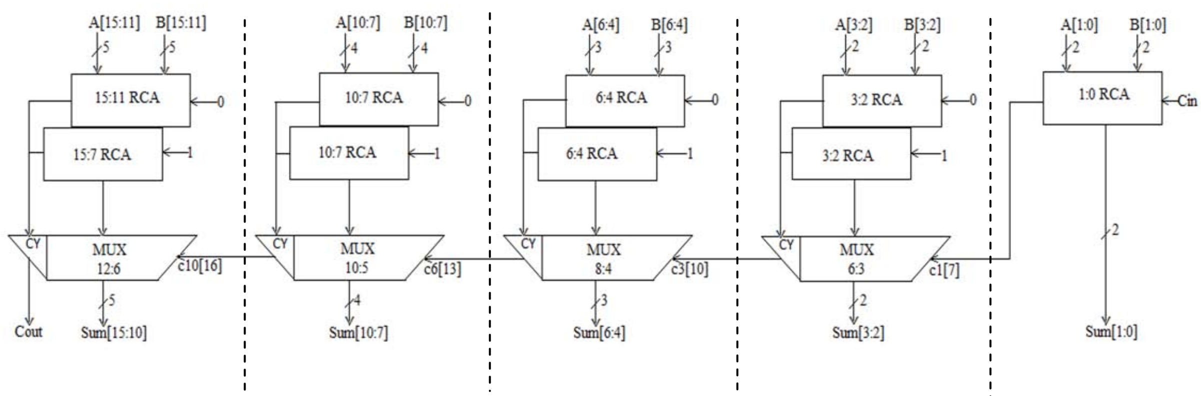

Figure 4 : Regular 16-Bit CSelA [1]

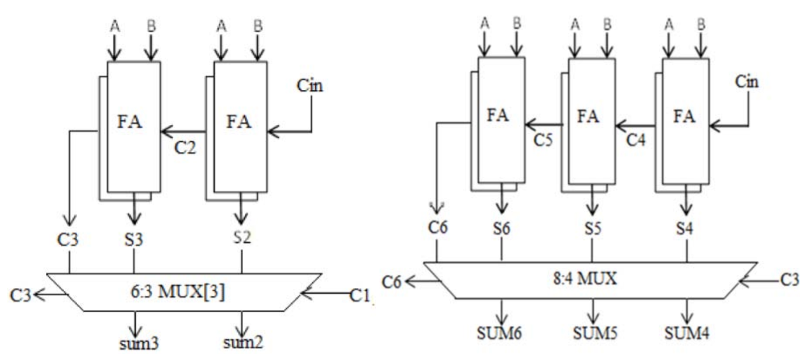

Figure 5 : Group 2 & Group 3

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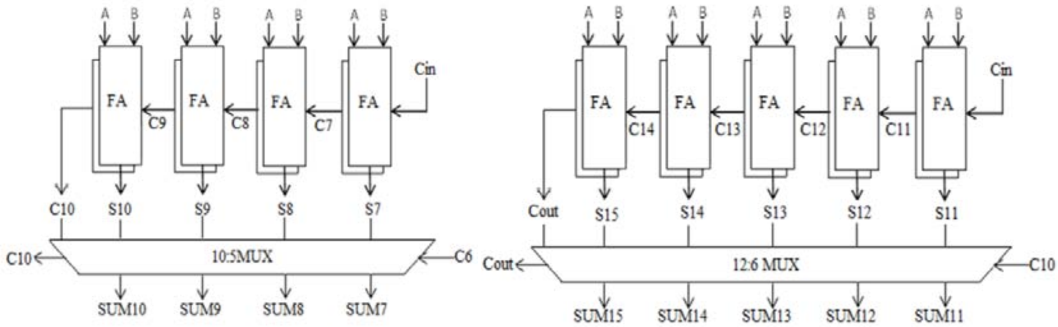

Figure 6 : Group4 & Group5

- In group 2, based on delay and area consideration listed in table I, the total number of gate count is:

Total gate count = 57 (Full adder + half adder + 2:1 Mux) FA = 13(AOI Logic), for 3 bit, 3 * 13 = 39

HA = 6 (1*6)

2:1 Mux =12 (3*4)

- Here, the propagation delay of N-Bit ripple carry adder is given as,

$$T_{RCA} = T + (N/M)\ Tcarry + M\ Tmux + Tsum$$

T = 4ns

Similarly, area and delay of other groups are evaluated for regular CSeLA

IV. Delay and Area Evaluation of Modified CSELA

The structure of the modified CSeLA using proposed RCA with Cin = 0 and BEC-1 with Cin = 1 is shown in the fig. Again the structure is divided into 5 groups. Area and delay analysis are performed in same fashion as regular CSeLA. The steps involved are detailed below:

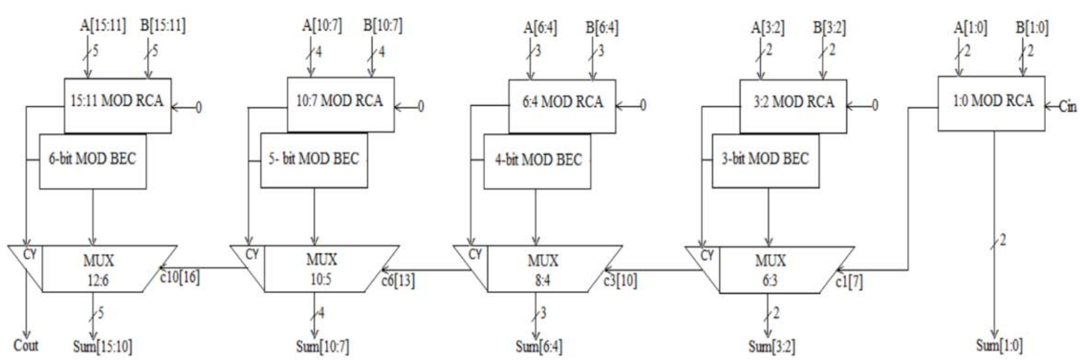

Figure 7 : 16-Bit Modified CSeLA

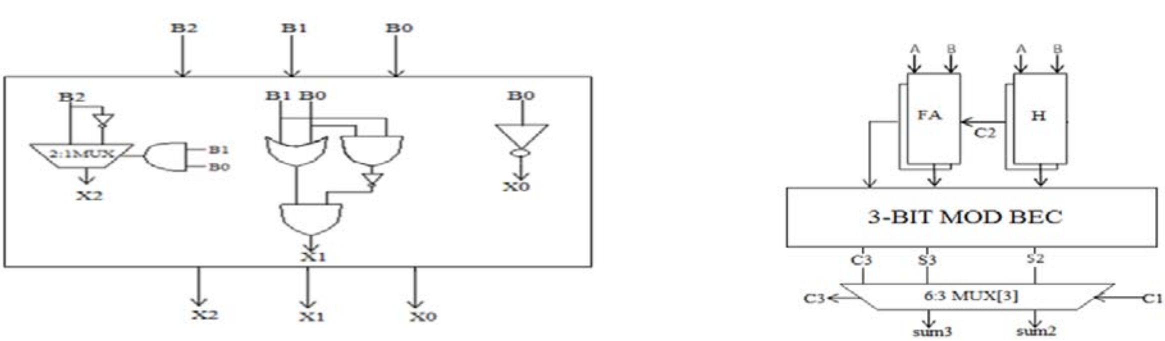

Figure 8 : 3-Bit Modified BEC

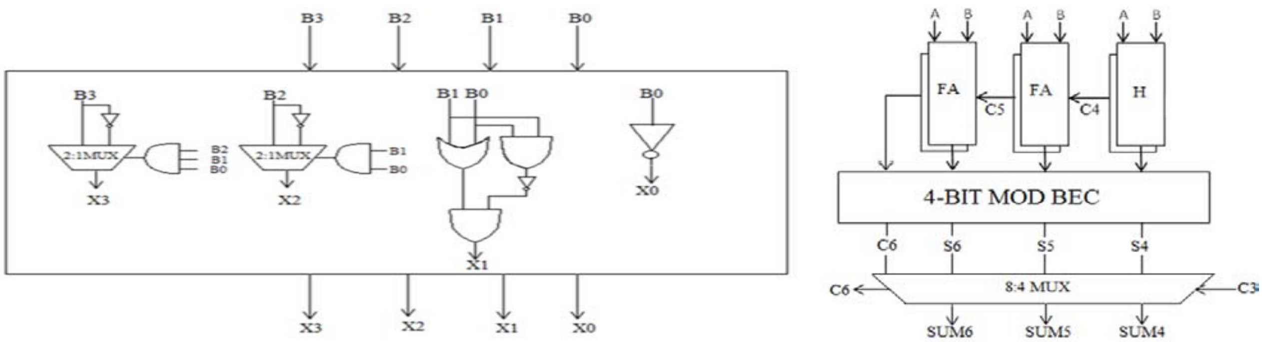

Figure 9 : 4-Bit Modified BEC

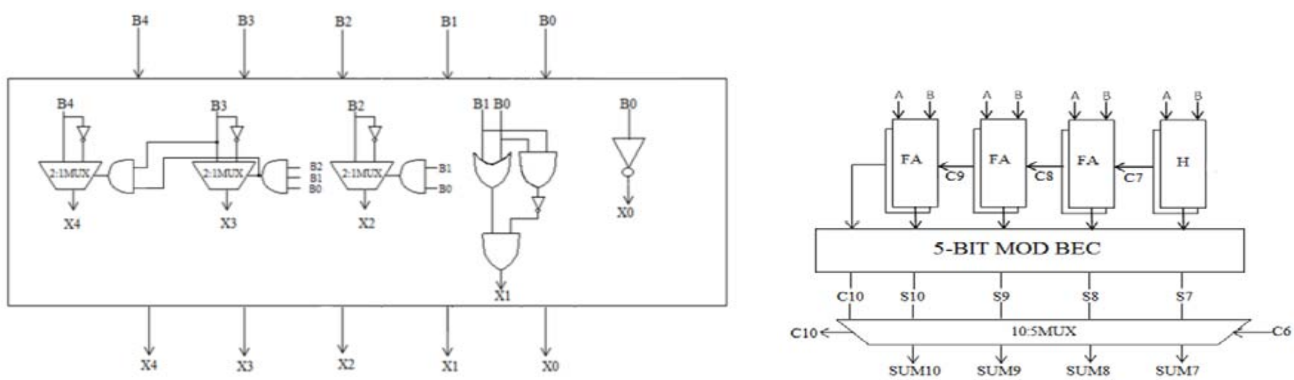

Figure 10 : 5-Bit Modified BEC

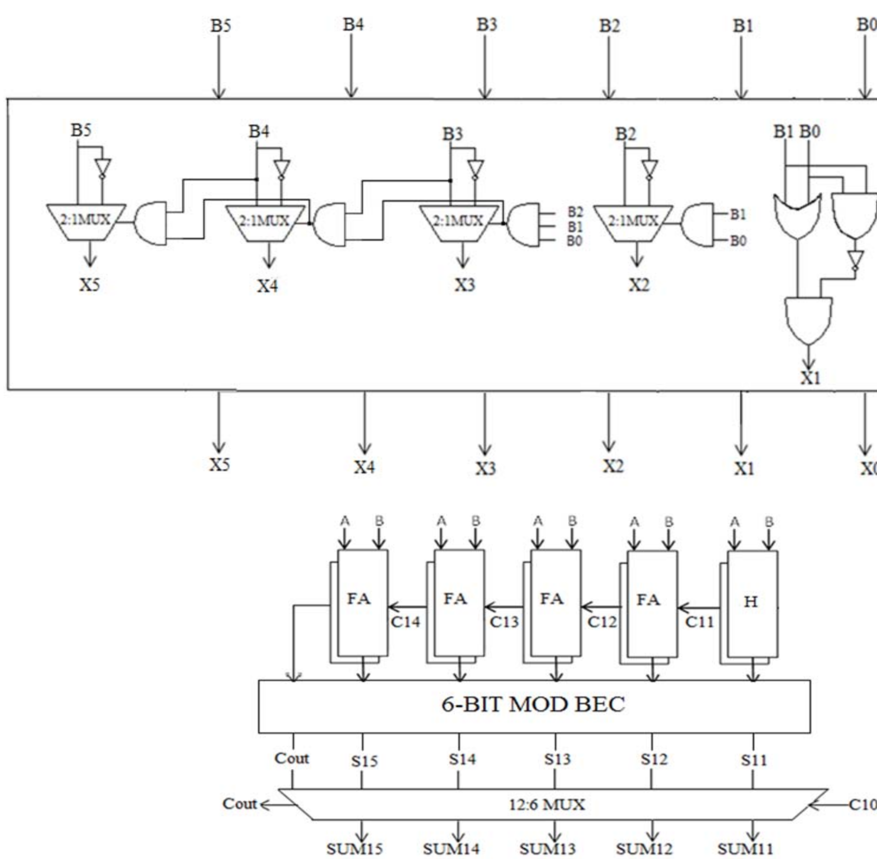

Figure 11 : 6-Bit Modified BEC

- The group 2 has two bit RCA, which comprises 1 FA and 1 HA with Cin=0 and other RCA with Cin=1 is replaced with modified BEC -1.
- Based on the delay and area analysis listed in Table I, the total number of gate count for group 2 is

Gate count = 44 (27 + 5 + 12)

FA =27 (9*3)

HA = 5 (1*5)

MUX= 12 (3*4)

- Propagation delay of proposed carry select adder is given as,

$$T_{Proposed} = T_s + (N\text{-}1)\, T_{mux} + T_{sum} = 3ns$$

- Area and delay is computed in same way as that of group 2 and listed in Table 1.

V. Experimental Results

The proposed work is designed using DSCH simulator and synthesized using 180nm technology. The synthesized verilognetlist is imported to Microwind and automatic layout is generated. From Microwind, power, area and delay is found by choosing different technology.

Table 2 shows the simulation results of both regular and modified CSeLA in terms of delay, power and area. Each individual cell in the design contributes the total cell area. Total power consumption is the sum of leakage power, switching power and static power. Area, power, delay, power delay product (PDP) is shown in fig. in terms of percentage reduction. The total power reduction for 8-b, 16-b, 32-b are 9.3 %, 23.1%, 9.7% respectively. Similarly Percentage reduction in area is shown in fig. There is delay overhead of 14.9%, 12.1%, 6.18% respectively.

Table 2 : Comparison of proposed and regular CSeLA

Word Size	Adder	Power (mW)	Area(um^2)	Delay(ns)	PDP(pW)
8-Bit	Conventional CSLA	0.32	941	1.61	0.515
	Modified CSLA	0.29	842	1.85	0.3885
16-Bit	Conventional CSLA	0.69	2435	2.62	1.80
	Modified CSLA	0.53	1829	2.94	1.55
32-Bit	Conventional CSLA	0.92	4683	4.93	4.53
	Modified CSLA	0.83	3826	5.13	4.25

VI. Conclusion

A modified approach for carry select adder is proposed in this paper to reduce power and delay compared to conventional CSLA. The modified structure of RCA and BEC provides the scope for further area reduction and power for 90nm technology. From the experimental results it is clear that there is 9.3 %, 23.1%, 9.7% reduction in power and 10.5 %, 24.9%, 18.3% reduction in area with 14.9%, 12.1%, 6.18% delay overhead. The modified Carry Save Adder is thus area and power efficient.

