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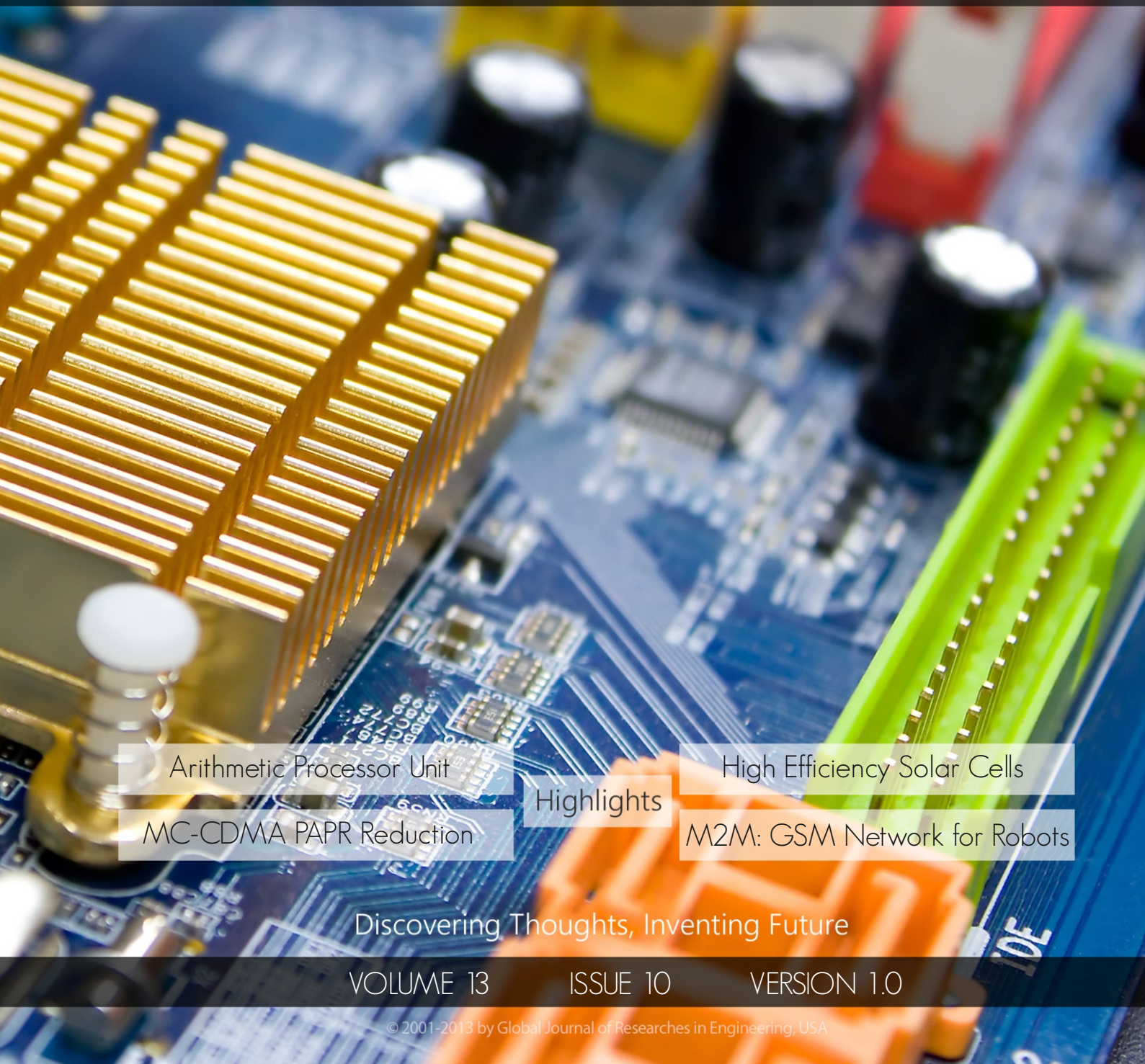

Arithmetic Processor Unit

MC-CDMA PAPR Reduction

Highlights

High Efficiency Solar Cells

M2M: GSM Network for Robots

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 10 VERSION 1.0

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High Performance Fuzzy Adaptive Control for D.C. Motor

By Ravinder Kumar & Vineet Girdha
Khalsa Institute of Engineering & Technology, India

Abstract - This paper presents speed control of a separately excited DC motor using fuzzy logic control (FLC) based on MATLAB Simulation program. This method of speed control of a dc motor represents an ideal application for introducing the concepts of fuzzy logic. The paper shows how a commercially available fuzzy logic development kit can be applied to the theoretical development of a fuzzy controller for motor speed, which represents a very practical class of engineering problems. From this it is seen that the simulation results are similar to the theoretical results which achieve the optimum control.

Keywords : *DC motor control, fuzzy logic controller, MATLAB simulation program.*

GJRE-F Classification : *FOR Code: 090699*

Strictly as per the compliance and regulations of :

High Performance Fuzzy Adaptive Control for D.C. Motor

Ravinder Kumar [α] & Vineet Girdha [σ]

Abstract - This paper presents speed control of a separately excited DC motor using fuzzy logic control (FLC) based on MATLAB Simulation program. This method of speed control of a dc motor represents an ideal application for introducing the concepts of fuzzy logic. The paper shows how a commercially available fuzzy logic development kit can be applied to the theoretical development of a fuzzy controller for motor speed, which represents a very practical class of engineering problems. From this it is seen that the simulation results are similar to the theoretical results which achieve the optimum control.

Keywords : DC motor control, fuzzy logic controller, MATLAB simulation program.

I. Introduction

Classic Control has proven for a long time to be good enough to handle control tasks on system control; however his implementation relies on an exact mathematical model of the plan to be controller and not simple mathematical operations. The fuzzy logic, unlike conventional logic system, is able to model inaccurate or imprecise models. The fuzzy logic approach offers a simpler, quicker and more reliable solution that is clear advantages over conventional techniques. Fuzzy logic may be viewed as form of set theory. At the present time, MATLAB Simulation simplifies the scientific computation, process control, research, industrial application and measurement applications. Because MATLAB has the flexibility of a programming language combined with built-in tools designed specifically for test, measurement and control. By using the integrated MATLAB environment to interface with real-world signals, analyze data for meaningful information and share results. Therefore take MATLAB for develop of the control system that append with fuzzy logic is incoming for modem control and the advantages in fuzzy control are more robust control method than usual conventional control to variation of system parameter. This paper presents the experimental results of the fuzzy logic controller using Matlab for speed control of Separately Excited DC Motor through fuzzy logic controller for speed control is used to facilitate and efficiency the implementation of controllers.

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II. System Description

a) Motor Model

The resistance of the field winding and its inductance of the motor used in this study are represented by R_f and L_a respectively in dynamic model. Armature reactions effects are ignored in the description of the motor. This negligence is justifiable to minimize the effects of armature reaction since the motor used has either interpoles or compensating winding. The fixed voltage V_f is applied to the field and the field current settles down to a constant value. A linear model of a simple DC motor consists of a mechanical equation and electrical equation as determined in the following equations (1) - (2).

$$T_m = J_m d\omega/dt + B_m\omega + T_L \quad (1)$$

$$V_a = E_b + I_a R_a + L_a (dI_a/dt) \quad (2)$$

Where

V_a is the armature voltage. (In volt)

E_b is back emf the motor (In volt)

I_a is the armature current (In ampere)

R_a is the armature resistance (In ohm)

L_a is the armature inductance (In henry)

T_m is the mechanical torque developed (In Nm)

J_m is moment of inertia (In kg/m^2)

B_m is friction coefficient of the motor (In Nm/ (rad/sec)) ω is angular velocity (In rad/sec) The dynamic model of the system is formed using these differential equations.

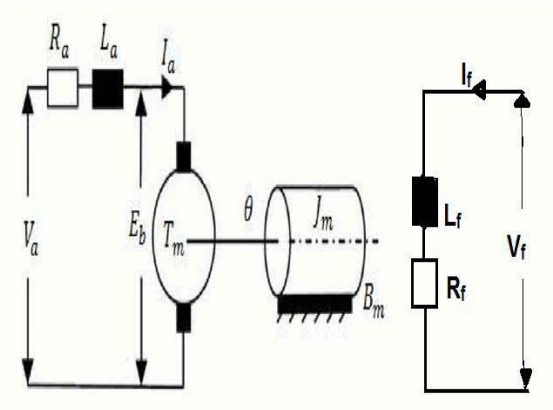

Figure 1 : Separately Excited DC Motor Model

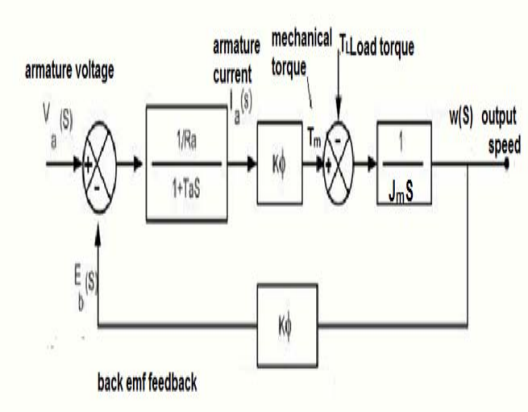

Figure 2 : Block Model of Separately Excited DC Motor

III. Fuzzy Logic Controller

Fuzzy logic is a method of rule-based decision making used for expert systems and process control that emulates the rule-of-thumb thought process used by human beings. The basis of fuzzy logic is fuzzy set theory which was developed by Lotfi Zadeh in the 1960s. Fuzzy set theory differs from traditional Boolean (or two-valued) set theory in that partial membership in a set is allowed. Traditional Boolean set theory is two-valued in the sense that a member belongs to a set or does not and is represented by 1 or 0, respectively. Fuzzy set theory allows for partial membership or a degree of membership, which might be any value along the continuum of 0 to 1. A linguistic term can be defined quantitatively by a type of fuzzy set known as a membership function. The membership function specifically defines degrees of membership based on a property such as temperature or pressure. With membership functions defined for controller or expert system inputs and outputs, the formulation of a rule base of IF-THEN type conditional rules is done. Such a rule base and the corresponding membership functions are employed to analyze controller inputs and determine controller outputs by the process of fuzzy logic inference. By defining such a fuzzy controller, process control can be implemented quickly and easily. Many such systems are difficult or impossible to model mathematically, which is required for the design of most traditional control algorithms. In addition, many processes that might or might not be modeled mathematically are too complex or nonlinear to be controlled with traditional strategies. However, if a control strategy can be described qualitatively by an expert, fuzzy logic can be used to define a controller that emulates the heuristic rule-of-thumb strategies of the expert. Therefore, fuzzy logic can be used to control a process that a human can control manually with expertise gained from experience. The linguistic control rules that a human expert can describe in an intuitive and general manner can be directly translated to a rule base for a fuzzy logic controller.

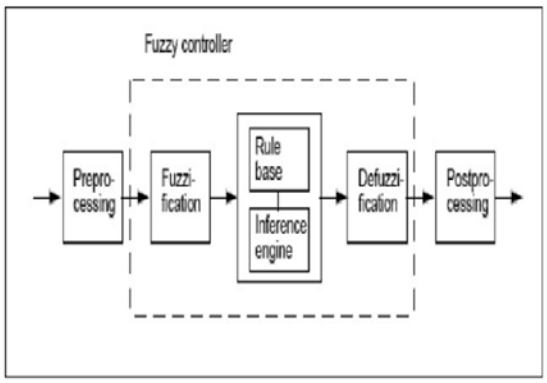

Figure 3 : Structure of fuzzy logic controller

IV. Problem Formulation

A Separately Excited DC motor is taken as a case study and the control is achieved using intelligent fuzzy logic based controller. The efficiency is improved by controlling the speed with fuzzy logic controller and results are shown graphically.

a) Fuzzy Logic Controller Design

The inputs to the Self-tuning Fuzzy Controller are speed error "e (t)" and Change-in-speed error "de (t)". The input shown in figure are described by

$$e(t) = wr(t) - wa(t)$$

$$de(t) = e(t) - e(t-1)$$

Using fuzzy control rules the output control is adjusted, which constitute the self control of D.C. machine.

V. Adjusting Fuzzy Membership Functions and Rules

In order to improve the performance of FLC, the rules and membership functions are adjusted. The membership functions are adjusted by making the area of membership functions near ZE region narrower to produce finer control resolution. On the other hand, making the area far from ZE region wider gives faster control response. Also the performance can be improved by changing the severity of rules.

a) Design of Membership Function (MF)

i. *Input Variables*

a. *Fuzzy Sets of Speed Error (E) Variable*

Table 1: Membership function of speed error

Fuzzy Set Error	Numerical Range	Shape of membership function
Very Low	0.2 to 0.5 1 to 1	Trapezoidal
Instant	-0.01 to 0 0 to 0.01	Triangular

Very High	-1 to -1 -0.5 to -0.2	Trapezoidal
Very Medium Low	0 to 0.2 0.2 to 0.4	Triangular
Very Medium High	-0.4 to -0.2 -0.2 to -0	Triangular

b. *Fuzzy Sets of Chnge in Speed Error (De) Variable*

Table 2 : Membership function of change in speed error

Fuzzy Set derivative of Error	Numerical Range	Shape of membership function
High Negative	-1 to -1 -1 to 0	Triangular
Error High Positive	0 to 1 1 to 1	Triangular

b) Output Variables

i. *Fuzzy Set for Control*

Table 3 : Fuzzy Set for Control

Output	Numerical Range	Shape of member-ship function
Decrease A lot	-30 to -25 -25 to -20	Triangular
Increase A lot	20 to 25 25 to 30	Triangular
Decrease Few	-15 to -10 -10 to -5	Triangular
Hold	-0.1 to 0 0 to 0.1]	Triangular
Increase Few	5 to 10 10 to 15	Triangular

c) Design of Fuzzy Rules

i. *Rule bases for Output Control*

e/de	Very High	Medium High	Instant	Medium Low	Very Low
High Negative	Decrease alot	Decrease few	Decrease few	Increase few	Increase alot
High positive	Decrease alot	Decrease few	Increase few	Increase few	Increase alot
			Hold		

