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Smart Control System

Compact Circular Slot Antenna

Highlights

FPGA based Hybrid Digital

EM Spectroscopy in Photodetector

Discovering Thoughts, Inventing Future

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A Smart Control System of Home Appliances Using SMS

Anirban Sarkar, Sadia Sultana & Md. Habibur Rahman

East West University

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Keywords: *GSM-SIM 808, 5v relay Unit, water level sensor, Arduino Uno (controlling unit) and Arduino development interface (IDE).*

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A Smart Control System of Home Appliances Using SMS

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Abstract- This paper is about the development and implementation of a GSM based password protected control system for electrical home appliances that enables to control remotely. GSM module is used for receiving short message service (SMS) from user's mobile phone that automatically enable the controller to take any further action such as to switch ON or OFF the home appliances such as lights, air-conditioners, fans, water pumps, door locks, TVs etc. Hardware of the system has been developed using an Arduino Uno board, a GSM modules, some switching relays and some other easily available electronic components. The driving software has been made using the Arduino IDE. The system is activated when only the user sends the SMS to the controller at home with the exact password. Upon receiving the SMS command, the microcontroller unit will decode the received SMS automatically and controls the electrical home appliances by switching ON or OFF the device according to the user direction. The ON and OFF of the appliances has been controlled by relays and the Arduino board. In addition to the controlling of the common home appliances, a smart water pump control has also been developed. The prototype has been successfully developed and its performance has been studied. It works perfectly and it could provide an effective means of remote controlling and efficient use of energy resource.

Keywords: GSM-SIM808, 5v relay Unit, water level sensor, Arduino Uno (controlling unit) and Arduino development interface (IDE).

I. Introduction

Nowadays most of the people from any places at any time are connected with the mobile phone and want to get easy access of technology through their cell phones. With the development of the electronics technology in the last two decades, a new concept called Smart Home has become prevalent and through this concept people have been trying to control and secure their home appliances remotely by using SMS with low cost. GSM based remote control management is a subject of creating interest which has found application in different zones. Many works are going on in this field all over the world. Tan and et al.[1] developed an automatic power meter reading system to send the power consumed reading to e-billing system at authorized office. The system works by integrating the GSM modem that was embedded with digital kWh power meter. It utilizes the GSM network to send power usage reading using SMS to the authorized office. The authorized office collect and manage the received SMS message contain the meter reading to generate the billing cost and send back the cost t the respective consumer through SMS. Authors [2] developed a system for acquiring water level and temperature status via SMS by utilizing PIC 16F877 and MPLAB IDE software for programming. The project was designed to detect level and temperature of the water in a pool. The system functions when the level of water and the temperature in pool exceed the desired limits. At the same time the PIC circuit will automatically interface to the mobile phone and send the alert message to the user. Furthermore, Author of [3] also developed a remote and security control system via SMS to control the switch for lamp, door and alarm system using Visual Basic 6.0 software. Visual Basic was chosen because it can easily communicate between computer and mobile phone.

Moreover, Wahab and et al.[4] developed a Integrated Water Billing System through GSM network. The system is designed to facilitate the Water authority to manage the monthly billing system without the use of human services. The system generates current billing by receiving SMS from the meter to central databases. It again sends an SMS notification to the user regarding the total amount that has been billed. A very similar work has been reported by an Author [5] who has developed and designed a device that can control variety of electrical home appliance using SMS. The system utilizes Ericsson T10s mobile phone as a receiver which is connected to the AT 9052313 microcontroller. It also used MPLAB IDE software for programming. It can control 8 electrical home appliances at any time. The work presented by B.Woodward and et al. [6] is about the development of a telemedicine system using a mobile telephone which interfaced with sensors to a patient's body using GSM simulation. The work presented here uses the same technique as described above, but here the system will be more versatile and secured by password.

Electricity has become an essential part of our life. So, we can't afford to misuse any fraction of it. If we unmindfully leave any of the home appliances switched on, this will lead to energy wastage. With an aim to solve this problem, a control system based on microcontroller device has been developed which automatically control

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any electrical equipment at home remotely both for long and short distances using mobile phone. Hence, using this system we can protect our home from any accident caused by over use of home appliances like- electric iron, microwave oven, water pump etc. Our developed system is more versatile and smarter that can control home appliances and water pump. The water pump will be controlled smartly by the system and the user through SMS. Traditional water pump is controlled manually which results wastage of time, energy as well as resources. Our system is designed in such a way which can control water pump automatically.

II. System Design

A simplified block diagram of the System is given in Fig.1. The mobile unit has been used as a transmitting section from which the subscriber sends text messages that contain commands and instructions to the mobile station. The received SMS message is stored in the SIM memory of the GSM module and then extracted by the microcontroller and processed accordingly to carry out specific operations requested by the user. The SMS from the user cell phone has been transmitted through the GSM chip to the microcontroller and the microcontroller finally performs the required actions as stated by the user. The relay driver unit has been used to drive the relays which switch different appliances connected to them. Two water level sensors have also been used for getting the notification of the present conditions of water tanks. According to the notification of the system the user can remotely turn ON/OFF the water pump through SMS. When the water level sensor senses the highest level of water in the over-head tank, it automatically turns the pump OFF. The design of different units is described below:

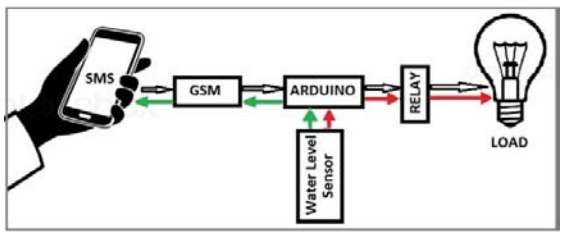

Fig.1: Block Diagram of Full Project

a) GSM Module-(SIM 808)

SIM 808 module is a GSM and GPS two-in-one function module. It supports GSM/GPRS Quad-Band network. The module is controlled by AT command and supports 3.3V and 5V logical level. To interface the GSM module with the Arduino board Tx and Rx pins of GSM module have been connected to the pin 2 and 3 of Arduino, respectively. The GSM module could have been connected to the Rx and Tx pins of Arduino Uno. As these pins are also used for uploading program into Arduino, the GSM module has been connected to the digital pins (pin 2 and pin 3).

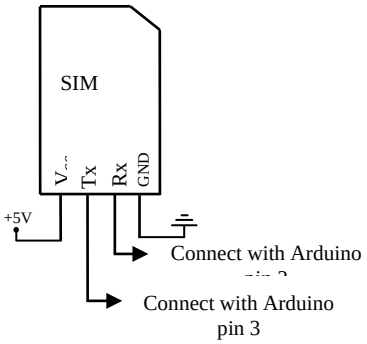

Fig. 2: GSM SIM808

b) 5V Relay Unit

Since the load ON/OFF frequency for any home appliances is very low, in this system, relays have been used for switching purpose. Moreover, for AC applications relays are very suitable and needs very simple connections. Here, 5V-10A AC relays have been used. The relays connect or disconnect the home appliances to the 220V AC power. The relays have been connected to the Arduino board using transistors. There are 4 channels in the relay unit. The channels ch-1, ch-2, ch-3, ch-4 are connected to the Arduino pin no. 8, 9, 10, 11 respectively. In a basic relay there are three contacts: Normally-Open (NO), Normally-Closed (NC) & Common (COM). When the relay is not energized, the COM is connected to NC. All loads are connected with COM port of Relay and direct power source is connected with NO port.

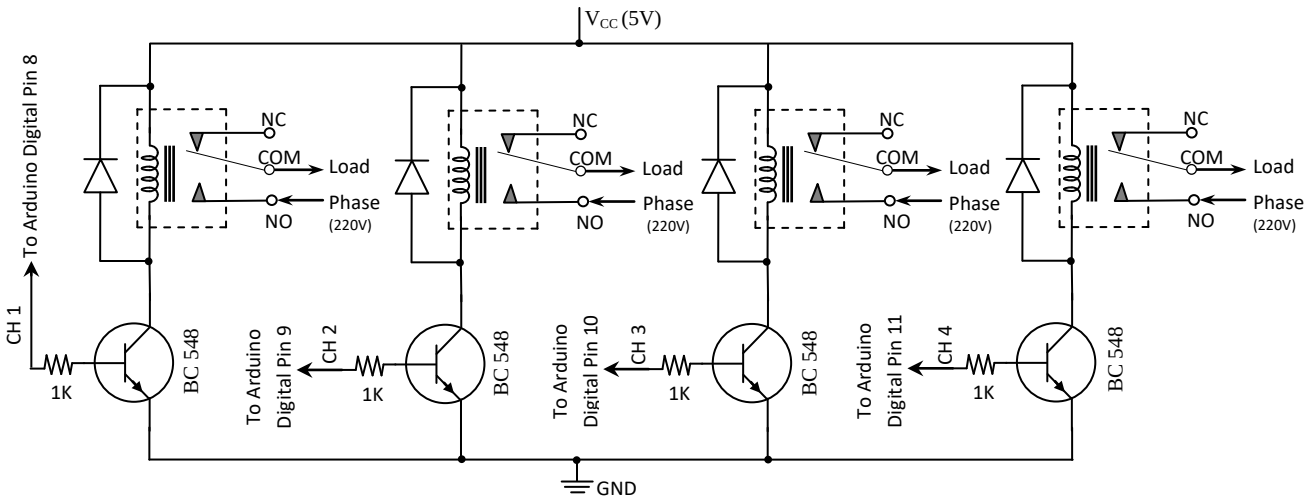

Fig. 4: 4-Channel 5V Relay Unit

c) Water Level Sensor

This simple transistor based water level sensor circuit is very useful to determine the water level in a tank. Whenever the tank gets filled, different sensors are activated at particular water levels. In this system, two level sensors have been used one for indicating low level of water and the other for full of the tank. The level sensors have been developed using galvanized metal (steel) strips. The metal strips are placed at the appropriate level of the tank and another metal strip has also been used to supply +5V into the water tank. When

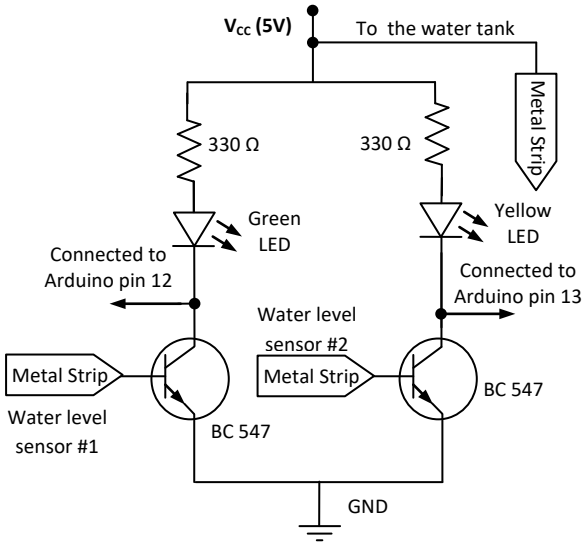

Fig. 3: Circuit diagram of Water level Sensor

water touches the metal strip the corresponding transistor turns on and the collector voltage goes to 0V. In this way the transistors sense the position of the water level and produce signals for the Arduino. Two LEDs have also been connected in this sensing circuit, to indicate two levels-Green LED) for lower level and Yellow LED for higher level. When Green LED glows it sends signal to the pin-12 of the Arduino. When Yellow LED glows it sends signal to the pin-13 of the Arduino.

Circuit Components:

a) BC547 Transistors -2 pcs
b) Resistors 330Ω -2 pcs
c) Color LED -2 pcs
d) 5V DC power source

d) Controlling Unit

The main controlling unit of this system is made by an Arduino Uno which contains ATmega328P microcontroller and other supporting chips. The technical specifications of the Arduino Uno are given bellow. This controlling unit gets signals from the GSM module and water level sensor circuit and controls the home appliances according to the conditions given in the driving software.

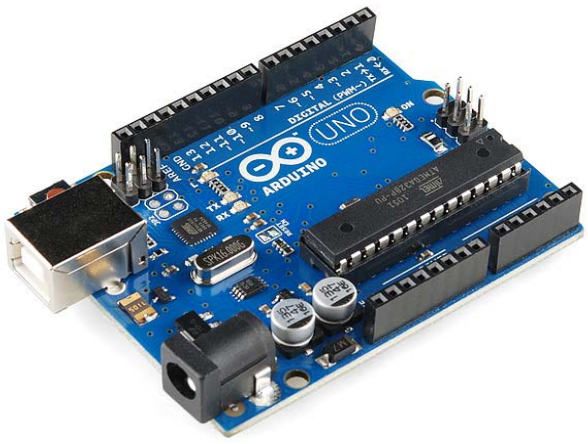

Fig. 5: Arduino Uno

Technical Specification [8]:

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provides PWM output)
PWM Digital I/O Pin	6
Analog Input Pin	6
DC Current per I/O Pin	20mA
DC Current for 3.3V Pin	50mA
Flash Memory	32 KB (ATmega328P) of which 0.5KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6mm
Width	53.4mm
Weight	25g

e) *Interconnection of Different Units*

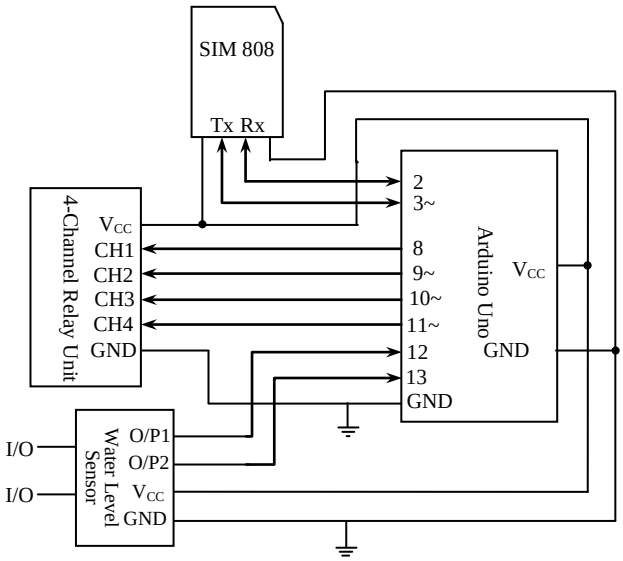

Fig. 6: Schematic Diagram

In this schematic diagram all units are connected together. For sending and receiving SMS, Tx and Rx pin of GSM module are connected with the Arduino pin 3(Rx) and 2(Tx) respectively. Home appliances are connected with Arduino pins 8, 9, 10, 11 through 4-channel Relay Unit. In water level sensor there are two input ports and two output ports. Two inputs are to be placed in water tank for water level measuring. Output terminals are directly connected to Arduino pins 12, 13. For all V_{CC} we've used same 5V source from a mobile power bank.

III. Flow Chart

The developed system has been made intelligent and automatic using a program. The program has been developed using Arduino IDE. The flowchart of the program is given in Fig.6. At first, the program initializes all variables and ports. Then it initializes GSM. After that a decision parameter determines whether there is any SMS or not. If there is any SMS available in the GSM module, the microcontroller reads that SMS and compares the password with the pre-set password. If the password matches, it reads the command given in the SMS, decode the command and turns ON/OFF the home appliances according to the command. An example SMS to turn first two appliances ON and another two appliances OFF is 12341100 (password-1234). It will work if the password is correct either it ignores the SMS. From the decision point if there is no SMS, it goes to another decision point which determines whether the water tank is empty or not. If the tank is empty it sends SMS to the user prompting that the tank is empty through the GSM module. Otherwise it will go back to the first decision point. In this way this process will be continued until the system is switched off or power disconnected.

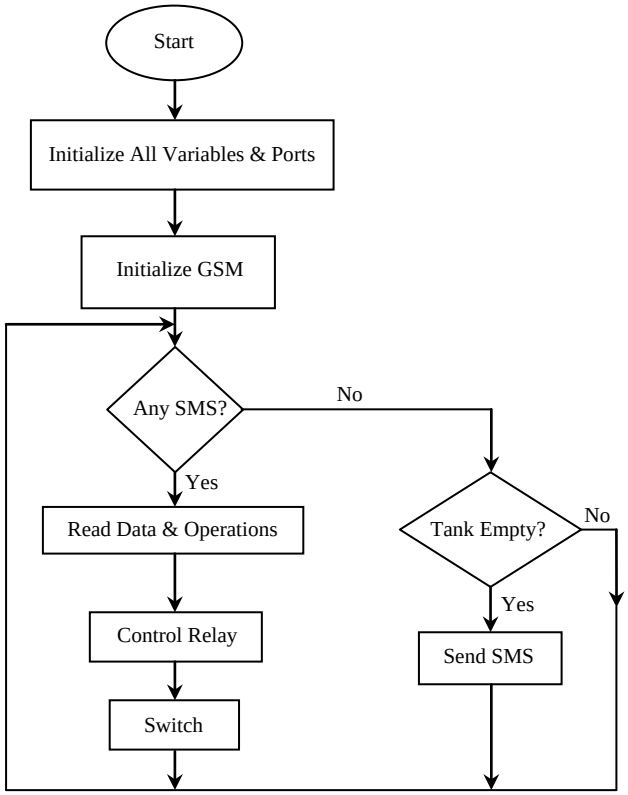

Fig. 7: Flow Chart

IV. Results & Discussions

All of the designed units have been interconnected in a bread board and the developed software has been uploaded into the Arduino microcontroller. A prototype model of the home has also been developed. The figures below show the hardware connection and the output results.

Step-1:

The initial state of the system is shown in Fig. 8 & 9. The power switch is off and no message is sent to the system. Hence, all of the appliances are switched off.

Fig. 8: Initial state of the system. All appliances OFF

Fig. 9: Initial state of the system. All appliances OFF

Step-2:

When an SMS (Password Command = 12341111) is sent for all switched ON command then all the appliances are switched ON. This is shown in Fig.10 & 11.

Fig. 10: Photograph of the system with all appliances ON

Fig. 11: Photograph of the system with all appliances ON

Step-3:

When water level goes to under the empty level in water tank then the GSM system sends an SMS to the user as "Tank Empty". Then user may send an SMS to turn ON the water pump as well as when water tank is full the water pump will automatically be turned OFF as shown in the following results.

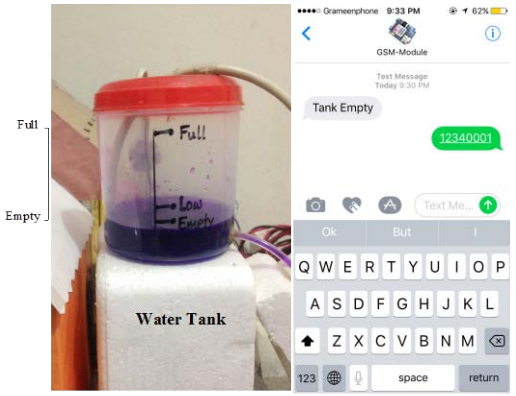

Fig. 11: Photograph of the water tank and its relevant SMS

V. Conclusion

SMS based home appliance control system is capable of controlling of the appliances from any place where GSM service is available. This paper presents the design and implementation of a smart control system for electrical appliances based on microcontroller along with GSM for user friendly application. The system is intelligent enough to control the water pump and any other electrical units of home. The system was designed considering some factors such as economic application, availability of components and research materials efficiency, compatibility, portability and durability. The system provides the reliable operation within reasonable cost and removes the system complexity. The system can be made more useful by detecting the water level of reserve tank and turning the pump ON/OFF as required. Although in this project, some common home appliances have been controlled it can be used for any other appliances from any place.

References Références Referencias

1. Tan, H.G.R. Lee, C.H.R. Mok, V.H. (2007). "Automatic Power Meter Reading System using GSM Network." In Proceeding on Power Engineering Conference 2007. 3-6 Dec 2007, Kualalumpur, pp. 465-469.
2. Mohd Noor Bin Abdullah (2008). "Acquiring Water Level and Temperature Status via SMS."Universiti Tun Hussein Onn Malaysia: Thesis Sarjana Muda.
3. Lock K.A (2004). "Remote and Security Control Via SMS." Kolej Universiti Tun Hussein Onn Malaysia:Thesis Sarjana Muda.
4. Mohd Helmy Abd Wahab, Siti Zarina Mohd Muji, Fazliza Md. Nazir. Integrated Billing System through GSM Network. In Proceeding of 3rd International

Conference on Robotics, Vision, Information and Signal Processing 2007 (ROVISP2007), Penang, Malaysia, 28– 30 November 2007.