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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

Relationship between New Types of Transitive and Chaotic Maps

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Abstract- The concepts of topological **γ**-transitive maps, **α**-transitive maps, **γ**-type chaotic and **α**-type chaotic maps were introduced by M. Nokhas Murad Kaki. In this paper, I study the relationship between two different notions of transitive maps, namely topological **α**- transitive maps, topological **γ**-transitive maps and investigate some of their properties in two topological spaces (X, **τα**) and (X, **τγ**), **τα** denotes the **α**–topology(resp. **τγ** denotes the **γ**–topology) of a given topological space (X, **τ**).. The two notions are defined by using the concepts of **α**-irresolute map and **γ**-irresolute map respectively Also, we study the relationship between two new types of chaotic maps, namely, **α**-type chaotic maps and **γ**-chaotic maps, and I will prove that the properties of **α**- transitive, **α**-type chaotic are preserved under **α**r-conjugacy and **γ**-transitive, **γ**-chaotic maps are preserved under **γ**r-conjugacy The main results are the following propositions:

1) Every topologically **γ**-type transitive map is a topologically **α**-type transitive map which implies topologically transitive map, but the converse not necessarily true..

2) Every **γ**-type chaotic map is **α**-chaotic map which implies chaotic map in topological spaces, but the converse not necessarily true..

Keywords: topologically γ- transitive, α - type chaotic, γ-type chaotic, α-dense.

GJRE-F Classification : FOR Code: 090699

RELATIONSHIPBETWEENNEWTYPESOFTRANSITIVEANDCHAOTICMAPS

Strictly as per the compliance and regulations of :

Relationship between New Types of Transitive and Chaotic Maps

Mohammed Nokhas Murad

Abstract- **The concepts of topological γ-transitive maps, α-transitive maps, γ-type chaotic and α-type chaotic maps were introduced by M. Nokhas Murad Kaki. In this paper, I study the relationship between two different notions of transitive maps, namely topological α- transitive maps, topological γ-transitive maps and investigate some of their properties in two topological spaces (X, τα) and (X, τγ), τα denotes the α–topology(resp. τγ denotes the γ–topology) of a given topological space (X, τ).. The two notions are defined by using the concepts of α-irresolute map and γ-irresolute map respectively Also, we study the relationship between two new types of chaotic maps, namely, α-type chaotic maps and γ-chaotic maps, and I will prove that the properties of α- transitive, α-type chaotic are preserved under αr-conjugacy and γ-transitive, γ-chaotic maps are preserved under γr-conjugacy The main results are the following propositions:**

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I. Introduction

Recently there has been some interest in the notion of a locally closed subset of a topological space. According to Bourbaki [16] a subset S of a space (X, τ) is called locally closed if it is the intersection of an open set and a closed set. Ganster and Reilly used locally closed sets in [13] and [14] to define the concept of LC–continuity, i.e. a function $f : (X, \tau) \rightarrow (X, \sigma)$ is LC–continuous if the inverse with respect to f of any open set in Y is closed in X. The study of semi open sets and semi continuity in topological spaces was initiated by Levine [6]. Bhattacharya and Lahiri [8] introduced the concept of semi generalized closed sets in topological spaces analogous to generalized closed sets which was introduced by Levine [5]. Throughout this paper, the word "space " will mean topological space The collections of semi-open, semi-closed sets and α–sets in (X, τ) will be denoted by $SO(X, \tau)$, $SC(X, \tau)$ and τ^{α} respectively. Njastad [7] has shown that τ^{α} is a topology on X with the following properties: $\tau \subseteq \tau^{\alpha}, (\tau^{\alpha})^{\alpha} = \tau^{\alpha}$ and $S \in \tau^{\alpha}$ if and only if $S = U \setminus N$ where $U \in \tau$ and N is nowhere dense $(i.e. Int(Cl(N)) = \varphi)$ in (X, τ). Hence $\tau = \tau^{\alpha}$ if and only if every nowhere dense (nwd) set in (X, τ) is closed, therefore every transitive map implies α-transitive. Also if every α-open set is locally closed then every transitive map implies α-transitive; and this structure also occurs if (X, τ) is locally compact and Hausdorff [36, p. 140, Ex. B]] and every α-open set is locally compact, then every α-open set is locally closed.

In 1943, Fomin [27] introduced the notion of θ-continuous maps. The notions of θ-open sets, θ-closed sets and θ-closure where introduced by Veliˇcko [19] for the purpose of studying the important class of H-closed spaces in terms of arbitrary fiber-bases. Dickman and Porter [20], [21], Joseph [22] and Long and Herrington [31] continued the work of Veličko. We introduce the notions of θ-type transitive maps, θ-minimal maps and show that some of their properties are analogous to those for topologically transitive maps. Also, we give some additional properties of θ-irresolute maps. We denote the interior and the closure of a subset A of X by Int(A) and Cl(A), respectively. By a space X, we mean a topological space (X, τ) A point x ∈ X is called a θ-adherent point of A [19], if $A \cap Cl(V) \neq \phi$ for every open set V containing x. The set of all θ-adherent points of a subset A of X is called the θ-closure of A and is denoted by $Cl_{\theta}(A)$. A subset A of X is called - closed if $A = Cl_{\theta}(A)$. Dontchev and Maki [22] have shown that if A and B are subsets of a space (X, τ), then

$\mathrm{Cl}_{\theta}(A \cup B) = \mathrm{Cl}_{\theta}(A) \cup \mathrm{Cl}_{\theta}(B)$ also

$\mathrm{Cl}_{\theta}(A \cap B) = \mathrm{Cl}_{\theta}(A) \cap \mathrm{Cl}_{\theta}(B)$.

Note also that the θ-closure of a given set need not be a θ - closed set. But it is always closed. Dickman and Porter [20] proved that a compact subspace of a Hausdorff space is θ-closed. Moreover, they showed that a θ-closed subspace of a Hausdorff space is closed. Jankovi´[25] proved that a space (X, τ) is Hausdorff if and only if every compact set is θ-closed. The complement of a θ-closed set is called a θ-open set. The family of all θ-open sets forms a topology on X and is denoted by τ^{θ} *or* θ topology.

This topology is coarser than τ and that a space (X, τ) is regular if and only if $\tau = \tau^{\theta}$ [26]. Then we observe that every theta-type transitive maps is transitive if (X, τ) is regular. In general, $Cl_{\theta}(A)$ will not be the closure of A with respect to (X, τ^{θ}). It is easily seen that one always has $A \subseteq Cl(A) \subseteq Cl_{\delta}(A) \subseteq Cl_{\theta}(A) \subseteq \overline{A}^{\theta}$

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where $\overline{A}^{\theta}$ denotes the closure of A with respect to (X,τ^{θ}). It is also obvious that a set A is θ-closed in (X, τ) if and only if it is closed in (X, τ^{θ}). The space (X,τ^{θ}) is called sometimes the semi regularization of (X, τ). A function $f: X \to Y$ is closure continuous [29] (θ continuous) at x ∈ X if given any open set V in Y containing f(x), there exists an open set U in X containing x such that $f(Cl(U)) \subseteq Cl(V)$.[29] In this paper, we will study the relationship between new classes of topological transitive maps called *γ type transitive* and α- type transitive, also, new classes of γ- type chaotic maps and α- type chaotic maps. We have shown that every γ-type transitive map is a α- type transitive map, but the converse not necessarily true and that every γ-type chaotic map is α-type chaotic map, but the converse not necessarily true we will also study some of their properties.

II. Preliminaries and Definitions

In this section, we recall some of the basic definitions. Let X be a space and $A \subset X$. The intersection (resp. closure) of A is denoted by Int(A) (resp. Cl(A).

- *Definition 2.1* [6] A subset A of a topological space X will be termed semi- open (written S.O.) if and only if there exists an open set U such that $U \subset A \subset Cl(U)$.
- *Definition 2.2* [8] Let A be a subset of a space X then semi closure of A defined as the intersection of all semi–closed sets containing A is denoted by sClA.
- *Definition 2.3* [9] Let (X, τ) be a topological space and α an operator from τ to Ƥ(X) i.e α: η → Ƥ(X), where Ƥ(X) is a power set of X. We say that α is an operator associated with η if $U \subset a(U)$ for all U ϵ η
- *Definition 2.4* [10] Let (X,τ) be a topological space and α an operator associated with η. A subset A of X is said to be α-open if for each x ϵ X there exists an open set U containing x such that $a(U) \subset A$. Let us denote the collection of all α-open, semi-open sets in the topological space (X,τ) by τ^{α}, SO(τ), respectively. We then have $\tau \subseteq \tau^{\alpha} \subseteq$ *SO* (τ). A subset B of X is said to be α-closed [7] if its complement is α-open.
- *Definition 2.5* [9] Let (X, τ) be a space. An operator α is said to be regular if, for every open neighborhoods U and V of each x ϵ X, there exists a neighborhood W of x such that $a(W) \subset \alpha(U)\ a(V)$.. Note that the family τ^{α} of α –open sets in (X, τ) always forms a topology on X, when α is considered to be regular finer than τ.
- *Theorem 2.6* [30] For subsets A, B of a space X, the following statements hold:

  (1) $D(A) \subset D_{\theta}(A)$, where D(A) is the derived set of A

  (2) *If* $A \subset B$, *then* $D_{\theta}(A) \subset D_{\theta}(B)$

  (3) $D_{\theta}(A) \cup D_{\theta}(B) = D_{\theta}(A \cup B)$. And $D_{\theta}(A \cap B) \subset D_{\theta}(A) \cap D_{\theta}(B)$

Note that the family τ^{θ} of θ –open sets in (X,τ) always forms a topology on X denoted θ-topology and that θ-topology coarser than τ.

- *Definition 2.7* [4]: Let A be a subset of a space X. A point x is said to be an α- limit point of A if for each α- open U containing x, $U \cap (A \setminus x) \neq \phi$. The set of all α- limit points of A is called the α-derived set of A and is denoted by $D_{\alpha}(A)$.
- *Definition 2.8* [4] For subsets A and B of a space X, the following statements hold true:

  1) $D_{\alpha}(A) \subset D(A)$ where D(A) is the derived set of A

  2) if $A \subset B$ then $D_{\alpha}(A) \subset D_{\alpha}(B)$

  3) $D_{\alpha}(A) \cup D_{\alpha}(B) \subset D_{\alpha}(A \cup B)$

  4) $D_{\alpha}(A \cup D_{\alpha}(A)) \subset A \cup D_{\alpha}(A)$
- *Definition 2.9* [10]: The point x ϵ X is in the α–closure of a set A⊂X if α(U) ∩ A≠θ, for each open set U containing x. The α- closure of a set A is the intersection of all α -closed sets containing A and is denoted by $Cl_{\alpha}(A)$.
- *Remark 2.10:* For any subset A of the space X, $A \subset Cl(A) \subset Cl_{\alpha}(A)$
- *Definition 2.11* [10] Let (X, τ) be a topological space. We say that a subset A of X is α- compact if for every α-open covering Π of A there exists a finite subcollection $\{C_1, C_2, ..., C_n\}$ of Π such that $/A \subset \bigcup_{i=1}^{n} C_i$. Properties of α –compact spaces have been investigated by Rosa, E etc. and Kasahara, S [9,10].The following results were given by Rosas, E etc. [9].
- *Theorem2.12* Let (X, τ) be a topological space and α an operator associated with η. A⊂ X and K⊂A. If A is α–compact and K is α –closed then K is α –compact.
- *Theorem2.13* Let (X, τ) be a topological space and α be a regular operator on η. If X is α - 2 *T* (see Rosa, E etc. and Kasahara, S) [9,10] and K⊂X is α –compact then K is α – closed.
- *Definition 2.14* [10] The intersection of all α – closed sets containing A is called α –closure of A, denoted by $Cl_{\alpha}(A)$.
- *Remark 2.15* For any subset A of the space X, A ⊂ Cl(A)⊂ $Cl_{\alpha}(A)$.
- *Lemma2.16* For subsets A and A_i (i ϵ I) of a space (X, τ) , the following hold:

1) A ⊂ $Cl_{\alpha}(A)$

2) $Cl_{\alpha}(A)$ closed; $Cl_{\alpha}(Cl_{\alpha}(A)) = Cl_{\alpha}(A)$

3) If A ⊂ B then $Cl_{\alpha}(A) \subset Cl_{\alpha}(B)$

4) $Cl_{\alpha}(\cap(A_i : i \in I)) \subset \cap(Cl_{\alpha}(A) : i \in I)$

5) $Cl_{\alpha}(\cup(A_i : i \in I)) = \cup(Cl_{\alpha}(A) : i \in I)$

- *Lemma 2.17* The collection of α –compact subsets of X is closed under finite unions. If α is a regular operator and X is an α- 2 *T* space then it is closed under arbitrary intersection.

- *Definition 2.18* Let (X, τ) be a topological any space, A subset of X, The $\text{int}_{\alpha}(A)=\cup\{U: U$ is α–open and $U\subset A\}$.
- *Remark 2.19* A subset A is α –open if and only if $\text{int}_{\alpha}(A)=A$.

Proof: The proof is obvious from the definition.

- *Definition 2.20* Let (X, τ) and (Y, ζ) be two topological spaces, a map $f: X\to Y$ is said to be α–continuous if for each open set H of Y, $f^{-1}(H)$ is α–open in X.
- *Theorem 2.21* [4]: For any subset A of a space X, $Cl_{\alpha}(A)=A\cup Cl_{\alpha}(A)$.
- *Theorem 2.22.*[4]: For subsets A, B of a space X, the following statements are true:

1) $\text{int}_{\alpha}(A)$ is the largest α –open contained in A
2) $\text{int}_{\alpha}(\text{int}_{\alpha}(A))=\text{int}_{\alpha}(A)$
3) If A⊂B then $\text{int}_{\alpha}(A)\subset\text{int}_{\alpha}(B)$
4) $\text{int}_{\alpha}(A)\cup\text{int}_{\alpha}(B)\subset\text{int}_{\alpha}(A\cup B)$
5) $\text{int}_{\alpha}(A)\cap\text{int}_{\alpha}(B)\supset\text{int}_{\alpha}(A\cap B)$

- *Lemma 2.23* [7] For any α– open set A and any α-closed set C, we have
  1) $Cl_{\alpha}(A)=Cl(A)$
  2) $\text{int}_{\alpha}(C)=\text{int}(C)$
  3) $\text{int}_{\alpha}\ Cl_{\alpha}\ A\ =\text{int}(Cl(A))$
- *Remark 2.24.*[4]: It is not always true that every α-open set is an open set, as shown in the following example:
- *Example 2.25* Let X={a, b, c, d} with topology η={ϕ,{c,d}, X}. Hence α (τ)={ϕ,{c, d},{b, c, d}, {a, c, d},X} So {b, c, d} is α-open but not open.
- *Theorem 2.26* Let (*X, f*) *and* (*Y, g*) be two topological systems, if $f: X\to X$ and $g: Y\to Y$ are topologically αr-conjugate. Then

  (1) *f* is topologically α- transitive map if and only if *g* is topologically α-transitive map;

  (2) *f* is α-type chaotic map if and only if *g* is α-type chaotic map;

  (3) *f* is γ-type chaotic map if and only if *g* is γ-type chaotic map.

III. Transitive and Minimal Systems

Topological transitivity is a global characteristic of dynamical systems. By a dynamical system (X, f) [15] we mean a topological space *X* together with a continuous map $f: X\to X$. The space X is sometimes called the phase space of the system. A set $A\subseteq X$ is called $f-$*inveriant* if $f(A)\subseteq A$. A topological system (*X, f*) is called *minimal* if *X* does not contain any non-empty, proper, closed $f-$*inveriant* subset. In such a case we also say that the map *f* itself is minimal. Thus, one cannot simplify the study of the dynamics of a minimal system by finding its nontrivial closed subsystems and studying first the dynamics restricted to them.