Figure 4 : Rule bases for output control

VI. MATLAB Simulation

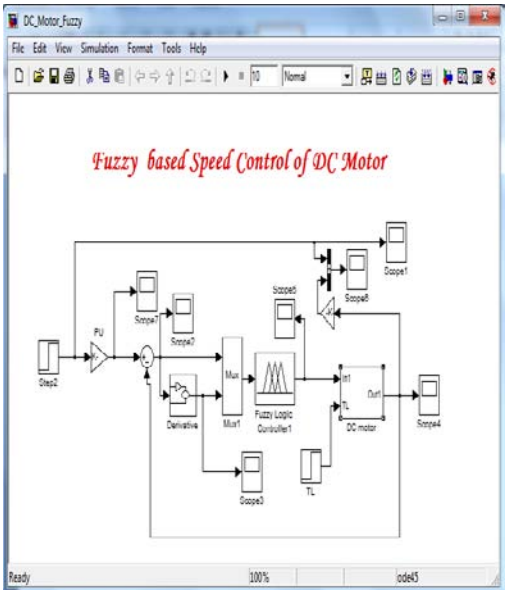

Figure 5 : SIMULINK model of fuzzy control D.C. machine

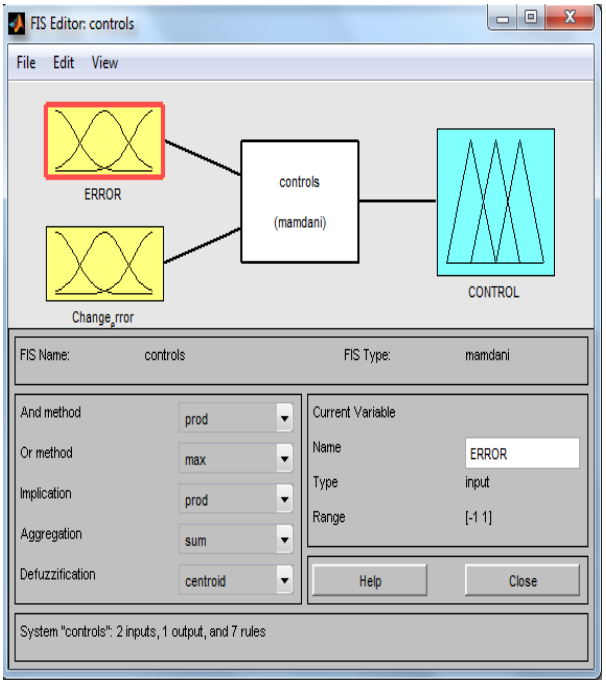

Figure 6 : FIS Editor

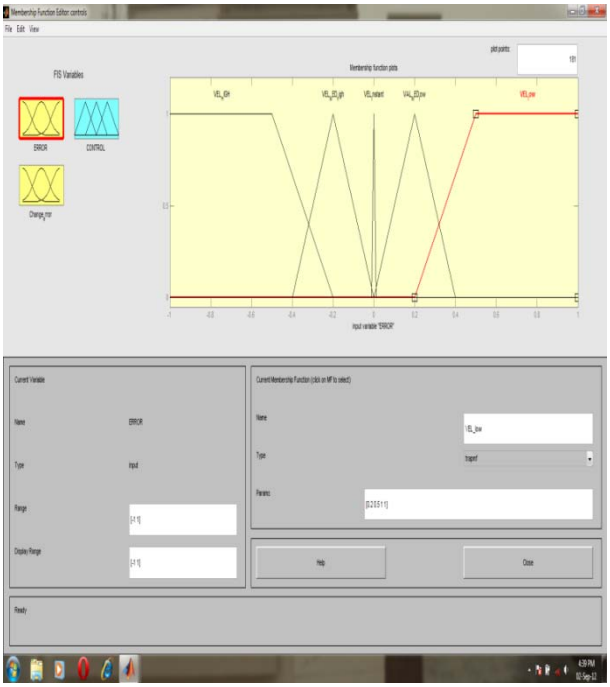

Figure 7 : Membership function for input variable "e"

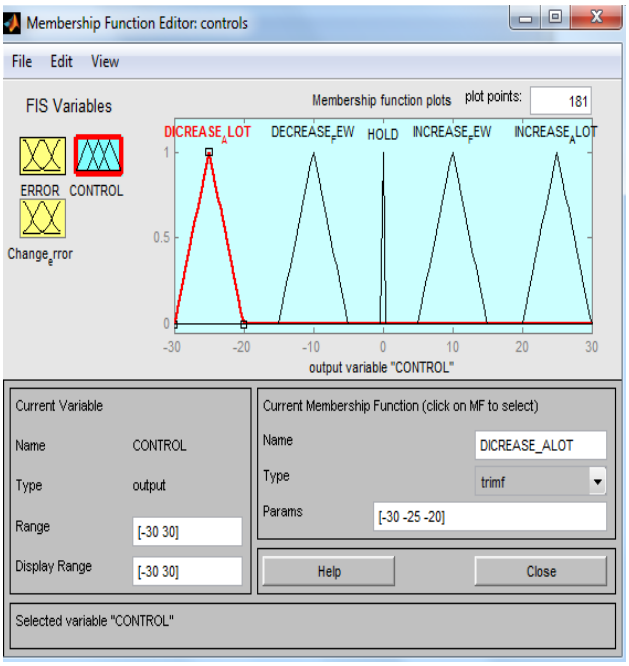

Figure 9 : Membership function for output variable "Controls"

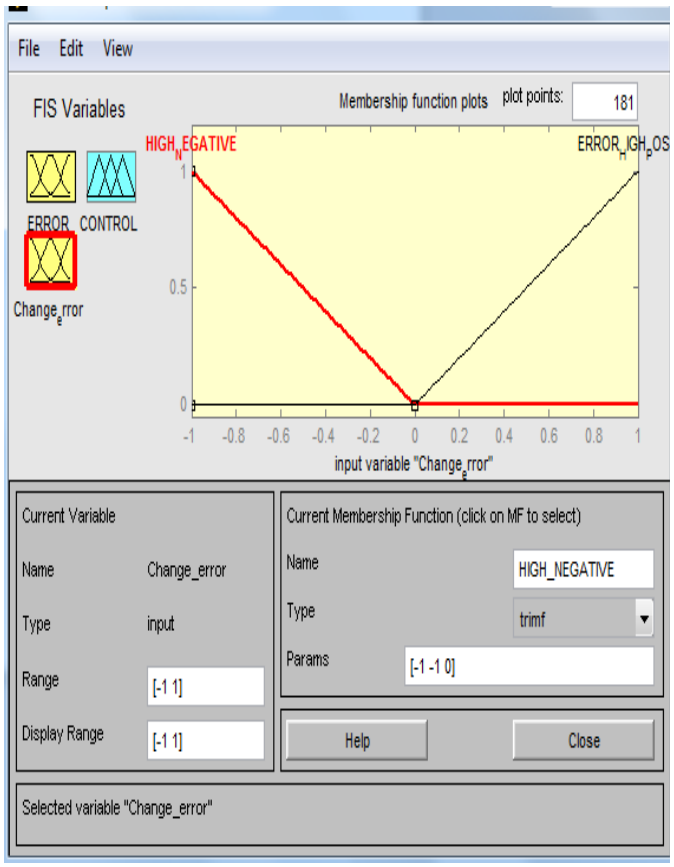

Figure 8 : Membership function for input variable "de"

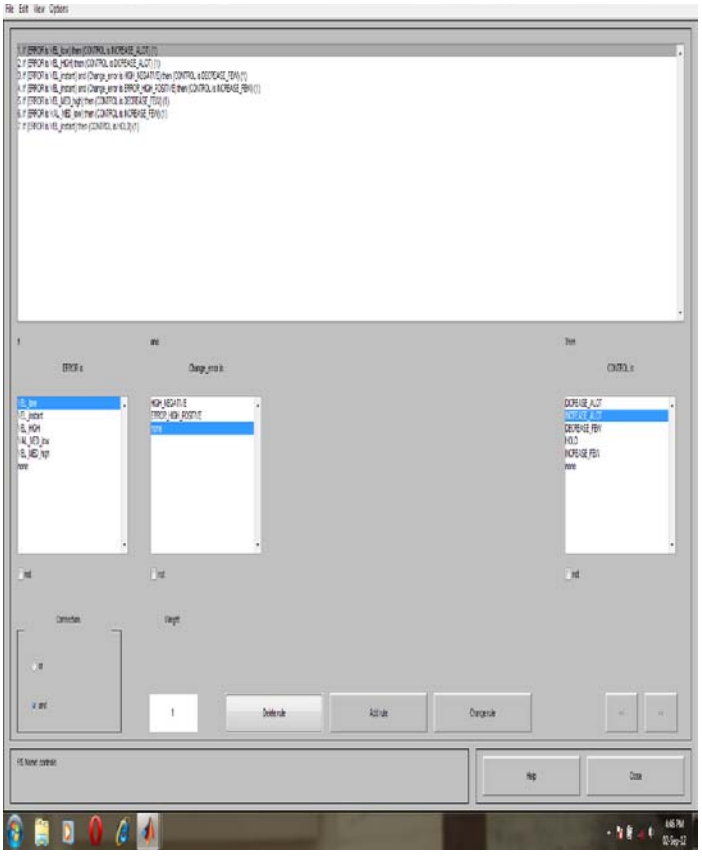

Figure 10 : Rule Editor

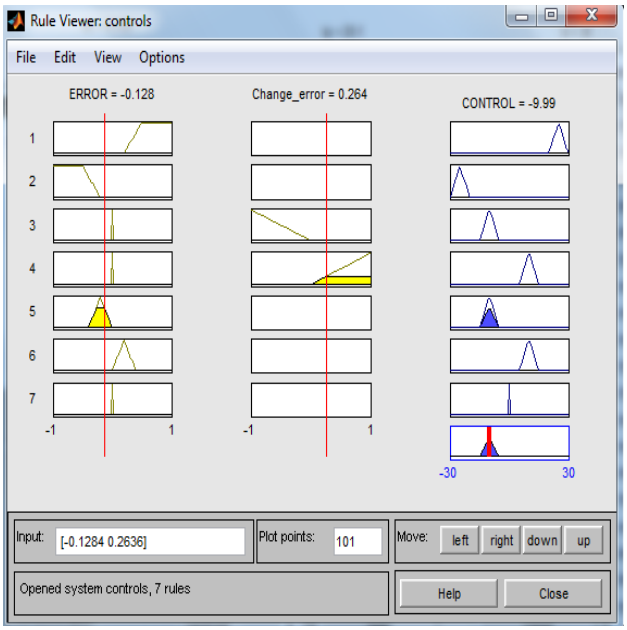

Figure 11 : Rule Viewer

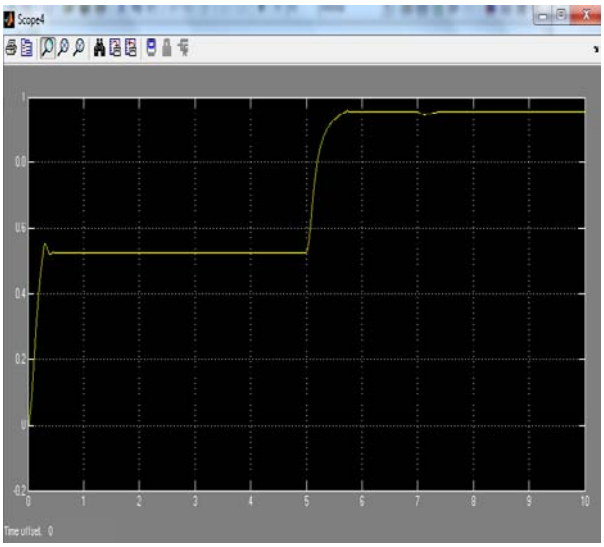

Figure 12 : Output of the System

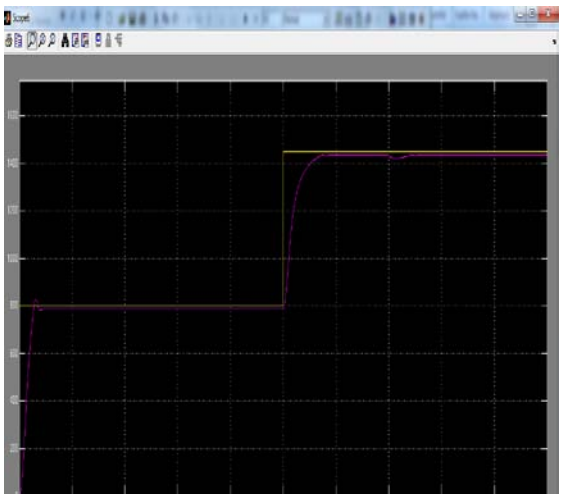

Figure 13 : Output of fuzzy logic controller

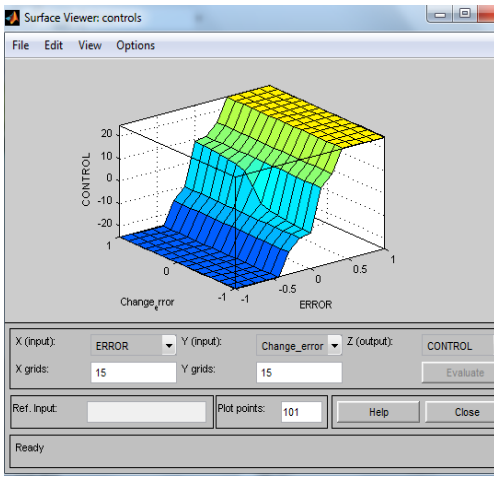

Figure 14 : Surface view for controls

VII. Conclusion

This paper proposes a straight-forward method of creating a mathematical model which has been successfully applied to a variety of membership functions. This new approach offers a key of advantage over the traditional methods, which makes it suitable for several dc motor drive applications. The paper focused the attention to apply the smooth control of speed in D.C. Machines up to the 95% and with minimization of speed error. The simulation and experimental studies clearly indicate the superior of fuzzy control. It is well seen in the case of sudden change due to load torque disturbances because it is inherently adaptive in nature. The final experimental results clarify the success, the simplicity and the generality of the design software controller. The extension of this research is to apply the neural network techniques for the dc motor applications.

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Design of 8-Bit Arithmetic Processor Unit based on Reversible Logic

By A. Kamaraj, C. Kalyana Sundaram & J. Senthil Kumar
Mepco Schlenk Engineering College, India

Abstract - Reversible logic is emerging as an important research area in the recent years due to its ability to reduce the power dissipation, which is the main requirement in low power digital design. Energy dissipation is proportional to the number of bits lost during computation. The reversible circuits do not lose information and can generate unique outputs from specified inputs and vice versa. It has application in diverse fields such as low power CMOS design, optical information processing, cryptography, quantum computation and nanotechnology. This paper proposes a reversible design of an 8 -bit arithmetic processor. The architecture of the processor has been proposed, in which, each block is realized using reversible logic gates. The important blocks of the processor are control unit, arithmetic and logical unit and register file. Each module has been coded using Verilog then simulated using Modelsim and prototyped in Xilinx-Spartan 3E.

Keywords : *reversible logic, reversible gate, FPGA, xilinx.*

GJRE-F Classification : *FOR Code: 290901*

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Keywords : reversible logic, reversible gate, FPGA, xilinx.

I. Introduction

In modern VLSI system, power dissipation is very high due to rapid switching of internal signals. Landauer showed that the circuits designed using irreversible elements dissipate heat due to the loss of information bits [1]. It is proved that the loss of every bit of information results in dissipation of KT*log2 Joule of heat energy where K is the Boltzmann constant and T is the temperature at which the operation is performed.

Bennett showed that this heat dissipation due to information loss can be avoided if the circuit is designed using reversible logic gates [1]. A gate is considered to be reversible only if each and every input has a unique output assignment. Hence there is a one to one mapping between the input and output vectors. A reversible logic gate has same number of inputs and outputs.

II. Basic Reversible Gates

There exist many reversible gates in the literature. Among them 2*2 Feynman gate, 3*3 Fredkin gate, 3*3 Toffoli gate and 3*3 Peres gate are the most referred. The detailed cost of a reversible gate depends on any particular realization of quantum logic [2]. Generally, the cost is calculated as a total sum of 2*2 quantum primitives used. The cost of Toffoli gate is exactly the same as the cost of Fredkin gate and is 5. The only cheapest quantum realization of a complete (universal) 3*3 reversible gate is Peres gate and its cost is 4.