5. Serasidis Vasilis (2003). "SMS Remote Control, For Ericsson T10 GSM Mobile Phone" Retrieved at http://www.serasidis.gr.
6. B. Woodward, H. Istepamian, and C. Richards, "Design of a Telemedicine system using a mobile telephone", *IEEE Transaction on Information Technology in Biomedicine*, vol, 5, no. 1, March 2001.
7. H. Sang, C. Lin, and Z. Youn, "A wireless Internet-based measurement architecture for air quality monitoring",*IEEE Conference Instrumentation and Measurement Technology*, IMTC 04,May, 2004
8. https://www.arduino.cc/
9. http://ieeexplore.ieee.org/Xplore/home.jsp
10. http://www.instructables.com/

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FPGA Based Hybrid Digital PWM for DC-DC Voltage Regulator

Joseph Anthony Prathap & T.S. Anandhi
Annamalai University

Abstract- This In general, telecommunication applications require low voltage, high current and reduced size power supplies. Selection of high switching frequency helps in the reduction of the DC-DC converter size. In this work, Digital PI (DPI) enables the Digital Pulse Width Modulation (DPWM) generator for generating high switching frequencies are developed and implemented using VHDL coding and Xilinx Spartan 3A DSP Field Programmable Gate Array (FPGA) kit. Hardware result of voltage regulation depicts the superiority and robustness of the proposed DPI enabled DPWM (MD-DPWM) methods under line and load disturbances. The MD-DPWM technique can be used to generate a very high switching frequency up to 1 MHz and more. Also the MD-DPWM proves to be cost effective, as it consumes low power and area.

Keywords: digital pulse width modulation, digital proportional integral-dc-to-dc buck converter, xilinx spartan 3A DSP field programmable gate array.

GJRE-F Classification: FOR Code: 090607

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I. Introduction

Buck converter is a circuit which step downs the voltage and step ups the current. A basic buck converter circuits requires inductor, diode and transistor as switch. As per the control of the switch by the PWM signals the inductor acts against the input voltage. The DPWM design involves digital circuits like adders, flip-flops, multiplexers, counters and shift registers.

DPWM has advantages like easy design, high accuracy, low area and low power consumption. High resolution digitally controlled DC-DC buck converter is designed without the use of high frequency clock [1]. FPGA based implementation of the DPWM is very simple comparatively consuming of few memories, multipliers and adders [2]. DPWM architecture developed with FPGA implies high reliability, linearity and low latency [3]. A brushless DC machines can be digitally controlled by FPGA implementation with no additional hardware and hence has low design complexity [4].

A DPWM technique in [5] gives consistent off-time and on-time control under heavy load and light load conditions with reduced switching losses. FPGA based high resolution DPWM designed using a digital clock manager and I/O delay elements have low cost and higher clock frequency [6]. In this work, the performances of the DC-DC buck converter with the DPWM as voltage regulator is analyzed.

II. DC-DC Buck Converter

The closed loop DC-DC buck converter with the proposed DPI enables the DPWM technique is shown in the Fig.1.

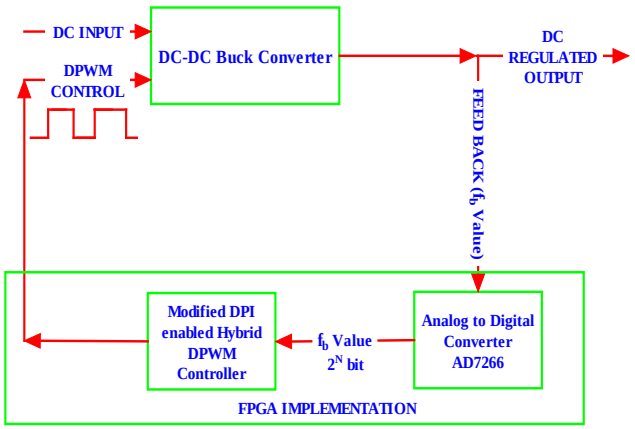

Fig.1: Closed loop DC-DC Buck Converter with MD-DPWM control

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e-mail: ans.instrus@gmail.com

The output voltage of the buck converter is less than the input voltage and is controlled by the duty cycle "d". The duty cycle "d" is the ratio of the ON period to the total period cycle of the controlling square pulse.

$$d = \frac{T_{on}}{T}$$

Where "Ton"refers to the ON period.

"T" refers to the total time period of the cycle.

The operation of the buck converter is related to the duty cycle as given below

$$V_{out} = d.V_{in}$$

Where "d" is the duty cycle.

"Vin" is the input voltage of the buck converter.

"Vout" is output voltage of the buck converter.

The digital switching control has more advantages like easy designing, high manipulation power, upgradable, immune to environmental changes, easy debugging.

In our work, the FPGA based DPWM DC-DC buck voltage regulator, is implemented which satisfies the demand of low voltage and high current application. ADC is utilized for the purpose of acquiring the feedback values of the DC-DC buck converter into the FPGA. ADC IC AD7266 has Successive Approximation Circuit (SAC) and is used for real time implementation. The FPGA based ADC architecture helps in the evaluation of digital error with high accuracy [7]. The Digital PI (DPI) control algorithm is designed using VHDL coding enables the DPWM. The Modified DPI enabled DPWM (MD-DPWM) generators are implemented by FPGA and found to perform efficiently for the disturbances and component variation. The AD7266 is provided to access the analog value in the form of digital equivalence (2N).

III. Digital Pulse Width Modulation Methods

The Digital Pulse Width Modulated (DPWM) signal is generated using logical design. The DPWM is generated by three methods. They are

i) Counter DPWM method. (CDPWM)
ii) Delay line DPWM method. (DDPWM)
iii) Hybrid DPWM method. (HDPWM)

Using ModelSim, the three DPWM methods are simulated. From the simulated results, the HDPWM generator is found to be advantages when compared to the CDPWM and DDPWM. The CDPWM require high frequency system clock and thus has high power consumption. The DDPWM occupies more area increasing the cost. The relationship of the clock frequency and the switching frequency for the DPWM generator is

$$F_{CLK} = F_{SW} \times 2^n$$

F_{SW}-Switching frequency

F_{CLK}-Clock frequency

2^n- Resolution in bits

In this work, the design of the Modified DPI enabled DPWM using 2^{11}-bit resolution is used which yields F_{SW} of 12.5 KHz and achieved the F_{CLK} of 21 MHz Hybrid DPWM generator is the combination of both counter based DPWM and delay-line based DPWM methods. The DC input signal of 2^{11}-bit resolution is bit split into 2^5-bit and 2^6-bit resolutions. In which 2^5-bit resolution is used for the generation of the DDPWM and 2^6-bit resolution for the generation of the CDPWM generation. The HDPWM has two set of SET and RESET signal (each from CDPWM and DDPWM generations) which are logically ANDed to give a SET and RESET signal for the SR-flip-flop are shown in Fig.2.

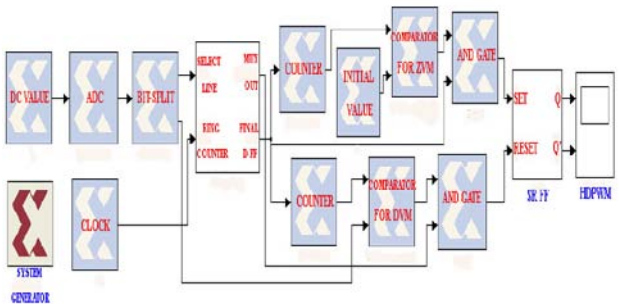


Fig. 2: SIMULINK-MATLAB block of Hybrid based DPWM

IV. The Proposed Method: Modified DPI Enabled Dpwm Generator

The modified DPWM generator utilizes the DPI controller to manipulate the duty cycle proportionate to the error as well as enable the DPWM generator. Real time feedback equivalence value of 0 to 5V is selected by the VHDL coding and fed to the ADC for processing. The resolution for the ADC is 2^{11} bits. The DPI controller gain parameters are k_p=0.6 and k_i=0.055. The DPI controller values are made visible by interfacing the 12 LEDs of the FPGA. The increase and decrease push buttons available in the FPGA kit is also activated for varying the voltage reference value. These push switch values are coded along with the limiter. These values are interfaced with the LCD display of the FPGA in order to monitor the variable set values and the settling values. Initially the set value is maintained at 10V by default in

the VHDL code. The structural style of VHDL code is used in the design of MD-DPWM

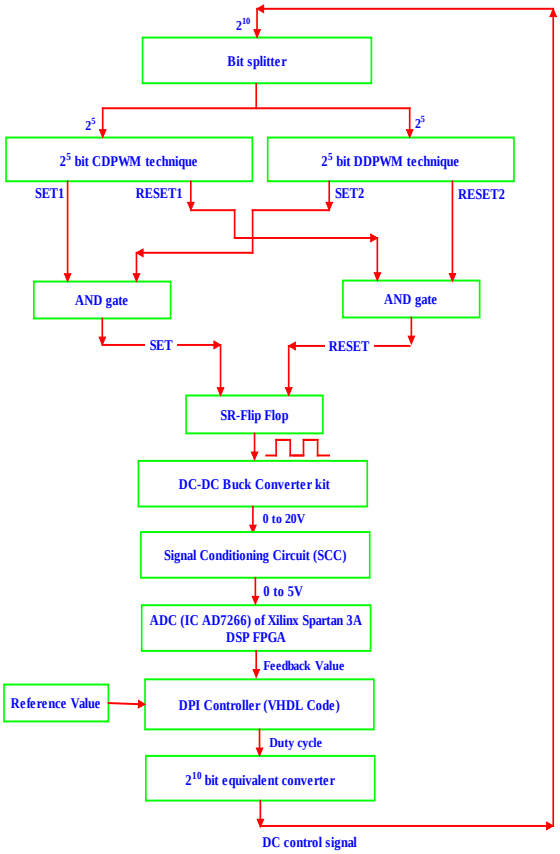


Fig. 3: Design flow for the Modified DPI enabled Hybrid DPWM controlled DC-DC buck converter using FPGA

The VHDL code uses mixed style of modeling. The FPGA implementation of the Modified DPI enabled Hybrid DPWM generator (MD-HDPWM) demands more real-time considerations like selection of resolution, uniformity of resolution, accurate digital equivalence for the obtained analog value, digitized comparison of AV and SP, and stabilizing the MD-DPWM control. The desired set point/ voltage reference (SP), k_p and k_i are fixed within the VHDL code. All these values are converted to bits. The actual value (AV) is measured as bit equivalents by the use of ADC AD7266. The values of the SP and AV are compared to evaluate the errors. Fig.3 shows the flowchart for the VHDL coded Modified DPI enabled DPWM controller.

a) Resolution

Resolution refers to the number of bits used in the design. In this work, the three MD-DPWM generators are designed using 2^{11} bit resolution. The MD-CDPWM generator uses a 2^{11} bit (2047 count) counter. The MD-DDPWM generator uses the 2048:1 multiplexer. The MD-HDPWM generator uses 2^{11} bit resolution in which 2^5 bit is used for the MD-DDPWM generation part and 2^6 bit is used for the MD-CDPWM generation part. The frequency of the DPWM generator is 12.5 KHz in the hardware due to the limitations in frequency range with the laboratory prototype. To achieve this frequency, the VHDL coding utilizes the scaled value given by the formula.

$$\text{Scaled\_value} = \frac{1}{2^n \text{ X Output frequency X Clock period}}$$

Where Clock period is 100 ns
Output frequency is 12.5 KHz

V. Hardware Details

The Xilinx Spartan 3A DSP FPGA is used for the design of the DC-DC buck type voltage regulator using MD-HDPWM. The Xilinx Spartan 3A DSP has IC AD7266 for the design of ADC. The set point variations are provided by the two variable push switches. The 16*4 LCD display is activated by the VHDL code. The VHDL codes for the DPI and ADC are designed with 10 times of the actual values to accomplish the FPGA requirements. This scaling is done to make sure that the fractional changes of the ADC and DPI are considered in the design, as the Xilinx Spartan 3A DSP kit do not support the float value implementation.

The AD7266 is 8 channels SAR ADC with maximum resolution of 2^{12} bits. The AD7266 is a 32 pin IC which operates from 2.7V to 5.25V of supply. The

ADC performs two functions of sampling and conversion of two channels simultaneously. These conversion values are concurrently accessible in separate data lines. When operated at 3V, the AD7266 gives a throughput rate of 1.5 MSPS with maximum power dissipation of 11.4 mW. Thus low power consumption for high throughput is achieved. The AD7266 has zero pipeline delay; since the sampling control of the two SAR ADCs are accurate. The ADC has two input ranges like 0V to VREF and 2*VREF

VI. Results and Discussions

a) *Simulated Results*

The simulation outputs of the MD-DPWM generator using the above mentioned three techniques are given below in Fig.4,5,&6 using ModelSim. The open loop response under line disturbance for the DC-DC buck converter is given for the three MD-DPWM techniques in Fig.7(a),(b)&(c). Fig.8(a),(b)&(c) depict the open loop response under load disturbance for the DC-DC buck converter for the three MD-DPWM techniques.

b) Experimental Results

Fig.9 show the start-up transient response along with the set-point variation of closed loop DC-DC buck converter using MD-HDPWM. The CSV file format is plotted using excel sheet format. The time transient parameters like settling time (t_s), rise time (t_r), delay time (t_d), peak time (t_p) and overshoot percentage (%MP) are also calculated and displayed in the graph. The input voltage is 20V.The set point variation is from 11V to 12.8 V for MD-HDPWM.

Fig.10 shows the analysis for the closed loop response under increased line disturbance from 10.4V to 12V and Fig.11 shows the analysis for the closed loop response under decreased line disturbances from 10.4V to 8.8V for the MD-HDPWM technique. The line voltage in this work are suddenly increased from 18V to 20V and decreased from 20V to 18V. Timing performance indices of the hybrid method are found to have less settling time comparatively and hence hybrid is selected. Fig.12 shows experimental DSO response for the set-point change and Fig.13 shows experimental DSO output for the positive and negative line disturbances.

Fig.14&15 indicate the performance of the MD-HDPWM based DC-DC buck converter in closed loop with load disturbances from 445Ω to 595Ω and 595Ω to 445Ω respectively. The set point is 10 V and input voltage is 20V. The settling time measured during the negative load disturbance with MD-HDPWM seems to be very minimal. Fig.16&17 show the experimental DSO response of load disturbance from 445 Ω to 595Ω and from 595Ω to 445Ω respectively for the MD-HDPWM in closed loop. Fig.18 shows experimental output response when the load is changed from 470Ω to 495Ω and from 495Ω to 470Ω using MD-DDPWM. Fig.19 shows experimental output for the negative load disturbance from 445Ω to 295Ω using MD-DDPWM. The RTL schematic for the MD-HDPWM technique is presented in Fig.20. Fig.21,22,&23 show the design utilization chart for the MD-CDPWM, MD-DDPWM and MD-HDPWM respectively. The experimental setup of DC-DC buck converter using the Xilinx Spartan 3A DSP is shown in Fig.24.

VII. Comparison and Analysis

Table I shows that the Modified DPI enabled HDPWM has lower steady state error and low settling time for the step change variation. The peak overshoot percentage is also less in MD-HDPWM. Table I also show that MD-HDPWM used with the closed loopDC-DC buck converter has less settling time and rise time when compared to the other two like MD-CDPWM and MD-DDPWM methods. Table II & III show the settling time for both the positive and negative line disturbances are good for the MD-HDPWM. Table IV shows that the MD-HDPWM has lower area utilization in FPGA device compared to the MD-DPWM and also the clock frequency of the MD-HDPWM is less in comparison of the MD-CDPWM. Thus the modified DPI enabled HDPWM method is cost effective in comparison with the other methods.

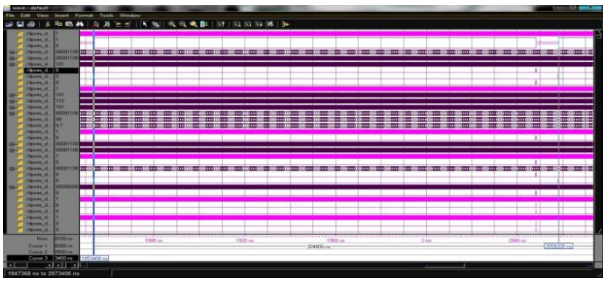


Fig. 4: Counter based DPWM generated in ModelSim

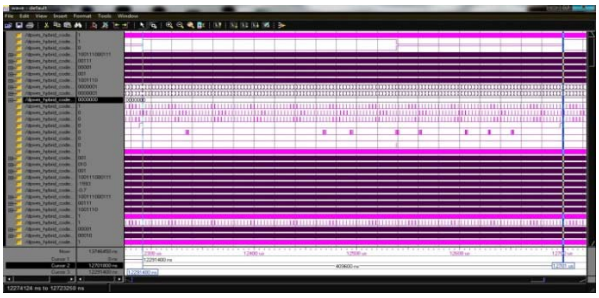


Fig. 5: Delay line based DPWM generated in ModelSim

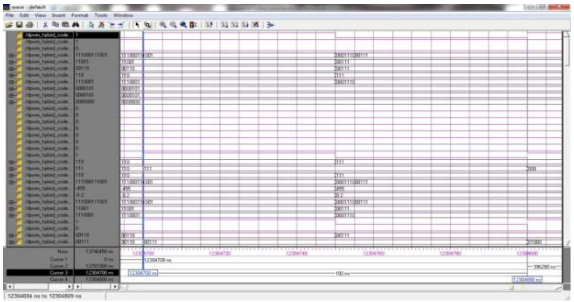
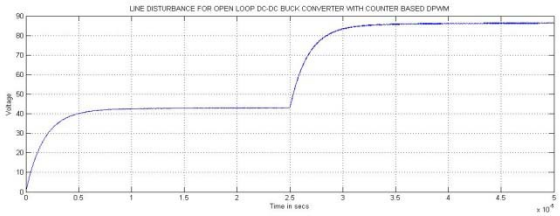
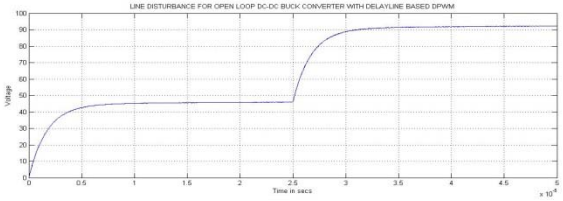


Fig. 6: Hybrid based DPWM generated in ModelSim

(a)



(b)



(c)

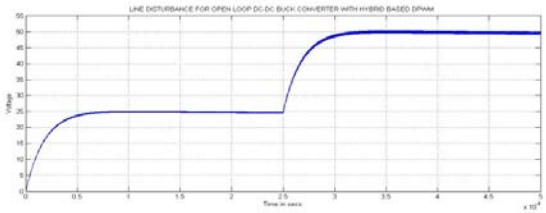


Fig. 7: Open loop deviated response of DC-DC buck converter with line disturbance using a) MD-CDPWM. b) MD-DDPWM. c) MD-HDPWM

(a)

(b)

(c)

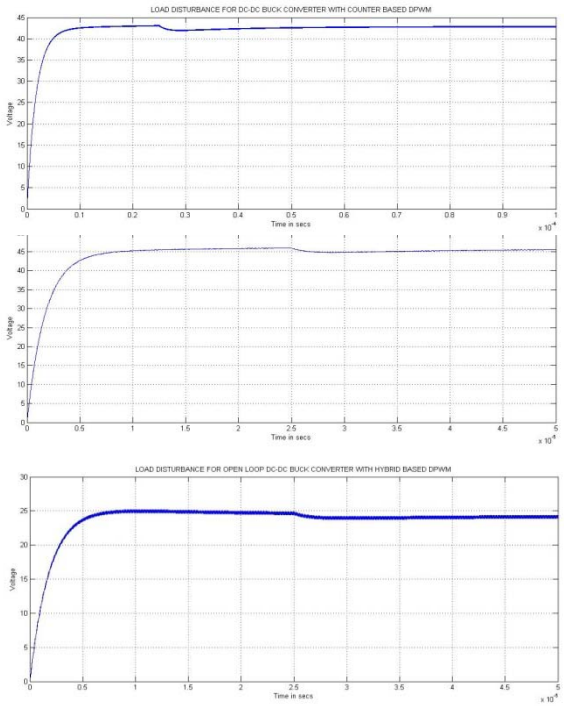


Fig. 8: Open loop deviated response of DC-DC buck converter with load disturbance using a) MD-CDPWM. b) MD-DDPWM. c) MD-HDPWM