Given a point x in X, $O_f(x)=\{x, f(x), f^2(x), ...\}$ denotes its orbit (by an orbit we mean a forward orbit even if f is a homeomorphism) and $\omega_f(x)$ denotes its ω - limit set, i.e. the set of limit points of the sequence . $x, f(x), f^2(x), ...$ The following conditions are equivalent:

- (X, f) is γ-minimal (resp. α-minimal),
- every orbit is γ-dense (resp. α-dense) in X ,
- $\omega_f(x)=X$ for every x ∈ X.

A minimal map f is necessarily surjective if *X* is assumed to be Hausdorff and compact.

Now, we will study the Existence of minimal sets. Given a dynamical system (X, f), a set $A\subseteq X$ is called a *minimal set* if it is non-empty, closed and invariant and if no proper subset of *A* has these three properties. So, $A\subseteq X$ is a minimal set if and only if $(A, f|A)$ is a minimal system. A system (X, f) is minimal if and only if X is a minimal set in (X, f).

The basic fact discovered by G. D. Birkhoff is that in any compact system (X, f) there are minimal sets. This follows immediately from the Zorn's lemma. Since any orbit closure is invariant, we get that *any compact orbit closure contains a minimal set*. This is how compact minimal sets may appear in non-compact spaces. Two minimal sets in (X, f) either are disjoint or coincide. A minimal set A is strongly $f-$ *inveriant*, i.e. $f(A)=A$. Provided it is compact Hausdorff.

Let (X, f) be a topological system, and $f: X\to X$ αr-homeomorphism of X onto itself. For A and B subsets of X, we let $N(A, B)=\{n\in\mathbf{Z}: f^n(A)\cap B\neq\phi\}$ We write $N(A,B)=N(x, B)$ for a singleton $A=\{x\}$ thus $N(x, B)=\{n\in\mathbf{Z}: f^n(x)\in B\}$ For a point $x\in X$ we write $O_f(x)=\{f^n(x): n\in\mathbf{Z}\}$ for the orbit of x and $Cl_{\alpha}(O_f(x))$ for the α-closure of $O_f(x)$. We say that the topological system (X, f) is α-type point transitive if there is a point $x\in X$ with $O_f(x)$ α-dense. Such a point is called α-type transitive. We say that the topological systems (X, f) is topologically α-type transitive (or just α-type transitive) if the set $N(U,V)$ is nonempty for every pair U and V of nonempty α-open subsets of X.

- *Theorem 2.8* [37] Let (X, f) be a topological system where X is a non-empty locally γ-compact Hausdorff topological space and $f: X\to X$ is γ-irresolute map and that X is γ-type separable. Suppose that f is topologically γ-type transitive. Then there is an element $x\in X$ such that the orbit $O_f(x)=\{f^n(x): n\in\mathbf{N}\}$ is γ-dense in X.

a) *Topologically α-Transitive Maps*

In [35], we introduced and defined a new class of transitive maps that are called topologically α-transitive maps on a topological space (X, τ), and we studied some of their properties and proved some results associated with these new definitions. We also defined and introduced a new class of α-minimal maps. In this paper we discuss the relationship between topologically α-transitive maps and θ-transitive maps. On the other hand, we discuss the relationship between α-minimal and θ-minimal in topological systems.

- *Definition 3.1.1* Let (X, τ) be a topological space. A subset A of X is called α-dense in X if $Cl_\alpha(A) = X$.
- *Remark 3.1.2* Any α-dense subset in X intersects any α- open set in X.

Proof: Let A be an α-dense subset in X, then by definition, $Cl_\alpha(A) = X$, and let U be a non-empty α- open set in X. Suppose that A∩U=ϕ . Therefore $B = U^c$ is α-closed and $A \subset U^c$=B. So $Cl_\alpha(A) \subset Cl_\alpha(B)$ i.e. $Cl_\alpha(A) \subset$ B, but $Cl_\alpha(A) = X$, so $X \subset$ B, this contradicts that U $\neq \varphi$

- *Definition 3.1.3* [12] A map $f: X \to Y$ is called α-irresolute if for every α- open set H of Y, $f^{-1}(H)$ is α- open in X.
- *Example 3.1.4* [35] Let (X, η) be a topological space such that X={a, b, c, d} and η ={ϕ, X ,{a, b}, {b}}. We have the set of all α-open sets is α(X, η)={ϕ, X, {b}, {a, b}, {b, c}, {b, d}, {a, b, c}, {a, b, d}}and the set of all α-closed sets is αC(X, η)={ϕ, X, {c, d, {a, c, d}, {a, d}, {}a, c}, {d}, {c}}. Then define the map f : X→X as follows f(a)= a, f(b)= b, f(c)= d, f(d)= c, we have f is α-irresolute because {b} is α open and f-1({b})={b} is α-open; {a, b} is α-open and f- 1({a, b})={a, b} is α-open; {b, c} is α-open and f-1({b, c})={b, d} is α-open; {a, b, c} is α open and f-1({a, b, c})={a, b, d} is α-open; {a, b, d} is α-open and f-1({a, b, d})={a, b, c} is α-open so f is α-irresolute.
- *Definition 3.1.5* A subset A of a topological space (X,τ) is said to be nowhere α-dense, if its α-closure has an empty α-interior, that is, $\operatorname{int}_\alpha(Cl_\alpha(A)) = \phi$.
- *Definition 3.1.6* [35] Let (X, τ) be a topological space, $f: X \to X$ be α-irresolute map then *f* is said to be topological α-transitive if every pair of non-empty α-open sets U and V in X there is a positive integer n such that $f^n(U) \cap V \neq \phi$. In the forging example 3.1.4: we have f is α-transitive because b belongs to any non-empty α- open set V and also belongs to f(U) for any α-open set it means that f(U)∩V≠ ϕ so f is . α - transitive.
- *Example 3.1.7* Let (X, η) be a topological space such that X ={a, b, c}and η={ϕ, {a}, X}.Then the set of all α-open sets is ηα={ϕ, {a}, {a, b}, {a, c}, X}. Define f : X→X as follows f(a)=b, f(b)=b, f(c)=c. Clearly f is continuous because {a} is open and f({a})=ϕ is open. Note that f is transitive because f({a})={b} implies that f({a})∩{b}≠ϕ. But f is not α-transitive because for each n in N , fn({a})∩{a, c}=ϕ; since fn({a})={b} for every n ε N, and {b}∩{a, c}=ϕ. So we have f is not α-transitive, so we show that transitivity not implies α-transitivity.
- *Definition 3.1.8* Let (X, η) be a topological space. A subset A of X is called θ-dense in X if $Cl_\theta(A) = X$.
- *Remark 3.1.9* [38] Any θ-dense subset in X intersects any θ-open set in X.

Proof: Let A be a θ-dense subset in X, then by definition, $Cl_\theta(A) = X$, and let U be a non-empty θ-open set in X. Suppose that A∩U=ϕ. Therefore $B = U^c$ is θ-closed because B is the complement of θ-open and $A \subset U^c$=B. So $Cl_\theta(A) \subset Cl_\theta(B)$, i.e. $Cl_\theta(A) \subset$B, but $Cl_\theta(A) = X$, so $X \subset B$, this contradicts that U ϕ φ

- *Definition 3.1.10.[33]* A function $f: X \to X$ is called θ − irresolute if the inverse image of each θ − open set is a θ − open set in X.
- *Definition 3.1.11* A subset A of a topological space (X,τ) is said to be nowhere θ-dense, if its θ-closure has an empty θ-interior, that is, $\operatorname{int}_\theta(Cl_\theta(A)) = \phi$.
- *Definition 3.1.12* [34] Let (X, τ) be a topological space, and $f: X \to X$ θ.-irresolute) map, then *f* is said to be topologically θ-type transitive map if for every pair of θ- open sets U and V in X there is a positive integer n such that $f^n(U) \cap V \neq \phi$

Associated with this new definition we can prove the following new theorem.

- *Theorem 3.1.13* [35]: Let (X, τ) be a topological space and $f: X \to X$ be α -irresolute map. Then the following statements are equivalent:
  (1) *f* is topological α-transitive map
  (2) For every nonempty α- open set U in X, $\bigcup_{n=0}^{\infty} f^n(U)$
  (3) For every nonempty α-open set U in X, $\bigcup_{n=0}^{\infty} f^{-n}(U)$
  (4) If $B \subset X$ is α- closed and B is f- invariant i.e. $f(B) \subset B$ then B=X or B is nowhere α-dense.
  (5) If U is α-open and $f^{-1}(U) \subset U$ then U is either empty set or α-dense in X.
- *Theorem 3.1.14* : [34] Let (X, τ) be a topological space and $f: X \to X$ be θ -irresolute map. Then the following statements are equivalent:
  (1) f is θ-type transitive map
  (2) $\bigcup_{n=0}^{\infty} f^n(D)$ is θ-dense in X, with D is θ-open set in X.
  (3) $\bigcup_{n=0}^{\infty} f^{-n}(D)$ is θ- dense in X with D is θ- open set. in X.
  (4) If $B \subset X$ is θ-closed and $f(B) \subset B$. then B = X or B is nowhere θ-dense
  (5) If and D is θ-open in X then D=ϕ or D is θ-dense in X.

IV. Alpha-Minimal Functions

We introduced a new definition on α-minimal[35] (resp. θ-minimal[34]) maps and we studied some new theorems associated with these definitions. Given a topological space X, we ask whether there exists α-irresolute (resp. θ-irresolute) map on X such that the set $\{f^n(x): n \geq 0\}$, called the orbit of x and denoted by $O(x)$ f, is α-dense(resp. θ-dense) in X for each x ϵ X.. A partial answer will be given in this section. Let us begin with a new definition.

- *Definition 4.1* (α-minimal) Let X be a topological space and f be α-irresolute map on X with α-regular operator associated with the topology on X. Then the dynamical system (X, f) is called α-minimal system (or f is called α-minimal map on X) if one of the three equivalent conditions [35] hold:

  1) The orbit of each point of X is α-dense in X.

  2) $Cl_\alpha(O_f(x)) = X$ for each x ϵ X

  3) Given x ϵ X and a nonempty α-open U in X, there exists nϵ N such that $f^n(x) \in U$

- *Theorem 4.2* [35] For (X, f) the following statements are equivalent:

  (1) f is an α-minimal map.

  (2) If E is an α-closed subset of X with $f(E) \subset E$, we say E is invariant. Then E= ϕ or E=X.

  (3) If U is a nonempty α-open subset of X, then $\bigcup_{n=0}^{\infty} f^{-n}(U) = X$.

V. Topological Systems and Conjugacy

In this section, I introduce and define θr-conjugated topological systems (X, f) *and* (Y, g), where X and Y are almost regular topological spaces. First I will define θr-homeomorphism and then I will prove new theorem associated with these new definitions:

- *Definition 5.1* A map.is said to be - homeomorphism if is bijective and thus invertible and both and are θr-irresolute
- *Definition 5.2* Two topological systems (X, f) and (Y, g) are said to be almost regular systems if X and Y are almost regular topological spaces.
- *Definition [38] 5.3* Let (X, f) and (Y, g) be two almost regular systems, then $f: X \to X$ and $g: Y \to Y$ are said to be topologically θr-conjugate if there is θr-homeomorphism $h: X \to Y$ such that $h \circ f = g \circ h$. We will call h a topological θr-conjugacy. Thus, the two almost regular topological systems with their respective function acting on them share the same dynamics

VI. New Types of Chaos of Topological Spaces

We will give a new definition of chaos for γ-irresolute (resp. α-irresolute) self map $f: X \to X$ of a locally compact Hausdorff topological space X, so called γ-type chaos (resp. α-type chaos). These new definitions imply John Tylar definition which coincides with Devanney's definition for chaos when the topological space happens to be a metric space, but not conversely.

- *Definition 4.1* Let (X, f) be a topological system, the dynamics is obtained by iterating the map. Then, f is said to be γ-type chaotic (resp. α-type chaotic) on X provided that for any nonempty γ-open (resp. α-open) sets U and V in X, there is a periodic point $p \in X$ such that $U \cap O_f(p) \neq \phi$ and $V \cap O_f(p) \neq \phi$.
- *Proposition 4.2* Let (X, f) be a topological system. The map f is γ-type chaotic (resp.α-type chaotic) on X if and only if f is γ-type transitive (resp. α-type transitive) and the set of periodic points of the map f is γ *dense* (*resp.* α *−dense*) in X.

  Let us prove only for γ-type chaotic

  Proof: If f is γ-type chaotic on X, then for every pair of nonempty γ-open sets U and V, there is a periodic orbit intersects them; in particular, the periodic points are γ-dense in X. Then there is a periodic point p and $x, y \in O_f(p)$ with x ∈ U and y ∈ V and some positive integer n such that $f^n(x) = y$, so that $y = f^n(x) \in f^n(U)$ therefore $f^n(U) \cap V \neq \phi$ that is, f is γ-type transitive map.

The γ-type transitivity of f on X implies that for any nonempty γ-open subsets U, V ⊂ X, there is n such that for some x ∈ U, $f^n(x) \in V$ Now define

$W = f^{-n}(V) \cap U$. Then W is γ-open and nonempty with the property that $f^n(W) \subset V$.

But since the periodic points of f are γ-dense in X, there is a p ∈ W such that $f^n(p) \in V$. Therefore, $U \cap O_f(p) \neq \phi$ and $V \cap O_f(p) \neq \phi$, so that f is γ- type chaotic map.

VII. Conclusion

We have the following results

- *Proposition 7.1.* Every topologically γ-type transitive map is a topologically α-type transitive map which implies topologically transitive map, but the converse not necessarily true..
- *proposition 7.2.*Every γ-minimal map is α-minimal map which implies minimal map, but the converse not necessarily true..
- *Theorem 7.3* Let (X, f) *and* (Y, g) be two topological systems, if $f: X \to X$ and $g: Y \to Y$ are topologicallyαr-conjugate. Then

  (1) f is topologically α- transitive map if and only if g is topologically α-transitive map;

  (2) f is α-type chaotic map if and only if g is α-type chaotic map;

  (3) f is γ-type chaotic map if and only if g is γ-type chaotic map.

- *Proposition 7.4* Let (X, f) be a topological system. The map f is γ-type chaotic (resp.α-type chaotic) on X if and only if f is γ-type transitive (resp. α-type transitive) and the set of periodic points of the map f is γ *− dense* (*resp.* α *− dense*) in X.

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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 MIMO Spatial Multiplexing using different Antenna Configurations and Modulation Techniques in AWGN Channel

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GJRE-F Classification : FOR Code: 090609

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Strictly as per the compliance and regulations of :

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Hardeep Singh [α] & Lavish Kansal [σ]

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I. Introduction

Next generation wireless systems will require high data rates and better spectral efficiencies due to multimedia applications. So MIMO (Multiple Input Multiple Output) systems are the key solution to this problem which employs multiple antennas at the transmitter as well as at the receiving side [1]. In order to design MIMO systems we have to study the performance limits of MIMO systems in various channels for better QOS (quality of service) or high spectral efficiencies. V-BLAST (Vertical- Bell Laboratories Layered Space Time) architecture is the first practical implementation of MIMO systems which has attained the spectral efficiency of 40bits/s/Hz [2]. V-BLAST architecture is simple and easy to implement in which the data streams are de-multiplexed into 'n' independent data Streams at the transmitter side and these 'n' independent streams are transmitted in parallel from 'n' independent transmitting antennas. The transmitted streams are received at the receiver and these streams are corrupted by noise [3].

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so various equalizers are used at the receiving side to combat inter symbol interference. Zero Forcing equalizer is used for this purpose and it is easy to implement and offers less computational complexity at the cost of noise enhancement [4].

Consider a MIMO system with two transmit antenna and two receiving antenna shown in Fig. 1.