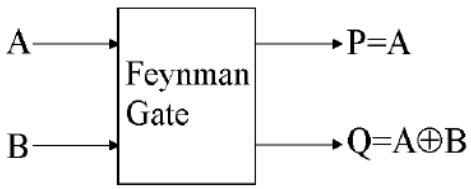

Figure 1: Feynman Gate

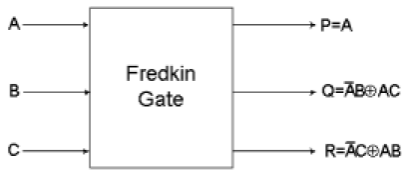

Figure 2 : Fredkin Gate

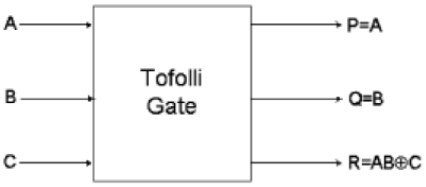

Figure 3 : Tofolli Gate

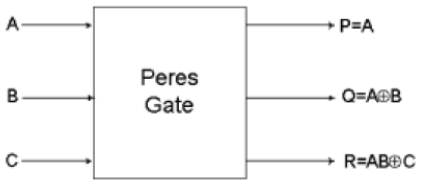

Figure 4 : Peres Gate

III. Processor Architecture

The architecture of the 8-bit reversible processor is shown in Figure.5. The various components included in the 8-bit reversible processor are as follows:

- Accumulator
- Temporary Register
- ALU Result Register
- Status Register
- Program Counter
- Instruction Register
- Register File of 16 registers
- Arithmetic And Logical Unit
- Control Unit

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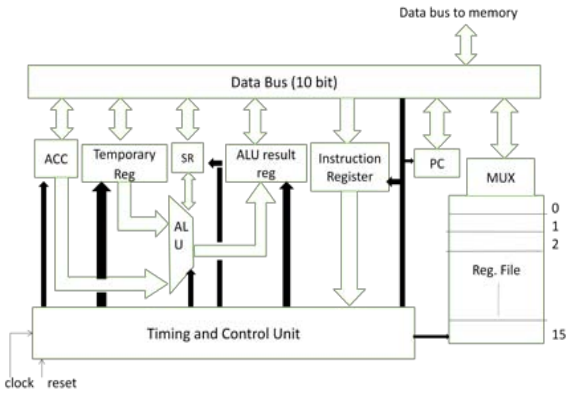

Figure 5 : Processor Architecture

The design of the various blocks of the processor is as follows:

a) Arithmetic and Logic Unit

The arithmetic and logic unit has 4-bit select inputs to select one from 16 operations as shown in Table.1. Two 8-bit data are given as input to the ALU. The logical operations include all basic logic gates. The various sub modules in the design are adder/subtractor, multiplier and a logical unit.

Table 1 : Operations in the ALU

I3	I2	I1	I0	Operation
0	0	0	0	Clear
0	0	0	1	A+B
0	0	1	0	A-B
0	0	1	1	A*B
0	1	0	0	A++
0	1	0	1	A--
0	1	1	0	Left Shift
0	1	1	1	Right Shift
1	0	0	0	Or
1	0	0	1	And
1	0	1	0	Not
1	0	1	1	Xor
1	1	0	0	Nor
1	1	0	1	Nand
1	1	1	0	Xnor
1	1	1	1	Preset

The 8-bit reversible adder/subtractor has been designed using Peres gates and Feynman gates [3]. HNG gates and Peres gates are used in the design of the 8-bit reversible multiplier [6].The left and right shifter blocks are designed using reversible multiplexers.

b) Register File

The register file includes 16 registers and two 4 to 16 decoders as shown in the Figure.6. The two select signals 'load' and 'enable' are used for loading data into and reading value of data from the individual registers of the register file respectively. The 4 to 16 decoder is designed using reversible Fredkin gates [4].

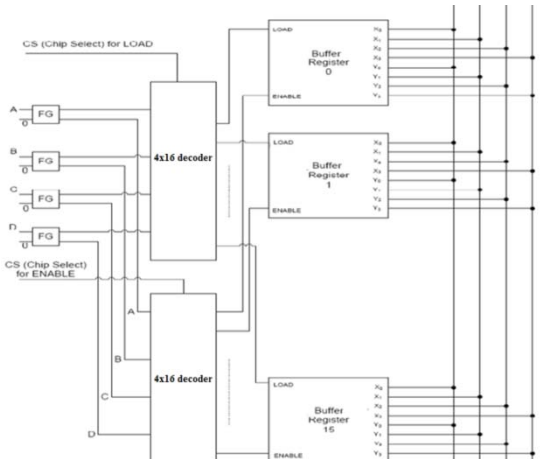

Figure 6 : Register File

c) Control Unit

The Figure. 7 shows the 10 bit instruction used in this design. The first two bits correspond to LOAD and ENABLE. The next 3-bits correspond to DEVICE ID of the memory component. The DEVICE ID assigned to each memory component is shown in Table.2. If the LOAD is 1, then the device specified by the DEVICE ID will take the input from the data bus. If the ENABLE is 1, the device specified by the DEVICE ID will output its content to the data bus. The lower 4-bits of the instruction carry useful information for both ALU and 16-bit Register File.

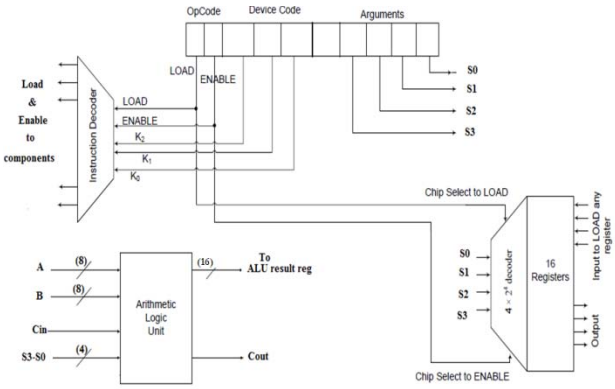

Figure 7 : Instruction Format

The important block of the control unit is the instruction decoder, which controls the eight memory components of the processor. Instruction decoder consists of two 3 to 8 decoders as shown in Figure.8. Two select signals 'load' and 'enable' are used for the decoders. The 3 to 8 decoder is designed using reversible Fredkin gates [4].

Table 2 : Device IDs of Memory Components

Device Id	Device Name
000	Accumulator Register
001	ALU Result Registers
010	Data Bus Buffer Register

011	Program Counter
100	Instruction Register
101	Status Register
110	Register File
111	Temporary Register

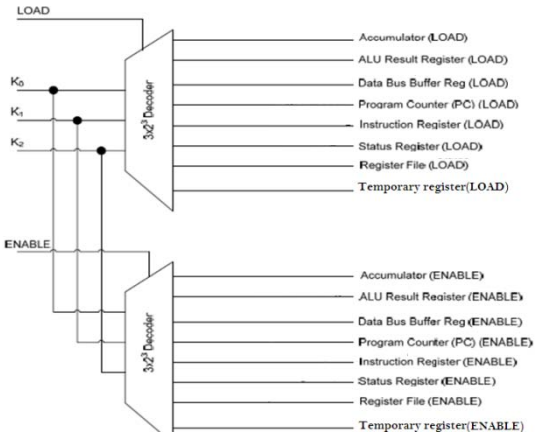

Figure 8 : Instruction Decoder

d) Memory Components

- The Accumulator is a controlled buffer that stores intermediate results or it may be used to store an operand for a binary operation performed by the ALU.
- Temporary Register is another controlled buffer register to store the second operand of any binary operation as performed by the ALU.
- Status Register is a 4-bit buffer register that represents the four flags (carry flag, overflow flag, sign flag, zero flag).
- ALU result registers are also controlled buffer register used to store the result of the ALU operation.
- The Data Bus Buffer is another controlled buffer register that takes input from memory module. It is directly connected to the data bus.

IV. Simulation Results

All the blocks are modelled using VERILOG. The functional verification of the codes is analysed using ModelSim-Altera 6.4a (Quartus II 9.0) Starter Edition and synthesised using Xilinx ISE Design Suite 13.4. The simulation results of the ALU, Instruction Decoder, Register File and Memory Components are shown in Figure.9, 10, 11, 12 respectively.

a) Arithmetic and Logical Unit

Here 'a' and 'b' indicates the 8-bit data and 'i' is a 4- bit input data that acts as the control signal. Depending on this value the required output results are obtained and stored in 'x' and 'y'.

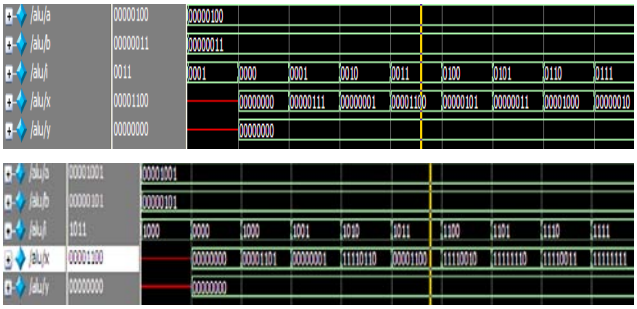

Figure 9 : Simulation Result of ALU

b) Instruction Decoder

Here two 3 to 8 reversible decoders are used. One for controlling the LOAD input 'l' of each of the 8 memory components and other to control the ENABLE input 'e' of each of the components. Here k is the 3-bit selection input to address each memory component.

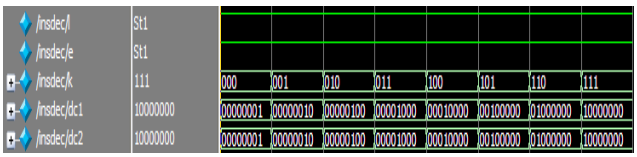

Figure 10 : Simulation Result of Instruction Decoder

c) Register File

Since 16 registers are present, 4-bit address 's' is used to select one of the registers. LOAD 'l' and ENABLE 'e' inputs act as control signals and 'din' acts as the data input to the register file.

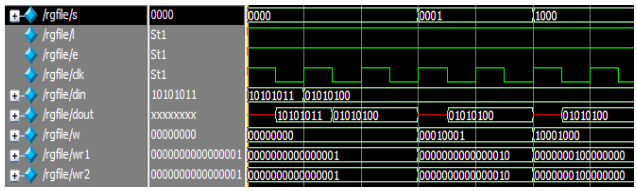

Figure 11 : Simulation Result of Register file

d) Memory Components

Accumulator, Temporary register, ALU result registers, Data Bus Buffer register are the memory components used in this design. The memory components are controlled buffer registers with two control signals LOAD 'l' and ENABLE 'e'.

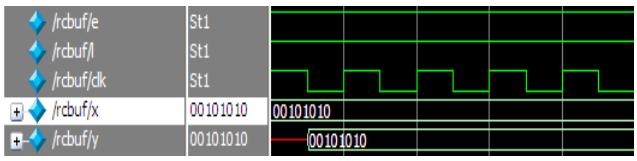

Figure 12 : Simulation Result of Controlled Buffer Register

V. Conclusion and Future Work

Reversible circuits are an emerging technology with promising applications because of the low power dissipation. In this paper a novel architecture of a

reversible 8-bit processor has been proposed. Each block of the processor was designed using the basic reversible gates.

In future, this design can be extended to any number of bits. This paper provides the circuit level implementation of the reversible processor. Further this design may be extended to transistor implementation which would help in easier analysis of power.

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Towards High Efficiency Solar Cells: Composite Metamaterials

By Galib Hashmi, Masudul Haider Imtiaz & Shahida Rafique
University of Dhaka, Bangladesh

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GJRE-F Classification : *FOR Code: 090605*

Strictly as per the compliance and regulations of :

Towards High Efficiency Solar Cells: Composite Metamaterials

Galib Hashmi [α], Masudul Haider Imtiaz [σ] & Shahida Rafique [ρ]

Abstract - Classification & Applicability of various metamaterials found to be promising in designing high efficiency solar cells. Also light absorption & polarization of electromagnetic energy have been found very prominent in case of metamaterials. Theoretical modeling of metamaterial solar cell has been developed in this study to achieve high efficiency. Hence, composite metamaterials have been investigated and metamaterial property like negative refractive index has been thoroughly studied. It has been found that if anti-reflective coating of solar cell is made of metamaterial, and its refractive index is 1 then no reflection occurs and the efficiency increases without any polarization effect. Also it has been realized that by using sawtooth structure in the second layer of metamaterial solar cell, the band gap can be tuned thus covering the whole solar spectrum and increasing efficiency. The simulation of the proposed model has been done utilizing PC1D, Wx AMPS and Matlab. Metamaterial solar cell shows promising future and this research work can be successfully used to design & develop metamaterial based highly efficient solar cells.

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I. Introduction

Providing enough energy to meet an ever-increasing demand is one of the greatest problems the world is now facing. Energy is the key to an industrialized economy, which calls for a doubling of electrical output every ten to twelve years. Meanwhile, the days of cheap abundant and environmentally acceptable power may be coming to an end. Coal is plentiful but polluting, natural gas is scarce and oil is not found everywhere. Nuclear power now is costly and risky. In many countries of the world, keen interest is being shown in alternative energy sources. A promising source of energy which would be able to solve a part of the energy crisis for the present & future, by instructively looking at the current technical and economic energy picture as well as sustainable energy is solar cell. But on an average single p-n junction solar cell efficiency is not more than 20% [1] as it cannot use the whole solar spectrum. Making a highly efficient solar cell is always a challenging task for today's scientists and engineers. [2] A lot of research works have been carried on and quite a few approaches have found efficient like: (1) To select the semiconductor materials with appropriate energy gaps to match the solar spectrum optimizing their optical, electrical, and structural properties; and (2) the innovative device engineering which enables more effective charge collection as well as better utilization of the solar spectrum through single and multi-junction approaches. However, both approaches haven't confirmed the utilization of entire spectrum of sunlight simultaneously, from the infrared to the ultraviolet and hence limit the efficiency of the solar cell.

Metamaterials might have a huge impact in this regard. These are artificial materials engineered to have properties that may not be found in nature which would be advantageous to utilize whole solar spectrum. Also, metamaterial is insensitive to polarization which can be used to precisely control the path of visible light regardless of the polarization of the light. Responding these motivations authors were intended to propose a new innovative approach to integrate metamaterials as anti-reflection coating with traditional p-n junctions. The design parameters of metamaterial based solar cell are conventional semiconductor parameters, emitter & base, grid pattern, anti-reflective coating, doping, band gap, carrier concentration, diffusion coefficients, diffusion length, air mass etc. Simulation results also support the whole design in terms of efficiencies and usability.

II. Background Study

a) Basics of Solar Cells

A solar cell (also called a photovoltaic cell) is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. Photovoltaic effect is the production of current due to the voltage difference across a p-n junction, as a result of the absorption of photons on the top layer of n-type material. This N–type material is often made of a shiny reflective material so it may send photons bouncing

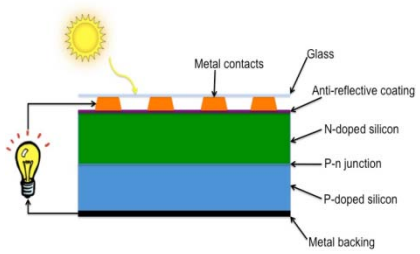

Figure 1 : Basic structure of a silicon solar cell. [3]

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away before they enter into the p-n junction; which is undesirable, so an anti-reflective coatingis often applied to reduce those losses, to limit the reflection of sunlight. There are also finger like contacts in top layer to reduce series resistance. While the P-type material is layered to a conductive back contact made of aluminum or some alloy. These metal contacts and the fingers on the top electrode are constructed to facilitate ample sunlight to enter into the n- and p-type layer and also a pathway for electrical flow out of current. Figure 1 shows the basic structure of solar cell.

b) Limitations of the Solar Cells

Even the best of today's silicon solar cells cannot use about 30 percent of the light from the sun: that's because the entire spectrum of sunlight, from infrared to ultraviolet, covers a range of about 0.0012 eV to about 4 eV, the semiconductors do not respond to the entire spectrum of sunlight. Solar cell works only in the visible spectrum. Photons with at least the band gap energy will be able to free electrons to create a current. Photons with energy less than material's band gap pass through the cell and are not absorbed, which wastes incoming energy. Also some sunlight is always reflected off the surface of the cell even though the surface is usually texturized and coated with an anti-reflective coating. Furthermore, some energy is lost from local recombination of newly created holes and electrons. Finally, there are some losses due to manufacturing impurities in the solar cell.

c) Concepts of MetaMaterials

In recent years, there has been much interest in the development of artificial electro-magnetic structures called "metamaterials" which can yield values for permittivity ε and permeability μ not achievable in nature. Metamaterials usually gain their properties from structure rather than the composition, using small inhomogeneities to create effective macroscopic behavior. Metamaterials can be classified according to the response in the presence of Electromagnetic field, broadly on the macroscopic parameters ε and μ of these materials. The classification is graphically illustrated in Figure 2 which indicates positive refractive index metamaterials are only in the first quadrant, all the other quadrants are of negative refractive index metamaterials. Most dielectrics are included in the DPS, Double Positive group (e > 0, μ > 0). In certain frequency regimes, many plasmas and gyrotropic material respectively exhibit the characteristics of ENG, Epsilon Negative (e < 0, μ > 0) and MNG, Mu Negative (e > 0, μ < 0) group. A medium with both permittivity & permeability less than zero (e < 0, μ < 0) are called as Double negative (DNG) or Left Handed medium(LHM). These DNG/LHM materials have only been demonstrated with artificial constructs. As light propagation must occur through metamaterial solar cell, double negative refractive index metamaterial (i.e. LHM) is rationally proposed in this study.