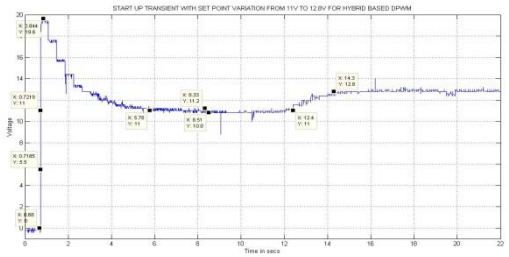


Fig. 9: Experimental regulated start-up transient response of MD-HDPWM buck converter with set point variation

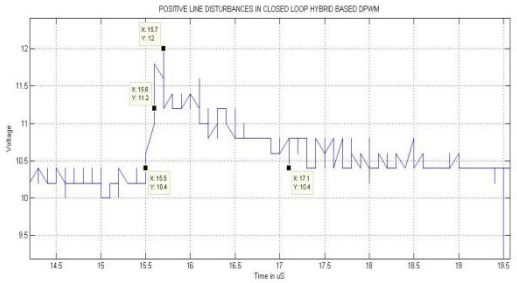


Fig. 10: Experimental response of MD-HDPWM based DC-DC buck converter with increased load disturbance from 10.4V to 12V

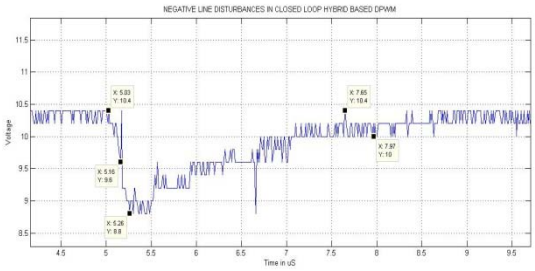


Fig. 11: Experimental response of MD-HDPWM based DC-DC buck Converter with decreased load disturbance from 10.4V to 8.8V

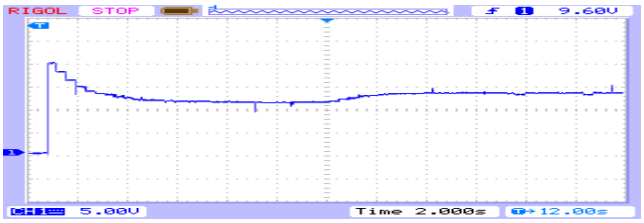


Fig .12: Experimental DSO start-up transient response of MD-HDPWM buck type voltage regulator with set point variation

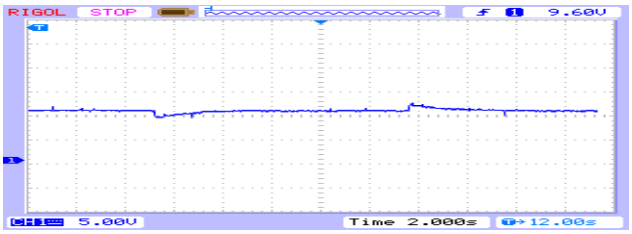


Fig. 13: Experimental DSO regulated response of MD-HDPWM buck type voltage regulator with line disturbances from 10.4V to 8.8V and 10.4V to 12V

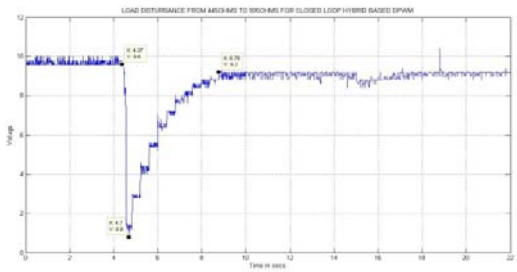


Fig. 14: Experimental CSV plotted result for Load disturbance of MD-HDPWM buck type voltage regulator from 445Ω to 595Ω

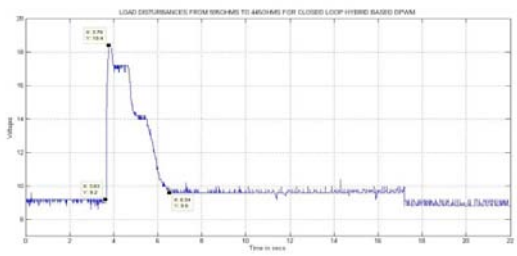


Fig. 15: Experimental CSV plotted result for Load disturbance for MD-HDPWM buck type voltage regulator from 595Ω to 445Ω

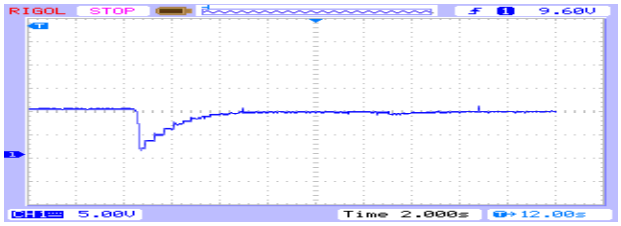


Fig. 16: Experimental DSO result for Load disturbance for MD-HDPWM buck type voltage regulator from 445Ω to 595Ω

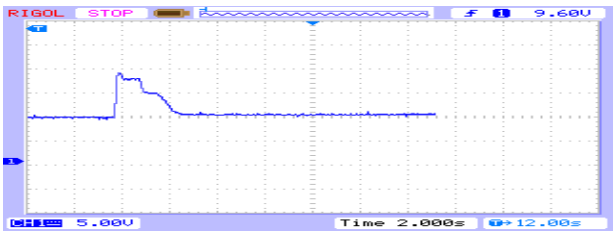


Fig. 17: Experimental DSO response for Load disturbance for MD-HDPWM buck type voltage regulator from 595Ω to 445Ω

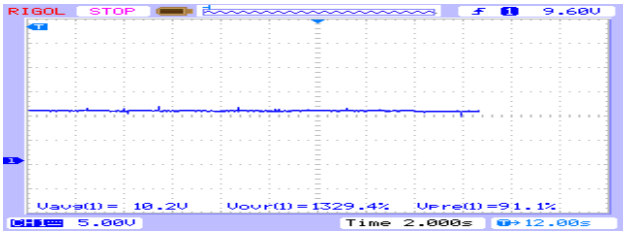


Fig. 18: Experimental DSO response for Load disturbance for MD-DDPWM buck type voltage regulator from 470Ω to 495Ω and from 495Ω to 470Ω

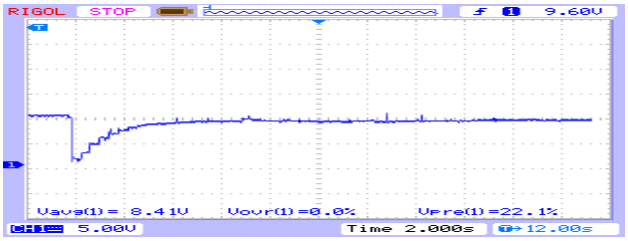


Fig.19: Experimental DSO response for Load disturbance for MD-DDPWM buck type voltage regulator from 445Ω to 295Ω

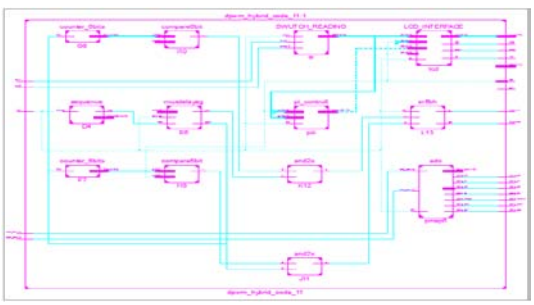


Fig. 20: Detailed RTL view of MD-HDPWM in Xilinx ISE

Device Utilization Summary			
Logic Utilization	**Used**	**Available**	**Utilization**
Number of Slice Flip Flops	665	33,280	1%
Number of 4 input LUTs	1,633	33,280	4%
Number of occupied Slices	1,090	16,640	6%
Number of Slices containing only related logic	1,090	1,090	100%
Number of Slices containing unrelated logic	0	1,090	0%
Total Number of 4 input LUTs	1,894	33,280	5%
Number used as logic	1,633		
Number used as a route-thru	261		
Number of bonded IOBs	37	519	7%
Number of BUFGMUXs	1	24	4%
Number of DSP48As	6	84	7%
Average Fanout of Non-Clock Nets	2.96		

Fig. 21: Design Utilization Table for MD-CDPWM in Xilinx Spartan 3A FPGA

Device Utilization Summary			
Logic Utilization	**Used**	**Available**	**Utilization**
Number of Slice Flip Flops	2,716	33,280	8%
Number of 4 input LUTs	2,670	33,280	8%
Number of occupied Slices	3,659	16,640	21%
Number of Slices containing only related logic	3,659	3,659	100%
Number of Slices containing unrelated logic	0	3,659	0%
Total Number of 4 input LUTs	2,931	33,280	8%
Number used as logic	2,670		
Number used as a route-thru	261		
Number of bonded IOBs	41	519	7%
Number of BUFGMUXs	1	24	4%
Number of DSP48As	6	84	7%
Average Fanout of Non-Clock Nets	2.59		

Fig. 22: Design Utilization Table for MD-DDPWM in Xilinx Spartan 3A FPGA

Device Utilization Summary			
Logic Utilization	**Used**	**Available**	**Utilization**
Number of Slice Flip Flops	697	33,280	2%
Number of 4 input LUTs	1,657	33,280	4%
Number of occupied Slices	1,130	16,640	6%
Number of Slices containing only related logic	1,130	1,130	100%
Number of Slices containing unrelated logic	0	1,130	0%
Total Number of 4 input LUTs	1,908	33,280	5%
Number used as logic	1,657		
Number used as a route-thru	251		
Number of bonded IOBs	37	519	7%
Number of BUFGMUXs	1	24	4%
Number of DSP48As	6	84	7%
Average Fanout of Non-Clock Nets	2.95		

Fig. 23: Design Utilization Table for MD-HDPWM in Xilinx Spartan 3A FPGA

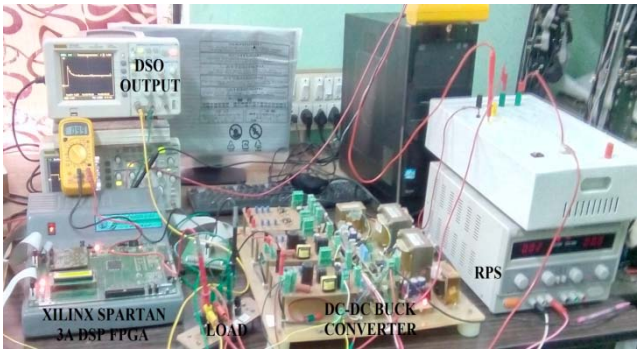


Fig. 24: Experimental setup for the Modified DPI enabled DPWM based DC- DC buck converter using FPGA

Table 1: Performance analysis for start-up transient response of modified DPI enabled DPWM techniques with no disturbance

Method	MD-CDPWM	MD-DDPWM	MD-HDPWM
Settling Time (ts)	4.71	6.2	5.1
Rise Time (tr)	0.035	0.002	0.0419
Delay Time (td)	0.032	0.023	0.0385
Peak Time (tp)	0.04	0.03	0.164

Steady State Error (ess)	0.0425	0.0385	0.0357
Step change variation time(tsc)	3.6	2.4	1.9
Percentage Overshoot (%MP)	113.04%	96%	78.18%

Table 2: Performance Analysis For Start-Up Transient Response Of Modified DPI Enabled DPWM Techniques With Increased Line Disturbance

Methods	MD-CDPWM	MD-DDPWM	MD-HDPWM
Rise Time in s (tr)	0.2	0.3	0.2
Time Delay in s (tp)	0.1	0.1	0.1
Settling Time in s (ts)	3.8	2.7	1.6
Percentage Overshoot(%MP)	14.286%	17.647%	15.38%
Output Voltage Ripple	0.04	0.04	0.03846
Initial Value before disturbance	9.8 V	10.2 V	10.4 V
Peak Value at disturbance	11.2 V	12 V	12 V

Table 3: Performance Analysis For Start-Up Transient Response Of Modified DPI Enabled DPWM Techniques With Decreased Line Disturbance

Methods	MD-CDPWM	MD-DDPWM	MD-HDPWM
Rise Time in s (tr)	0.2	0.2	0.23
Time Delay in s (tp)	0.142	0.135	0.13
Settling Time in s (ts)	3.26	2.82	2.62
Percentage Overshoot (% MP)	14.2857%	13.725%	15.38%
Output Voltage Ripple	0.04	0.04	0.04
Initial Value before disturbance	9.8 V	10.2 V	10.4 V
Minimum Value at disturbance	8.4 V	8.8V	8.8 V

Table 4: Device Utilization For The Modified DPI Enabled DPWM Techniques

Methods	MD-CDPWM	MD-DDPWM	MD-HDPWM
Resolution with specification	2^{11}-bit Counter Designed	2^{11} 2048 : 1 Mux Designed	$2^{11}=2^6+2^5$ (2^6-bit Counter & 32:1 Mux Designed)
Number of Sliced Flip Flops	665	2716	697
Number of 4 input LUTs	1633	2670	1657
Number of occupied slices	1090	3659	1130
Number of bonded IOBs	37	41	37
Average Fan-out of Non-clock nets	2.96	2.59	2.95

VIII. Conclusion

Simulation results show the possibilities of achieving high switching frequency up to 16MHz DPWM. Hardware results show the feasibility of the proposed technique for the available prototype model in our laboratory and found to be satisfactory. The Modified DPI enabled DPWM generators also perform voltage regulation of the power supply. The FPGA based Modified DPI enabled Hybrid based DPWM voltage regulator is found to be immune to circuit component variations, and also to line–load disturbances.

References Références Referencias

1. Luca Corradini, Aleksandar Bjeleti´c, Regan Zane, and Dragan Maksimovi´c, "Fully Digital Hysteretic Modulator for DC–DC Switching Converters" *IEEE Transactions on Power Electronics, Vol. 26, No. 10,* pp. 2969-2979, October 2011.
2. Bo Li, Xuefang Lin-Shi, Bruno Allard, and Jean-Marie Rétif, "A Digital Dual-State-Variable Predictive Controller for High Switching Frequency Buck Converter With Improved Σ-DPWM" *IEEE Transactions on Industrial Informatics, Vol. 8, No. 3,* pp. 472-481, August 2012.
3. Daniel Costinett, Miguel Rodriguez, and Dragan Maksimovic, "Simple Digital Pulse Width Modulator under 100 ps Resolution Using General-Purpose FPGAs" *IEEE Transactions on Power Electronics*, *Vol. 28, NO. 10,* pp.4466-4472, October 2013.
4. Nikola Milivojevic, Mahesh Krishnamurthy, Yusuf Gurkaynak, Anand Sathyan, Young-Joo Lee, and Ali Emadi, "Stability Analysis of FPGA-Based Control of Brushless DC Motors and Generators Using Digital PWM Technique" *IEEE Transactions on Industrial Electronics, Vol. 59, No. 1,* pp. 343-351, January 2012.
5. Chia-An Yeh, and Yen-Shin Lai, "Digital Pulse width Modulation Technique for a Synchronous Buck DC/DC Converter to Reduce Switching Frequency" *IEEE Transactions on Industrial Electronics, Vol. 59, No. 1,* pp. 550-561, January 2012.
6. Denis Navarro, O´ scar Luc´ıa, Luis Angel Barraga´n, Jose´ Ignacio Artigas, Isidro Urriza,n and O´ scar Jime´nez, "Synchronous FPGA-Based High-Resolution Implementations of Digital Pulse-Width Modulators" *IEEE Transactions on Power Electronics, Vol. 27, No. 5,* pp.2515-2525, May 2012.
7. Mukti Barai, Sabyasachi Sengupta, and Jayanta Biswas, "Digital Controller for DVS-Enabled DC–DC Converter" *IEEE Transactions on Power Electronics, Vol. 25, No. 3,* pp. 557-573, March 2010.

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Modeling of Single-Phase to Three-Phase Drive System

Boosharaju Ravikumar & Dr.Y.R. Manjunath

Abstract- This paper presents single-phase to three-phase with dc-link converters with parallel rectifier and series inverter for reduction in the input current and reduction of the output voltage processed by the rectifier circuit and inverter circuit respectively. In this paper we proposed better solution for single phase to three phase drive system by employing 2parallel single phase rectifier stages, a 3-phase inverter stage. Parallel converters can be used to improve the power capability, reliability, efficiency and redundancy. An isolation transformer is not used for the reduction of circulating currents among different converter stages. It is an important objective in the system design. The complete comparison between the comprehensive model of proposed converter and standard configurations will be presented in this work. Simulation of this model will be carried out by using MATLAB/ Simulink.

Keywords: *AC-DC-AC power converter, drive system, parallel converter, fault identification system(fis).*

GJRE-F Classification: *FOR Code: 290901*

Strictly as per the compliance and regulations of :

Modeling of Single-Phase to Three-Phase Drive System

Boosharaju Ravikumar [α] & Dr.Y.R. Manjunath[σ]

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I. Introduction

Most power conversion applications consist of an AC-to-DC conversion stage immediately following the AC source. The DC output obtained after rectification is subsequently used for further stages. There by an ac to dc converter has become an integral part of mostly all the electronic equipments. Mainly, it is used as an interface between utility and most of the power electronic equipments[1]. These electronic equipments also form a major part of load on the utility. Two factors that provide a quantitative measure of the power quality in an electrical system are Power Factor (PF) and Total Harmonic Distortion (THD).The amount of useful power being consumed by an electrical system is predominantly decided by the PF of the system. Generally, to convert line frequency ac to dc, a line frequency diode bridge rectifier is used. To reduce the ripple in the dc output voltage, a suitable filter capacitor and/or an inductor is used at the rectifier output[2]-[3]. But due to these reactive components, the current drawn by this converter is peaky in nature, very much differed from asinusoidal shape. This input current is rich in lower order harmonics. Also, as power electronics equipments are increasingly being used in power conversion, they inject low order harmonics into the utility. Due to the presence of these harmonics, the total harmonic distortion is high when so many are put together in a huge electronic system. Additionally, the input power factor becomes poorer. Due to the disadvantages associated with low power factor and harmonics, utilities enforces (in some countries) harmonic standards and guidelines which will limit the amount of current distortion allowed into the utility. Looking into the serious effects generated by conventional converters, the simple diode rectifiers should not be used. There is a need to achieve rectification at close to unity power factor and low input current distortion.

Several solutions have been proposed when the objective is to supply three-phase motors from single-phase ac mains [8]–[16]. It is quite common to have only a single-phase power grid in residential, commercial, manufacturing, and mainly in rural areas, while the adjustable speed drives may request a three phase power grid. Single-phase to three-phase ac–dc–ac conversion usually employs a full-bridge topology, which implies in ten power switches, as shown inFig.1.

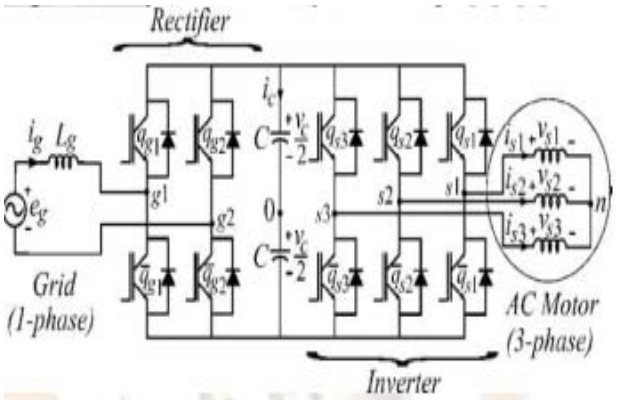

Fig. 1: Conventional single-phase to three-phase drive system

This converter is denoted here as conventional topology. In this paper, a single-phase to three-phase drive system composed of two parallel single-phase rectifiers and a three-phase inverter is proposed, as shown in Fig. 2.