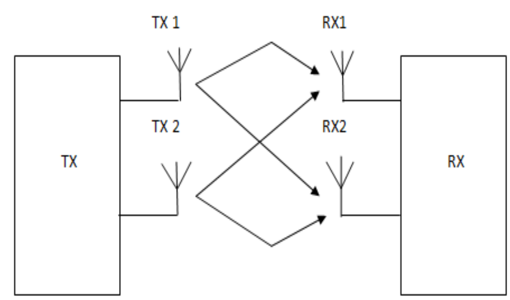

Figure 1 : MIMO system with 2 transmit and 2 receive antennas

The MIMO system model is represented as:

$$Y = HX + N \qquad (1)$$

Equation 1 is the MIMO system representation if 'Z' is the no of transmitting antenna and 'M' is the no of receiving antenna ,then Y is the received vector of 'M×1' dimension , H is the channel matrix of 'Z×M' dimension, X is the transmit vector of 'Z×1' dimension and N is the noise vector of 'M×1' dimension.

MIMO systems offers 3 advantages Beam forming, Spatial Multiplexing, Spatial Diversity based on Space time coding. The Space time coding jointly encodes the data streams, which leads to reduction in symbol error rate due to channel fading. The space time coding improves the diversity gain and at the same time improves the communication links. Higher order modulations can be applied to attain high data rates along with diversity gain in case of space time coding [5].

In this paper, the MIMO Spatial Multiplexing technique is analyzed for different antenna configurations and different modulation techniques in AWGN (Additive White Gaussian Noise) channel. The modulation techniques used are M-PSK (M-ary Phase Shift Keying) and M-QAM (M-ary Quadrature Amplitude Modulation). The Zero Forcing detector is used at the receiving end. The 2×2, 3×3, 4×4 antenna configurations are analyzed for the above mentioned modulation techniques.

II. Mimo Spatial Multiplexing

Spatial Multiplexing is a technique which is responsible for increment in spectral efficiency of MIMO systems by transmitting independent streams from independent antennas [6]. The data stream at the input of a transmitter section is divided into 'n' independent data streams and these 'n' independent data streams are transmitted from 'n' independent antennas. The signal from 'n' independent antennas will follow different paths to reach the receiver and these streams will arrive at the receiver at the same time. The different spatial dimensions of the channel are utilized to carry different data streams. Each of these paths will have different spatial signatures at the receiving antenna. The receiving antenna makes use of these spatial signatures to differentiate b/w symbols transmitted from different transmitting antenna. Thus the capacity gain of MIMO channel is increased by 'N' times, where Nis the no of transmitting antennas. The MIMO spatial multiplexing system employing 2 transmit antenna and two receiving antenna is described by Fig. 2.

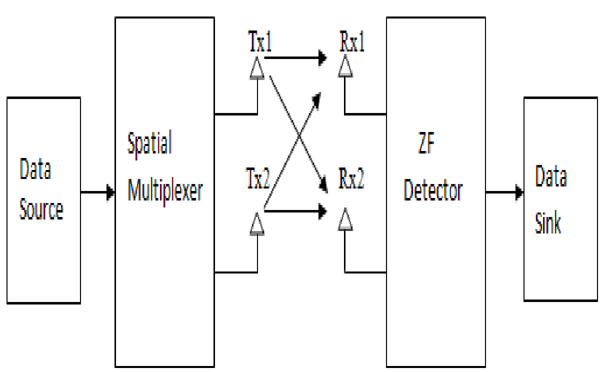

Figure 2 : MIMO Spatial Multiplexing system

The data streams corrupted by noise interfere with each other at the receiving antenna side, so we need equalizer to mitigate inter symbol interference. For this purpose two types of equalizers can be employed at the receiving side one is linear and another is non linear. Linear receivers are used in majority of cases due to their low computational complexity and implementation is also easy. Zero Forcing and Minimum Mean Square Error (MMSE) equalizers are kind of linear equalizers. Maximum likelihood comes in the category of non linear equalizers which is optimal but offers high computational complexity [7]. For Spatial Multiplexing the no of receiving antenna must be greater than or equal to the no of transmitting antenna. The different data streams are sent in the same frequency domain and with the same transmission power from different transmitting antenna as all the data streams follow different paths to reach the receiver [8]. The maximum spatial streams are limited to minimum no of transmit and receive antennas. Spatial Multiplexing can be implemented with or without channel knowledge [9].

III. Modulation Techniques

The mapping of incoming digital bits onto the analog carrier is known as modulation. As most channels in the environment support pass band communication, so signals at the transmitter side is modulated with pass band carrier, so that it can be sent in the pass band spectrum. The various parameters of carrier wave are changed to convey information such as amplitude, frequency or phase. The antenna height is proportional to the wavelength of operation, so if we operate at pass band frequencies, antennas of smaller heights has to be installed. With the help of modulation schemes the various signals can be multiplexed and can be sent over the same channel and at the same time. At the receiver side inverse operation is performed, which is known as demodulation, in which the transmitted information is recovered.

a) Phase Shift Keying (M-PSK)

In Phase Shift Keying the information is represented by changing the phase of a modulating waveform. The amplitude of M-PSK modulated signal waveform remains constant thereby yielding a circular constellation [10]. The M-PSK modulated signal $S_i(t)$ is represented as:

$$S_i(t) = \sqrt{\frac{2E_s}{T_S}} cos\left(2\pi f_c t + 2\pi\left(\frac{i-1}{M}\right)\right) \quad (2)$$

$$i = 0,1,2, \dots \dots M$$

$$0 < t < T_s$$

Where $'E_s'$ is the signal energy, $'T_s'$ is the symbol duration, $'f'_c$ is the carrier frequency and 'M' possible signal waveforms. The carrier phase θ_i will have M possible value which is given by:

$$\theta_i = 2(i-1)^{\frac{\pi}{M}} \quad (3)$$

Signal space diagram for 8-PSK is given by Fig. 3.

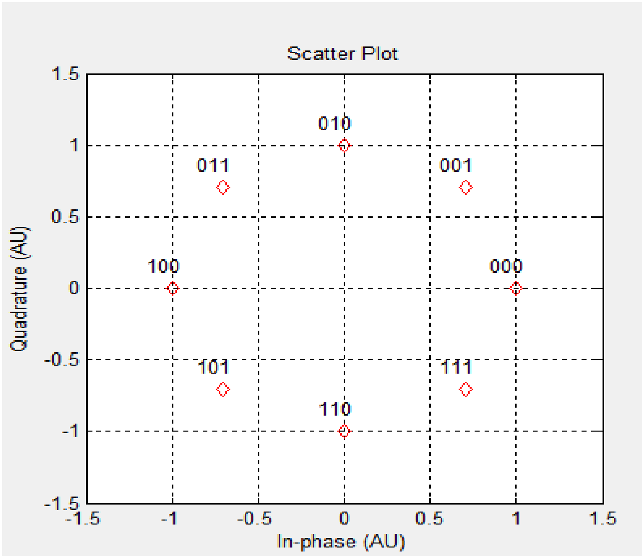

Figure 3 : Signal space for 8-PSK

b) Quadrature Amplitude Modulation (M-QAM)

In QAM two carriers, which are 90° out of phase are used to encode the incoming digital bits. Both amplitude and phase variations are used to represent the information. In 16-QAM four in-phase and four quadrature values are used which results in 16 possible states for the signal. The QAM modulation is more spectrally efficient as compared to BPSK, QPSK, as symbol rate for QAM is ¼ of the bit rate [11]. The QAM modulated signal $S_i(t)$ is represented as:

$$S_i(t) = \sqrt{\frac{2}{T_s}}d_n \cos(2\pi f_c t) - \sqrt{\frac{2}{T_s}}e_n \sin(2\pi f_c t) \quad (4)$$

Where $'d_n'$ and $'e_n'$ are amplitudes values and $'f_c'$ is the carrier frequency.

$$d_n, e_n = \pm a, \pm 3a, \dots \dots \dots . \pm(\log_2(M-1))a \quad (5)$$

Where 'M' is mostly taken as power of 4 and it represents the possible waveforms. The signal energy E_s can be related to parameter a as:

$$a = \sqrt{\frac{3E_s}{2}}(M-1) \quad (6)$$

IV. Channels

The digital bit stream is conveyed from transmitter to receiver via channel which may be a wired connection or wireless link such as radio channel. The characteristics of transmitted signal vary as they travel from transmitting side to receiving side via channel. The convolution of the transmitted signal with the impulse response of channel will give the power profile of the received signal [12]In this paper the main focus will be on performance analysis of MIMO SM scheme using different antenna configuration and different modulation techniques in AWGN channel.

a) AWGN Channel

In AWGN channel, the communication process will have the addition of white noise, whose power spectral density is flat for all the frequencies and its amplitude is Gaussian distributed. The signal will not undergo any kind of fading or frequency selectivity process. The AWGN channel model is presented by Fig. 4.

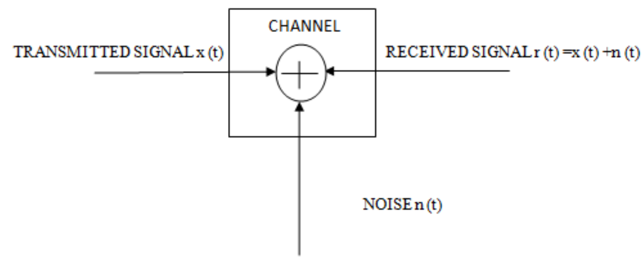

Figure 4 : Block diagram of AWGN channel

The received signal $r(t)$ can be modelled as:

$$r(t) = x(t) + n(t) \quad (7)$$

Where $x(t)$ is the transmitted signal and $n(t)$ is additive white Gaussian noise.

V. Zero Forcing Equalizer

When inter symbol interference dominates noise, then zero forcing equalizer can be used to recover the transmitted streams in case of MIMO SM. This equalizer uses inverse frequency response of channel to perform equalization operation. The estimation of strongest signal is done by cancelling the effect of weakest signal from it. The estimated strongest signal is subtracted from the received signal and it performs calculations on the remaining signal to look for the strongest signal in the remaining transmitted signal [13]. The received signal 'S' in case of MIMO SM (2×2) can be represented as:

$$S = Ha + n \quad (8)$$

Where 'H' represents the channel matrix, 'a' is the transmitted vector, 'n' is the noise vector. The signal S_1 on first receiving antenna is:

$$S_1 = [h_{1,1} \quad h_{1,2}]\begin{bmatrix} a1 \\ a2 \end{bmatrix} + n1 \quad (9)$$

Similarly signal S_2 on second receive antenna is:

$$S_2 = [h_{2,1} \quad h_{2,2}]\begin{bmatrix} a1 \\ a2 \end{bmatrix} + n2 \quad (10)$$

Where $h_{1,1}$ is the fading coefficient from first transmitting antenna to first receive antenna.

$h_{1,2}$ is the fading coefficient from second transmitting antenna to first receive antenna.

$h_{2,1}$ is the fading coefficient from first transmitting antenna to second receive antenna.

$h_{2,2}$ is the fading coefficient from second transmitting antenna to second receive antenna.

'a1' is the symbol transmitted from first antenna and 'a2' is the symbol transmitted from second antenna, 'n1' is the noise at first receive antenna and 'n2' is the noise at second receive antenna.

The received signal in terms of matrix notation can be represented as:

$$\begin{bmatrix} S_1 \\ S_2 \end{bmatrix} = \begin{bmatrix} h_{1,1} & h_{1,2} \\ h_{2,1} & h_{2,2} \end{bmatrix} \begin{bmatrix} a1 \\ a2 \end{bmatrix} + \begin{bmatrix} n1 \\ n2 \end{bmatrix} \qquad (11)$$

The algorithm for ZF equalizer is given by:

$$W_{zf} = (H^H H)^{-1} H^H \qquad (12)$$

'W_{zf}' is the weight matrix and 'H' is channel matrix. Before quantization the result of ZF equalizer is given by:

$$\hat{a} = (H^H H)^{-1} H^H S \qquad (13)$$

Where $\hat{a}$ is the estimate of transmitted vector.

VI. Results and Discussion

The performance of MIMO Spatial Multiplexing employing ZF equalizer is compared for different antenna configurations (2×2, 3×3, 4×4) under different modulation techniques such as M-ary Phase Shift Keying (M-PSK), M-ary Quadrature Amplitude Modulation (M-QAM) in AWGN channel and results are shown in terms of SNR vs. BER plot. The 2×2 antenna configuration is compared with 3×3 antenna configuration at BER of 10^{-3} and similarly 3×3 antenna configuration is compared with 4×4 antenna configuration at the same BER and improvement in SNR (db) is taken into account. The figures 5(a)-(j) show that if antenna configurations are increased from 2×2 to 3×3 and similarly from 3×3to 4×4 an increment in SNR (db) is required to achieve same amount of BER. The figures 6(a)-(e) shows the performance analysis of MIMO SM technique when M-QAM modulation scheme are employed. By comparing the results in table 1 and table 2 we can easily we can easily figure out that a small amount of SNR is required to achieve same amount of BER if M-PSK modulation schemes are employed as compared to M-QAM modulation schemes in case of MIMO SM technique.