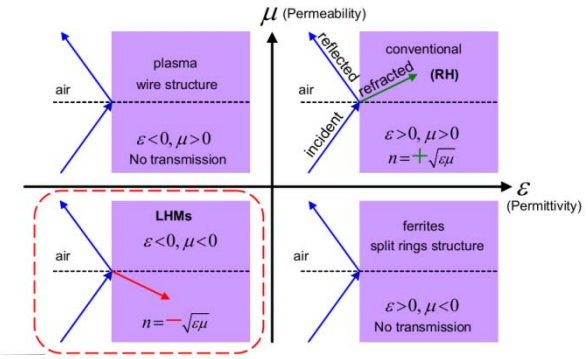

Figure 2 : Classification of different metamaterials

d) Applicability of Metamaterial on Solar Cells

i. *Metamaterials of Sawtooth Structure*

According to Nicholas X. Fang, the Brit (1961) and Alex (1949) d'Arbeloff, Associate Professor of the Department of Mechanical Engineering, MIT, the thinnest materials used to fully capture light are limited to a very narrow range of wavelengths and the angles of incidence. They proposed a design composed of a pattern of wedge-shaped ridges whose widths are precisely tuned to slow and capture light of a wide range of wavelengths and the angles of incidence. These metamaterials could be made extremely thin, saving weight and cost. Also, Kin Hung Fung, an MIT postdoc has proposed a design of multilayer sawtooth structure to absorb a wide range of frequencies with an efficiency of more than 95 percent [4].

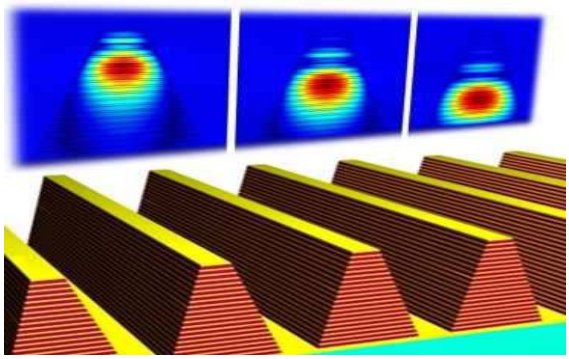

Figure 3 : Sawtooth Tapered ridges, made from alternating layers of metal and insulating material deposited on a surface, can produce a metamaterial that is tuned to a range of specific frequencies of light. Light of different wavelengths is absorbed by the material at different levels, where the light's wavelength matches the width of the ridges. Designed in MIT's Department of Mechanical Engineering

In the case of a general solar cell we get only one band gap and only a portion of visible light can be absorbed by solar cell. Using sawtooth structure in

metamaterial band gap can be tuned. Figure 4 shows the general Band gap vs refractive index curve of this equation

$$n = \sqrt{[1 + \{A / (E_g + B)^2\}]}$$

Where A is hydrogen ionization energy ≈ 13.6 eV, B is 3.47 eV and n is the refractive index. The curve is continuous, leads to the efficient utilization of solar cell by utilizing metamaterial grooves (sawtooth) structure.

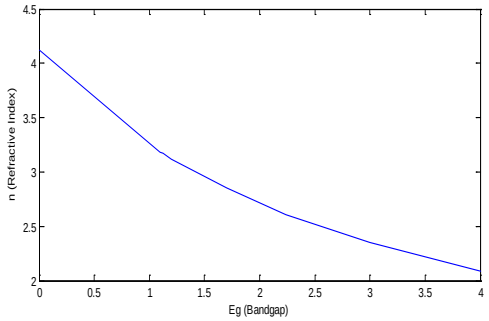

Figure 4 : Typical band gap vs refractive index Curve

ii. *Polarization and Absorption Effect*

L. Huang and H. Chen, the Electromagnetics Academy at Zhejiang University, have shown that the metamaterial absorber is almost insensitive to the polarizations of the incident wave due to the symmetric pattern of the closed rings [5]. Figure 5 shows the performance of the metamaterial absorber for different polarizations of the incident wave. It is found that, refractive index μ change from $0\pm$ to $40\pm$ (the measurement for μ from $50\pm$ to $90\pm$ is same to that from $0\pm$ to $40\pm$ due to the rotational symmetric of the closed rings), the absorption frequency only shift 0.8% and the absorptions are all lower than 15 dB, reflecting the insensitiveness of the metamaterial absorber to the wave polarizations. Because metamaterial has no polarization effect, by using metamaterial in solar cell, efficiency has to increase.

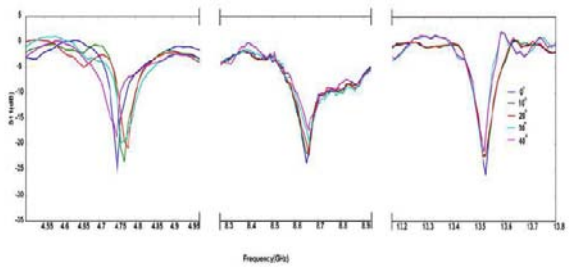

Figure 5 : Measured reflection coefficients of the metamaterial absorber for different polarizations of the incident wave. [Photo courtesy: The Electromagnetics Academy at Zhejiang University]

Also Yang liu, Yitung chen, Jichun li, UNLV Center for Energy Research have shown that absorption due to silicon nitride (SiN) metamaterial is higher the than normal material. (Figure 6-7 shows the parametric study and the data comparison with other materials.) So metamaterial solar cell absorption capability would be higher and the efficiency would be bound to increase.

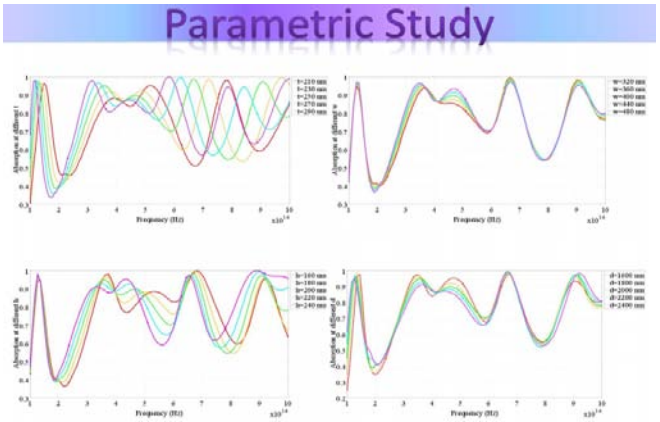

Figure 6 : Photo Courtesy, UNLV Center for Energy Research

Absorption in Visible Region%	SiN	Si	a-Si	Poly-Si
Au	82.35	58.03	58.53	58.64
Cu	81.97	54.78	56.07	56.33
Ni	**84.29**	65.52	67.90	68.22
W	84.28	62.51	64.92	65.01

Absorption over Solar Spectrum%	SiN	Si	a-Si	Poly-Si
Au	74.92	53.76	48.37	47.05
Cu	74.47	45.35	46.09	44.82
Ni	**77.18**	56.51	56.70	56.01
W	76.85	53.53	54.08	53.02

Figure 7 : Data Courtesy, UNLV Center for Energy Research

e) Proposed Solar Cell Model

Figure 8 shows the schematic of the proposed multi-junction solar cell with an anti-reflecting coating followed by a layer of metamaterial of saw tooth structure. The anti-reflective coating is also made of the metamaterial with refractive index 1 equivalent to the air refractive index. As the shiny n type layer may send photons bouncing away before they've done their job, an anti-reflective coating is applied to reduce those losses. And because of refractive index is one, the anti-reflective coating would be transparent to the incoming light; no reflection would carried out to decrease the efficiency. Also anti-reflective coating on glass cover would prevent solar cell from temperature variation, dust and other natural disturbance.

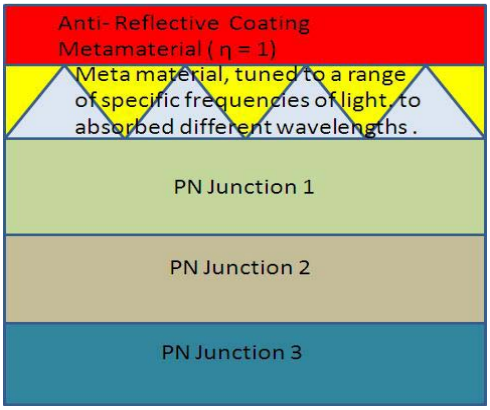

Figure 8 : Proposed metamaterial solar cell, where P-N junction can be normal or composite metamaterial

The second layer is made of the metamaterial of sawtooth structure. Each sawtooth has a different negative refractive index. As the band gap and refractive index are inversely proportional to each other, thus tuning the refractive index, any band gap can be achieved. Thus the whole solar spectrum -0.5 to 2.9 or 0 to 4 eV can be achieved by this sawtooth structure. Solar ray incident on the multilayer cell and get absorbed. The PN junction layers followed by sawtooth layer could be normal P-N junction layers or metamaterial PN junction layers. Metamaterial PN junction layer would make the solar cell more efficient but it might be costly. The normal PN junction layers could be used in those cases.

f) Design Parameter of Metamaterial Solar Cell

For an efficient solar cell design, the technical standards should be met and must to satisfy the design parameters. The central semiconductor parameters that determine the performance of a solar cell are:

i) Concentrations of doping atoms: N_D and N_A - the concentration of donor & acceptor atoms respectively. These concentrations determine the width of a space-charge region of a junction.

ii) Mobility (μ) and diffusion coefficient (D) of charge carriers that characterize the carriers' transport due to drift and diffusion respectively. Typical electron and hole mobility for Si at room temperature (300'K) is respectively 1400 cm^2/ (V·s) and 450 cm^2/ (V·s).

iii) Lifetime, τ, and diffusion length, L, of the excess carriers that characterize the recombination-generation processes.

iv) Band gap energy, E_G, absorption coefficient, α, and refractive index, n, that characterize the ability of a semiconductor to absorb visible and other radiation.

v) The name *Emitter* & *Base* is used in the software approach instead of typical P & N type. If we use 300 micrometer p, n should be 1-2 micrometer. The ratio is very much similar in nanometer range. But if nanometer range considered, then surface energy effect must be taken into consideration.

vi) All available states in the conduction and valence band can be represented by an effective density of states N_C and an effective density of states N_V respectively. The range of N_C is around $1x10^{18}$ to $4x10^{18}$ and range of N_V is around $4x10^{18}$ to $8x10^{18}$.

vii) The Air Mass (AM) quantifies the reduction in the power of light as it passes through the atmosphere and also absorbed by the air and dust. The solar industry uses AM-1.5 for all standardized testing of terrestrial solar panels, so AM-1.5 is used in case of metamaterial solar cell. Figure 9 shows the solar radiation spectrum of different air mass.

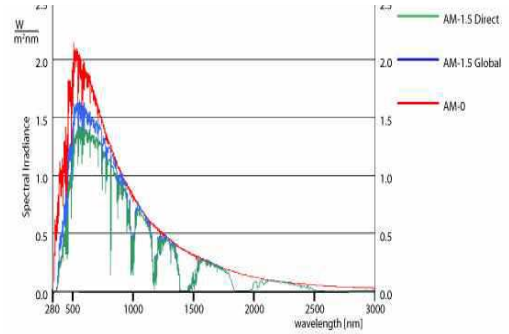

Figure 9 : Solar radiation spectrum of different air mass

g) Simulation and Analysis

In this work, PC1D (Photovoltaic cell 1 dimension) & WxAMPX (Analysis of microelectronic & photonic structure, Wx - widget provided) softwares were used to simulate the whole process. PC1D was used to check the impacts of the layer wise refraction index variations with the changing of layer wide in nano scale change. Figure 10 shows the screenshot of the *Reflectance* changing option of PC1D software. Current I or Power P vs Voltage V curves found from PC1D are shown in the figure-11 and the numerical results also are in Table-1.

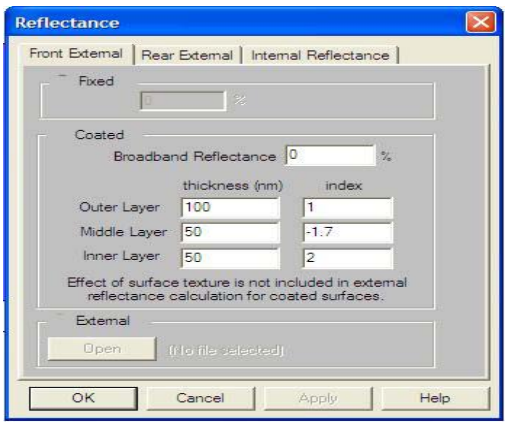

Figure 10 : Refractive index change in PC1D

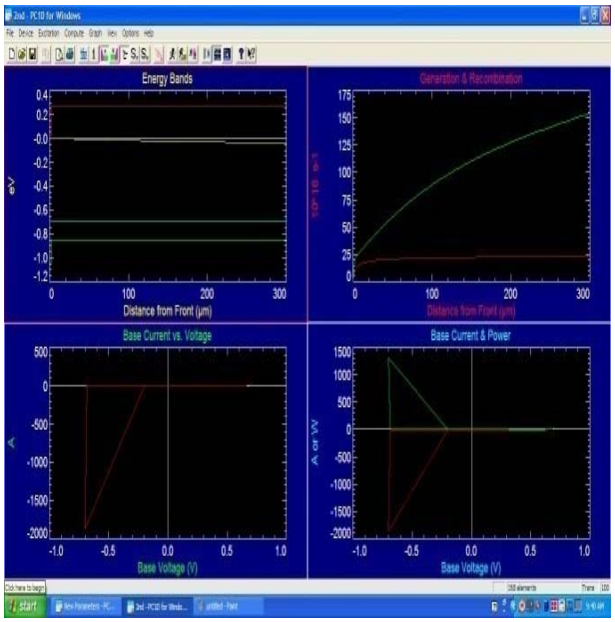

Figure 11 : Projected all graphs (Energy band, Generation & Recombination, Base Current vs. Voltage, Base Current & Power) at a glance

Table 1 : Showing Refractive index of different layers and corresponding I_{sc},V_{oc} and Max power

Refractive Index			I_{sc} (amp)	V_{oc} (volts)	Max. Power (watts)
Outer layer	Middle layer	Inner layer			
1	-2	3	-3.17	0.6455	1.711
1	-2	4	-2.921	0.6437	1.571
1	-1.5	-2	-3.281	0.6462	1.774
-2	3	3	-3.155	0.6454	1.703
1	2	-2	Transient Convergence Failure		
-1	-2	3	Transient Convergence Failure		
-1	-1.1	2	-3.095	0.645	1.669
1	-1.8	-2	-3.323	0.6469	1.746
1	-1.7	2	-3.269	0.6461	1.767
2	-1.7	2	-2.555	0.6396	1.366
3	-1.7	2	-2.154	0.635	1.143

Impact of the anti-reflecting coating refractive index change in Isc, Voc and Max Power can be found by considering the last 3 data of the table 1, where only the anti-reflecting coating refractive index column has the different values. Band gap 3.5 with refractive index is 2.21 is often used as anti-reflective coating of anormal solar cell. So assuming that refractive index is 2 for a normal solar cell a comparison has been made. If the anti-reflective coating has refractive index **1** instead of 2.21,

Current Increased: [(3.269-2.555)/2.555] * 100 = **27.945%**

Voltage Increased: [(0.6461-0.6396)/0.6396] * 100 = **1.016%**

Efficiency Increased: [(1.767-1.366)/1.366] * 100 = **29.356%**

If the anti-reflective coatings refractive indexwas chosen **3** instead of 2 then the metamaterial solar cell efficiency would be decreased by [(1.366-1.143)/1.366] * 100 = **16.325%.**

So, refractive index **1** is the best choice for anti-reflective coatings. Efficiency would increase to 30% and 60% for choosing refractive index 1 over 2 and 3 respectively.