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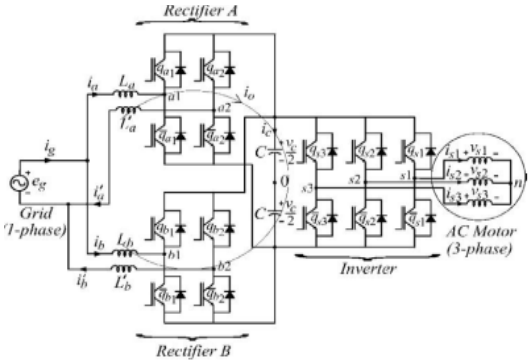
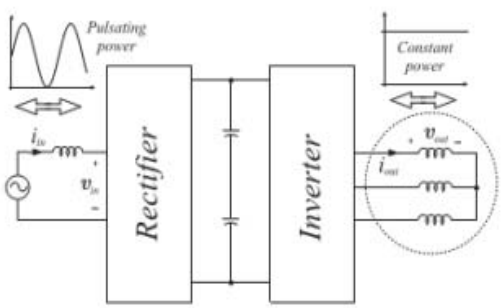


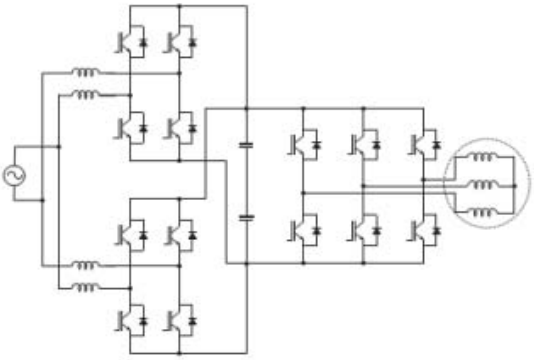
Fig. 2: Proposed single-phase to three-phase drive system

The proposed system is conceived to operate where the single-phase utility grid is the unique option available. Compared to the conventional topology, the proposed system permits: to reduce the rectifier switch currents; the total harmonic distortion (THD) of the grid cur-rent with same switching frequency or the switching frequency with same THD of the grid current; and to increase the fault tolerance characteristics. In addition, the losses of the proposed system may be lower than that of the conventional counterpart. The aforementioned benefits justify the initial investment of the proposed system, due to the increase of number of switches.

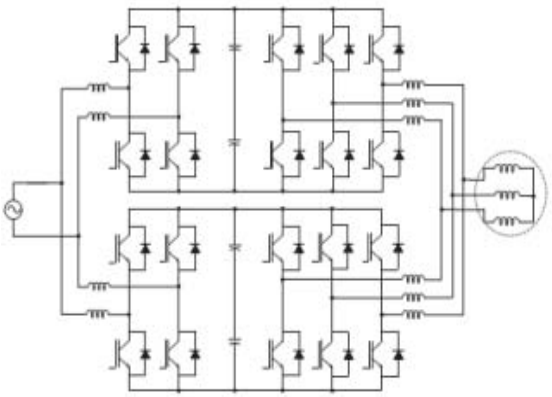
Fig 3. Shows the single-phase to three-phase power conversion with parallel configuration. Another important characteristic observed in the single-phase to three-phase power converters that also has been considered in this paper is the irregular distribution of power losses among the switches of the converter, as observed in Fig. 4.It means that, for a 600 V 50A class of insulated gate bipolar transistor (IGBT), 63% of the total losses measured in the single-phase to three-phase converter is concentrated in the rectifier circuit, while the rest 37% is observed in the inverter circuit. With those numbers, it is possible to measure the stress by switch, which means that each rectifier switch is responsible for 15.7% of the total converter losses, while each inverter switch is responsible for only 6.1%. The loss per switch gives an important parameter regarding the possibilities of failures in the power converters.



(a)



(b)



(c)

Fig. 3: Single-phase to three-phase power conversion. (a)Type of power processed by rectifier and inverter circuits.(b) Solution employed in [15]. (c) Solution employed in[16]

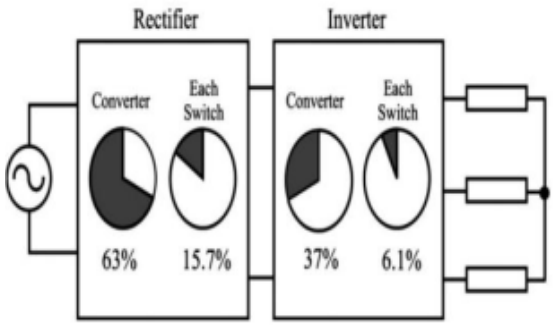


Fig. 4: Converter power losses distribution in both rectifier and inverter units:63% in the rectifier circuit and 37% in the inverter one. Power losses in each switch of the rectifier (15.7%) and inverter (6.1%)

II. System Model

This section will present the model of the proposed configuration. Such a configuration is constituted by a where p = d/dt and symbols like r and l represent the resistances and inductances of the input inductors. The circulating current io can be defined from ia and i' a or ib and i'b i.e.

$$i_0 = i_a - i'_a = -i_b + i'_b$$

$$V_a = e_s - [r_a + r'_a + (I_a + I'_a)p]i_a + (r'_a + I'_a p)$$

$$V_b = e_s - [r_b + r'_b + (I_b + I'_b)p]i_b + (r'_b + I'_b p)i_0$$

$$V_0 = -[r_a' + r'_b + (I_a' + I'_b)p]i_0 - (r_a - r'_a + (I_a + I'_a)p]i_a + [r_b + r'_b + (I_b + I'_b)p]i_b$$

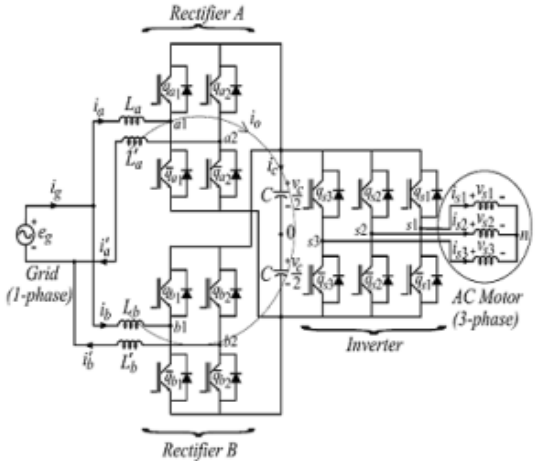


Fig. 5: Proposedsingle-phase to three-phase drive system.

To avoid the circulating current, the following three approaches are used commonly

i. Isolation. In this approach, the overall parallel system is bulky and costly because of additional power supplies or the ac line-frequency transformer.
ii. High impedance. They cannot prevent a low frequency circulating current.
iii. Synchronized control. This approach is not suitable for modular converter design. When more converters are in parallel, the system becomes very complicated to design and control.

In this proposed method the system is designed to reduce the circulating current (Io). From fig.5.the following quations can be derived for the front end rectifier.

$$V_{a10} - V_{a20} = e_s - (r_a + I_a p)i_a - (r'_a + I'_a p)i'_a$$
$$V_{b10} - V_{b20} = e_s - (r_b + I_b p)i_b - (r'_b + I'_b p)i'_b$$
$$V_{a10} - V_{b10} = (r_a + I_a p)i_a - (r_b + I_b p)i_b$$

In this ideal case, the circulating current can be reduced to zero imposing

$$V_0 = V_{a10} + V_{a20} - V_{b10} - V_{b20} = 0$$

When $I_a = 0$ then $I_a = I'_a$ and $I_b = I'_b$ and the system model reduced to the model given by

$$V_a + \frac{V_0}{2} = e_s - 2(r_s + I_s' p)i_a$$
$$V_b + \frac{V_0}{2} = e_s - 2(r_s' + I_s' p)i_b$$
$$V_0 = 2(r_s' + I_s' p)i_0$$

$$V_{ab} = \frac{V_a + V_b}{2} = e_s - (r_s' + I_s' p)i_a$$
$$V_a - \frac{V_0}{2} = e_s - 2(r_s' + I_s' p)I_a'$$
$$V_b - \frac{V_0}{2} = e_s - 2(r_s' + I_s' p)I_b'$$
$$V_a = e_s - 2(r_s + I_s' p)i_a$$
$$V_b = e_s - 2(r_s' + I_s' p)i_b$$

III. Control Strategy

The gating signals are obtained by comparing pole voltages with one (vt1), two (vt1 and vt2) or more high frequency triangular carrier signals. In the case of double carrier approach, the phase shift of the two triangular carrier signals (vt1 and vt2) is 1800. The parameter μchanges the place of the voltage pulses related to va and vb. When vx* = vx*min ($\mu = 0$) orvx* = vx*max ($\mu = 1$) are selected, the pulses are placed in the beginning or in the end of half period (Ts) of the control block diagram of Fig.2, highlighting the control of the rectifier. To control the dc-link voltage and to guarantee the grid power factor close to one. Additionally, the circulating current io in the rectifier of the proposed system needs to be controlled.

In this way, the dc-link voltage vc is adjusted to its reference value v_c* using the controller R_c, which is a standard PI type controller. This controller provides the amplitude of the reference grid current I_s*. To control power factor and harmonics in the grid side, the instantaneous reference current I_s* must be synchronized with voltage e.g., as given in the voltage-oriented control (VOC) for three-phase system. This is obtained via blocks Ge-ig, based on a PLL scheme Fig 6. The reference currents I a*and ib* are obtained by making i_a* = i_b* = I_s*/2, which means that each rectifier receives half of the grid current. The control of the rectifier currents is implemented using the controllers indicated by blocks R_a and R_b. These current controllers define the input reference voltages va*and vb*. The homo polar current is measured (i_o) and compared to its reference (i_o* = 0). The error is the input of PI controller Ro, that determines the voltage v_o*. The motor there-phase voltages are supplied from the inverter (VSI). Block VSI-Ctr indicates the inverter and its control. The control system is composed of the PWM command and a torque/flux control strategy(e.g., field-oriented control or volts/hertz control)

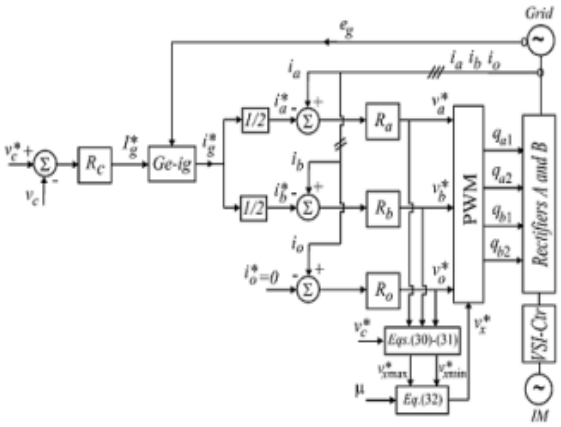


Fig. 6: Control block diagram

IV. Simulation Results

The simulink models of the Proposed converter system, its control strategy and fault diagnosis is also carried out. The simulation results were obtained with the grid- and machine-phase voltages equal to 127 Vrms, dc-link voltage of 225 V, capacitance of 2200 μF, and input inductor filters with resistance and inductance given respectively by 0.1Ωand 2.6 mH. The load power was of 5 kVA.

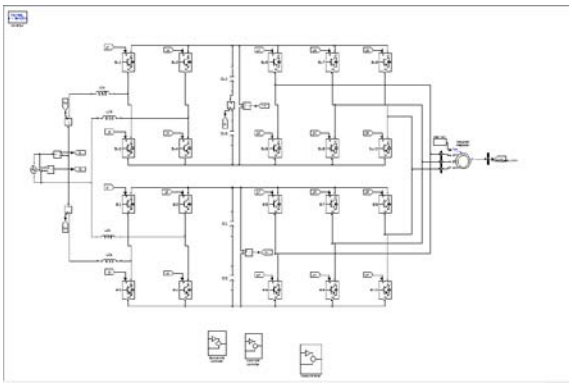


Fig 7: MATALB/SIMULINK diagram of proposed system

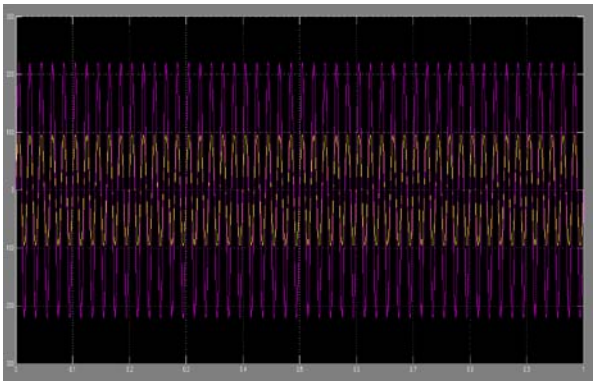


Fig. 8: voltage and current of the grid,

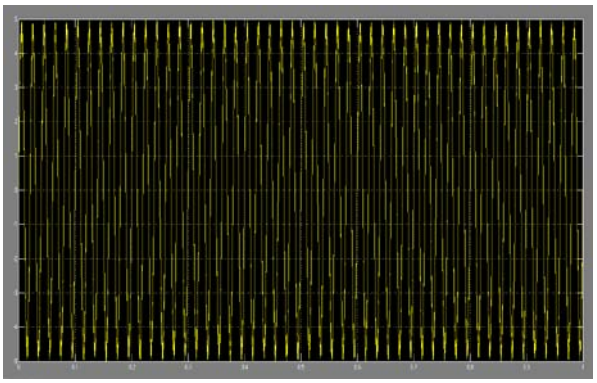


Fig. 9: Input current of the converter 1

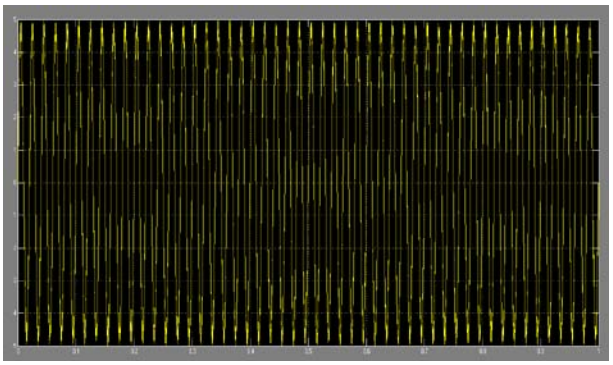


Fig. 10: Input current of the converter 2

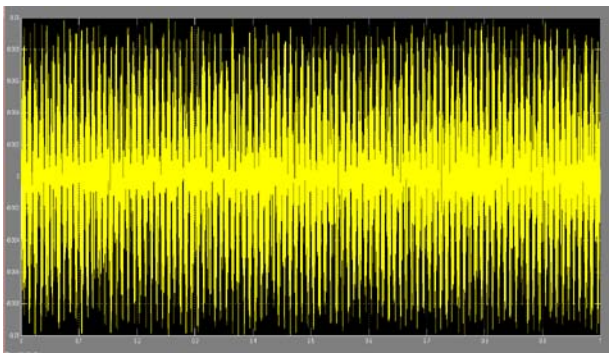


Fig. 11: Circulating current

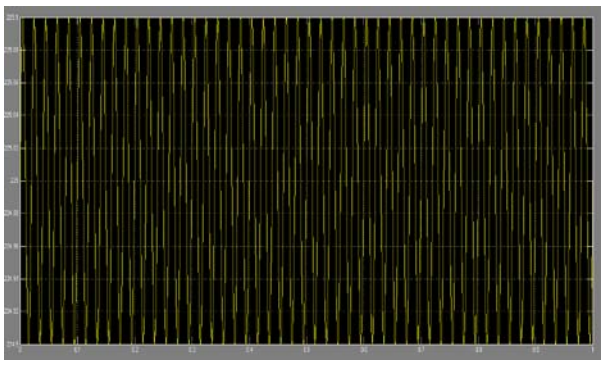


Fig. 12: dc-link voltage in C12

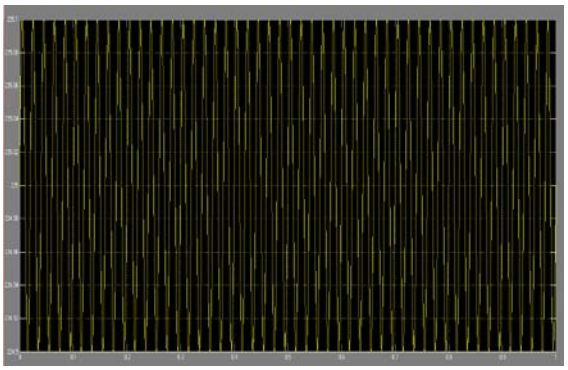


Fig. 13: dc-link voltage in C34

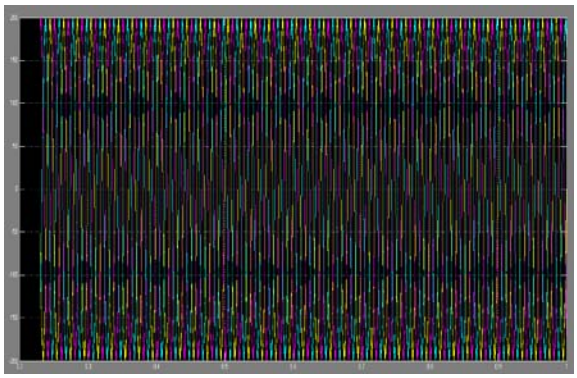


Fig. 14: load currents

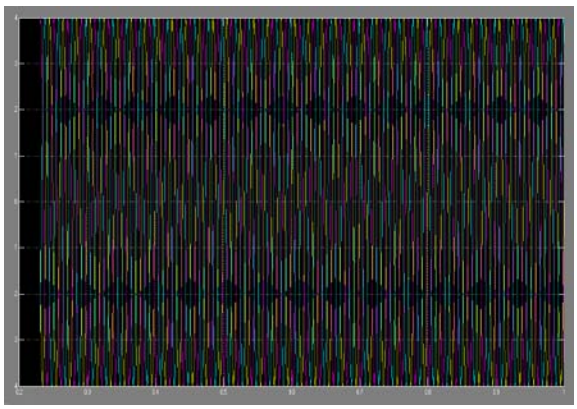


Fig. 15: load voltages

V. Conclusion

A single-phase to three-phase drive system composed of two parallel single-phase rectifiers, a three-phase inverter and an induction motor was proposed. The system combines two parallel rectifiers without the use of transformers. The system model and the control strategy, including the PWM technique, have been developed. The complete comparison between the proposed and standard configurations has been carried out in this paper. Compared to the conventional topology, the proposed system permits to reduce the rectifier switch currents, the THD of the grid current with same switching frequency or the switching frequency with same THD of the grid current and to increase the fault tolerance characteristics. In addition, the losses of the proposed system may be lower than that of the conventional counterpart. The initial investment of the proposed system (due to high number of semiconductor devices) cannot be considered a drawback, especially considering the scenario where the cited advantages justify such initial investment.

References Références Referencias

1. Bhim Singh, Sanjeev Singh, Ambrish Chandra, and Kamal Al-Haddad, " Comprehensive Study of Single-Phase AC-DC Power Factor Corrected Converters With High-Frequency Isolation" , IEEETRANSACTIONS ON INDUSTRIALINFORMA-TICS, VOL. 7, NO. 4, NOVEMBER2011, pp 540-556
2. Bhim Singh and Ganesh Dutt Chaturvedi "Analysis, Design, Modeling, Simulation and Development of Single-Switch AC-DC Converters for Power Factor and Efficiency Improvement", Journal of Power Electronics, Vol. 8, No.1, January2008, pp51-59.
3. Gerry Moschopoulos and Praveen Jain, "Single Phase Single-Stage Power-Factor-Corrected Converter Topologies", IEEE Transactions On Industrial Electronics, Vol. 52, No.1, February2005, pp23-35.
4. M. Liserre, —Dr. Bimal K. Bose: A reference for generations[editor's column], IEEE Ind. Electron. Mag., vol. 3, no. 2, pp.2–5, Jun. 2009.
5. F. Blaabjerg, A. Consoli, J. A. Ferreira, and J. D. van Wyk, —The future of electronic power processing and conversion, IEEETrans. Ind. Appl., vol. 41, no. 1, pp. 3–8, Jan./Feb. 2005.
6. F. W. Gutzwiller, —Thyristors and rectifier diodes-these miconductor workhorses, IEEE Spectrum, vol. 4, no. 8, pp.102–111, Aug. 1967.
7. A. Elasser, M. H. Kheraluwala, M. Ghezzo, R. L. Steigerwald, N. A. Evers, J. Kretchmer, and T. P. Chow, —A comparative evaluation of new silicon carbide diodes and state-of-the-artsilicon diodes for power electronic applications, IEEE Trans. Indust. Appl., vol. 39, no. 4, pp. 915– 921, Jul. /Aug. 2003.
8. M.-K. Nguyen, Y.-G. Jung, and Y.-C. Lim, —Single-phase AC–AC converter based on quasi-z-source topology, IEEE Trans. Power Electron., vol. 25, no. 8, pp. 2200–2210, Aug. 2010.
9. M.-K. Nguyen, Y. cheol Lim, and Y.-J. Kim, —A modifiedsingle-phase quasi-z-source AC–AC converter, IEEE Trans. Power Electron., vol. 27, no. 1, pp. 201–210, Jan. 2012.
10. B. Saint, —Rural distribution system planning using smart gridtechnologies, in Proc. Rural Electric Power Conf., Apr. 2009,pp. B3-1–B3-8.
11. A. R. C. de Lima Montenegro Duarte, U. H. Bezerra, M. E. de Lima Tostes, and G. N. da Rocha Filho, —Alternative energy sources in the Amazon, IEEE Power Energy Mag., vol. 5, no. 1,pp. 51–57, Jan./Feb. 2007.