a) Simulations using M-PSK scheme

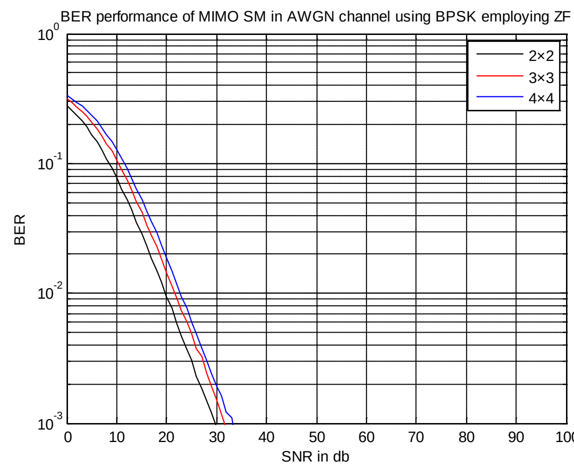

Figure 5 : (a) BER performance of MIMO SM using BPSK in AWGN channel

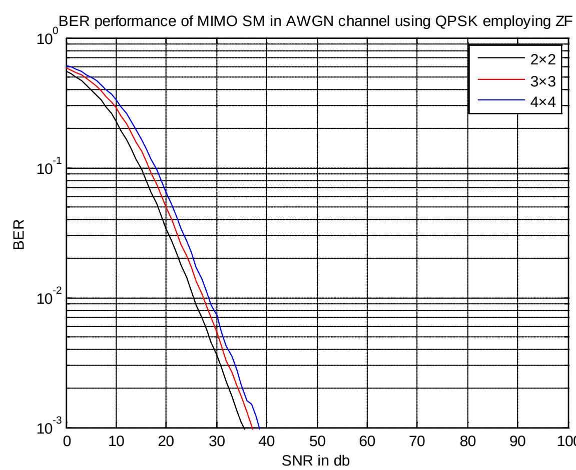

Figure 5 : (b) BER performance of MIMO SM using QPSK in AWGN channel

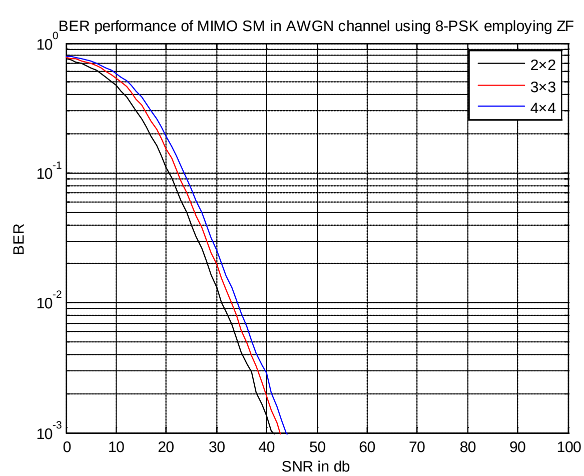

Figure 5 : (c) BER performance of MIMO SM using 8-PSK in AWGN channel

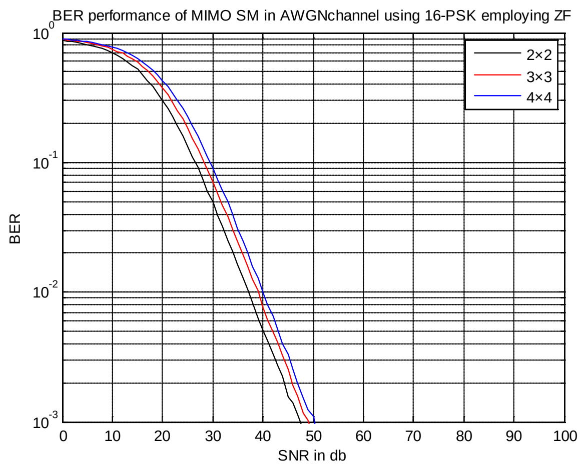

Figure 5 : (d) BER performance of MIMO SM using 16-PSK in AWGN channel

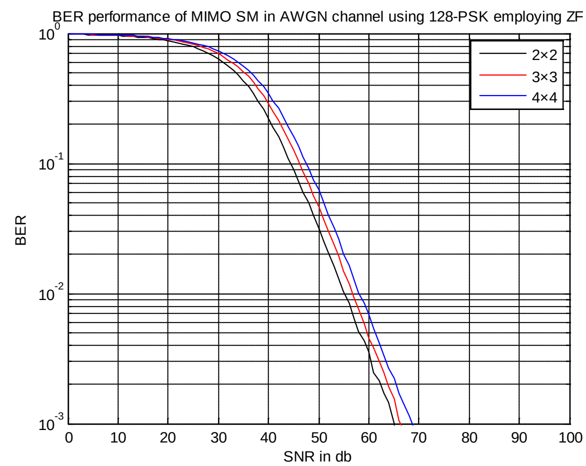

Figure 5 : (g) BER performance of MIMO SM using 128-PSK in AWGN channel

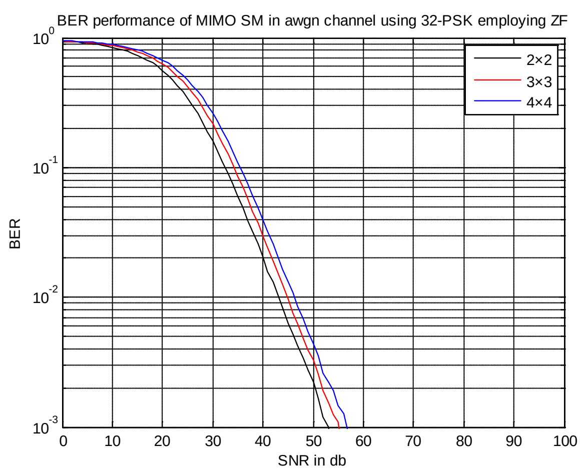

Figure 5 : (e) BER performance of MIMO SM using 32- PSK in AWGN channel

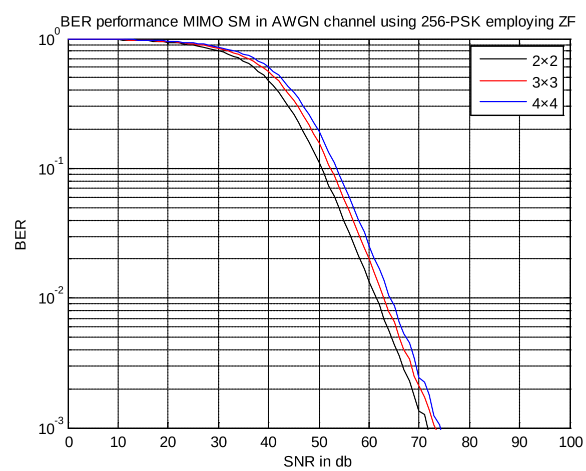

Figure 5 : (h) BER performance of MIMO SM using 256-PSK in AWGN channel

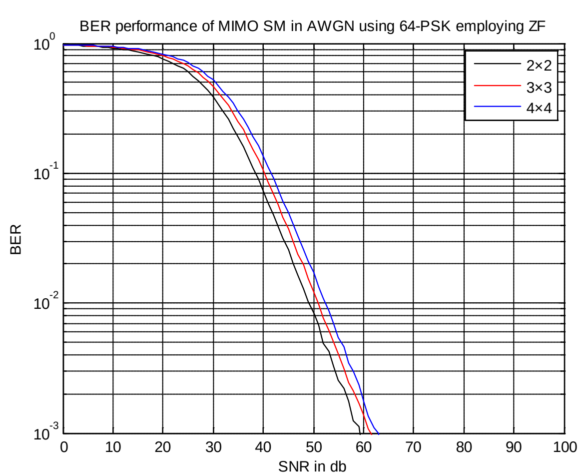

Figure 5 : (f) BER performance of MIMO SM using 64-PSK in AWGN channel

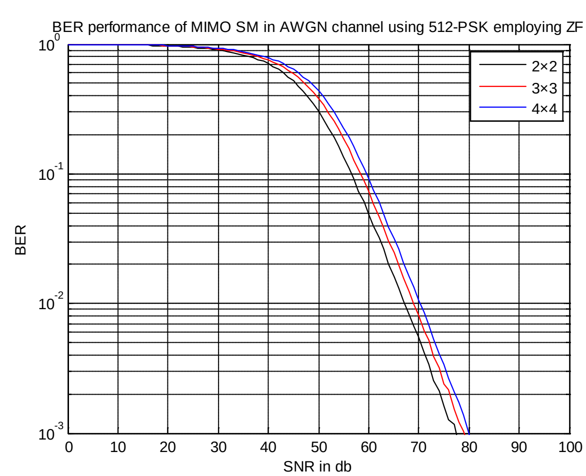

Figure 5 : (i) BER performance of MIMO SM using 512-PSK in AWGN channel

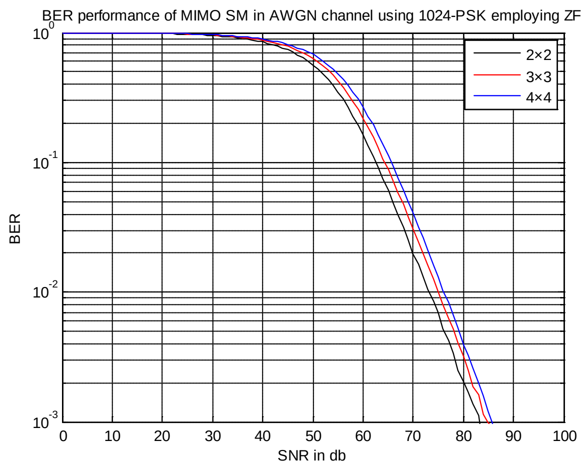

Figure 5 : (j) BER performance of MIMO SM using 1024-PSK in AWGN channel

Figure 5(a)-(j) *BER* vs. SNR plots over AWGN channel for MIMO SM technique using different M-PSK modulation schemes.

Table 1 : Comparison of different antenna configurations for MIMO SM technique employing ZF equalizer in AWGN channel using M-PSK (M-ary Phase Shift Keying) modulation schemes

Modulation	2×2	3×3	Improvement In SNR	4×4	Improvement In SNR
BPSK	29.7	31.5	1.8	33.2	1.7
QPSK	36.1	37.7	1.2	38.5	1.2
8-PSK	41.4	42.6	1.2	43.9	1.3
16-PSK	47.4	49.2	1.8	50.3	1.1
32-PSK	52.9	55.2	2.3	56.8	1.6
64-PSK	59.2	61.5	2.3	62.9	1.4
128-PSK	64.9	66.2	1.3	68.6	2.4
256-PSK	71.7	73.2	1.5	74.2	1.0
512-PSK	77.5	79.1	1.6	79.9	0.8
1024-PSK	83.3	85.0	1.7	85.8	0.8

Table 1 presents that MIMO SM technique requires 1 to 2.5db increment in SNR to achieve the BER of 10^{-3} , if antenna configurations are changed from 2×2 to 3×3 when M-ary Phase Shift Keying (M-PSK) modulation scheme is employed. The table also points that if antenna configurations are changed from 3×3 to 4×4, an increment of .7 to 2.5db SNR has to be provided to achieve BER of 10^{-3}. Table 1 also states that the spectral efficiency gets doubled in case of MIMO SM technique if antenna configurations are changed from 2×2 to 4×4, at the cost of 1 to 4db increment in SNR.

b) Simulations using M-QAM scheme

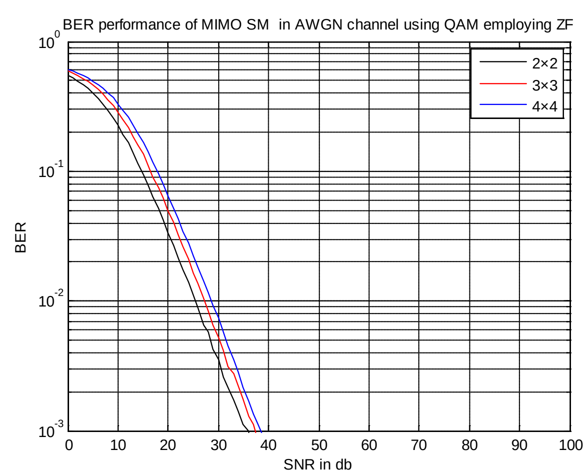

Figure 6 : (a) BER performance of MIMO SM using QAM in AWGN channel

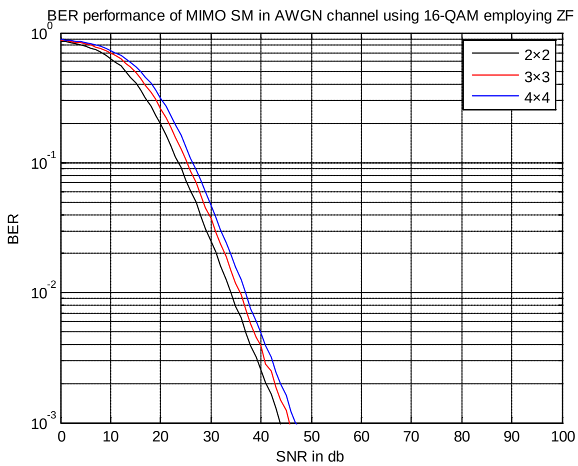

Figure 6 : (b) BER performance of MIMO SM using 16-QAM in AWGN channel

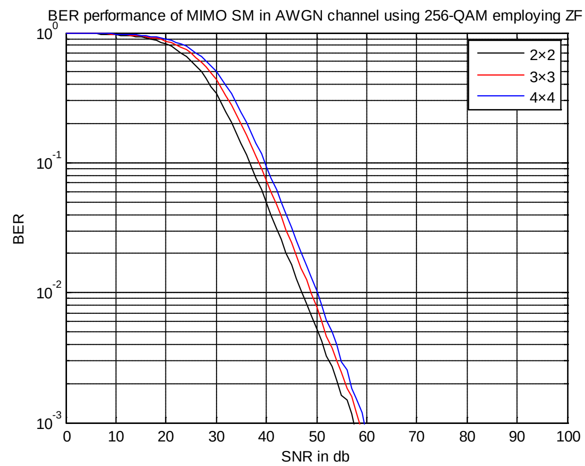

Figure 6 : (d) BER performance of MIMO SM using 256-QAM in AWGN channel

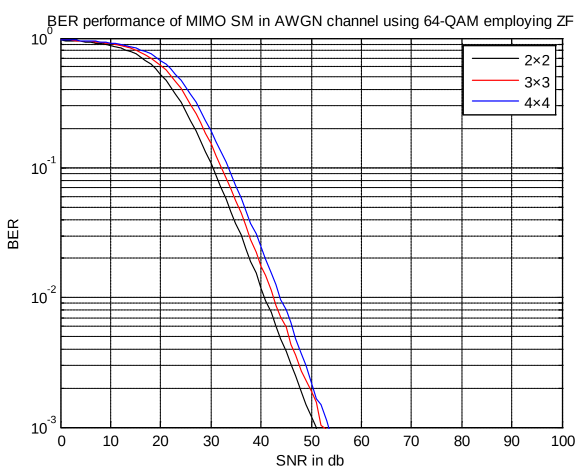

Figure 6 : (c) BER performance of MIMO SM using 64-QAM in AWGN channel

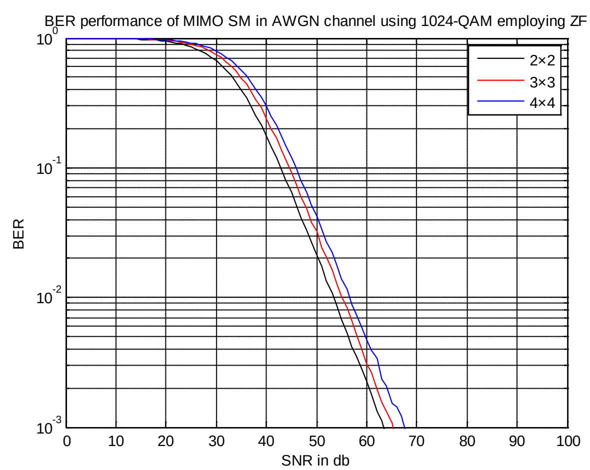

Figure 6 : (e) BER performance of MIMO SM using 1024-QAM in AWGN channel

Figure 6(a)-(e) BER vs. SNR plots over AWGN channel for MIMO SM technique using M-QAM modulation schemes.

Table 2 : Comparison of different antenna configurations for MIMO SM technique employing ZF equalizer in AWGN channel using M-QAM (M-ary Quadrature Amplitude Modulation) modulation scheme

Modulation	2×2	3×3	Improvement In SNR	4×4	Improvement In SNR
QAM	35.9	37.4	1.5	38.5	1.1
16-QAM	43.8	45.6	1.8	46.9	1.3
64-QAM	50.9	52.5	1.6	53.4	0.9
256-QAM	57.4	58.6	1.2	59.5	0.9
1024-QAM	63.3	65.2	1.9	67.6	2.4

Table 2 presents that MIMO SM technique employing ZF equalizer requires 1 to 2db increment in SNR to achieve BER of 10^{-3}, if antenna configurations are changed from 2×2 to 3×3 when M-QAM modulation schemes are employed. The table also depicts if antenna configurations are shifted from 3×3 to 4×4, an increment of 0 to 2.5db is required to achieve BER of 10^{-3}.

VII. Conclusion

In this paper, the performance of MIMO SM technique employing ZF equalizer in AWGN channel is presented for different antenna configurations (2×2, 3×3, 4×4) using higher order modulation schemes (M-PSK,M-QAM). As we go on increasing the antenna configurations from 2×2 to 3×3 an increment of 1 to

2.5db in SNR has to be made to achieve same amount of BER of 10^{-3}. Thus the spectral efficiency gets doubled in case of MIMO SM technique at the expense of small amount of increment in SNR (0 to 4db) ,that has to be made in AWGN channel when higher order modulation (M-PSK,M-QAM) schemes are employed.