Also the efficiency would show better results if there is tuned multilayer metamaterial architecture and no

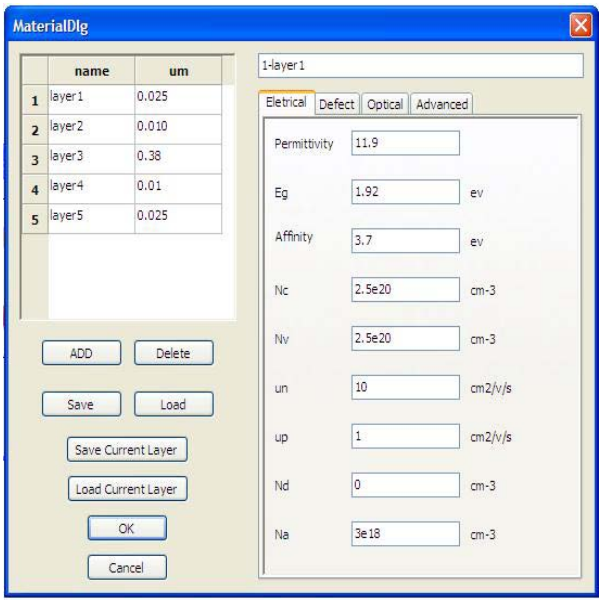

Figure 12 : Dialog box for material configuration in WxAMPS

polarization effect. As it is not possible to have visualization of the constituent layers, WxAMPS simulator was used to visually investigate the layer architecture to configure layer parameter individually. Figure-12 shows a sample layer parameter configuration option in WxAMPS.

WxAMPS follows the Maxwell's equations that the refractive index, $n = \varepsilon_r^{1/2} \eta_r^{1/2}$

As the relative permittivity for optical frequencies is considered 1 [$\eta_r^{1/2} = 1$], the equation becomes, $n = \varepsilon_r^{1/2}$

Here a solar cell is also simulated with CdS (cadmium sulfide - n type), CdTe (cadmium telluride – p type) with metamaterial Tin oxide (SnO_2) layer (with refractive index =1). It is found that the efficiency is

13.0968% (From the I–V characteristics curve shown in Figure 13) whereas in normal solar cell efficiency is 7%. So we can notice a definite increase of efficiency in the metamaterial solar cell.

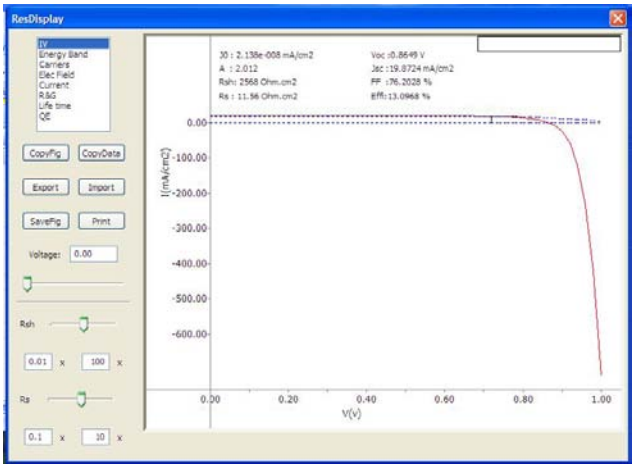

Figure 13 : Cds – CdTe metamaterial solar cell I-V curve

h) Limitations and Future Work

As there has been a very little work on metamaterial solar cell research, the main emphasis of this work was to demonstration theoretically whether metamaterial on solar cell would increase the overall efficiency or not. Also, most thin materials used to capture sunlight are limited to a very narrow range of wavelengths and the angles of incidence. The proposed design uses a pattern of wedge-shaped ridges whose widths are precisely tuned to slow variation and thus made enable to capture light of a wide range of wavelengths and angles of incidence. Because of using metamaterial, there is no polarization effect of unpolarized sunlight, thus the efficiency has increased manifold.

Some difficulties had been faced during this study. The first and foremost is that there was no open source reference software that could be used for designing metamaterial solar cell. Also there was not any complete metamaterial solar cell model to compare; also the lack of physical implementation in the third world country likes Bangladesh. Despite of all the difficulties, proposed metamaterial model shows promising feature for achieving high efficiency solar cell; hopefully this work would be beneficial to the scientists and engineers.

III. Conclusion

A theoretical model of metamaterial solar cell is developed, simulated and discussed above. It was found that if the anti-reflective coating of solar cell is made with metamaterial and its refractive index is made 1 then efficiency of the metamaterial solar cell is maximum. Furthermore, sawtooth structure, polarization effect and metamaterial absorption are taken into consideration. And it can be concluded that metamaterial solar cell is highly efficient. Time has come to look forward and work in these fields to produce highly efficient solar cells rather than depending wholly on conventional method because metamaterial solar cell shows promising future in solving world's power crisis problem.

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MC-CDMA PAPR Reduction using a Modified Exponential Companding Transform with Clipping

By B. Sarala, D. S. Venkateswarulu & B. N. Bhandari
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Keywords : *MC-CDMA, PAPR, HPA, BER, MECCT.*

GJRE-F Classification : *FOR Code: 290903p*

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Abstract - Multicarrier Code Division Multiple Access (MC-CDMA) system has the inherent problem of a high Peak to Average Power Ratio (PAPR), which results in nonlinear distortion at the High Power Amplifier (HPA) and consequently reduces power efficiency, performance degradation at the receiver. High PAPR causes lowers battery life, and requires HPAs. HPAs result in increased cost, reduced battery life, increased co-channel interference and Inter Symbol Interference (ISI). This paper analyzes a new idea that is combination of exponential companding transform and clipping concept to obtain a new Modified Exponential Companding with Clipping Transform (MECCT) technique for MC-CDMA PAPR reduction. This method evaluates performance analysis of MC-CDMA while considering linear companding and exponential companding (nonlinear) with the Additive White Gaussian Noise (AWGN) channel and is simulated using MATLAB. The simulation results show that the proposed algorithm reduces the PAPR by 2.0 dB, and are able to improve Bit Error Rate (BER), reduced Power Spectral density (PSD), and improvement in spectral bandwidth.

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I. Introduction

In recent years, Multicarrier Code Division Multiple Access (MC-CDMA) system has been receiving wide spread interests for future wireless communications. Combining Orthogonal Frequency Division Multiplexing (OFDM) modulation and Code Division Multiple Access (CDMA), a new scheme is developed which reaps the benefits of both the techniques. A patented 4th Generation (4G) wireless technology like higher spectral efficiency, result in higher bit rates and multiple access capability, robustness in case of frequency selective channels. MCCDMA is a multiple access scheme used in Orthogonal Frequency Division Multiplexing (OFDM) telecommunication systems, allowing the system to support multiple users at the same time. The main idea of the MCCDMA system relies on transmission of data by dividing the high data rate stream into several low data rate subcarriers. MC-CDMA spreads each user in the frequency domain [1, 2]. MC-CDMA modulation causes high Peak to Average Power Ratio (PAPR), which results in nonlinear distortion at the High Power amplifier (HPA) and consequently degradation of BER performance at the receiver. It requires a linear amplifier with a large dynamic range. However, this linear amplifier has poor power efficiency and is very expensive. Power efficiency is required for wireless and mobile communication as it provides adequate coverage area, saves power consumption and allows portable terminals etc. Hence, a better solution is to try to prevent the occurrence of interference by reducing the PAPR of the MC-CDMA transmitted signal. PAPR reduction results in reduction of cost and consumes less power, low BER, and improvement in spectral bandwidth by using few companding transform techniques. To reduce the PAPR of MC-CDMA system, many techniques are proposed [3].

This paper uses companding techniques for PAPR reduction. The companding transformation is applied at the transmitter to attenuate the high peaks and increase low amplitude of the MC-CDMA signal, before transmission. At the receiver, the de-companding method is applied through the inverse companding function in order to pick up the original signal. Companding systems are useful for reducing PAPR in MC-CDMA transmitted signal. Companding method describes compression in the transmitter and expansion in the receiver. Transmitter and receiver requires compander and expander [4].

This paper analyzes a modified exponential companding with clipping technique for PAPR reduction of MC-CDMA transmitted signals and compares with exponential and linear companding schemes, in terms of PSD, BER, and PAPR. The proposed companding technique reduces PAPR and minimizes Out of Band Interference (OBI) and also improves BER.

The rest of the paper is organized as follows: Section I describes MC CDMA system PAPR analysis. Section A describes proposed MC-CDMA system; in section B related works are discussed. In section C a newly introduced MECCT companding and de-companding algorithms are discussed. In section D Computer simulations are presented and in section II finally, conclusions are listed.

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II. MC-CDMA PAPR Analysis

In MC-CDMA system, entire system bandwidth is divided into several orthogonal subcarriers with narrow bandwidth, and K user data symbols are modulated by Phase Shift Keying (PSK) and transmitted independently on subcarriers. In the MC-CDMA transmitter, a group of $N\log_2 M$ input bits are encoded into block of N_c symbols x_t (l = 0… N_c-1), where symbol duration is T_s (sec) and MC-CDMA-array modulation, is considered. These symbols are converted from serial to parallel (S/P) form and modulated using N_c subcarriers whose frequencies are regularly spaced with Δf = (HZ) Where T_s is the symbol period; N_c is the number of subcarriers. Thus MC-CDMA signal x(t) for a block of duration N_cT_s (sec) may be represented as

$$X(t) = \frac{1}{\sqrt{N_c}} \sum_{l=0}^{N_c-1} s_l \, e^{j2\pi\Delta f t} \qquad (0 \le t \le N_c T_s) \qquad (1)$$

Where x_t represents the l^{th} modulated data symbol and Δf represents the l^{th} subcarrier frequency.

By discretizing x (t) in equation (1) at t= lT_s (l = 0,….,Nc-1) then the discrete MC-CDMA signal as given as

$$x(l) = x(lT_s) = \frac{1}{N_c} \sum_{l=0}^{N_c-1} s_l e^{j2\pi l/N_c} \qquad (2)$$

Equation (2) is equivalent to N_c point Inverse Fast FourierTransform (IFFT) of Nc symbols xl, followed by parallel- to–serial (P/S) converter. Thus, a fast implementation using IFFT may be employed, at the receiver, and subcarrier demodulation can be effectively implemented by Nc –point Fast Fourier Transform (FFT).

The transmitted MC-CDMA signals x(t) follow a Gaussian distribution when the number of subcarriers N_c are large , resulting in high PAPR, the PAPR of continuous frequency domain MC-CDMA signals are generally defined as

$$\text{PAPR} = \frac{\max_{0 \le t \le N_c T_s} (|x(t)|^2)}{\frac{1}{N_c T_s} \int_0^{N_c T_s} |x(t)|^2 dt} \qquad (3)$$

From equation (3) it is observed that PAPR reduction of MC-CDMA signals is mainly obtained by decreasing the maximum instantaneous signal power

The variation of the envelope of a multicarrier signal can be defined by Peak to Average Power Ratio (PAPR) , which is given as

$$PAPR = \frac{max|x_m|^2}{\frac{1}{N_c}\sum_{m=0}^{N_c-1}|x_m|^2} \qquad (4)$$

The values x_m, m=0… Nc-1, are the time samples of an MCCDMA symbol.

The relation between Crest Factor (CF) and PAPR is given as

$$CF = \sqrt{PAPR} \qquad (5)$$

PAPR for MC-CDMA Up-link as represented as

$$PAPR \le 2max \frac{\left\{\left|\sum_{l=0}^{L-1} c_l^k \, e^{j2\pi lt/T_s}\right|^2\right\}}{L} \qquad (6)$$

The PAPR of an MC-CDMA down-link signal with k users and N_c = L can be represented as [5, and 6].

$$PAPR \le 2max \frac{\left\{\sum_{k=0}^{K-1}\left|\sum_{l=0}^{L-1} c_l^k \, e^{j2\pi lt/T_s}\right|^2\right\}}{L} \qquad (7)$$

a) Proposed Mc-Cdma System

Figure 1.shows MC-CDMA transmitter with companding technique. The companding transformation is applied at the transmitter after Inverse Fast Fourier Transform (IFFT) and Cyclic Prefix (CP) block so as to attenuate the high peaks and increase low amplitude of the MC-CDMA signal, accordingly decreasing the PAPR.

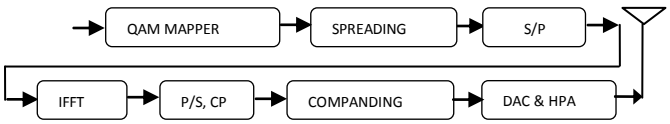

Figure 1 : MC-CDMA transmitter with companding

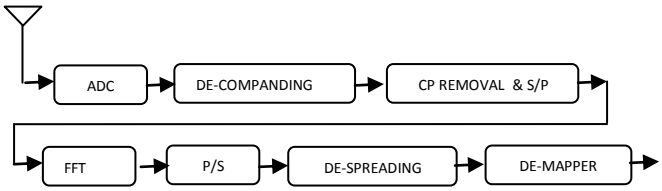

Figure 2 : MC-CDMA receiver with de-companding

Figure 2 shows MC-CDMA receiver with de-companding. At the receiver, the de-companding method is applied through the inverse companding function before CP removal and Fast Fourier Transform (FFT) block in order to pick up the original signal. The transmitted signal power is amplified by using HPA [7]. Companding technique is an attractive technique to reduce PAPR of MC-CDMA signals due to its simplicity and effectiveness.

b) Related Work

Sulaiman, et.al proposed linear companding transform for PAPR reduction in Orthogonal Frequency Division Multiplexing (OFDM) signals. In this scheme, the proposed technique utilizes a new Linear Companding Transform (LCT) to reduce the PAPR of the OFDM signal. A new LCT with more design flexibility than Linear Non Symmetrical Companding Transform

(LNST) was investigated. The authors proposed a LCT that has one –tone mapping of input and output transformed signal. The proposed scheme degrades Power Spectral Density (PSD), lower PAPR and BER than LNST [8]. Tao Jiang, et.al proposed a new nonlinear companding technique, called "exponential companding", to reduce PAPR of OFDM signals. The exponential companding scheme can offer better PAPR reduction, BER, and phase error performance, and less spectrum side lobes [9].