12. X. Wang, H. Zhong, Y. Yang, and X. Mu, —Study of a novelenergy efficient single-phase induction motor with three series connected windings and two capacitors, IEEE Trans. Energy Convers., vol. 25, no. 2, pp. 433– 440, Jun. 2010.
13. M. Khan, I. Husain, and Y. Sozer, —Integrated electric motor drive and power electronics for bidirectional power flow between the electric vehicle and DC or AC grid, IEEE Trans. Power Electron., vol. 28, no. 12, pp. 5774–5783, Dec. 2013.
14. Y.-S. Lai, W.-T. Lee, Y.-K.Lin, and J.-F. Tsai, —Integrated inverter/converter circuit and control technique of motor drives with dual mode control for EV/HEV applications, IEEE Trans. Power Electron., vol. 29, no. 3, pp. 1358–1365, Mar. 2014.
15. C. B. Jacobina, E. C. dos Santos, Jr, N. Rocha, and E. L. Lopes Fabricio,—Single-phase to three-phase drive system using two parallel single-phase rectifiers, IEEE Trans. Power Electron., vol. 25, no. 5, pp. 1285–1295, May 2010.

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Bandwidth Enhancement of Compact Circular Slot Antenna for UWB Applications

Sonalika P. Kulkarni & Veeresh G. Kasabegoudar

Dr. Babasaheb Ambedkar Marathwada University

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Keywords: microstrip antenna, return loss, UWB antenna.

GJRE-F Classification: FOR Code: 090699

Strictly as per the compliance and regulations of :

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Indexterms: microstrip antenna, return loss, UWB antenna.

I. Introduction

With the rapid development of wireless communication systems and increase in their applications, compact and wideband antenna design has become a challenging topic [1]. Printed slot antennas are widely used in a variety of communication systems because wide-slot antennas have two orthogonal resonance modes, which are merged to create a wide impedance bandwidth [2]. Thus, printed slot antennas have recently received a great deal of attention from researchers. As is well known, an antenna with various shapes such as circle [3], ellipse [4], and triangle [5] were reported for wide bandwidth. Each slot shape requires a feed stub of appropriate shape. An optimum impedance bandwidth can be obtained by the coupling between the feeding structure and the slot.There are some more methods of Bandwidth of antenna Increases Like bandwidth of a dual patch antenna is improved by etching dummy EBG pattern on the feed- line [6]and proximity coupled feed and aperture coupled feed methods are used [7].The slots etched on the ground plane and split square ring slots etched on the patch has been designed with wide bandwidth and minimal return loss characteristic for UWB applications [8].The new method of enhancing the bandwidth of a proximity coupled microstrip patch antenna using an integrated impedance matching network (IMN) is presented [9].

Patch antenna possesses many advantages such as low profile light weight small volume and compatibility with monolithic microwave integrated circuits (MMIC) and MIC. The narrow bandwidth is the major obstacle in wide application for the micro strip antenna [10]. Basically, the maximum achievable data rate or capacity for the ideal band-limited additive White Gaussian noise (AWGN) channel is related to the bandwidth and the signal-to-noise ratio through Shannon-Nyquist criterion [12].

$$C = B \log_2 (1 + SNR) \quad (1)$$

Where C denotes the maximum transmit data rate, B stands for the channel bandwidth, and SNR is the signal-to-noise ratio. From this principle, the transmit data rate can be enhanced by increasing either the bandwidth occupation or the transmission power.

In this article, we report a technique to enhance the bandwidth using a microstrip-fed planar circular disc monopole. The circular disc monopole with a 50-Ω microstrip feed line is fabricated on the FR4 substrate. To improve the bandwidth, we modified the original ground plane to be T-shaped with diagonal cuts at the top corners and rectangular slots on the body with the ring and slot introduced in the patch of the antenna. Applications of corner cut technique have been previously employed to improve the impedance bandwidth for microstrip patch antennas [4– 6]. The preliminary simulation results of our proposed antenna are compared with the measured ones. Following this introduction, the rest of the paper is organized as follows.

The detail of the antenna design and preliminary results from simulations are described in Section 2, and Section 3 presents the modifications done to achieve UWB operation. Experimental validation and discussions are presented in Section 4 followed by conclusions of the work carried out in Section 5.

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II. Basic Antenna Geometry

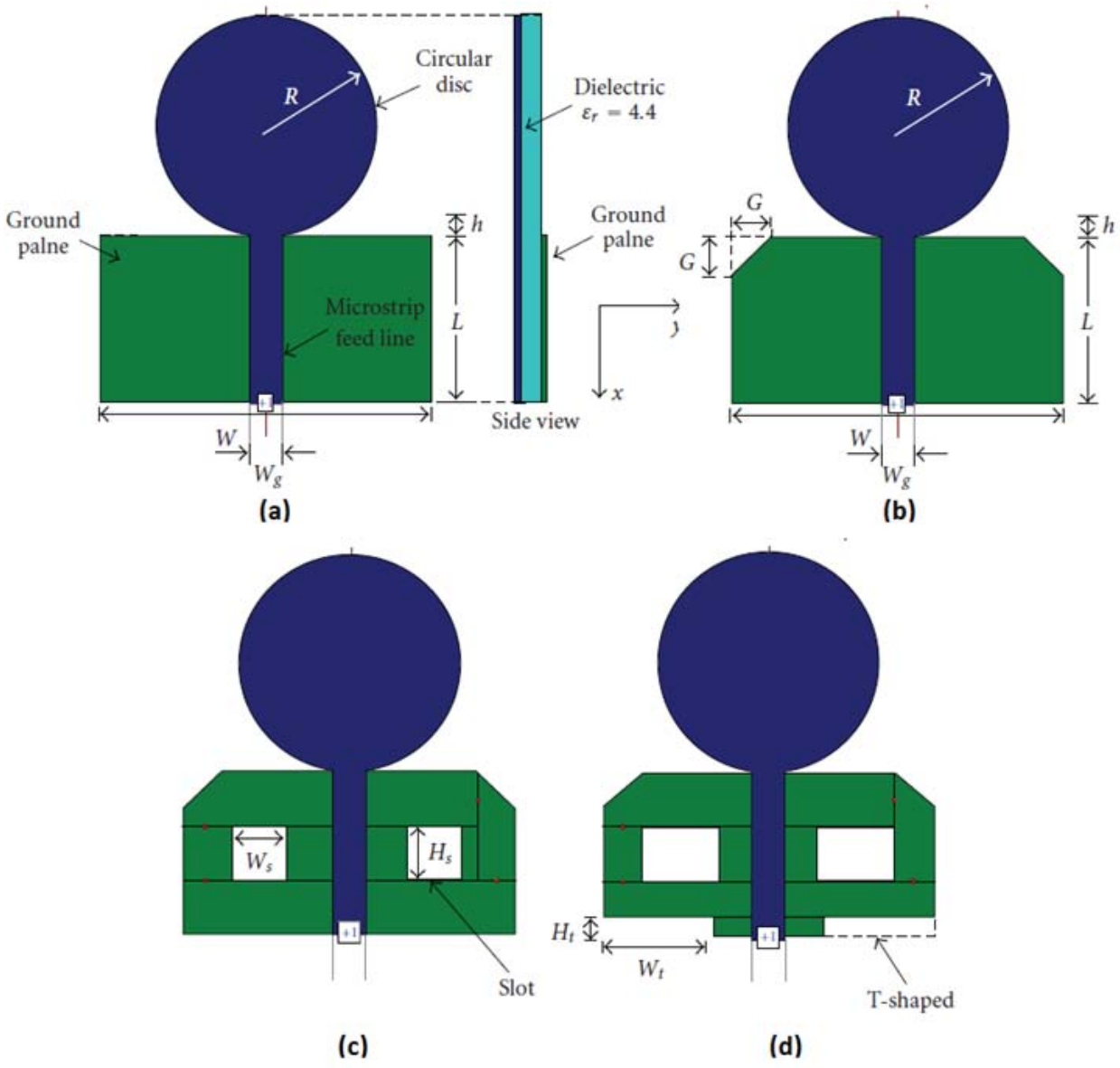
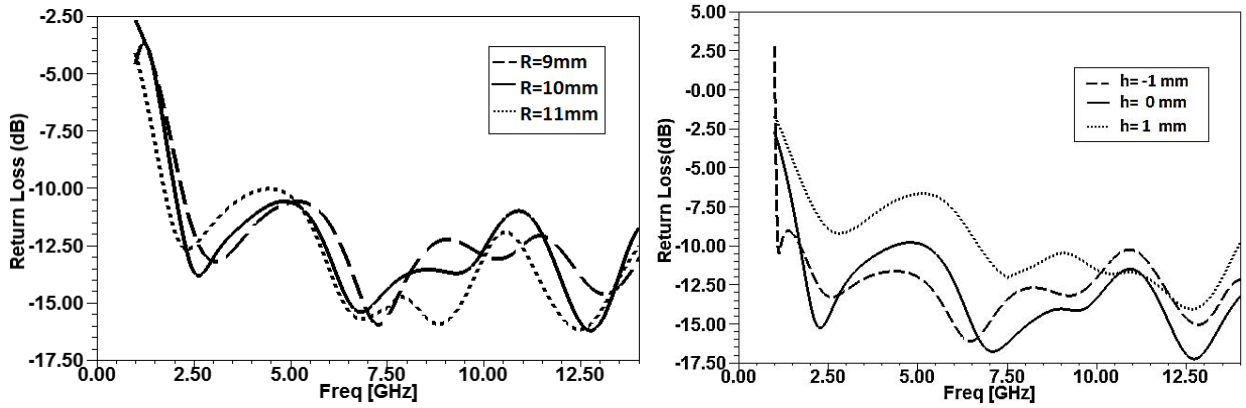


Figure 1: Geometries of the circular microstrip antennas (a) original shape, (b) with diagonal edges, (c) with slots, and (d) with T-shaped cut on the ground plane

The geometry of the proposed antenna is shown in Figure 1.The proposed antenna, with overall dimensions of only 30x41mm^2 is fabricated on a FR4 substrate with a relative permittivity of 4.4 and a thickness of 1.6 mm. On one side of the substrate, two ring-shaped slots are etched to create a relatively wide frequency band since the larger inverted slot affects the lower frequency mode, while the smaller one influences the higher frequency mode. Moreover, at the end of the feed line, a rectangular conducting patch is applied to create a good impedance matching for the proposed antenna to attain the bandwidth enhancement for the UWB applications. By properly varying the lengths of L and W, a wider impedance matching is achieved. To investigate the performance of the proposed antenna, the electromagnetic simulation software Ansoft HFSS is used for parameter studies and other parameters are also described in Figure 1.Unlike most of the ultra-wideband printed antennas which have partial or defected ground planes (DGS) for ultra-wide bandwidth enhancement, this antenna has a full ground plane.

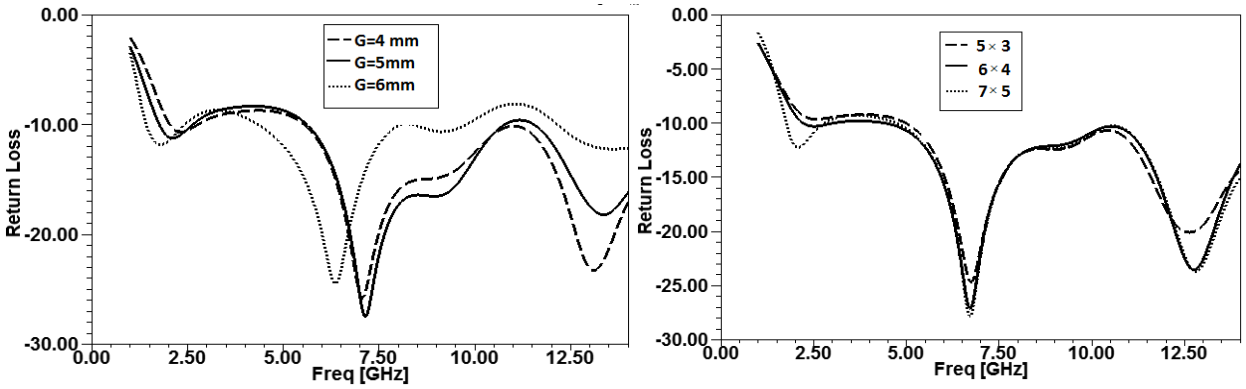


(a) (b)

Figure 2: Return losses as functions of (a) disc radius R and (b) vertical gap

In order to increase the impedance bandwidth, two C-shaped slots are inserted in the ground plane of the designed antenna as shown in Figure 1.The slotted ground planes that provide one more resonance is shown in Figure 2.The monopole antenna with slotted ground plane has wider impedance matching in comparison to the same antenna without slot in ground plane. The Results in Figure 2indicate the varying radius values increase the impedance bandwidth of the antenna and for this we have chosen the 10mm radius for optimum impedance bandwidth.

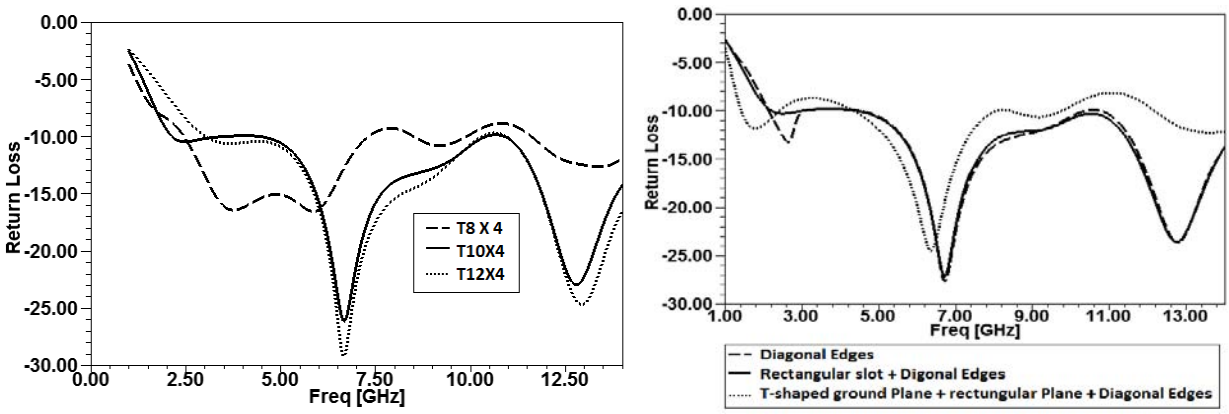
While the next parameter for selection of the gap (G) between the ground planes of the UWB antenna with respect to the feed line of the UWB antenna. Whenever the *h* is positive the bottom of the disc is at the higher level than the top of the ground plane. The same can be said for the negative value of *h* in the opposite direction. The results of the return loss and bandwidth as a function of the parameter h are shown in Figure 2(b).By analysing the *h* parameters we select it is zero value for the good frequency resonance. Later the length of the ground plane of the UWB antenna is analysis on the basis of parametric study. The length equal to L=15 mm for the high impedance bandwidth of the antenna. Second, the length of the ground plane affects the impedance matching more significantly at higher frequencies than at lower frequencies as shown in Figure 3.



(a) (b)

Figure 3: (a) Return losses as a function of the parameter *G* associated with the removed area on the ground plane. (b) Return loss (Γ) of antenna with slot dimension

In this study, a change in the dielectric constant leads to a shift in the characteristic impedance of the feeding strip from 50 ohm [13]. The corner cut used here plays an important role in balancing resistive part and reactive part which affect the impedance matching shown in Figure 3(a). Triangle slot at the Ground plane of the antenna increases radiating edges which results in improved bandwidth [14]. A parametric analysis for the effect of the position of rectangular slot with respect to the ground plane on the return loss is shown in Figure 3(b).



(a) (b)

Figure 4: (a) Return losses of antenna as a function of T-shaped cut dimension (b) Comparison of return lossless of all three antennas shown in Figure 1(i.e., Figures 1(b), 1(c), and 1(d))

As it could be observed from Figure 4, at each frequency band the surface current is concentrated around different part of the slots, indicating that the slots functioned as band stop filters to reject each target band. In order to further improve the overall bandwidth, rectangular-shaped slot in the patch is incorporated. The return loss of the antenna in Figure1 (d) Shown in Figure 4(b).Fig illustrates the return loss for different values of slot width and with different parameters of antenna. It is seen that the bandwidth is dependent on the width of the rectangular slot. In order to achieves to highest bandwidth of UWB antenna the rectangular slots, T-shaped slots and the Corner cut slots are introduced in the UWB antenna. A Comparison among the Antennas with modified dimension of ground plane is shown in Figure 4.

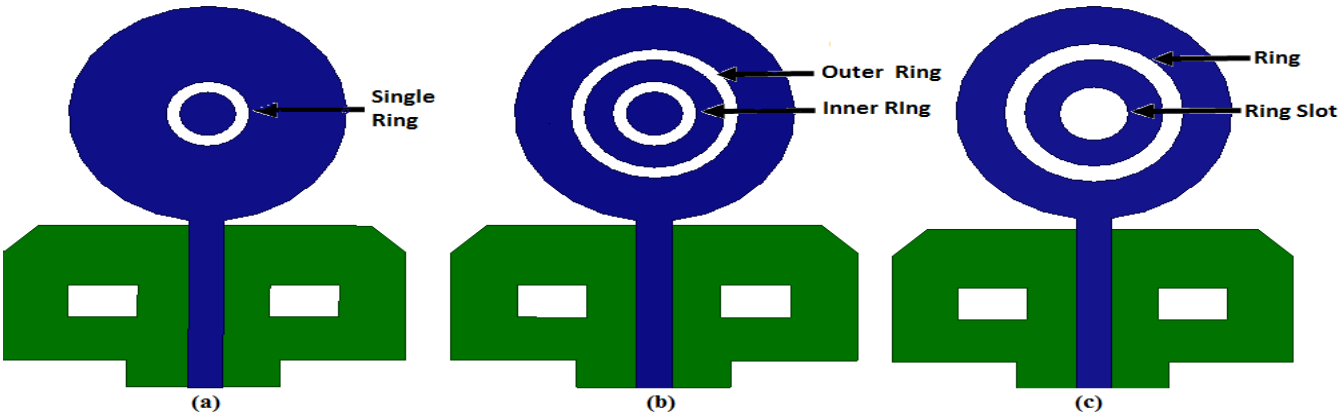
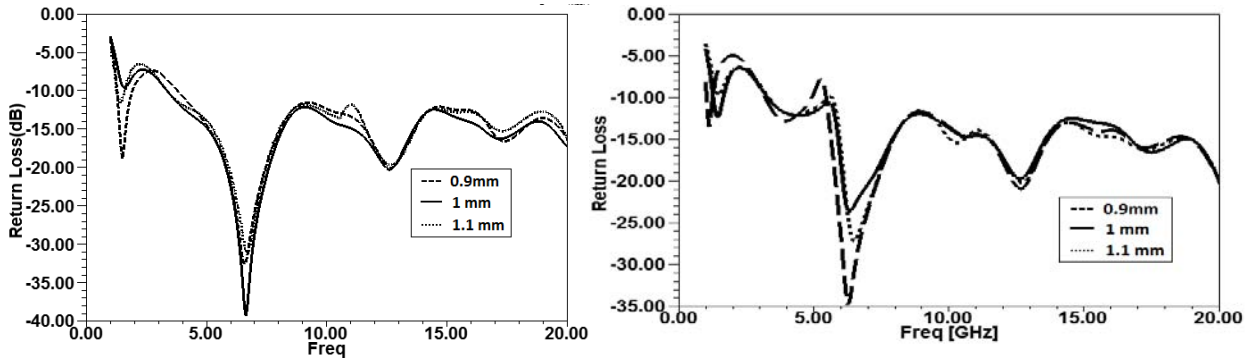


Figure 5: Different Ring Structure (a) Single Ring (b) Inner and outer ring (c) Single ring with slot antennas

III. Antenna Modifications with Ring slot

For more increasing the impedance bandwidth of the antenna the ring type structure enter in the patch of the UWB antenna. In the first UWB antenna, single ring slot insert in the patch of UWB antenna which shown in Figure5. And figure 6(b) shows the two ring structure insert in the patch antenna. Due to insertion of slot in the Patch of the antenna which results shown in Figure 6 and the proposed antenna structure which shown in Figure 5(d) which insert one slot and one Ring structure shaped slot in the patch of UWB antenna.