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Global Journal of Researches in Engineering (F) Volume XIV Issue V Version I Year 2014

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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

Examining the Effectiveness of Electricity Billing System against the Mobile Phone Billing System in Active Mining Rural Communities in the Western Region of Ghana

By Emmanuel Effah, Christian Kwaku Amuzuvi & Kingsley Bediako Owusu
University of Mines and Technology, Ghana

Abstract- This paper examines the effectiveness of the electricity billing and payment system and its probable contribution to energy losses vis-à-vis the billing and payment system deployed by the telecommunication companies in rural mining communities in the Western Region of Ghana. We used field observations, interviewed respondents with both open-ended and structured questionnaires and literature survey to validate our conclusion. This study firmed up the following facts: over 50% of Electricity Company of Ghana's (ECG's) legal customers in most mining rural areas do not pay commensurable electricity bills every month for the power used; a heap of power customers (47% of respondents) are unmetered and 26% of respondents used power freely. The study also revealed that most rural folks are capable of paying their electricity bills without any external interventions for the reasons imbued in their business activities for livelihoods and the sums of money disbursed on mobile phone recharge cards. Finally, the installed metering and payment system for electricity consumption contributes immensely to the ECG's non-technical losses. Weighing the current costs of electricity production, this study provides real and premier foundation for future research on the type of energy metering and payment systems and energy policies to be adopted by developing countries.

Keywords: electricity company of ghana, energy meters, illegal connections.

GJRE-F Classification : FOR Code: 280204, 290903p

EXAMININGTHEEFFECTIVENESSOFELECTRICITYBILLINGSYSTEMAGAINSTTHEMOBILEPHONEBILLINGSYSTEMINACTIVEMININGRURALCOMMUNITIESINTHEWESTERNREGIONOFGHANA

Strictly as per the compliance and regulations of :

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Abstract- This paper examines the effectiveness of the electricity billing and payment system and its probable contribution to energy losses vis-à-vis the billing and payment system deployed by the telecommunication companies in rural mining communities in the Western Region of Ghana. We used field observations, interviewed respondents with both open-ended and structured questionnaires and literature survey to validate our conclusion. This study firmed up the following facts: over 50% of Electricity Company of Ghana's (ECG's) legal customers in most mining rural areas do not pay commensurable electricity bills every month for the power used; a heap of power customers (47% of respondents) are unmetered and 26% of respondents used power freely. The study also revealed that most rural folks are capable of paying their electricity bills without any external interventions for the reasons imbued in their business activities for livelihoods and the sums of money disbursed on mobile phone recharge cards. Finally, the installed metering and payment system for electricity consumption contributes immensely to the ECG's non-technical losses. Weighing the current costs of electricity production, this study provides real and premier foundation for future research on the type of energy metering and payment systems and energy policies to be adopted by developing countries.

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I. Introduction

Electrical energy has become an indispensable part of life, and among others, it is the most limited resource in most developing countries. Grid capacities principally determine national levels of industrialization. The mammoth expectation is that, generated electricity must be securely transmitted and distributed efficiently without any illegal and free usage and also not at outrageous with limited levels of losses. Though the desired metering system for mitigating these illegal and free usages has not been done, much effort has not been put in place to curtail the free usage due to theft and pilferage, especially in the rural communities in Ghana.

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As at 2006, the management of domestic and industrial electricity consumption in Ghana was based on manual meter readings, which are read at irregular intervals making it difficult to accurately estimate consumers' monthly bills. With this manual metering system, electricity consumption of all domestic appliances is amalgamated into one monthly bill, which did not allow for differentiation of electricity use within any specific or regular interval. By way of improving the system, most of these meters in the urban centres were recently replaced with the prepaid and or digital/electronic ones, which do not address the prevailing problems even in the urban centres entirely. On the other hand, almost all rural communities on the national grid use the electromechanical or the manual metering system. Aside monitoring illegal connections, accessing these communities for their meter readings, distributing their monthly electricity bills and getting all bills paid on time are major challenges for the ECG. ECG is the main electricity distribution company in Ghana.

Considering the increasing financial cost of power generation, transmission and distribution [1-2] in Ghana currently, this study examines the effectiveness of the electromechanical or manual metering and billing system against the flexible billing systems deployed by the telecommunication or cell phone service providers in Ghana.

An electricity meter is a device that measures the amount of electrical energy consumed by a residence, business, or an electrically powered device. The different types of electric meters used to calculate the household or commercial consumption of electricity [3], are Electromechanical Induction Meter or Standard Meter, Variable Rate Electric Meters, Prepayment Electric Meters, Solid State Electric Meters and Electronic Meters. With the electromechanical induction meter or standard metering system, a human interface meter reader notes the consumed unit of electricity shown on the meter and bills are later sent to the customer along with other statutory costs [4]. This is the main device in limbo as far as this paper is concerned.

$$\%Losses = \frac{[EnergyInput \quad EnergyBilled]}{EnergyInput} \times 100\% \quad (1)$$

II. Materials and Methods

Losses are indispensable part of power generation, transmission and distribution, but can be minimized if properly managed [5]. From Figure 1 and Equation 1, ECG classifies losses into technical and non-technical or commercial, even though their percentage compositions are unknown. Losses are any input energy that goes unbilled or unmetered [6]. But it is known that a larger percentage of the losses are non-technical, which emanate from the consumers' end [7]. Among the common factors responsible for non-technical losses are: energy pilferages and thefts, defective meters generating errors in meter readings, wrongful estimation of meter readings, un-metered or flat rated consumers, customers tampering with their meters, free power usage (for legally connected consumers), illegal connections, etc. [8].

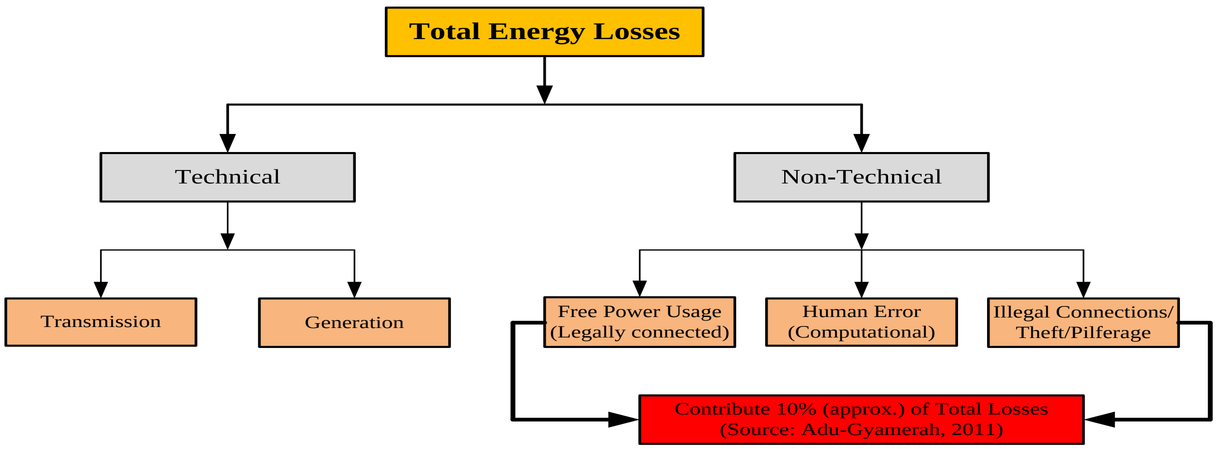

Figure 1 : Classification of Energy Losses

As at 2011, 26.6% of the total power ECG purchased from the Volta River Authority (VRA) was wasted, with majority attributable to illegal connections to the national Grid and free power usage mostly in rural communities. The 26.6% losses estimated totalled to GH¢ 478.88 million (US$239.44 million) with a unit per cent loss valued at GH¢ 17.74 million (US$8.87 million) [7]. Inflation rate has almost tripled since 2011 affecting the cost of power generation and distribution. Consequently, losses incurred by ECG currently stands at 30% out of which, free power usage and other illegalities constitute 10% (approximately) [9]. Importantly, ECG was unable to bill over 100,000 customers connected to the national grid [10]. Again, 9,537 illegal electricity connections (by-passing the prepaid meters) were detected, constituting a GH¢ 18.23 million (US$9.115 million) loss of revenue to the nation [9].

It has been estimated that ECG has over 1.4 million customers of which 17–20 percent are rural population. Electricity usage in the rural areas is estimated to be higher in the coastal (27%) and forest ecological zones (19%), than in the savannah areas (4.3%) of the country [11].

This study sets out to investigate the probable losses attributable to free power usage (being it theft or pilferage or illegal connections) in some active mining rural communities. Thus, we investigate the extent to which, these communities vigorously exploit electricity without paying the due bills. With this basis, the effectiveness of the metering and billing system in use will be examined vis-à-vis the billing system deployed by telecommunication companies in the country. We targeted the communities along the forest and coastal ecological zones, since they form the majority of ECG's rural customers.

In this paper, we used qualitative approach to address the research problem. The authors adopted a literature survey as secondary data source. Primary data was collected using questionnaire, interviewing and field observations to conclusively examine the situation. In terms of grid power usage, there is no significant difference between the urban centres and the densely populated rural communities especially those along the coastal and the forest belt due to "galamsey" (illegal mining) and small scale mining (legal) activities. 421 respondents from these communities were interviewed.

III. Results and Discussions

a) Respondents' Bio Data

This part of the questionnaire considered respondents' sex, age, education levels, sources of income, years lived in their respective communities and their dependence on the national electricity grid. Out of the 421 respondents interviewed, 76% were males while 24% were also females. 94% were between 18–60 years, 2% below 18 years and 2% above 60 years. Also, 29% lived in the communities in less than five years ago, while 71% have lived in the communities for at least five years. Their highest education levels were tertiary (39%), secondary (36%), basic (21%) and no schooling (4%). Figures 2 and 3 illustrate respondents' sources of livelihood and dependence on the national electricity grid respectively. In principle, Figure 3 represents the breakdown of the percentage of respondents who are legally and illegally connected to the national electricity grid.

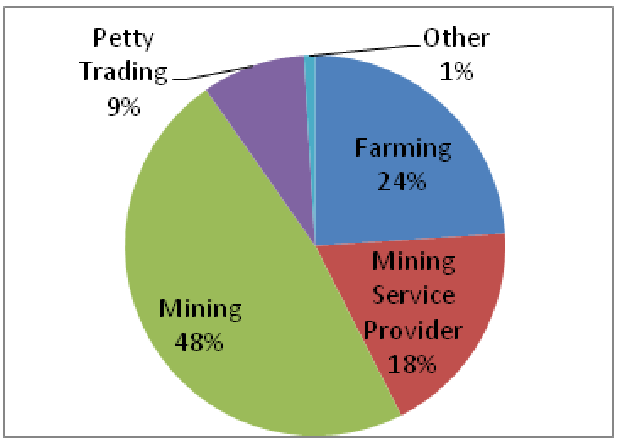

Figure 2 : Sources of Livelihood

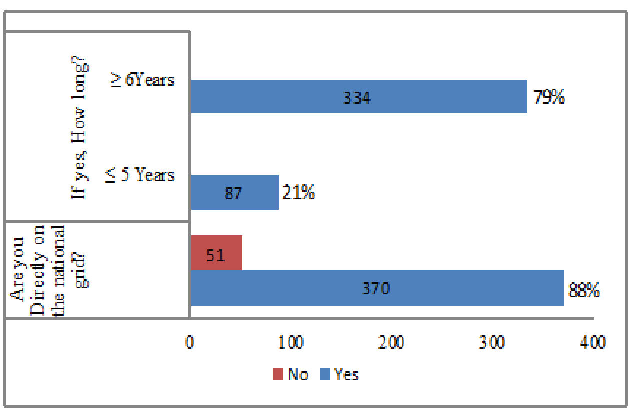

Figure 3 : Dependence on National grid

b) Electricity Billing and Payment System

This section examines how monthly bills are estimated, how often respondents pay their electricity bills, annual average bills often paid, consequences of not paying electricity bills on time and at all and electricity usage. Figure 4 summarises the outcome for this section.

Typical of present mining rural communities, there are no slums in terms of electrical appliances and their usage. Generally, there is no much difference in the domestic and commercial usage of electricity between these mining rural communities and the urbanized areas. Commercially, inhabitants of these communities use electricity in support of their businesses such as refrigeration of drinks, water, foodstuffs, fishes and meats. Other commercial or business usages of electricity include fabrication and building of mine support equipment (example Tromel Gold recovery Plants), foodstuffs milling operations, dress making operations, electronic appliance and repairs operations, hair dressing saloons operations, fuel stations operations, etc.

These commercial usages of electricity brings substantial amounts of money to the inhabitants involved in these businesses, but unfortunately results in significant non-technical losses to power generation companies due to lapses in the metering and billing systems of such communities.

From Figure 4, it is realised that 21% of the inhabitants interviewed use electricity without being metered and billed at all. Due to the free power usage by these inhabitants, they are not instigated to use electricity astutely and efficiently, which further aggravates the issue of non-technical losses. For other 26% of inhabitants interviewed, who are billed at a flat rate also contributes substantially to the non-technical losses as they might use electricity above the rate they are to pay. Even with the 53% legally metered inhabitants, there is no certainty that they all pay their bills.

Under the frequency of electricity bill payment from Figure 4, 26% of inhabitants interviewed do not pay electricity bills at all, 57% inhabitants pay once in three months (ECG officials come at every three month intervals) and only 17% of the inhabitants pay every month.

About 50% of the inhabitants interviewed pay less than GH¢ 50 (US$19.10) for their electricity usage annually, which is equivalent to GH¢ 4 (US$1.53) a month. This is virtually like not paying at all since street light and Government levy charges on electricity is about GH¢ 2 (US$0.76) per month. About 45% of the inhabitants pay between GH¢ 50–100 (US$19.10–38.17) for their electricity usage annually, which is about GH¢ 4–8 (US$1.53–3.05) a month. Examining these domestic and commercial (or business) usages of electricity and the resulting bills paid in these communities, we noticed inefficiencies in electricity metering, billing and payment systems constituting non-technical losses.

As to the repercussions of not paying the electricity bills, 82% of the respondents received no punishment or confrontation from ECG officials, 7% were warned and 11% disconnected. Again, this clearly shows extreme degree of non-technical losses emanating from most rural mining communities doing serious economic activities.