Earlier we proposed the technique for the use of DCT/DWT in combination with companding in order to achieve a very substantial reduction in PAPR of the MC CDMA signal. In this scheme, in the first step, the data is transformed by a Discrete Cosine Transform (DCT) or Discrete Wavelet Transform into new modified data. In the second step, this scheme also uses the companding technique further to reduce the PAPR of the MC CDMA signal. The DCT may reduce PAPR of an MC CDMA signal, but does not increase the BER of system. The proposed scheme uses the spreading codes for MC CDMA like Walsh codes, Gold codes, and Maximal length Pseudo Noise (PN) codes, in order to minimize the BER, and to reduce Multiple Access Interference (MAI) and has implemented the same proposed techniques to reduce the PAPR and PSD for MC CDMA system [3, and 4].

This paper analyzes a new idea that combines exponential companding transform and clipping concept to obtain a new Modified Exponential Companding with Clipping Transform (MECCT) for MC-CDMA PAPR reduction. This method evaluates performance analysis of MC-CDMA while considering linear companding and exponential companding. The proposed algorithm reduces the PAPR by 2.0 dB, and is able to improve Bit Error Rate (BER), Out-of Band Interference (OBI).

This paper first compares the PAPRs of MC-CDMA original, MC-CDMA with linear companding, MC-CDMA with exponential companding and a newly introduced MCCDMA with MECCT. Simulation results show that the PAPRs of MC-CDMA with MECCT system have low PAPR when compared with other companding based MC CDMA systems. The power spectral density of the resultant signal has 10 dB less in main and side lobes which minimize interference between signals when compared with the LCT based MC-CDMA system. The MECCT technique reduces PAPR, without degradation in BER performance.

c) *Modified Exponential Companding with Clipping Transform*

This new idea is a combination of clipping concept which has a value of threshold and exponential concept. It generates a new algorithm named as a Modified Exponential Companding with Clipping Transform (MECCT). The MECCT companding algorithm as given below:

Step1: Calculate threshold value at the transmitter is given by

$$T_1 = \frac{median(|x_n|)}{{\sigma_{x_n}}^2} \tag{8}$$

σ_{xn}^2 is a variance of (standard deviation)^2,
$|x_n|$ is modulus of the MC-CDMA transmitted symbol, T_1 is the threshold value.

Step2:

$$x_n{}' = T_1 + \log(|x_n| - T_1 + 1) \tag{9}$$

Step3:

$$x_m = \begin{cases} x_n, when\ 0 \le |x_n| \le T_1 \\ x_n{}', when\ |x_n| > T_1 \end{cases} \tag{10}$$

Step4:

$$x_{mm} = |x_m|\ e^{j\theta} \tag{11}$$

When $= \boldsymbol{\theta} = \tan^{-1}\left(\frac{b}{a}\right)$ and x_n is in the form of $ax_n + jbx_n$

At the receiver, the inverse companding transform operates on the received signal to obtain an estimation of the transmitted signal. The MECCT de-companding algorithm as given below:

Step1: Calculate threshold value at the receiver is given by

$$T_2 = \frac{median(|r_n|)}{{\sigma_{x_n}}^2} \tag{12}$$

σ_{xn}^2 is a variance of standard deviation,
$|r_n|$ Is modulus of MC-CDMA received symbol, is the threshold value at the receiver.

Step 2 :

$$r_m{}' = T_2 - 1 + 10^{(|r_n| - T_2)} \tag{13}$$

Step 3 : When$= \boldsymbol{\theta} = \tan^{-1}\left(\frac{b}{a}\right)$ and r_n is in the form of

$$ar_n + jbr_n \tag{14}$$

Step4 : The original received signal after de-companding

$$\widehat{x_n} = \begin{cases} r_n, when\ |r_n| \le T_2 \\ r_m{}' e^{j\theta}, when\ |r_n| > T_2 \end{cases} \tag{15}$$

d) *Simulation Results*

Original MC-CDMA, MC-CDMA with Linear, exponential, and newly introduced MECCT systems are implemented using MATLAB with the following specifications: number of symbols are 256, 512, 1024, 4096 symbols, IFFT size is 256, and number of subcarriers are 128, 64, 32 and spreading codes are PN

codes, Gold codes, Walsh Hadamard codes and modulation used Quadrature Phase Sift Keying (QPSK). This paper evaluates the performance of PAPR using complementary cumulative distribution of PAPR of MC-CDMA with different codes and companding techniques. The results are compared with original MC-CDMA, MC-CDMA with Linear companding, and MC-CDMA with exponential companding, and MCCDMA with newly introduced MECCT.

i. *CCDF Performance*

This paper evaluates the performance of PAPR using cumulative distribution of PAPR of MC-CDMA signal. The Complementary Cumulative Distribution Function (CCDF) is one of the most regularly used parameters, which is used to measure the efficiency of PAPR technique.

Figures 3, 4, 5 show that, using MC-CDMA with MECCT technique and PN codes PAPR is reduced by 1.75dB, and 1.5 dB when compared with the original MC-CDMA (no companding), and MC-CDMA with linear and exponential companding techniques. If the numbers of subcarriers are doubled the PAPR is increased by 2.0 dB. Figures 6, 7, 8 show that, using MC-CDMA with Gold codes and MECCT technique PAPR is reduced by 2.5dB, and 2.0dB when compared with the original MC-CDMA (no companding), and MC-CDMA with linear and exponential companding techniques. If the numbers of symbols are increased, the PAPR is further reduced by 0.5 dB.

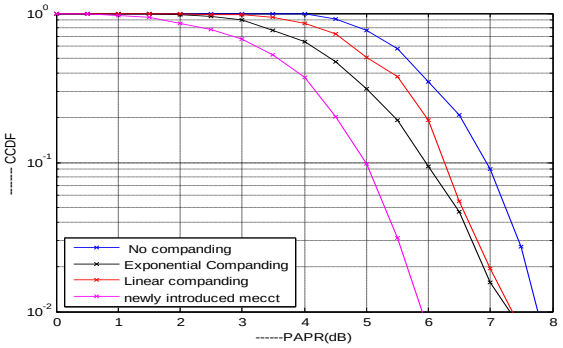

Figure 3 : Nsym=512, nfft=256, nsub=64, μ =0.825,d=1.1, QPSK, PN codes

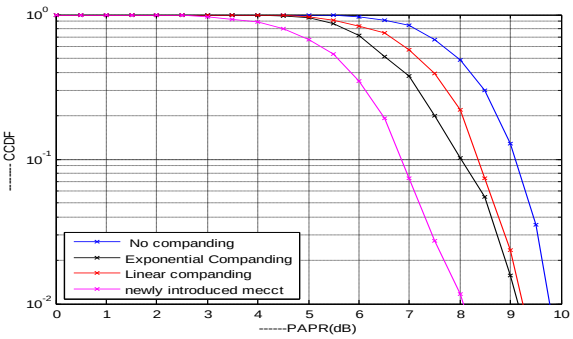

Figure 4 : Nsym=512, nfft=256, nsub=128, μ =0.825,d=1.1, QPSK, PN codes

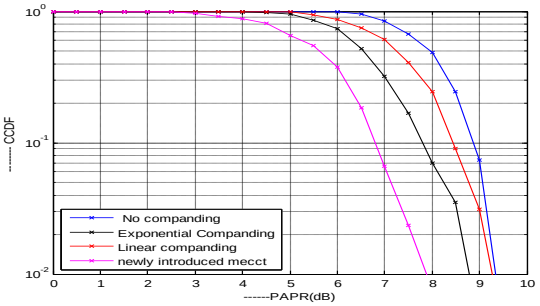

Figure 5 : Nsym=1024, nfft=256, nsub=128, μ =0.825,d=1.1, QPSK, PN codes

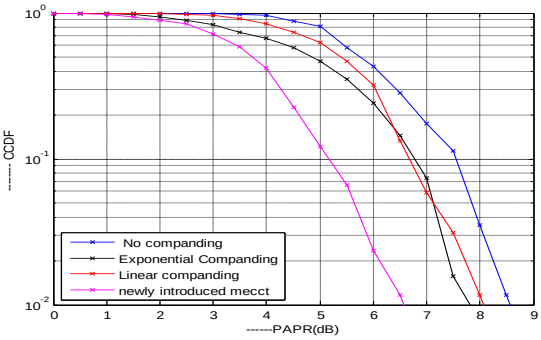

Figure 6 : Nsym=512, nfft=256, nsub=64, μ =0.825,d=1.1, QPSK, Gold codes

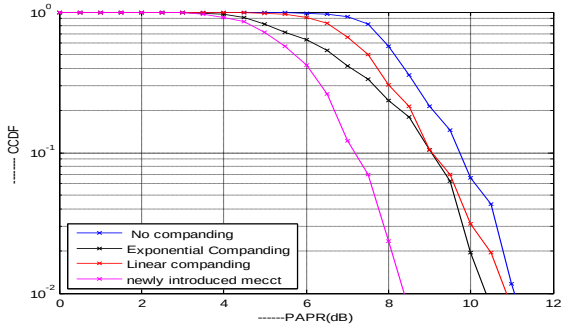

Figure 7 : Nsym=512, nfft=256, nsub=128, μ =0.825, d=1.1, QPSK, Gold codes

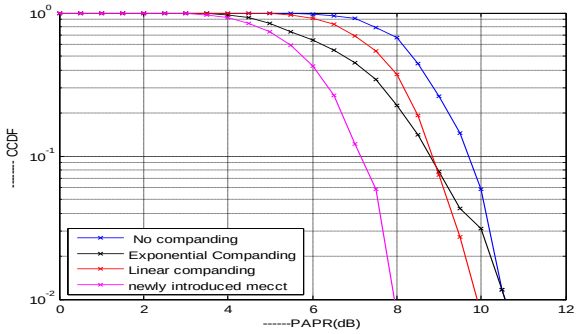

Figure 8 : Nsym=4096, nfft=256, nsub=128, μ =0.825,d=1.1, QPSK, Gold codes

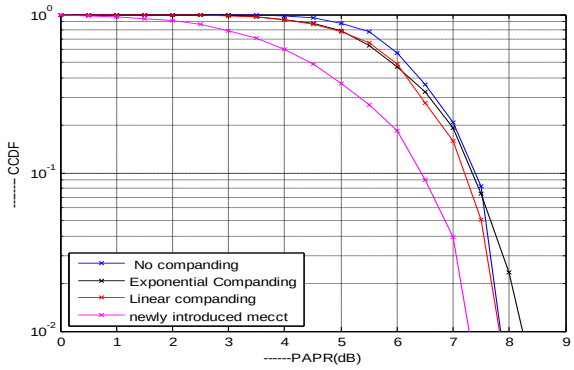

Figure 9 : Nsym=256, nfft=256, nsub=64, μ =0.825,d=1.1, QPSK, Walsh codes

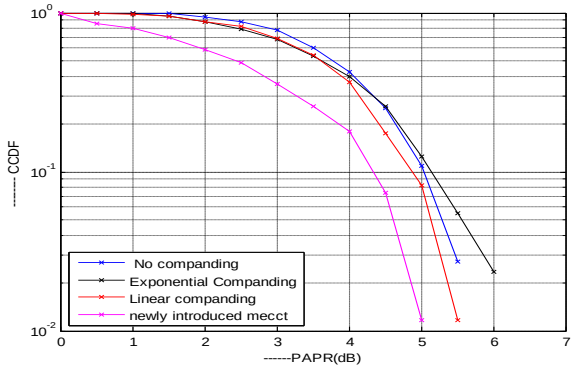

Figure 10 : Nsym=256, nfft=256, nsub=32, μ =0.825,d=1.1, QPSK, Walsh codes

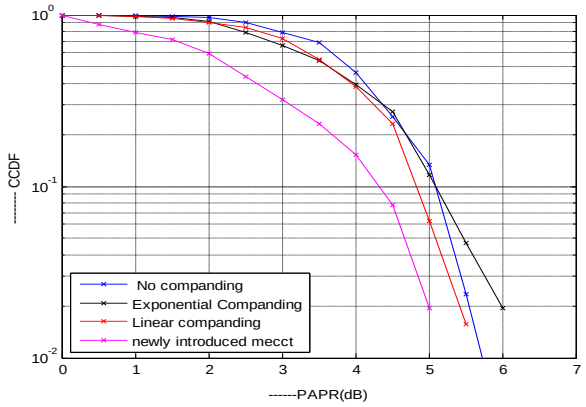

Figure 11 : Nsym=4096, nfft=256, nsub=32, μ =0.825, d=1.1, QPSK, Walsh codes

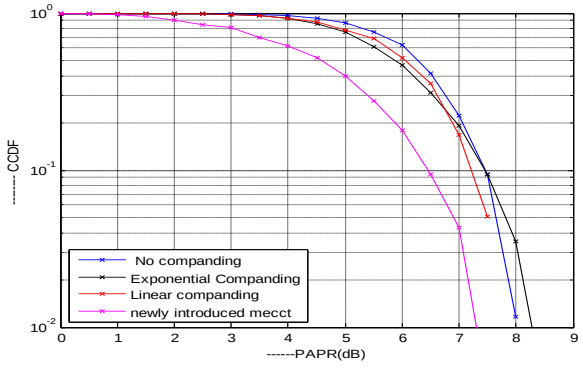

Figure 12 : Nsym=4096, nfft=256, nsub=64, μ=0.825, d=1.1, QPSK, Walsh codes

Figures 9, 10, 11, 12 show that, using MC-CDMA with Walsh codes and MECCT technique PAPR is reduced by 0.75dB, and 1.0dB when compared with the original MCCDMA (no companding), MC-CDMA with linear, and MCCDMA with exponential companding techniques. If the number of symbols is increased, the PAPR is further reduced by 0.5 dB. If the numbers of subcarriers are doubled, the PAPR is increased by 2.25 dB.

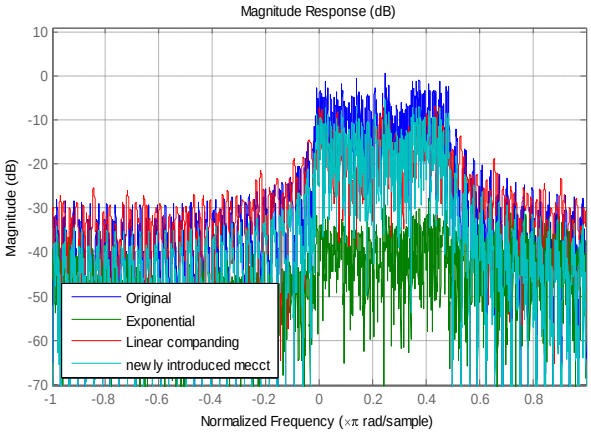

Figure 13 : Power Spectral Density comparison

The simulation results of Power Spectral Density (PSD) in figure 13 shows that the MECCT based MC-CDMA system has 10 dB less in lower side and main lobe when compared with the original MC-CDMA system, and MCCDMA with linear companding. MC-CDMA with exponential companding has less mean amplitude and system maintains constant main lobe bandwidth compared to other MC-CDMA systems.

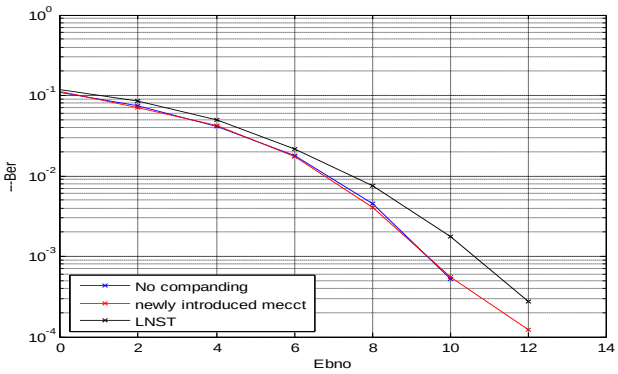

Figure 14 : BER analysis of newly introduced MECCT with Linear companding technique

The simulation result of BER Using PN codes of the MCCDMA and MECCT with AWGN channel is shown in figure 14. Found BER 10-4 at 12 dB, the MC-CDMA with linear companding found BER is 0.8*10-3 at 12 dB. A newly introduced MECCT with MC-CDMA system has ideal BER when compared with the original and MC-CDMA with linear companding technique.