(a) (b)

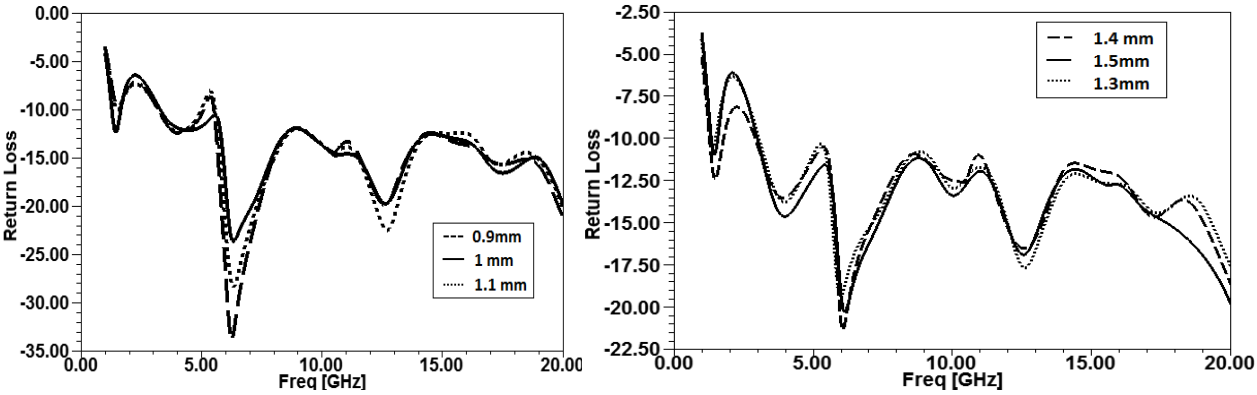
Figure 6: (a) Return loss of antenna with Single Ring dimension b) Return loss of antenna with inner Ring dimension

To meet the required objectives, some geometrical alterations have been made in the antenna when compared to the conventional micros trip patch antenna. By varying the radiuses of the ring in the patch of UWB antenna is shown in Figure 7.

The comparison over the different slot of the antenna shown in Figure 5 over the bandwidth and return loss and gain frequency shown in Table 1. Fractional bandwidth is also calculated and gain of the UWB antenna is also shown in Table 1.

Table 1: Comparison of the ring and round circular slot on antenna parameters

Sr. No.	Types	Resonance Frequency	Return Loss(dB)	VSWR	Bandwidth (MHz)	% BW	Gain (dB)
1	Single Ring	6.6	-39.32	1.05	1670	143%	3
2	Two Rings	6.2	-23.16	1.15	1680	144%	4.3
3	Two Ringswith Slot	6.6	-20.19	1.21	1710	149%	4.4s

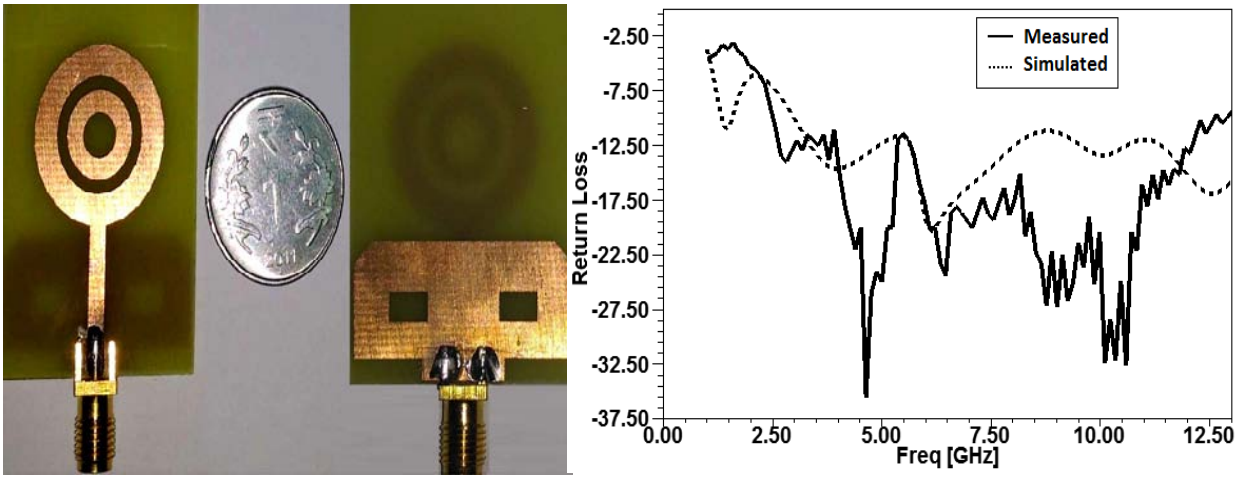


(a) (b)

Figure 7: (a) Return loss of antenna with outer ring dimension (b) Return loss of antenna with single ring dimension with slot antenna

IV. Results and Discussions

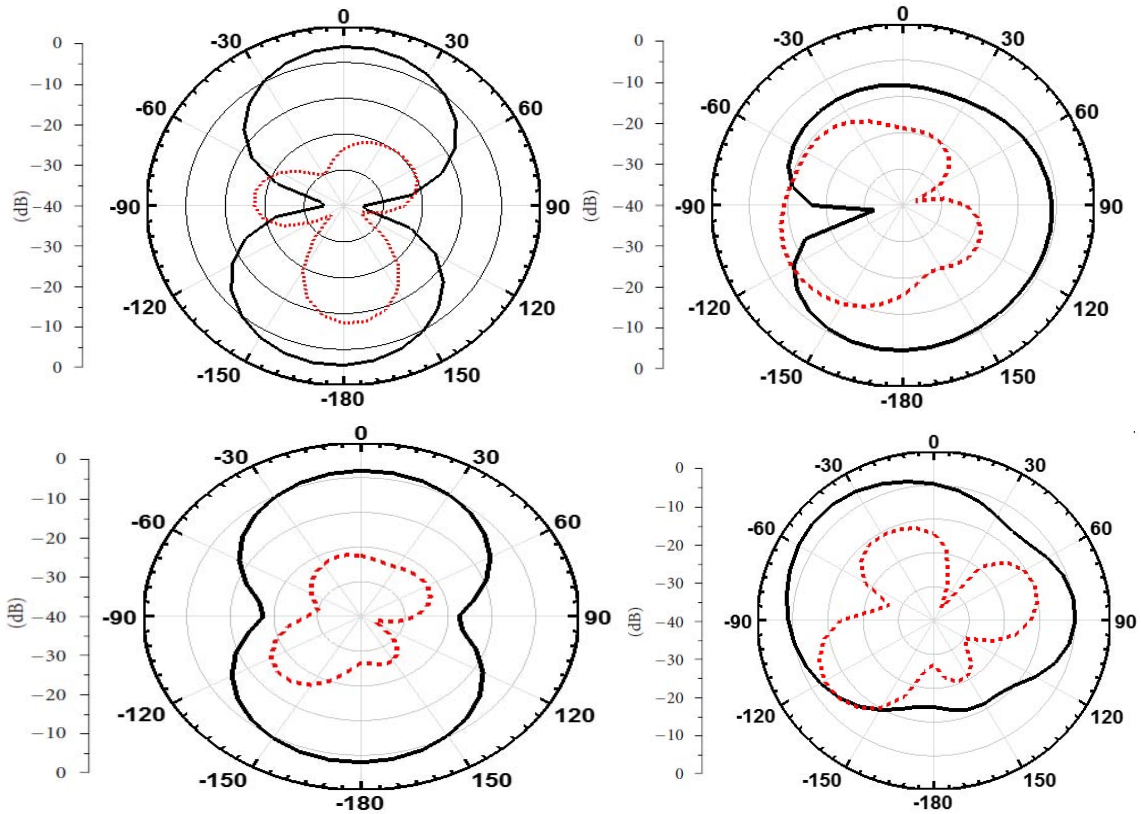
The comparison between the simulated results using commercial high frequency structure simulator (HFSS) and the results from the measurement of the fabricated antenna using a ROHDE N SCHWARZ ZVL Vector Network Analysers is shown in Figure 8(b). The measured result is relatively close to that obtained from simulation. The discrepancy of the return loss at the first resonant frequency would be caused by the size difference of the circular discs [17–19] between the simulation model and the fabrication as mentioned in the previous section.



(a) (b)

Figure 8: (a) Prototype of fabricate Antenna (b) Comparison of simulated and measured return loss of antenna

Antenna radiation patterns demonstrate the radiation properties on antenna as a function of space coordinate. For a linearly polarized antenna, performance is often described in terms of the E and H-plane patterns [8].



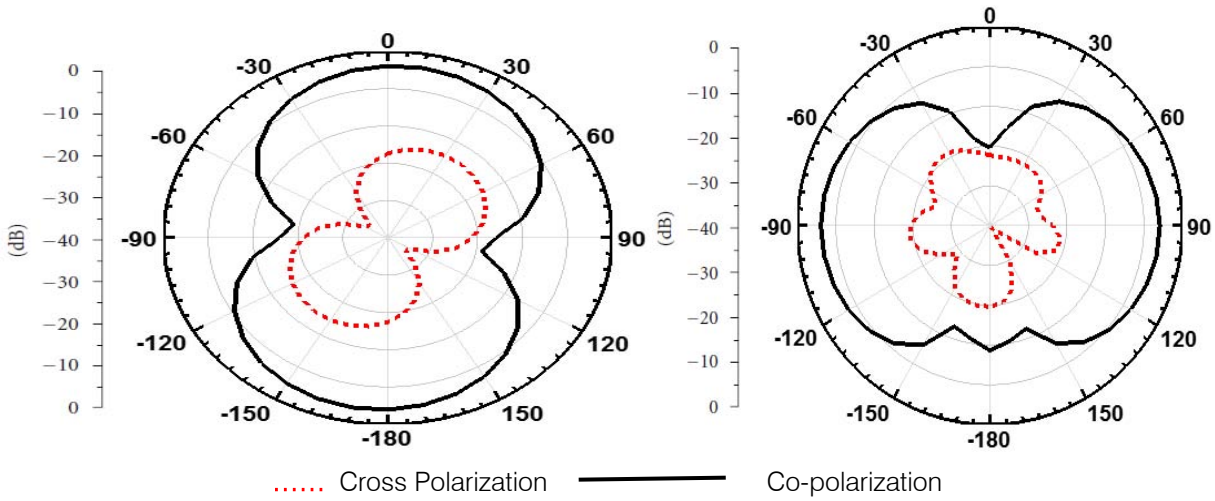


Figure 9: Simulated far-field radiation patterns; *(left)* H (x-z)-plane and *(right)* E (y-z)-plane at (a) 3.24 (b) 4.22, and (c) 9.12 GHz

The electric field (E) and magnetic field (H) planes at different frequencies are shown in Figure 9. It is obvious that the antenna behaves like a typical monopole antenna that acquires Omni-directional pattern in the lower frequencies and quasi Omni-directional pattern in the higher ones. It is known that a conventional thin patch antenna with a full ground plane is inherently narrow band. Thus, to achieve a very wide bandwidth, several bandwidth enhancement techniques, such as inclusion of multiple resonators [13], slots [15], and parasitic element [16] are applied.

The 10 dB return loss bandwidth is indeed slightly decreased (4.2 to 9.3 GHz) compare to the flat one. This shows that the antenna is relatively robust against the physical deformation. The peak gain of the antenna is shown in Figure 10.

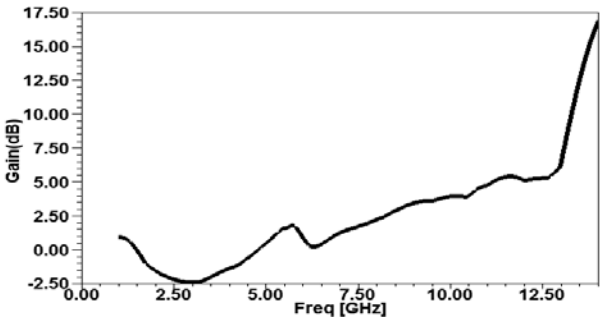


Figure 10: Simulated gain of the antenna vs. frequency

V. Conclusions

In this paper, a compact small square monopole antenna suitable for UWB applications has been investigated and presented. By inserting the ring shaped structure and circular slot on the patch of antenna which resulted in the good impedance bandwidth. The length of the ground plane at the bottom layer and the position of the slot with respect to the ground plane play a great role in optimizing the return loss, and the antenna radiation parameters. The radiation patterns of this antenna show good omni-directional performance throughout the UWB frequency range and positive gain. Because of its simple structure, compact size, and good performance the proposed antenna is expected to be a good candidate in various UWB systems.

References Références Referencias

1. K. L. Wong, *Compact and Broadband Microstrip Antennas*. NewYork: Wiley, 2002.
2. M. Kahrizi, T. K. Sarkar, and Z. A. Maricevic, "Analysis of a wide radiating slot in the ground plane of a microstrip line," *IEEE Trans. Antennas Propag.*, vol. 41, no. 1, pp. 29–37, Jan. 1993.
3. S.-W. Qu, J.-L S. Li, J.-X. Chen, and Q. Xue, "Ultra-wideband strip-loaded circular slot antenna with improved radiation patterns," *IEEE Trans. Antennas Propag*., vol. 55, no. 11, pp. 3348–3353, Nov.2007.
4. P. Li, J. Liang, and X. Chen, "Study of printed elliptical/circular slot antennas for ultra-wideband applications," *IEEE Trans. Antennas Propag*., vol. 54, no. 6, pp. 1670–1675, Jun. 2006.
5. W.-S. Chen and F.-M. Hsieh, "A broadband design for a printed isosceles triangular slot antenna for wireless communications," *Microw. J*., vol. 48, no. 7, pp. 98–112, Jul. 2007.
6. M. Gujral1, J. L.-W. Li1, T. Yuan2, and C.-W. Bandwidth improvement of microstrip antenna array using dummy EBG pattern on feed line, *Progress in Electromagnetics Research*, vol. 127, pp. 79-92, 2012.
7. M. Albooyeh, N. Komjani, and M. Shobeyri, "A novel cross-slot geometry to improve impedance bandwidth of microstrip antennas" *Progress in Electromagnetics Research Letters*, vol. 4, pp. 63–72, 2008.

8. E. Sarva Rameswarudu and P.VSridevi," Bandwidth enhancement defected ground structure microstrip patch antenna for K and Ka band Applications", *International Conference on Advances in Electrical, Electronics, Information, Communication and Bio-Informatics*(AEEICB16).
9. E.H Kwak and B.G.Kwin," Bandwidth enhancement method for a proximity coupled microstrip patch antenna"978-1-4799-8767-2-/15.
10. K.P.Ray and Girish Kumar, *Broadband Microstrip Antennas*, Artech House,Boston London.
11. C. Balanis, *Antenna Theory, Analysis and Design*, 2nd Edition, John Wiley and Sons, NewYork, 1997.
12. J. G. Proakis, *Digital Communications*, Mc-Graw-Hill, NewYork, NY, USA, 1989.
13. Anurag Garg, Deepak Kumar Pankaj Kumar Dhaker, "A Novel Design Dual Band-Notch Small Square Monopole Antenna with Enhanced BandwidthforUWB Application" *IEEE International Conference on Computer, Communication and Control* (IC4-2015).
14. Ramesh Garg, IndrBahl, and Prakash Bhartiya, *Microstrip Antenna Design Handbook* Published in 2001 in Boston (Mass.) by Artech house.
15. S. I. Latif, L. Shafai, and S. K. Sharma, "Bandwidth enhancement and size reduction of microstrip slot antennas," *IEEE Trans. Antennas Propag*., vol. 53, no. 3, pp. 994–1003, Mar. 2005.
16. S.-H. WI, Y.-S. Lee, and J.-G. Yook," Wideband microstrip patch antenna With u-shaped parasitic elements," *IEEE Trans. Antennas Propag*., vol. 55, no. 4, pp. 1196–1199, Apr. 2007.
17. R. Zaker, Ch. Ghobadi, and J. Nourinia, "A modified Microstrip-fed two-step tapered monopole antenna for UWB and WLAN applications," *Progress in Electromagnetics Research*, vol. 77, pp. 137–148, and 2007.
18. S. L. S. Yang, K. F. Lee, A. A. Kishk, and K. M. Luk, "Design and study of wideband single feed circularly polarized microstrip Antennas," *Progress in Electromagnetics Research*, vol. 80, pp.45–61, 2008.
19. Y. Yang, Y. Wang, and A. E. Fathy, "Design of compact Vivaldi antenna arrays for UWB see through wall applications," *Progress in Electromagnetics Research*, vol. 82, pp. 401–418, and 2008.

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A Study on the Prospect of Geothermal Energy in Bangladesh

Vivekananda Das
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Abstract- Energy plays a vital role in ensuring sustainable development of a country. At present, Bangladesh is experiencing a lot of drawbacks as power demands are increasing at a rate greater than that of production. The country depends mainly on its natural gas reserve for power production, which is predicted to exhaust soon. As conventional sources of energy are finite and have negative impacts on environment, countries around the world are putting greater emphasis on harnessing electricity from renewable sources. In this context, geothermal energy can provide a viable solution for Bangladesh to ameliorate power crisis scenario and ensure a secured future. The Ganges-Brahmaputra Delta, world's largest one has formed the most parts of Bangladesh, which also has a large sedimentary basin. Different studies carried out by geologists in abandoned deep wells of northwest region found suitable temperatures of more than 100°C (in the depth of 3 to 4 kilometers) for geothermal plants. This paper recapitulates the fundamental concepts of geothermal energy, observes the potential geothermal resources of Bangladesh based on previous geological studies, also considers prevailing scenario in energy sector and government policy to provide suggestion for utilizing the resources in future.

Keywords: *geothermal energy, renewable energy, energy policy, environment.*

GJRE-F Classification: *FOR Code: 850502*

Strictly as per the compliance and regulations of :

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Keywords: geothermal energy, renewable energy, energy policy, environment.

I. Introduction

The thermal energy generated and stored inside the earth is known as 'Geothermal Energy'. This kind of energy is extracted from hot water or steam found a few kilometers underneath the earth's surface and further deeper to the level of magma which is molten rock of exceedingly high temperature. Geothermal energy from hot springs has been used for bathing purpose since Paleolithic ages and also for space heating since the times of ancient Roman Empire [1]. In modern day world, this energy is utilized as a clean and sustainable source of electricity production. Currently, 24 countries are producing electricity from geothermal resources. In January 2015, the global market was about 12.8 GW and highly anticipated to extend between 14.5 GW and 17.6 GW by 2020 [2].

Bangladesh is in dire crisis of electricity; the per capita energy consumption is only 371 KWh as of January 2016 [3], among the lowest in the world. Major share of the total generation is based on natural gas [4], but the country's gas reserve is in an alarming situation with the possibilities of dying out within 2020 [5]. Other plants are mainly dependent on petroleum and coal, but the additional amount spent in those imports are disrupting GDP as much as 2% annually [5]. For tackling the prevailing energy crisis to some limit, Ruppur Nuclear Plant – first of its kind in the country – is expected to start operating in 2021; however, it will include higher probability of disastrous consequences like environmental and health hazards. In such a situation, geothermal energy, a renewable one, has been proposed to meet the challenges of increasing power demand in a safe, sustainable and environmentally friendly way.