Global Journal of Researches in Engineering (F) Volume XIV Issue V Version I Year 2014

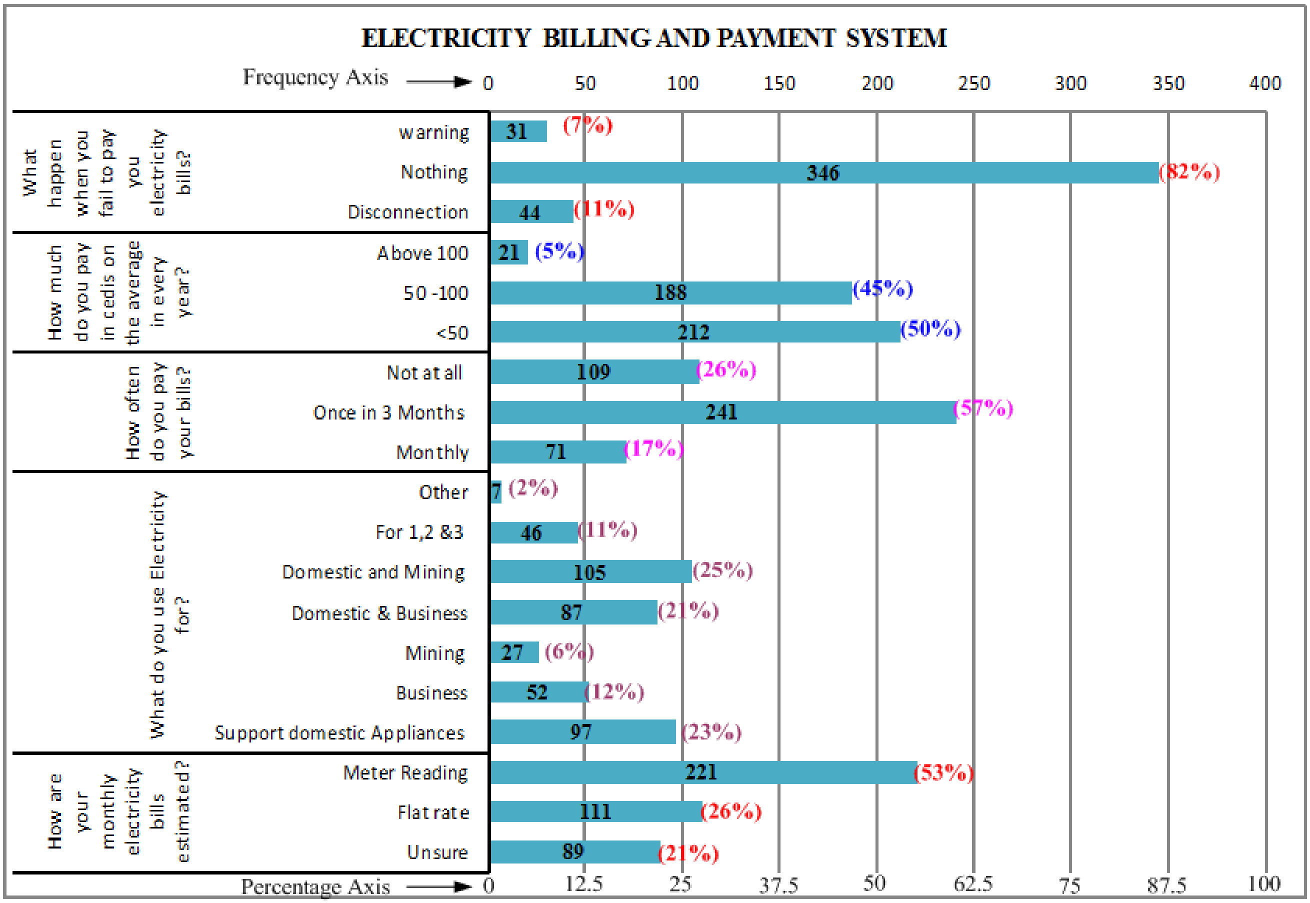

Figure 4 : Electricity Billing and Payment system

c) Mobile/Cell Phone Billing and Payment system

This section probed whether or not respondents used cell phones, how long they have used cell phones and their abilities to pay the resultant bills. Figure 5 presents the result displaying in both frequencies and percentages. Telecom prepayment networks restrict subscribers' access to making phone calls if they run out of units. Customers are therefore compelled to economise the usage of their units and use them when and if necessary. Amidst current global economic crisis, folks in the rural communities are still busy acquiring cell phones and pay the concomitant bills as they go.

It can be realised from Figure 5 that, about 98% of the inhabitants interviewed owned a mobile phone or more and were active users as well. Out of respondents representing this 98%, 46% of them actively started using the cell or mobile phone in less than 5 years, 26% had been active mobile phone users within 5–10 years and 28% had been active mobile phone users for over 10 years.

It was realised from this investigation that, only 5% of the inhabitants interviewed spent less than GH¢ 500 (US$190.84) on mobile phone recharge cards per year or GH¢ 42 (US$16.03) per month. A significant number totalling 73% spent between GH¢ 500–1000 (US$190.84–381.68) per year or GH¢ 42–84 (US$16.03–32.06) per month and the remaining 22% spent over GH¢ 1000 (US$381.68) per year or GH¢ 84 (US$32.06) per month. This clearly proves that, the inhabitants in these mining rural areas are not at all underprivileged as it is assumed. This also reveals how vibrant business activities exist in these communities.

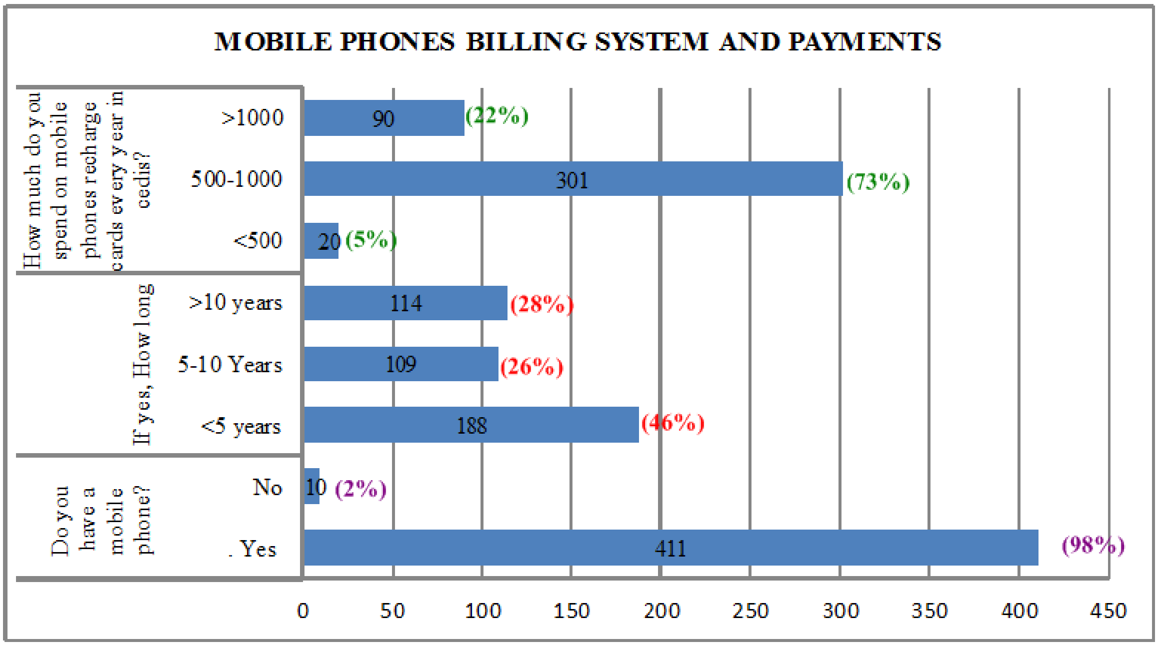

Figure 5 : Mobile/Cell Phone Billing and Payment system

IV. Conclusion

Electricity and telecommunication devices (mobile phones) have become unavoidable agents of convenient living. An effective method of metering, billing and payment system stimulates judicious electricity or mobile phone usage and compels consumers to pay their bills on time. The method of billing and payment system used by telecom companies is tamper-free (fully secured) to customers. Installed energy meters by electricity companies do not have effective security or tamper-evident integrations and consequently breed free usage and illegal connections. This study is expected to aid electricity companies in their policies, and also trigger future studies into the technicalities of electricity billing and payment systems. We recommend temper-impossible energy meters for ECG.

V. Acknowledgement

Emmanuel Effah, Christian Kwaku Amuzuvi and Kingsley Bediako Owusu, thanks the University of Mines and Technology, Tarkwa, for its support. Also, the authors acknowledge the support received from Small Scale Mining Communities in the Central and Western Regions of Ghana.

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Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 14 Issue 5 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

Design of a Novel Low-Power SRAM Column

By Sunil Kumar Ojha, O.P. Singh, G.R. Mishra & P.R. Vaya
Amity University Lucknow Campus, India

Abstract- A novel SRAM column was designed. SRAM column includes SRAM cell, column select circuit, precharging circuit, and sense amplifier. The transmission gates are used for word line access in place of pass transistors which rectify the voltage drop problem; also there is an NMOS switch at the bottom of the cell which restricts the short circuit current flowing through the cell during operation. Using the standard process parameters of the PTM 7nm transistor model the SRAM column was simulated by HSPICE. The simulation results indicate the proper logic operation of the column and also it shows the low power operation.

Keywords: SRAM column, storage cell, precharging circuit, NMOS switch, sense amplifier.

GJRE-F Classification : FOR Code: 090699

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Keywords: SRAM column, storage cell, precharging circuit, NMOS switch, sense amplifier.

I. Introduction

Static random access memory (SRAM) is widely used in present day logic LSIs. SRAM memory cell array normally occupies around 40% of the chip area and hence affects the operating speed, power, supply voltage, and chip size. Therefore, a good design of SRAM cell and SRAM cell array is essential. This paper present a novel SRAM column architecture using standard 7nm process technology provided by the predictive technology model (PTM) [9].Various kinds of SRAM memory cell have been proposed, developed, and used. To resolve the problem of switching capacitances at the word line clocked transmission gate adiabatic SRAM has been designed [1], this topology uses the bootstrapped NMOS transistors and CMOS latch structure to recover the charge of large switching capacitances on word-line, write bit line, and sense amplified lines and so on. Since this circuit uses clocked transmission gate logic as well as sampling of the input signals so it may be slower comparatively, also it has floating nodes for some period of time which may not be desired for the memory array, this design also uses sub array selection signal with some delays which is again not desirable; all these issues has been taken care for the presented design. Now the variations in the threshold voltage (Vt) for the transistors of the cell may create some undesired effects which are again resolved by controlling the memory cell-power line (MCPL) and word-line voltage [2],this design provide low current operation with negligible area penalty; in this design the word line voltage is changed stepwise which may effect in slower operation of the memory array; furthermore in these circuits, the memory cell power line voltage is almost equal to Vdd, which is not very effective for resolving the Vt variation problem. The MCPL cannot be decreased to ground because the data of the unselected word line (WL) vanish if the MCPL set to ground, here the data vanishes because the MCPL is shared with different loads. Also in the conventional six transistors (6-T) SRAM cell [6] there will be voltage drop problem at the word line access which increases the overall power dissipation of the cell; also there may be a short circuit current flowing through the circuit. All these problems have been taken care for this novel design.

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II. Proposed Sram Column

Fig.1 shows the design of a proposed SRAM column. It includes precharging circuit (mo & m1) from where the precharged voltage is generated and this equalizes the bit and bit-bar lines with equal potential, storage cell (m2 – m7) is used to store the data [either 0 or 1] in the memory cell, sense amplifier (m8 – m12) is used during reading operation of the required data from the memory array and column select circuit (m13 & m14) used to select the corresponding column from the memory array. Working of this design can be understood in the following mode viz. i) Read, ii) Write.

For the first case when a read control signal is given to the column, it first selects the respective column, then the precharging circuit is activated and the voltage Vp is transferred to the bit and bit-bar lines which makes both the lines at equal potential. After that the word lines (WL and WLB) are activated which enable the transfer of stored values on the memory cell (either 0 or 1) to the bit lines resulting in one of the bit line go high and the other bit lines go low. Finally the sense amplifier is enabled which senses the potential difference between bit and bit-bar lines and transmits the signals to the bi-directional input-output data lines.

For write operation a write signal is applied to select the respective column without activating the precharging circuit. The data (either 0 or 1) to be entered is supplied by bi-directional input-output data lines to the bit lines. The word line is then activated to store the required information into the cell. Note that for efficient read or write operation the transistor sizing should be appropriate otherwise it may leads to wrong data read or write. For the standby operation word line (WL) voltage is not applied to the cell hence the stored information remains latched and the inverters connected back to back reinforce each other and maintain the required data into the cell.

The proposed SRAM column includes two transmission gates (TG-1 and TG-2) in place of pass transistors for word line access transistors, the use of pass transistors as word line shows the voltage drop problem for the cell but in case of transmission gates there is negligible voltage drop. Also as there is a static current flow through the cell during memory cell operation (especially when writing the data to the cell), so to restrict the short circuit current the NMOS switch (m6) is used at the bottom of the cell which turns on during memory cell operation and shows high resistance to the current flow. The proposed SRAM column was simulated using HSPICE simulator. The design parameters (or process parameters) for the column was taken from PTM and the technology used here is standard 7nm. The Vdd was 0.8 V. The trapezoidal clock pulse was used for the word line access. The simulation results for reading and writing of the SRAM column are shown in fig.2 and fig.3 respectively.

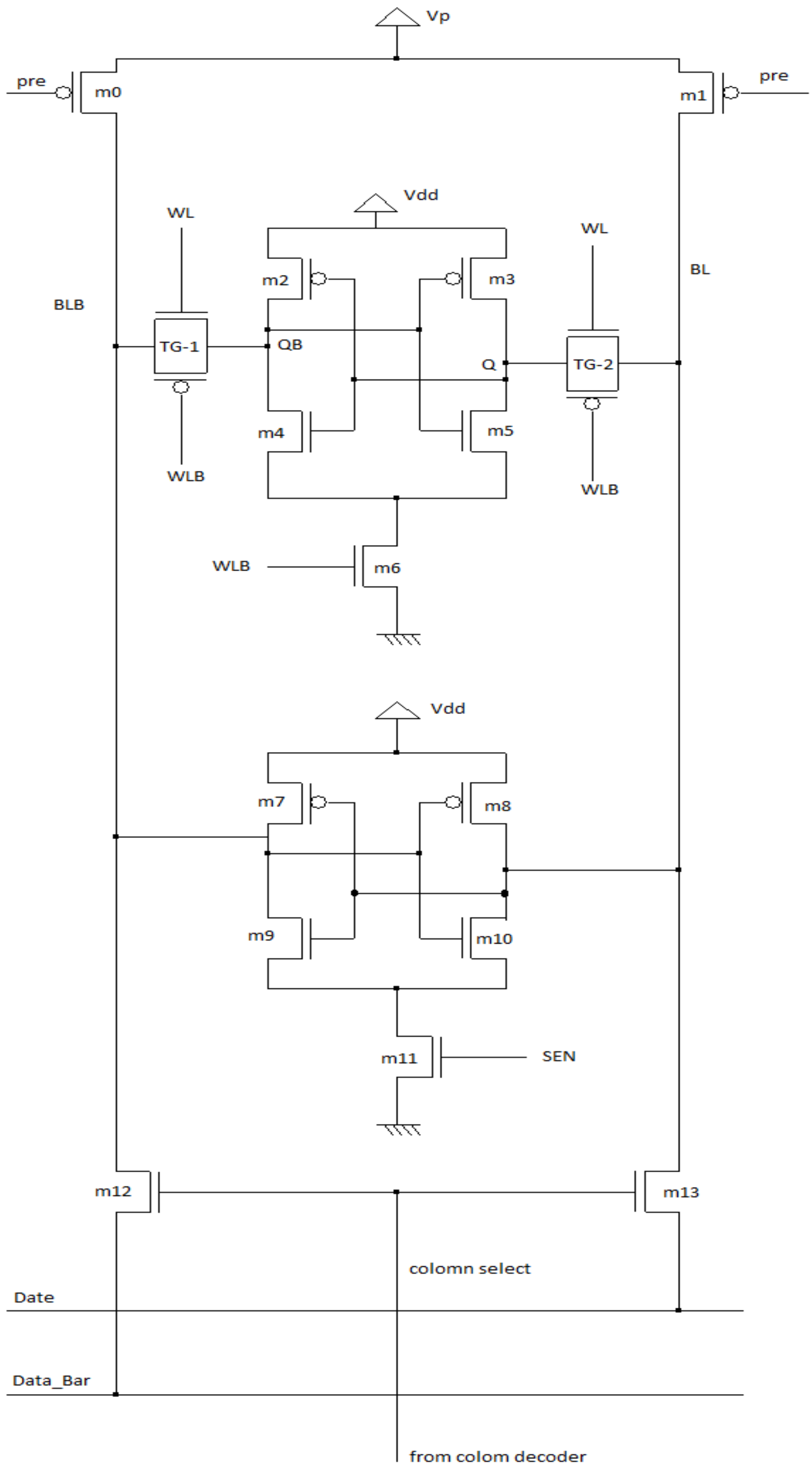

Figure 1 : Proposed SRAM Column

III. Simulation Results

Fig.2 shows the simulated waveforms of proposed SRAM column during read cycle; furthermore fig.2 (a) shows the waveform of precharge signal (Vp and pre) which is transferred in equalized manner to the bit and bit-bar (BL and BLB) lines of the column. Also fig.2 (b) shows the waveform of word line (WL and WLB) which is trapezoidal in nature, after the arrival of word line signal the stored data will be transferred to the bit lines which makes one bit line to go high and other to go low depending on the data stored, and then after column select (c_sel) and sense enable (sen) signals the values at the bit and bit-bar lines will be read out and can be seen at the bidirectional data and data-bar lines.