III. Conclusions and Future Work

In this paper, a newly introduced MC-CDMA system using MECCT to reduce the PAPR about 2.0 dB for Gold codes and PN codes and 0.75 dB for Walsh codes, decrease the BER over linear companding technique, and improve the spectrum efficiency. This technique found that the MECCT based MC-CDMA has 10 dB less in side and main lobe when compared with the MC-CDMA based linear companding and Original MC-CDMA system. MC-CDMA based MECCT technique reduces the PAPR substantially by 2.0 dB without any data loss in the system performance. Proposed companding technique is of much less implementation complexity when compared with the exponential companding, and requires no side information.

At the same time achieves subsequent PAPR reduction and BER performance is also improved. Additionally, the technique is efficient, easy to implement, and does not require any complex optimization algorithm. The simulation results show that the PAPR reduction is improved by using a newly introduced MECCT based MC-CDMA system can also improved BER, reduced PSD and improved spectral bandwidth. This paper concludes that MECCT based MCCDMA system reduced by 2.0dB at the transmitter. At the receiver using MECCT de-companding algorithm expands by the 2.0 dB in BER analysis and also improves BER.

This research will continue in PAPR reduction of MCCDMA by improved performance, low data rate loss, and less complexity and efficient use of channel. Further it is implemented with the Raleigh fading channel.

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M2M: GSM Network for Robots using DTMF

By Md. Nasimuzzaman Chowdhury & Md. Khaled Hossain
American International University, Bangladesh

Abstract - In recent world cellular mobile communication system has developed significantly. In almost all sector we use mobile phones for communication. Two main reasons for vast mobile communication are mobility and coverage area. We use mobile to talk, share our status, asks for help and so on. In this paper we have developed a system where robots can call each other, communicate with each other, ask their positions, ask for help, can increase their database of phone numbers of other robots asking each other and lots more. The number of robots can communicate with each other is unlimited and distance between robots to communicate is also unlimited. Wherever GSM network is available robots can communicate with each other. Any robot from U.S.A can communicate with any robot from Bangladesh. But obviously the robot should have credits in its mobile to make the call. Since only mobile phone is used as transmitter & receiver, the system is much simple, cost effective and easy to implement.

Keywords : *microcontroller, DTMF, robots, communication, network, M2M.*

GJRE-F Classification : *FOR Code: 090602p, 090602*

Strictly as per the compliance and regulations of :

M2M: GSM Network for Robots using DTMF

Md. Nasimuzzaman Chowdhury [α] & Md. Khaled Hossain [σ]

Abstract - In recent world cellular mobile communication system has developed significantly. In almost all sector we use mobile phones for communication. Two main reasons for vast mobile communication are mobility and coverage area. We use mobile to talk, share our status, asks for help and so on. In this paper we have developed a system where robots can call each other, communicate with each other, ask their positions, ask for help, can increase their database of phone numbers of other robots asking each other and lots more. The number of robots can communicate with each other is unlimited and distance between robots to communicate is also unlimited. Wherever GSM network is available robots can communicate with each other. Any robot from U.S.A can communicate with any robot from Bangladesh. But obviously the robot should have credits in its mobile to make the call. Since only mobile phone is used as transmitter & receiver, the system is much simple, cost effective and easy to implement.

Keywords : microcontroller, DTMF, robots, communication, network, M2M.

I. Introduction

Numbers of robots & wireless communication protocols are increasing day by day. But most of the communication protocols are complex and only valid for short distance communication. Keeping it in mind that communication between robots should not be bounded by area or should not be bounded by number of nodes we have implemented this project. In this project we have implemented a way of communication between robots by DTMF (Dual-Tone Multi-Frequency) and atmega8 microcontroller. As humans call to one another robots will generate call and send data through DTMF. Lots of research work has been published on DTMF control system. Yun Chan Cho and Jae wook Jeon [1] used DTMF of mobile phone. D. Manojkumar et.al. [2] controlled a robot by a mobile using DTMF tone. To control domestic systems DTMF has been used [3]. Smart phones also have been used to control mobile robots [4]. Human-Robot interaction mechanisms that allow a human commander to control a mobile robot via cellular phone have been developed and successfully tested by Ali Sekmen et.al. [5] and T. Kubik et.al. [6].

Tho Nguyen and Linda G. Bushnell have implemented DTMF communication For Robots using DTMF transceiver [7]. But all of them are used as limited controlling signal. Only 9 buttons has been used just to control relay, cars or communicate etc. In our project using DTMF tone we have implemented complete ASCII chart. Communication between robots can be initiated from any one anytime. First robot will generate the call and receivers mobile will remain in auto receive mode.

After receiving the call both the robot will start sending DTMF tones to communicate. Both the robots will use DTMF transceiver. From transmitting side the ASCII value of information will be encoded and transmit through DTMF tone. Receiver side will receive DTMF tone and decode it into ASCII value. As both the robots are using DTMF transceiver they can transmit or receive data during the course of a call. But this is a half duplex communication system. ATmega8 is used to encode information into DTMF digits, MT8880 DTMF transceiver will receive the digits and generate DTMF tones and Mobile will transmit the tone. At receiver end Mobile will forward the tone to MT8880 transceiver and it will decode DTMF tone. From the transceiver Microcontroller will receive 4 bit data and it will decode these data into ASCII value.

The figure below describes DTMF communication between two robots. First robot consists of DTMF transciever, microcontroller and a mobile. Second robot also consists of same parts.To stablish a communication microcontroller makes a call through cell phone. But data is sent to DTMF transciever from microcontroller for encoding. Communication between microcontroller and DTMF transciever is bidirectional. DTMF transciever encode it and transmit dual tone to cell phone. Communication between cell phone and transciever is also bidirectional. In recieving mode transciever recieve tones from mobile and decode it to microcontroller. The delay to stablish a communication depends on the delay of call generation and connection establishment.

Communication establishment time between two robots under one operator takes less time than different operators. In this communication good network connection is required to avoid data loss.

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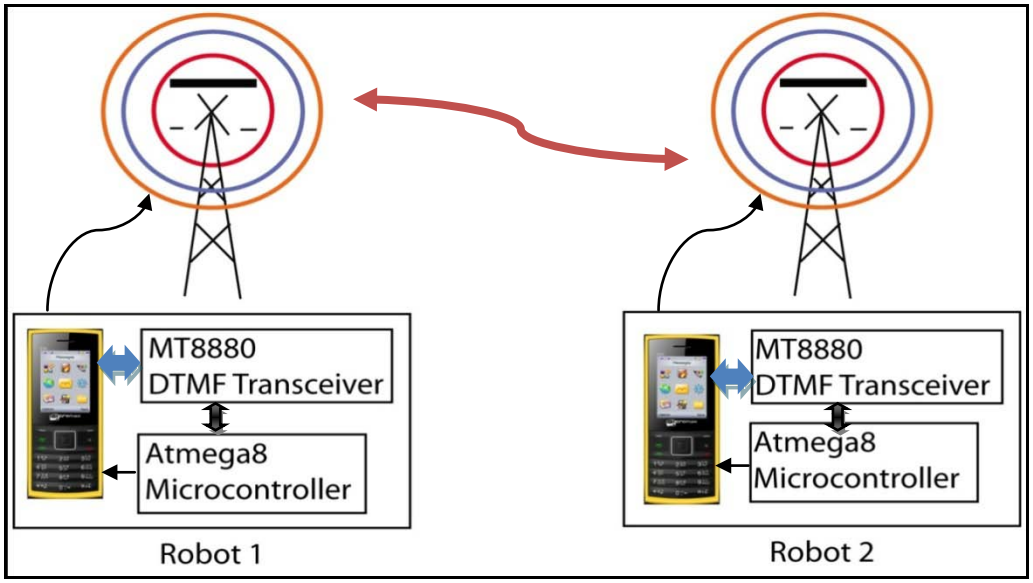


Figure 1 : DTMF communication between two robots

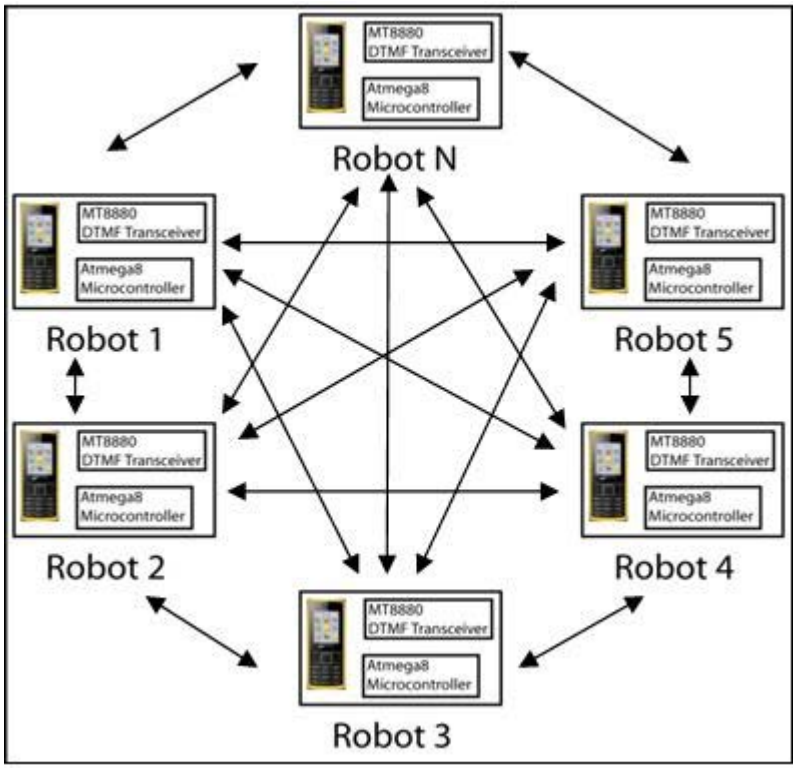


Figure 2 : Fully Connected Network Between Robots

In this communication protocol robots can establish a fully connected network.Any robot can communicate with any robot anytime.

Cell numbers of robots need to be saved in mobile previously.If Any robot wants to communicate it needs to select the desired robot cell number from phone book of the mobile and dial yes button. Adding more button of phone pad will give robot to add a new number.

If any robot finds another robot busy or waiting, it will generate call again after 5 minutes by default.

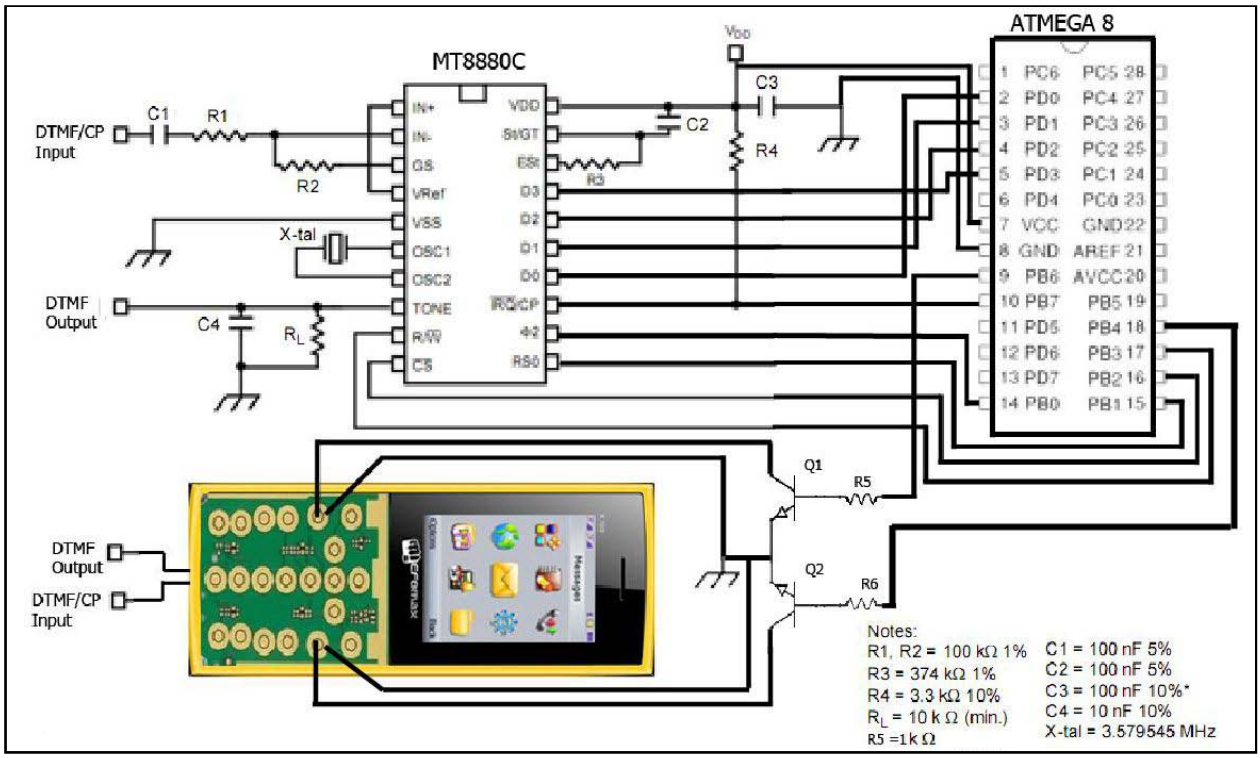


Figure 3 : Main Circuit Diagram

II. Circuit Description

MT8880C is the DTMF transceiver and Atmega8 is the microcontroller used in this circuit. Both the IC is given +5v power input. MT8880C takes DTMF input by pin IN- & GS. And gives DTMF output by pin Tone. TTL Data pins from D0 to D3 are connected with PD0 to PD3 of atmega8. Some control pins like IRQ_bar, RS0, CS_bar, R/W_bar etc are connected with PORTB GPIO pins. PB6 and PB4 pins are connected to the base of BC548 transistors. In each keypad button there are two circles. The outer circle of the button work as negative terminal and the inner circle of the button work as positive terminal [9]. When the positive and negative terminal is shorted corresponding button works as pressed. In this circuit two transistors are connected with two buttons of mobile those are accept & reject buttons. When any voltage is passed through the base of transistor, two terminals of the button gets shorted and the button is pressed.

To transmit any information at first 1st robot initialize a call sending voltage to PB6 pin twice. At first press, mobile goes to its dialed list and at second press it initiate a call to the last dialed number. Desired robots number can be saved in dialed list manually or we can connect more 10 transistors to 0 to 9 buttons of mobile. And these 10 buttons can be controlled by microcontroller to press a new number.

At 2nd robot terminal mobile is in auto receive mode. Transmitting microcontroller checks that receiver accepted or rejected the call through sending start bits. When robot 2 receives start bits it sends back acknowledge bits and robot1 starts to send information in DTMF tones. Microcontroller sends data through PD0 to PD3 and MT8880C converts the data into DTMF tone. Trough microphone of mobile DTMF tones is transmitted. At receiving terminal Mobile receive the tone and transmit the tone to MT8880C through speaker.MT8880C converts the tone into 4bit data and send the data to microcontroller. If robot2 wants to communicate it also sends start bits and after getting acknowledges bits it starts transmission. When robot2 finish sending data it sends terminate bits. When robot1 also sends terminate bit both the microcontroller send voltage to PB4 bit and terminate the call.