II. Background of Geothermal Energy

Two Greek words – Geo and Therme, meaning the earth and the heat respectively [7] are combined to derive the word Geothermal. So, it means the heat within the earth.

Earth's core with temperature of approximately 6000^0 C is the source of geothermal energy. Fundamentally, five layers form the earth - inner core, outer core, mantle, upper mantle and the crust. Temperature increases about 17° to 30°C per every kilometer in case of going downwards from the earth's surface [8]. This energy inside the earth is produced from the primordial heat and radioactive decay. Immense amount of heat produced during the formation of earth about 4.5 billion years ago is known as primordial heat. Radioactive decay is from substances that were radioactive during the earth's early days, and the decay is still occurring deep within the earth, releasing enormous heat [8].

From the earth's core, the heat consistently moves upwards to reach mantle which is a layer of rock. Some of the mantle melts to become magma as temperature and pressure reaches a certain value. Because of being lighter than the rock nearby, the magma moves slowly upwards the earth's crust, carrying the heat along with it. Sometimes the hot magma finds a way to reach the earth's surface, then it is called lava. But on most occasions, the magma stays beneath the earth's crust, heats surrounding rocks and water. Some of the hot geothermal water moves upwards through faults and cracks which is referred to as hot spring or geyser. Usually, it remains trapped in cracks and porous rocks deep underground to form a geothermal reservoir [9]. Production wells are used to lead hot water/steam from the reservoir to the power plant.

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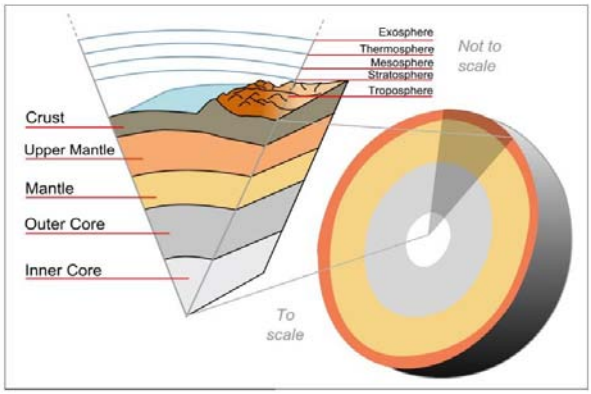

Fig.1: The earth layers [8]

III. Prospective Areas in Bangladesh with Geothermal Resources

Studies performed by geologists in various abandoned deep wells excavated for finding natural gas and oil indicated possibilities of geothermal reservoirs in Bangladesh. Because of varying geo-tectonic patterns of the country, probable resources of geothermal energy are basically divided into two regions- i) Northwest, known as 'Shield areas of the country' and ii) Southeast, referred to as 'Bengal foredeep region' existing in the deep sedimentary basin [13].

Different geological aspects of the northwest, such as the hydrogeological settings, seismicity and earthquakes, clustering of basement faults, and surface thermal anomalies indicate possible existence of geothermal reservoirs at a depth of few kilometers below the earth's surface. In this region, the geothermal gradient ranges from 20.8° to 48.7°C/km [13]. Study carried out by Mizanur Rahman exhibited the potential of a geothermal resource in Thakurgao district [12]. Singra-Kuchma-Bogra are promising areas of inspection in the Bogra shelf region; the Singra well with over 150° C bottom hole temperature is the most propitious among the three areas [10]. Two other zones of interest are the Barapukuria coal basin area and the Madhyapara hard rock mine area [11]. Using geochemical information from water samples of the Madhyapara hard rock mine area's basement aquifer, temperature was found to be varying in the range of 67° to 153°C, referring to a probable low-temperature geothermal reservoir in this area [13].

In the southeast region, geothermal gradient varies from 19.8° to 29.5°C/km. Sitakund hilly area is a place of interest because of having few thermal springs. Elsewhere Hatiya trough at Shahbajpur 1 well has the highest gradient of 29.5°C/km followed by Saldanadi 1 with gradient of 27.2°C/km in this region [13].

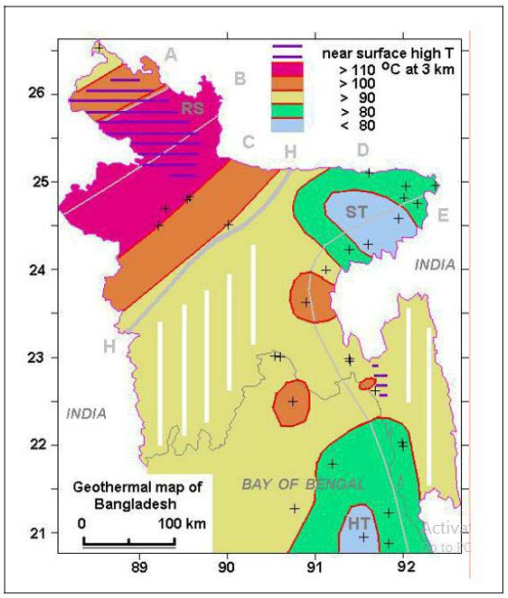

Fig.2: Geothermal Map of Bangladesh showing temperatures at 3 km [10]

IV. Available Methods of Geothermal Energy Extraction

Geothermal power plants work on the same principle as other thermal power plants using steam driven turbines – heat derived from a fuel source (Earth's core for this case) is applied to heat water or any other working fluid to produce steam or vapor which rotates a turbine to activate a generator, ultimately generating electricity. Afterwards, the fluid is cooled and brought back to the original heat source to reuse. Based on working principle, geothermal plants can be divided into three types- dry steam, flash steam, and binary cycle [14].

Dry Steam: In a dry steam power plant, steam is drawn from reservoir located underground and piped directly to a turbine generator unit. Underground source of steam is necessary here [14]. It is the oldest among the various types of plants.

Flash Steam: For a flash steam plant, hot water of high-pressure is pulled into lower-pressure tanks, and the resultant flashed (vaporized) steam is used to operate turbines. It necessitates fluid of more than 182°C temperature. It is the most usual type of plant operating in present day world [14].

Binary Cycle: Binary cycle plant is the latest advancement in this field. It uses water of lower temperatures, between 107^0 to 182^0 C [14]. The hot water is utilized to vaporize a working fluid, commonly a hydrocarbon; for instance, isopentane or a refrigerant of lower boiling point [15]. In a heat exchanger, the working fluid is then vaporized to turn a turbine. Finally, the water is fed back into the reservoir to be reutilized. Currently, binary cycle plants exploit two distinct geothermal resources: enhanced geothermal systems (EGS) and low-temperature or co-produced resources [14].

Along with the three types of geothermal plants discussed above, hybrid systems are also in use, which are actually combined systems consisting of more than two of the basic types connected in series and/or in parallel.

Table I: Uses and Technologies for Various Reservoir Temperatures

Temperature of Reservoir	Available Fluid	Technologies Used
High Temperature (>220^0C) [1]	Steam, Water	Dry Steam, Flash Steam, Combined Cycle (Flash and Binary)
Intermediate Temperature (100^0 – 220^0 C) [1]	Water	Flash Steam, Binary Cycle
Low Temperature (30^0 – 150^0 C) [1]	Water	Binary Cycle

V. Present Scenario of Energy Sector, Renewable Energy Policy and Geothermal Resources of Bangladesh

a) *Energy Sector In Bangladesh And Dependence On Coal For Future Development*

Bangladesh's installed electric power generation capacity was 15351 MW in January, 2017, which included 2200 MW of captive power. Among the installed capacities, sources of power generation were- natural gas (62.78%), furnace oil (21.19%), diesel (7.82%), coal (1.9%), hydro power (1.75%), and imported power from India constituted rest of 4.56% [16]. By 2030, the country's peak demand has been predicted to reach 33,708 MW [17]. Present government of Bangladesh has primarily identified coal based plants as the major solution of the energy crisis, but given their adverse effects on agricultural land, livelihood, and environment, people often become dissatisfied with such projects; consequently, making the conundrum even more difficult for the government to solve. Environmentalists have expressed concerns over government's plan to construct a thermal power station (1320 MW) at Rampal, Bagerhat – demonstrating protests against the project ever since its inception. According to them – being situated in close proximity to Sundarbans—the coal-fired power station will adversely affect the bio-diversity of the world's largest mangrove forest, which is also a UNESCO world heritage site [18]. Meanwhile, in another incident last year, government's decision to build two Chinese financed coal-fired plants were violently protested in Chittagong [19]. Previously in 2006, government's initiative to build open pit coal mining project at Phulbari, Dinajpur was also protested by local communities, human rights activists, and environmentalists, ultimately forcing the government to postpone further development [20].

b) *Renewable Energy policy of Bangladesh*

Government of Bangladesh formulated a renewable energy policy in 2008 to attain specific national goals. The policy mainly focused on developing solar, wind, bio-mass, bio-gas, and hydropower resources. It mentioned geothermal energy twice, but very implicitly, with no specific goals or guidelines [21].

c) *Current condition of geothermal resources*

Research for utilizing geothermal resources of Bangladesh has been largely restricted within few works carried out by geologists. In 2011, Anglo MGH Energy, a Dhaka based private company announced the construction of 200 MW geothermal plant, first ever of such kind, in Thakurgaon district [22]. But for some unknown reasons, this project never commenced, and

no development in this field has been announced afterwards.

VI. Observation of Geothermal Resources and Suggestion for Future Development

Based on the geological studies done in various parts of Bangladesh, it appears that some of the prospective sites in the northwest region, such as Singra-Kuchma-Bogra area, Barapukuria coal basin area, and the Madhyapara hard rock mine area- with temperature gradient above 30°C/km and bottom hole temperature in excess of 100°C– meet the requirements of binary cycle power plants. But to reach a forgone conclusion on exploiting the resources in a viable, feasible, and economically profitable way, extensive research is required. The process can only begin if the government realizes the prospect of this abundant natural resources indicated by geological works and takes necessary initiatives to develop it.

The research work must go through several steps. First of all, estimation of the geothermal energy potential of Bangladesh is required. To estimate the value, detailed geological, geochemical, shallow geophysical and shallow drilling data are required. After estimating and assessing geothermal potential, a revised policy should be formulated to develop the resources within a time frame. Additionally, Bangladesh can take into account India's effort in this relevant field, as the two neighboring nations are in close proximity with many geological similarities. Indian government has been patronizing efforts in geothermal research for over two decades. Methodical approach to explore geothermal potential began back in 1976 and some prospective areas were proposed after the initial study. A draft policy of "Indian geothermal energy development framework" was issued on 6 June, 2016 by the government's Ministry of New and Renewable Energy (MNRE). It mentioned the government's target to develop 1,000 MW geothermal energy capacity in the primary stage till 2022 and 10,000 MW by 2030 with active international collaboration with countries such as the US, Philippines, Mexico and New Zealand [23].

One of the main barriers in geothermal energy exploitation is that its profitability in countries unexposed to active volcanos is still not convincing, mostly because of extremely capital intensive and risky exploration stage. That is probably the reason why countries around the world prefer more established renewable energy resources like solar, wind, and hydropower at present. But interest on geothermal energy among many countries has gained momentum over the last few decades as technology has vastly improved with the introduction of binary cycle plants and enhanced geothermal systems (EGS).

Although right now Bangladesh has better alternatives like coal, nuclear, and solar energy for electricity production, geothermal energy utilization can help the nation's energy sector in the long run as it provides a virtually inexhaustible source of energy, available throughout the day, round the year. But for that to happen, interdisciplinary research and development projects should be carried out. Prominent universities and institutes should be encouraged and funded to research not only on the geological aspects, but also on the engineering side of the geothermal energy extraction, for example, generating electricity through enhanced conversion efficiency cycles, utilizing shallow resources for small scale use, and ensuring sustainable production from geothermal resources.

VII. Conclusion

Besides solar, wind, hydropower, and other renewable resources, geothermal energy can help Bangladesh in tackling issues like energy scarcity and variation in fuel prices in a self-sustained and environmentally safe process. Extensive studies and field surveys are required to harness this energy, which is accessible in abundance but stays predominantly unexploited. Energy crisis is no more an issue based on a single country or two, but a far greater phenomenon concerning the whole of human race. So, all the countries including Bangladesh have immense responsibility to contribute in the ongoing research and development of geothermal energy, as technological advancement will benefit every nation and ensure a habitable planet for generations to come.

References Références Referencias

1. Martha Mburu, "Geothermal energy utilization," Presented at Short Course VII on Exploration for Geothermal Resources, organized by UNU-GTP, GDC and KenGen, at Lake Bogoria and Lake Naivasha, Kenya, Oct. 27 – Nov. 18, 2012.
2. Geothermal Energy Association, *2015 Annual U.S. & Global Geothermal Power Production Report.* [Online]. Available: http://geo-energy.org/reports-/2016/2016%20Annual%20US%20Global%20Geothermal %20Power%20Production.pdf
3. Power Division, Ministry of Power, Energy & Mineral Resources, Government of the People's Republic of Bangladesh, *Power Sector At a Glance (January 2016).* [Online]. Available: http://www.power-cell.gov.bd/in dex.php?page_id=267
4. http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=5&Itemid=6
5. http://www.thedailystar.net/op-ed/bangladesh-the-case-renewable-energy-1201162
6. http://bdnews24.com/bangladesh/2015/05/04/cabinet-clears-draft-law-to-form-company-to-operate-rooppur-nuclear-power-plant

7. Ann Heinrichs, *Sustaining Earth's Energy Resources,* New York: Marshall Cavendish Benchmark, 2011.
8. Þórir M. Wardum, *Geothermal Energy*, 7th Semester [Dissertation], University Horsens, 2010. [Online]. Available: https://www.ucviden.dk/student-portal/files/9447806/Dissertation.pdf
9. http://geothermaleducation.org/pwrheat.html#Q3
10. D.K. Guha, H. Henkel, and B. Imam, "Geothermal potential in Bangladesh - results from investigations of abandoned deep wells," *Proceedings of the World Geothermal Congress 2010,* Bali, Indonesia, 8 pp, April 2010.
11. S.M. Kabir, "Subsurface temperature and geothermal gradient in Bangladesh," M.Sc. thesis, Department of Geology, Dhaka University, 2008.
12. M. Rahman, "Geothermal potential resources in Thakurgaon district, northern Bangladesh," *Bangladesh Journal of Geology,* 25: 13-30, 2006.
13. Md. A. Akbar, "An assessment of the geothermal potential of Bangladesh", United Nations University, Geothermal Training Programme, Orkustofnun, Grensasvegur 9, IS-108 Reykjavik, Iceland, Reports 2011, Number 5.
14. National Renewable Energy Laboratory, US Department of Energy, *Learning about renewable energy*. [Online]. Available: http://www.nrel.gov/learning/re_geo_elec_production.html
15. T. Maghiar and C. Antal, "Power Generation from Low-Enthalpy Geothermal Resources," *Geo-Heat Center Quarterly Bulletin 2001*; 22:35-8.
16. http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=12&Itemid=126
17. http://sreda.gov.bd/files/EEC_Master_Plan_SREDA.pdf
18. http://www.thefinancialexpressbd.com/2017/01/17/59374/Discard-Rampal,-Rooppur-power-plant-projects
19. https://www.theguardian.com/environment/2016/apr/06/bangladesh-coal-plant-protests-continue-after-demonstrators-killed
20. http://www.dhakatribune.com/bangladesh/2016/08/27/phulbari-like-movement-save-sundarbans/
21. https://www.iea.org/media/pams/bangladesh/Bangladesh_RenewableEnergyPolicy_2008.pdf
22. http://www.power-eng.com/articles/2011/03/anglo-mgh-energy-plans.html
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Absorption Improvement and EM Spectroscopy in Photodetector based on Plasmonic Effect by Introducing Sio2 Layer and Ag Nano Particles

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Rajshahi University of Engineering and Technology

Abstract- We have a light detector structure based on plasmonic effects for maximum light absorption at a wavelength of 820 nm have suggested and the two-stage absorption rate to have increased considerably compared to the previous ones. Firstly, by placing layers of glass between gold and the semiconductor GaAs is Grating and secondly embedding silver nanoparticles in the metal Grating gold. With the implementation of each stage can be seen to increase light absorption in the detector in this structure we proposed for the first time we've done it both ways, to intensify the absorption coefficient is 25.83.

Keywords: *nanostructured materials, photodetectors, plasmons, metal grating, nanoparicles.*

GJRE-F Classification: *FOR Code: 290901*

Strictly as per the compliance and regulations of :

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Omid Davarpanahi [α], Hasan Rasooli [σ] & Sayyed Salar Hosseini [ρ]

Abstract- **We have a light detector structure based on plasmonic effects for maximum light absorption at a wavelength of 820 nm have suggested and the two-stage absorption rate to have increased considerably compared to the previous ones. Firstly, by placing layers of glass between gold and the semiconductor GaAs is Grating and secondly embedding silver nanoparticles in the metal Grating gold. With the implementation of each stage can be seen to increase light absorption in the detector in this structure we proposed for the first time we've done it both ways, to intensify the absorption coefficient is 25.83.**

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I. Introduction

Today, the network of data transmission Such as the fitting of Types of the high-speed chip, Internet and telephone communication has created incentives to build and use light detectors. study of the structure of Light metal-semiconductor-metal detectors-from the early 1970s began[1]. The surface plasmon resonance in the context of the emergence and realization of sub-wavelength aperture to improve the absorption of light. In recent decades a number of experimental work and theory research to study ultra-light transmission through The reviews ultra-light transmission by sub-wavelength aperture is done.[2] Nano grating nano-under-wavelength light creates a robust response and for potential trapping the light in the semiconductor area. Interconnect metal - semiconductor-metal detector electrodes led to a significant increase in bandwidth and reduce the dark current in the detector LED p-i-n structures that have the same active region, is. [3] Detectors plasmonic nano-scale response time due to the distance between the electrodes is about a few tens of picoseconds to the transportation of products from the metal connection is limited. In addition, reducing the distance the electrodes will lead to a reduction in the active region and the decrease in sensitivity. [4] Surface plasmons, which are electromagnetic waves along a metal are released. Properties of their interaction with light, causing surface polariton plasmon waves and create features by which we can photonic components with dimensions much smaller than what has been achieved to build. [5] study and understanding of the plasmons, are widely idea of what began in the 1950s after the article was. These studies also cast a frequent flashpoint of the surface plasmons in thin metal Filter trick of the light scattering of particles of nano metal was done in the early 1970s. Find the improved transmission of light through periodic array of holes with dimensions smaller than the wavelength plasmons in metal films drew much attention. [6]

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a) The structure design

Metal-semiconductor-metal detector structure usually consists of three separate parts, including:

A) metal grating, b) sub-wavelength aperture and f) substrate

Is as shown in Figure 1.