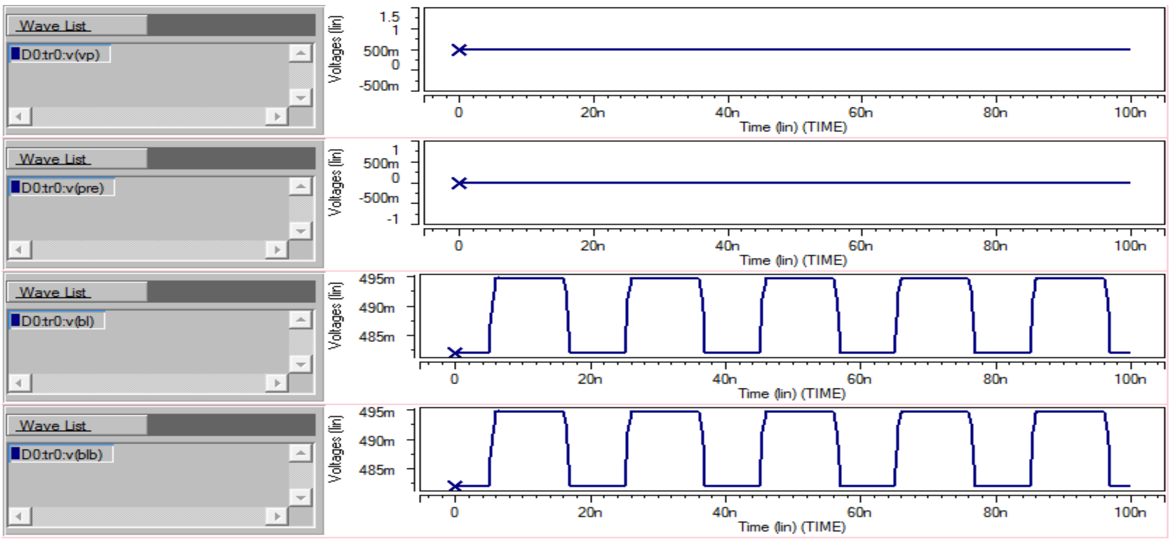

Figure 2 : (a)

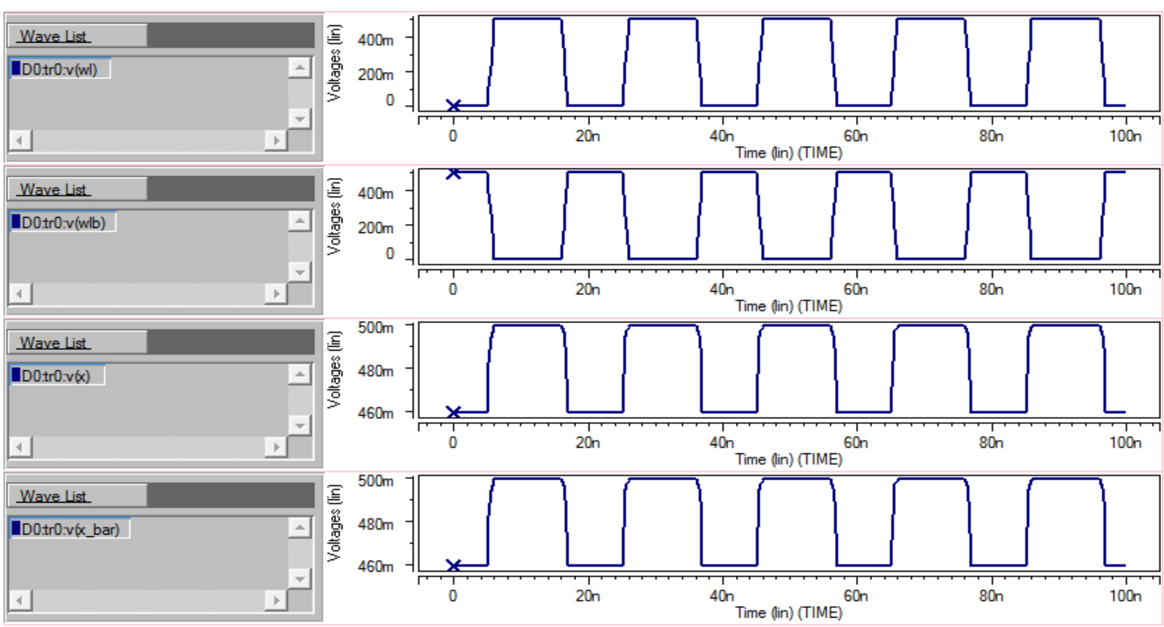

Figure 2 : (b)

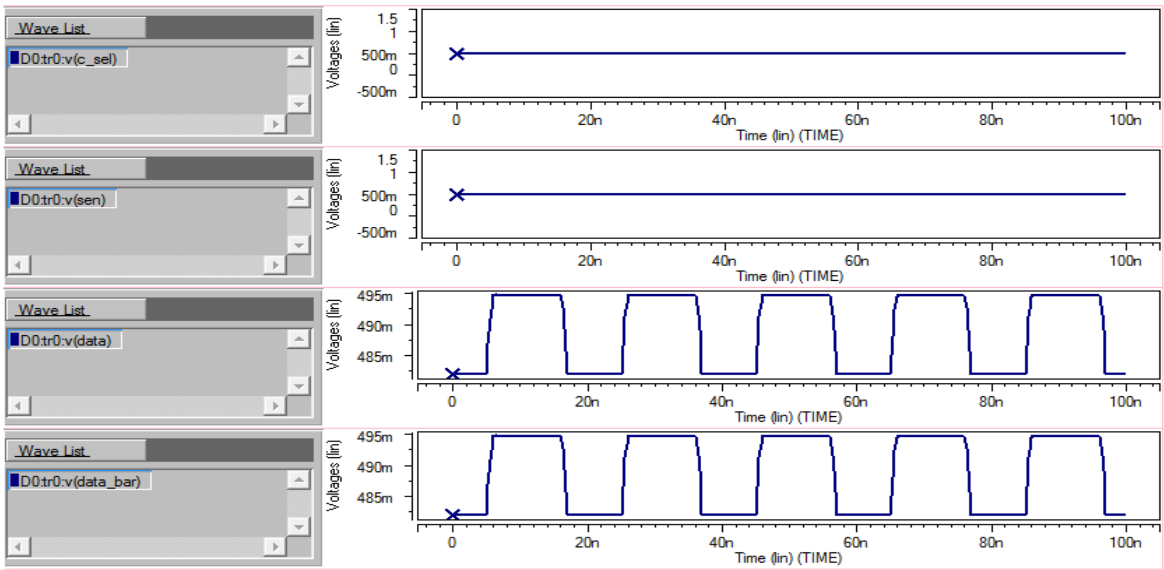

Figure 2 : (c)

Figure 2 : Simulated waveforms during read operation

Fig.3 shows the simulated waveforms of proposed SRAM column during write cycle; fig.3 (a) shows the required data which is to be stored into the cell and the respective column to be selected. Fig.3 (b) shows the bit and bit-bar potentials after transferring the data by selecting the desired column. The stored data (x and xb) can be easily seen after arrival of word line signal in fig.3 (c).

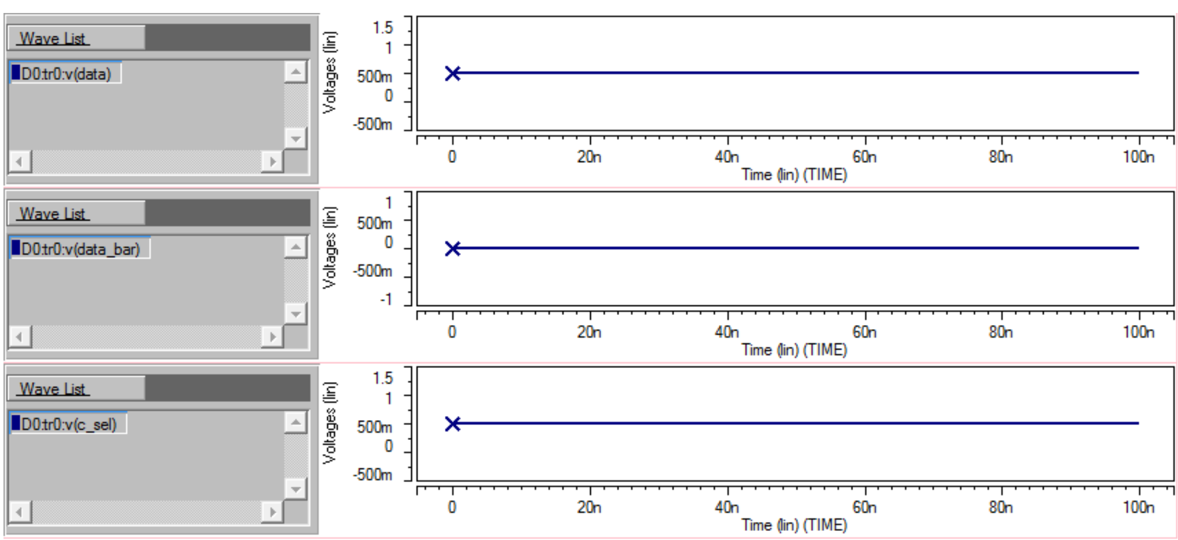

Figure 3 : (a)

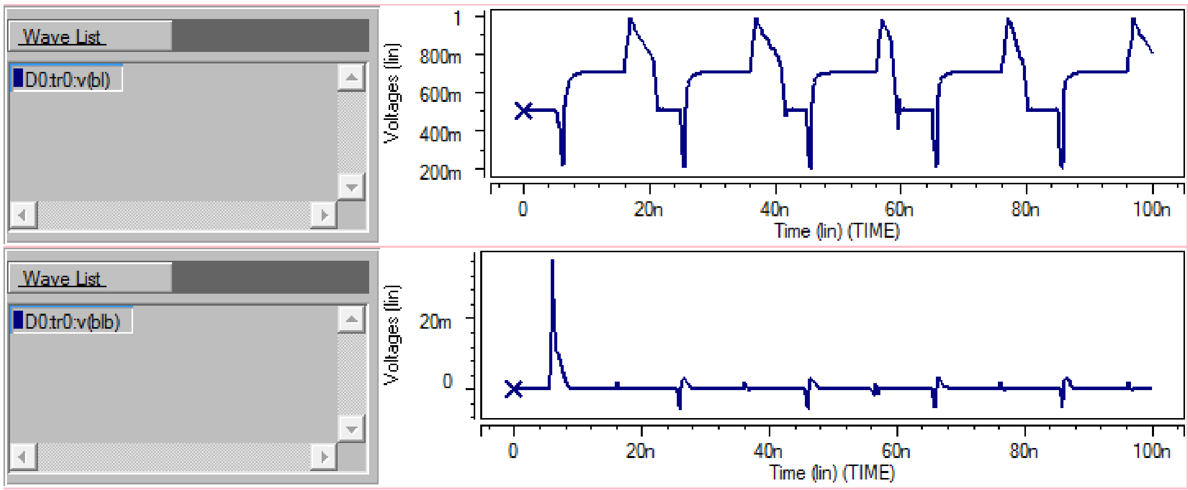

Figure 3 : (b)

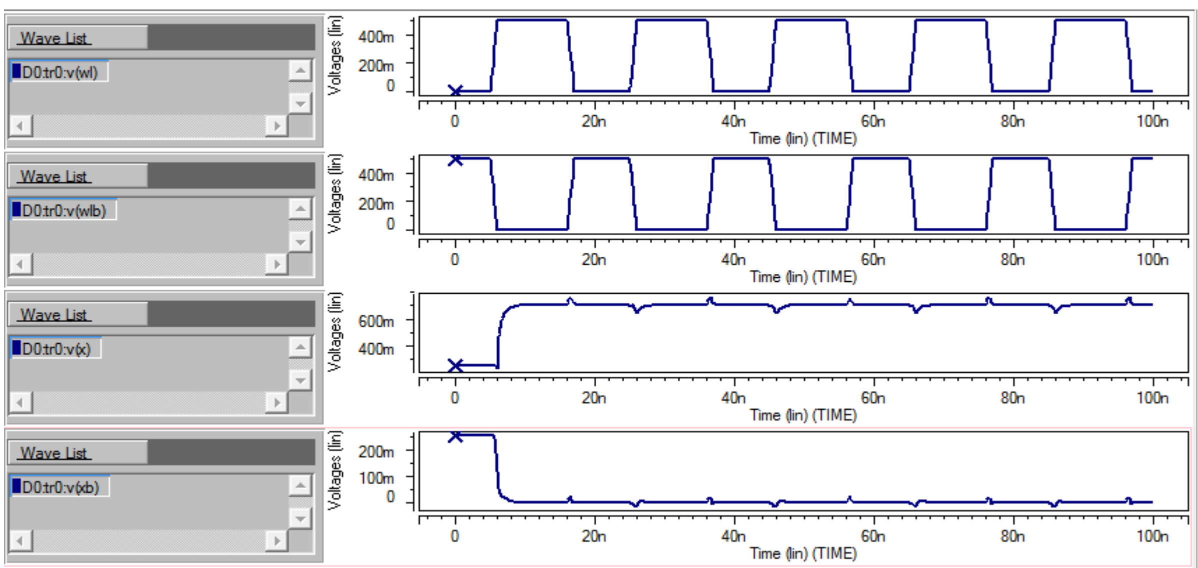

Figure 3 : (c)

Figure 3 : Simulated waveforms during write operation

The values of power dissipation during various operations of the proposed SRAM column are listed in table-1 as shown below.

Table 1

Proposed SRAM Column	Average Power Consumed
During Read Operation	$1.45 * 10^{-4}$ W
During Write Operation	$4.70 * 10^{-5}$ W

IV. Conclusion

In summary, a new SRAM column was designed by using standard 7nm process models from PTM. In the design transmission gates are used in place of pass transistors to rectify the voltage drop problem, an additional NMOS switch is also used at the bottom of the cell instead connecting the cell directly to the ground this helps in reducing the static current flow through the cell during memory operation especially during writing the data to the memory cell. Trapezoidal wave pulses are used at the word line access signal which helps in reducing the power of the memory cell. Finally, by observing the output files generated by HSPICE it was concluded that the proposed SRAM column consumes low power and functioning correctly.

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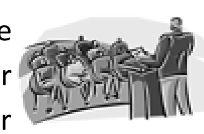

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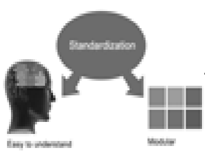

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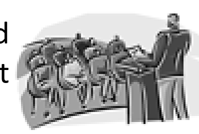

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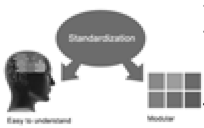

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The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research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

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

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

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

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

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

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

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

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

(h) Brief Acknowledgements.

(i) References in the proper form.

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

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

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

Format

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

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

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

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

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).

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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.

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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.

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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
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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

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ISSN 9755861