The circuit Diagram of this system consists of the following equipments:

a) Mobile:

Our goal is to establish long distance communication between robots. DTMF tones are our information data. To transmit & receive DTMF tones from long distance we have used mobile phones. And also to initialize or receive a call mobile is the easiest and simplest way to perform the task. As mobile phones are portable both stationary and mobile robots can use mobile phones.

b) DTMF Transceiver:

The MT8880C is a monolithic DTMF transceiver. It is fabricated in Mitelís ISO2- CMOS technology, which provides low power dissipation and high reliability [8]. This IC can be interfaced with microcontroller easily.

Internal counters provide a burst mode such that tone bursts can be transmitted with precise timing. Digit sequence consists of all 16 DTMF tones & all 16 tone pairs decode them into 4bit BCD code. Tone duration=40 ms. Tone pause=40 ms. error rate of less than 1 in 10,000 [8].

c) Atmega8 Microcontroller:

Brain of this project is Atmega8 micro-controller. It is a 8 bit Micro controller with RISC architecture. Its speed is up to 16MIPS throughput at 16MHz. It has 8K bytes of flash and 512bytes EEPROM. Operating voltage 2.7v -5.5v, in active mode it consumes only 3.6mA & in sleep mode it consumes less than 1uA current [10] which made it a perfect choice for this project.

III. Main Technology Used

a) DTMF Tone:

DTMF generation is a composite sinusoidal signals of two tones between the frequency of 697Hz and 1633Hz [11]. The DTMF keypad is arranged such that each row will have it's own unique tone frequency and also each column will have it's own unique tone. Below is a representation of the typical DTMF keypad and the associated row/column frequencies.

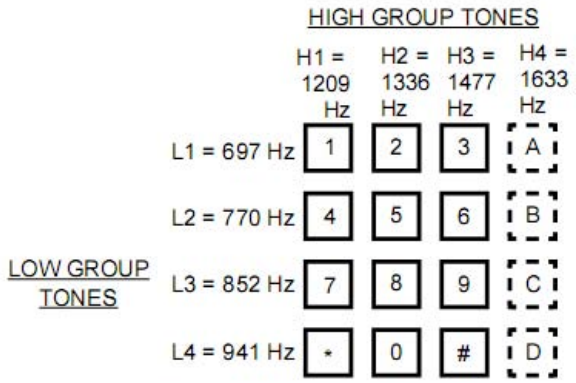


Figure 4 : DTMF Keypad Layout

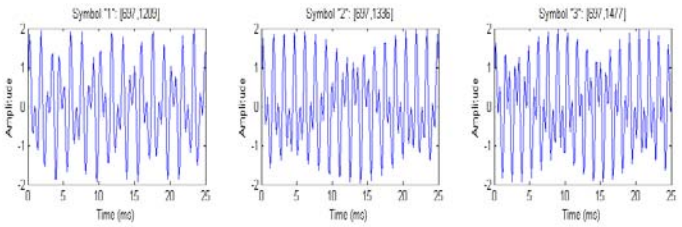


Figure 5 : DTMF frequency when one digit is pressed

b) Interface between MT8880C & Microcontroller

Write cycle consists of the following steps (starting with the MT8880's CS pin high to deselect it) [12]:

1) Put the data pins into output mode
2) Write the data to the bus
3) Set up RS0: 0 = write data; 1 = write instructions
4) Clear the RW bit to request a write
5) Clear CS to activate the MT8880
6) Set CS to terminate the write operation and deactivate the MT8880.

Reading the MT8880 is similar. Starting with CS high, the steps are:

1) Put the data pins into input mode
2) Set the RW bit to request a read
3) Set up RS0: 0 = read data; 1 = read instructions
4) Clear CS to activate the MT8880
5) Read the data from the bus
6) Set CS to terminate the read operation and deactivate the MT8880.

MT8880C is also interfaced with mobile. An earphone is plugged in cell phone audio port. Two wears of earphone are Ring and Tip.

Input from the earphone is interfaced with IN- pin and output with TONE pin of MT8880C.

Table 1 : MT8880C DTMF transceiver truth table

f_{LOW}	f_{HIGH}	KEY	TOE	Q_4	Q_3	Q_2	Q_1
697	1209	1	1	0	0	0	1
697	1336	2	1	0	0	1	0
697	1477	3	1	0	0	1	1
770	1209	4	1	0	1	0	0
770	1336	5	1	0	1	0	1
770	1477	6	1	0	1	1	0
852	1209	7	1	0	1	1	1
852	1336	8	1	1	0	0	0
852	1477	9	1	1	0	0	1
941	1209	0	1	1	0	1	0
941	1336	*	1	1	0	1	1
941	1477	#	1	1	1	0	0
697	1633	A	1	1	1	0	1
770	1633	B	1	1	1	1	0
852	1633	C	1	1	1	1	1
941	1633	D	1	0	0	0	0
-	-	ANY	0	Z	Z	Z	Z

c) Our Software Defined DTMF

Figure 6 : DTMF keypad with digits E, F added

In our project we have eliminated * & # button and added E & F button. Now this keypad contains all 16 digits of BCD (binary coded decimal) digits. We have also changed the table value of DTMF tones according to BCD values. Bellow is the chart of values of all 16 digits.

Table 2 : Software defined DTMF tone values

KEY	TOE	Q_4	Q_3	Q_2	Q_1
0	1	0	0	0	0
1	1	0	0	0	1
2	1	0	0	1	0
3	1	0	0	1	1
4	1	0	1	0	0
5	1	0	1	0	1
6	1	0	1	1	0
7	1	0	1	1	1
8	1	1	0	0	0
9	1	1	0	0	1
A	1	1	0	1	0
B	1	1	0	1	1
C	1	1	1	0	0
D	1	1	1	0	1
E	1	1	1	1	0
F	1	1	1	1	1
ANY	0	Z	Z	Z	Z

Microcontroller receives original DTMF value but it converts the original value into the above value using look up table. To form a ASCII character we need two BCD digits. To represent any digit robot1 has to send two DTMF tones. For Example if robot1 wants to send a character 'H' it will send DTMF tones 4 & 8 as the hex value of 'H' is 0x48. In this way robots can send any character it wants from ASCII table. Bellow we have shown the ASCII chart and corresponding DTMF tones in red color.

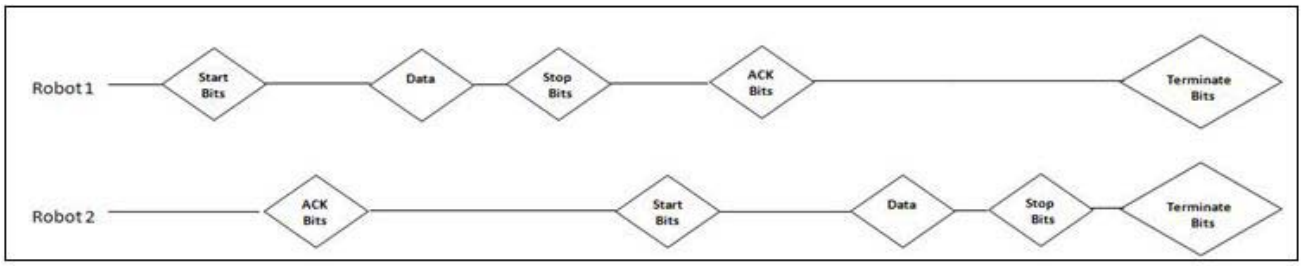
Before transmitting each digit MT8880C makes strobe pin high. which indicates that one tone is available for input.

This tone certainly helps to reduce errors detecting zero or repeated tones. Some of the ASCII values are reserved for specific use. Like to indicate start bits robots use 0x00,0xEE is used as acknowledge bits.This acknowledge bits helps a robot to understand the call is received or not. To terminate a call robots use terminate bits 0xDD.If both the robots send terminate bits means there are no more data to transmit or receive. Both the robots terminate the call pressing no button in mobile.

Table 3 : Complete ASCII chart using DTMF tones only

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL 0x00	SOH 0x01	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI 0x0F
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	HS	RS	US
2	SPC	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	P	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL
8	€		‘	ƒ	„	…	†	‡	ˆ	‰	Š	‹	Œ		Ž	
9		‘	’	“	”	•	–	—	˜	™	š	›	œ		ž	Ÿ
A		¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬	-	®	¯
B	°	±	²	³	´	µ	¶	·	¸	¹	º	»	¼	½	¾	¿
C	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
D	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
E	À	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
F	Ð 0xF0	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	Ÿ 0xFF

d) Timing Diagram



DTMF is half duplex two way communication system. When the transmitter sends information the receiver needs to listen and wait for the transmission to complete. This communication system can use hand shaking technique or it can use only acknowledgement bits. Here bellow a timing diagram has show of communication.

The timing diagram is shown here is after call has established between two robots. Robot1 has send start bits 0x00 then robot2 has replied acknowledge bits 0x06. After receiving robot1 sends end bits 0xFF. When both the robots completed their communication they confirm it sending terminate bits 0xFE.

IV. Hardware Implementation

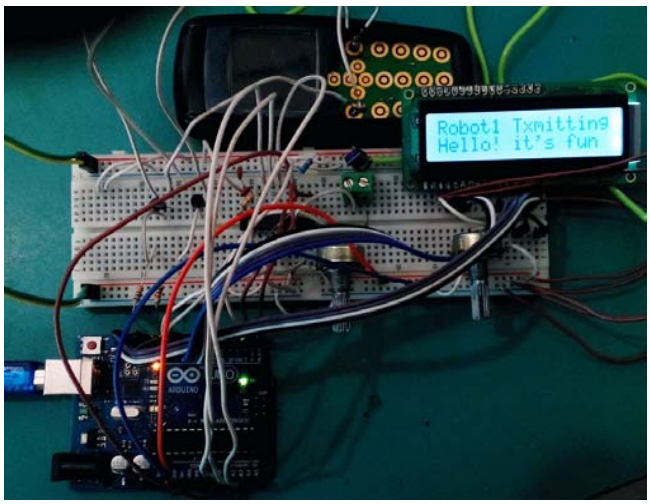


Figure 8 : Robot 1 Transmitting

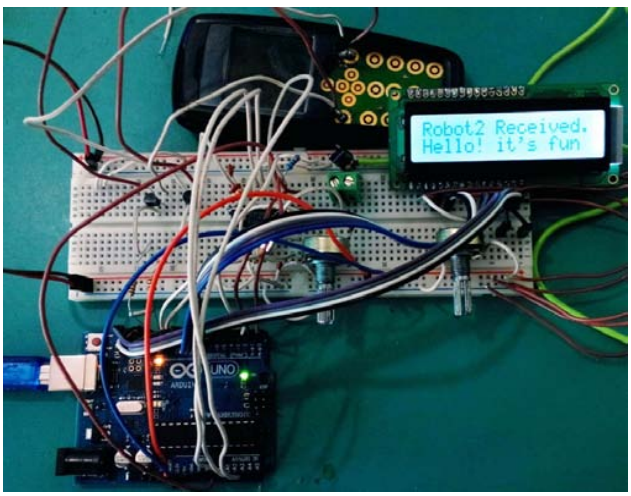


Figure 9 : Robot 2 Receiving

In this experiment we have used Arduino instead of atmega8 for easy prototyping. These two microcontrollers are almost same in operation. Here robot1 transmitted "Hello! It's fun".Robot1 generated the call through shorting yes button twice as number of robot2 was the last dialed number in phone list, a call initiated to robot2. Robo t1 transmitted start bits 0x00 and robot2 resend acknowledge bits 0xEE. Robot1 starts transmitting data through DTMF. Tones for "Hello! It's fun" are " 48 65 6C 6C 6F 21 90 69 74 27 73 90 66 75 6E". Robot2 received these tones, decoded it and displayed in LCD. Then robot2 transmitted terminate bits 0xDD. Robot1 confirms there is no more data for transmission and resend 0xDD. Both the robots shorted 'NO' button of mobile and terminated the call.

V. Further Application

1) Robots community development and share intelligence.
2) GPRS based network using internet.
3) GSM based Wireless Sensor Network.
4) Wireless Robot Control.
5) Industry and home automation (unlimited switches control).
6) Long distance Data transmission.
7) Military communication through encrypted data of DTMF values.

VI. Conclusion

DTMF is a reliable technique for very long distance data transmission. Though Genave Super Fast rate of 20/20 (25 tons per second) from an automatic encoder or Genave decoder responding to a code sent at a blazing DTMF rate of 20/5 also known as 40 digits per second)[13]. But MT8880C is capable of 12tones per second means around 48bits per second. If the bits rate can be increased then DTMF will become a good communication way for short distance also. But for long distance and unlimited node communication it is very reliable, easy, cheap solution for small amount of data transmission.

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- 'FARSE' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'FARSE" can be added to name in the following manner. eg. Dr. John E. Hall, Ph.D., FARSE or William Walldroff Ph. D., M.S., FARSE
- Being FARSE is a respectful honor. It authenticates your research activities. After becoming FARSE, you can use 'FARSE' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
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- Being MARSE is a respectful honor. It authenticates your research activities. After becoming MARSE, you can use 'MARSE' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 40% Discount will be provided to MARSE members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- MARSE will be given a renowned, secure, free professional email address with 30 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, SpamAssassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- MARSE member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 10% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
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- MARSE is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), MARSE can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 40% of its earning by Global Journals Inc. (US) will be transferred to MARSE member's bank account after certain threshold balance. There is no time limit for collection. MARSE member can decide its price and we can help in decision.

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- Annual Member will be authorized to receive e-Journal GJRE for one year (subscription for one year).
- The member will be allotted free 1 GB Web-space along with subDomain to contribute and participate in our activities.
- A professional email address will be allotted free 500 MB email space.

PAPER PUBLICATION

- The members can publish paper once. The paper will be sent to two-peer reviewer. The paper will be published after the acceptance of peer reviewers and Editorial Board.

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

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

(II) Choose corresponding Journal.

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

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

Preferred Author Guidelines

MANUSCRIPT STYLE INSTRUCTION (Must be strictly followed)

Page Size: 8.27" X 11'"

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

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

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3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

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

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

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

4. MANUSCRIPT'S CATEGORY

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

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

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

Research articles: These are handled with small investigation and applications

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

5.STRUCTURE AND FORMAT OF MANUSCRIPT

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

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

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

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

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

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

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

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

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

(h) Brief Acknowledgements.

(i) References in the proper form.

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

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

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

Format

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

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

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

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

Structure

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

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

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

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

Key Words

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

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

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

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

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

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

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

Acknowledgements: Please make these as concise as possible.

References

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

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

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

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

Tables, Figures and Figure Legends

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

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

Preparation of Electronic Figures for Publication

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

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

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

6. AFTER ACCEPTANCE

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

6.1 Proof Corrections

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

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

(Free of charge) from the following website:

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

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

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

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

6.3 Author Services

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6.4 Author Material Archive Policy

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

6.5 Offprint and Extra Copies

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

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

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Informal Guidelines of Research Paper Writing

Key points to remember:

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

Final Points:

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

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

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

General style:

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

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

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

In every sections of your document

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

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

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

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

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

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

Title Page:

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

Abstract:

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

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

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

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

Approach:

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

Introduction:

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

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

Approach:

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

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

Procedures (Methods and Materials):

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

Materials:

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

Methods:

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

Approach:

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

What to keep away from

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

Results:

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

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

Content

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

What to stay away from

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

Approach

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

Figures and tables

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

Discussion:

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

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

Approach:

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

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

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

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

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

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

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

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

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