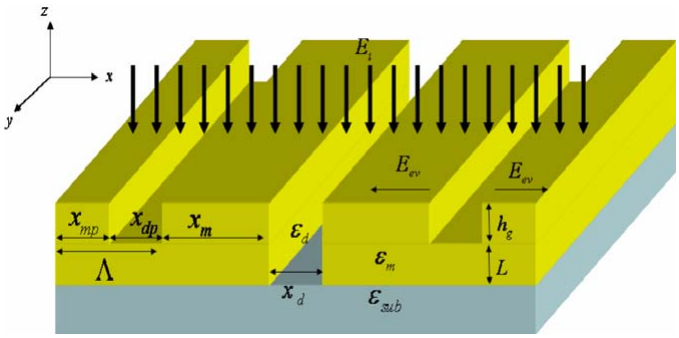

Fig. 1: Structure of the metal detector with diffraction, sub-wavelength aperture and substrate provided by tan and et

Part A metal grating that includes a good conductor and the x axis is parallel grooves. Dimensions has been optimized light wavelength surface plasmon polariton is designed to be coupled along the axis x prompt. Surface plasmon polariton wave vector with a period Λ for metal grating in Equation 1, we see that in 1991 was used by Soole. [1]

$$k_{sp} = \frac{\omega}{c} sin\theta \pm j\frac{2\pi}{\Lambda} = \frac{\omega}{c}\sqrt{\frac{\varepsilon' m\varepsilon_d}{\varepsilon' m+\varepsilon_d}} \quad (1)$$

In relation (1), ω the angular frequency, θ the angle of the incoming light, c is the speed of light in vacuum and permittivity factor in the metal in the form of equation (2) is defined. In reference [1] is mentioned.

$$\varepsilon_m = \varepsilon'_m + i\varepsilon''_m \quad (2)$$

ε_d is the air permittivity used. Each groove surface plasmon polariton E_{spp} metal grating by electric field excitation and emission during both positive and negative x-axis location will be done. Surface plasmon polariton wave intensity decreases exponentially with propagation distance and depth is a factor that is proportional to permittivity material. [7] The amplification factor of attraction for "normalized power transition metal grating detector on "normalized power no = structure transition metal grating as in reference [7] are used, we define. The surface plasmon polariton by restrictions on slots (not the center) to release the sub-wavelength aperture triggered a wave of surface plasmon polariton light input (which is presented in Figure (1) with E_i) interference (coupling) is.] 2] the total surface plasmon polariton increase optical transmission through sub-wavelength aperture is. In fact, metal grating as collector or lens focused wave in the resonant frequency of the acts. Highly dependent increase in light transmission parameters such as frequency grating x_m and thick metal grating is h_g.[7]

Coupled surface plasmon polariton wave E_{spp} of the incoming wave E_i hybrid transmission t_{12} and it've shown in Figure (2).

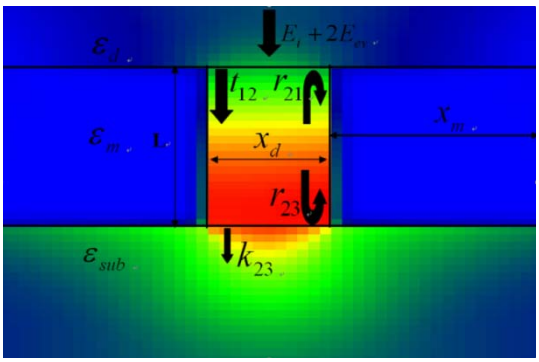

Fig. 2: Modified model of attract high above based the Fabry–Perot model-based presented in reference [8] red zone (where r_{23} located) has a high energy intensity and energy intensity is less water locations

Using semi-analytical calculation Fabry–Perot [8] and formalism expansion mode [2] Green tensor analysis [9] In reference [7] is calculated; When the sub-wavelength aperture width x_d is much smaller than the wavelength of emission λ_0, increase light transmission and improve absorption in semiconductors absorb light transmission caused by metal grating can be achieved. A more accurate model improved light transmission through sub-wavelength aperture as well as by Sturman and et [10] described. Modify the parameters of (1) changes in the semiconductor light transmission is desired wavelength. So we improved the best parameters [7] use.

b) The simulation desired model

In this article we improve absorption in three stages as follows absorbance at a wavelength of 820 nm have the amplification factor, we speak to all three structures. Finite difference time domain simulation models expressed are using.

1. plasmonic optical detector structure with gold grating and gallium arsenide substrate.

We design gold metal grating (Au) and the substrate of gallium arsenide (GaAs) consider. Gold permittivity rate ε_m of Drude-Lorentz model worked in the reference [11] and the coefficient of permittivity substrate (gallium arsenide) ε_sub real value was assumed to be 12.25. The imaginary part for infrared wavelengths were ignored. [12]

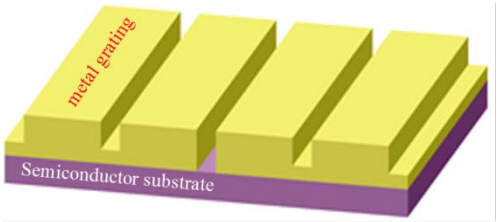

Fig. 3-A: proposed framework for gold grating and gallium arsenide substrate detector

In this model, the (3-a) by setting the parameter can be reached absorb light in the desired wavelength, the absorption rate for the model in Figure (3-b) shown is equal to 0.16.

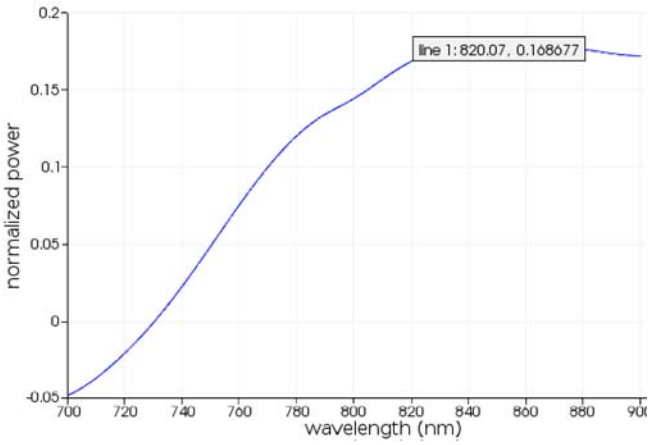

Fig. 3-b: the normalized power absorbance detector with gold grating and gallium arsenide substrate

2. plasmonic optical detector structure with gold grating and substrate layers of glass between gold grating and gallium arsenide substrate

The idea of putting layers of glass (SiO2) between gold grating and substrate gallium arsenide

(under sub-wavelength aperture) of the E-plain Tee is a split in the microwave, is used [13] The detector is also used by Jamalpur et al. was. [14] performance glass substrate which is an insulator for the rejection of electron-hole pairs in the semiconductor to metallic connection. To sum carriers on both sides of the gold structure can be used vertically. In this structure, the absorption rate was 0.24. Figure 4 shows a structure in the form of (4-B) absorption at a wavelength of 820 nm curve we see.

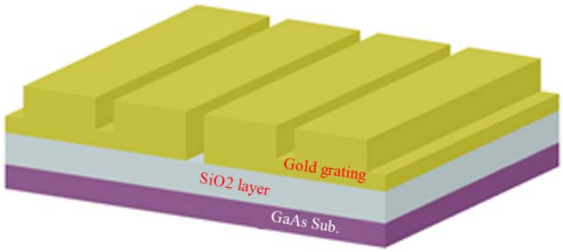

Fig. 4 –A: our proposal model for detector with substrate layers of glass between gold grating and gallium arsenide substrate

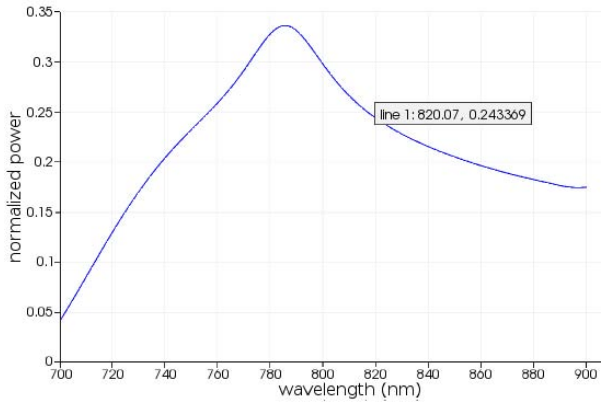

Fig. 4-b: power normalized absorbance detector with substrate layers of glass between gold grating and gallium arsenide substrate

3. plasmonic optical detector structure with silver nanoparticles on glass substrates, between gold grating and gallium arsenide substrate

Our silver nanoparticles under sub-wavelength aperture (in place of glass layer) placed. This is similar to gallium arsenide substrate and intermediate layer of germanium. [15] Due to the high refractive index semiconductor base frequency must be chosen too small metallic nanoparticles. It features some difficult and sensitive process with a common manufacturing techniques. In this structure, the absorption rate was 0.31. Figure 5 shows a structure in the form of (5-b) absorption at a wavelength of 820 nm curve we see.

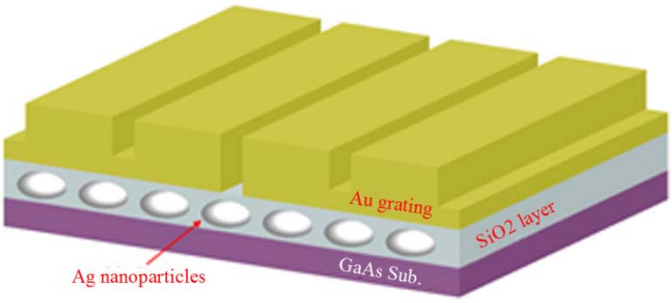

Fig. 5-A: Our proposed model for plasmonic optical detector with silver nanoparticles on glass layer, between gold grating and gallium arsenide substrate

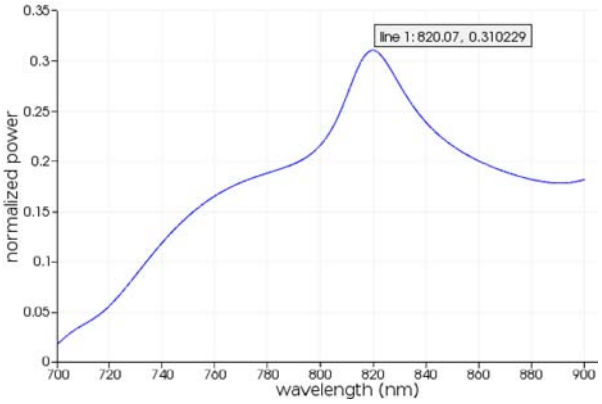

Fig. 5 (b): normalized power absorption optical detector plasmonic with silver nanoparticles on glass layer, between gold grating and gallium arsenide substrate

c) *Data of models*

In this paper, results of the three proposed structure your previous jobs on the graph (1) We compare the amplification factor of attraction for "normalized power transition detector with metal grating" on "normalized power without transition metal grating " in [7] is used to optimize and use our sub-contractor relations.

$$AEF = \frac{P_{npt,g}}{P_{npt}} \quad (3)$$

Explaining the relation (3) is as follows: Absorption Enhancement Factor as the ratio of: the normalized power transmittance of the metal-grating MSM photo detector to the normalized power transmittance of an MSM photo detector structure without a metal grating.

This relationship is expressed for the results of three structures and substrate in the denominator we can use as a reference gallium arsenide. Normalized power transmission substrate gallium arsenide (without metal grating) in the form (6) is shown at a wavelength of 820 nm is equal to 0.012.

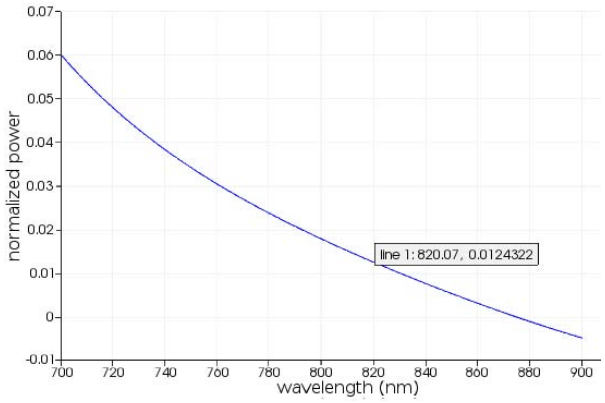

Fig. 6: normalized power transmission gallium arsenide substrate (without metal grating)

4. EM Model

we have established that by performing finite element EM computation to the following expression, the absorption QE, labeled as η, of any detector geometry can be predicted [16]:

$$\eta = \frac{n\alpha}{AE_0^2}\int_V |E_z(\vec{r})|^2 d^3r \qquad (4)$$

where n is the material refractive index of the detector material, α is the absorption coefficient for vertically polarized light, A is the detector area, E0 is the incident electric field from the air, V is the detector active volume, Ez is the self-consistent vertical electric field. Equation (4) states that QE can be calculated from the volume integral of |Ez |2 in the presence of a finite α. Since E0 and Ez are linearly proportional to each other, E0 can be set arbitrarily, and the only input parameter in (1) is the wavelength-dependent α(λ), which can be calculated based on the material layer structure [17]. For a known α(λ), there will be no more free parameters, and the value of η(λ) is uniquely and unambiguously determined. To solve Ez numerically, we use a commercial finite element solver. In addition to η, we also define another quantity, the external QE or ηext , which is QE × pixel area fill factor (≡A/Apitch).

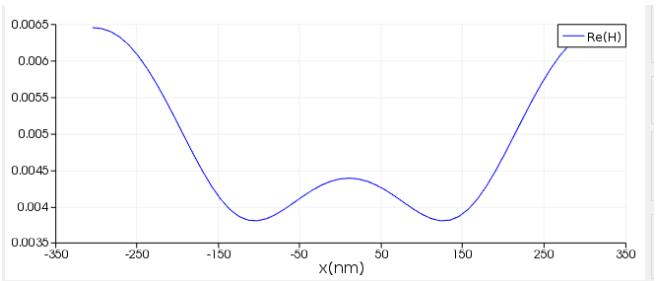

Fig. 7-a: Plot of EM spectroscopy in linear type

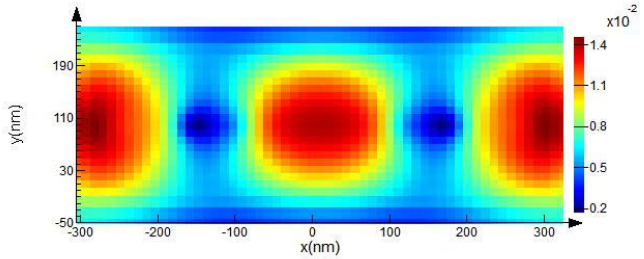

figure 7-b: plot of EM spectroscopy in surface type

Results 1-3 of plasmonic optical detector structure with gold grating and infrastructure in relation gallium arsenide (2), we have:

$$AEF = \frac{0.168}{0.012} = 14 \qquad (5)$$

Which represents an increase absorption due to grating adjusting parameters compared with similar structure. Results of the 2-3 structure plasmonic optical detector with gallium arsenide layers of glass between Gold grating and substrate in equation (2), we have:

$$AEF = \frac{0.243}{0.012} = 20.25 \qquad (6)$$

Results 3-3 of plasmonic optical detector structure with silver nanoparticles on glass substrates, gallium arsenide between Gold grating and infrastructure in equation (2) we have:

$$AEF = \frac{0.31}{0.012} = 25.83 \qquad (7)$$

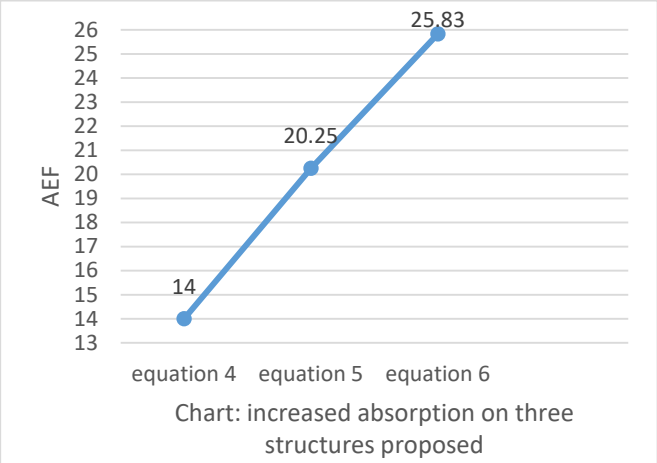

Chart: increased absorption on three structures proposed

II. Simulation Setup

The 3D - plasmonic optical detector structure shown in Fig. 5(a) was simulated using the FDTD software package developed by Lumerical. For the FDTD simulation, we used a mesh size 10nm. This high-resolution sampling yielded convergent solutions at reasonable computation times. A periodic boundary condition was assumed along the y-direction for an incident light wave propagated along the normal direction. perfectly matched layer (PML) boundary

condition was assumed along the y-direction to accurately simulate the absorption of the light reflected from the bottom as well as light transmitted from the top boundaries of the simulated plasmonic optical detector structure.

III. Conclusion

In this article we construct the optical detection based on plasmonic effects by improving the detection parameters for maximum light absorption at a wavelength of 820 nm have suggested. We improved amplification factor of attraction even for the initial state, including gold and base gallium arsenide grating was obtained as a result of adjusting parameters grating compared with a similar structure and was 14 times. The coefficient of resonant absorption by adding layers of glass between gold grating and base the amount of gallium arsenide 20.25 for the glass came up with. Then proceeded to put silver nanoparticles on glass substrates that absorb amplification factor increased to 25.83. Compared with previous work Jamalpur and colleagues [14] in 2015 which attracted about 15 have reached the amplification factor, we have increased every neighborhood we have our final difference is the structure of 10.83.

References Références Referencias

1. J. B. D. Soole, H. Schumacher, "InGaAs metal-semiconductor-metal photodetectors for long wavelength optical communication", IEEE J. Quantum Electronics, Vol. 27, No. 3, pp. 737–752, 1991.
2. F.J. García-Vidal, H.J. Lezec, T.W. Ebbesen, and L. Martín-Moreno, "Multiple Paths to Enhance Optical Transmission through a Single Subwavelength Slit", physical review letters, Vol. 90, 213901, 2003.
3. M. Ito and O. Wada, "Low dark current GaAs metalsemiconductormetal (MSM) photodiodes using WSi contacts", IEEE J. Quantum Electron., vol. QE-22, no. 7, pp. 1073–1077, Jul. 1986.
4. J. Hetterich, G. Bastian, N. A. Gippius, S. G. Tikhodeev, G. von Plessen, and U. Lemmer, "Optimized design of plasmonic MSM photodetector," IEEE J. Quantum Electronics, 40, No.10, pp. 855-859, 2007.
5. Hecht, B., Bielefeldt, H., Novotny, L., Inouye, Y., and Pohl, D. W., "Local excitation, scattering, and interference of surface plasmons", Physical Review Letters, vol. 77, pp. 1889-1892, 1996.
6. Ebbesen, T. W., Lezec H. J., Ghaemi, H. F., Thio, T., and Wolff, P. A., "Extraordinary optical transmission through sub-wavelength hole arrays", Nature, vol. 391, pp. 667-669, 1998.
7. C. L. Tan , V. V. Lysak, K. Alameh, Y. T. Lee "Absorption enhancement of 980 nm MSM photodetector with a plasmonic grating structure" Optics Communications Elsevier, Vol. 283, Issue 9, pp. 1763–1767,2009.
8. Justin S. White, Georgios Veronis, Zongfu Yu, Edward S. Barnard, Anu Chandran, Shanhui Fan, Mark L. Brongersma, Opt. Lett. 34 (5) (2009) 686.
9. J. Weiner, "The physics of light transmission through subwavelength apertures and aperture arrays", reports on progress in physics, Vol. 72, No. 6, 2009.
10. B. Sturman, E. Podivilov, M. Gorkunov, Phys. Rev. B 77 (2008) 075106.
11. D. Rakic´ , A.B. Djurišic´ , J.M. Elazar, M.L. Majewski, Appl. Opt. 37 (1998) 5271.
12. W.E. Courtney, IEEE Trans. Microw. Theory Tech. 25 (1977) 8.
13. N. Marcuitz, waveguide handbook ,New York Dover Publications, pp.337-339,1950.
14. Kamal Jamalpoor, Abbas Zarifkar, Abbas Alighanbari, "A new approach for absorption enhancement in plasmonic photodetectors", The 21st Iranian Conference on Optics & Photonics & 7th Iranian Conference On Photonics Engineering 13-15 January 2015, Shahid Beheshti University. page1675-1678.
15. Chee Leong Tan, Ayman Karar,4 Kamal Alameh, and Yong Tak Lee, "Optical absorption enhancement of hybrid-plasmonic-based metal-semiconductor-metal photodetector incorporating metal nanogratings and embedded metal nanoparticles", OSA 28 January 2013 / Vol. 21, No. 2 / OPTICS EXPRESS 1713.
16. W.Wu,A.Bonakdar, andH.Mosheni, "Plasmonic enhanced quantum well infrared photodetector with high detectivity," Appl. Phys. Lett., vol. 96, pp. 161107-1–161107-3, 2010.
17. S. U. Eker, Y. Arslan, A. E. Onuk, and C. Besikci, "High conversion efficiency InP/InGaAs strained quantum well infrared photodetector focal plane array with 9.7 μm cut-off for high-speed thermal imaging," IEEE J. Quantum Electron., vol. 46, no. 2, pp. 164–168, Feb. 2010.

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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.

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

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

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

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

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

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

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

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form 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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