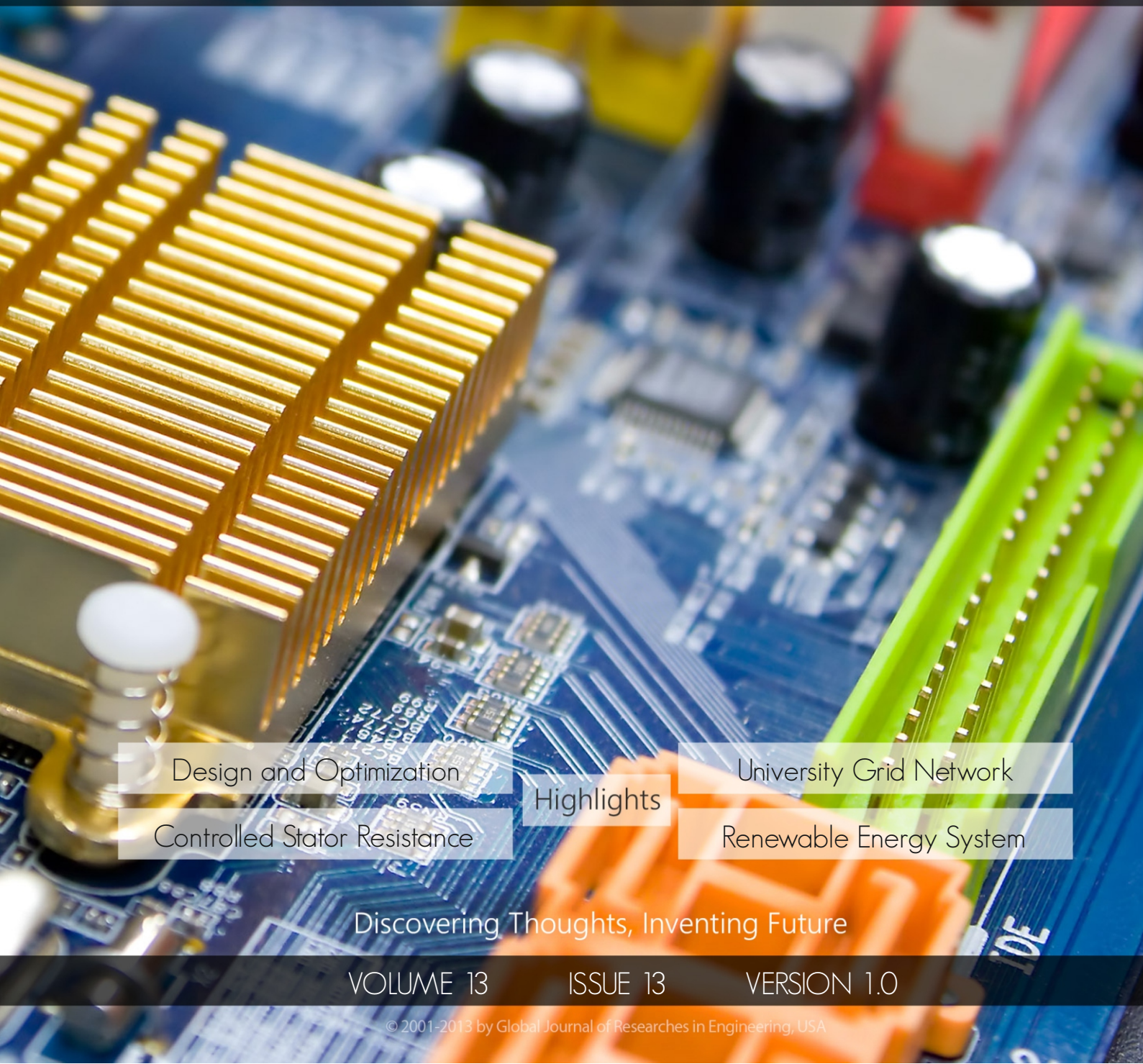
Online ISSN : 2249-4596
Print ISSN : 0975-5861

Global Journal

of Researches in Engineering: F

Electrical and Electronic Engineering



Design and Optimization

Controlled Stator Resistance

Highlights

University Grid Network

Renewable Energy System

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 13 VERSION 1.0

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Volume 13 Issue 13 (Ver. 1.0)

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Contents of the Volume

Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 13 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

IOT: Detection of Keys, Controlling Machines and Wireless Sensing Via Mesh Networking Through Internet

By Md. Nasimuzzaman Chowdhury , MD. Mahbub Hossain Bhuiyan & Samiul Islam

American International University, Bangladesh

Abstract - Internet of things is getting developed rapidly. Each and every day new devices are getting connected with internet. This stream of IOT brings new experience in our daily life. Connecting our wearable devices, gadgets, keys etc can make our own home a new world to us. Every component of our house can communicate with us through IOT. But connecting each device with internet requires costly devices like Wi-Fi modems, GPRS modems etc. This makes connecting each component with internet quiet expensive. In this paper we have developed a cost effective way of connecting each component with internet quiet expensive. In internet. As most of the household components are stationary and close to each other they can be connected with each other through mesh networking. A central device will receive their information and transmit it to internet. The cheapest way to create a mesh network is to use NRF protocol and a WIFI modem does the rest of the work to upload each and every data of this network to internet. In this project there are several nodes regarding their purpose like sensor nodes to collect temperature, humidity, co2 gas quantity and monitor through internet. Control nodes turn on or off AC, fans, lights of house and detection node to find out keys, sun glasses, and small objects.

Keywords : internet of things (IOT), mesh network, Wi-Fi, home automation, sensor monitor.

GJRE-F Classification : FOR Code: 100510, 090905

Strictly as per the compliance and regulations of :

IOT: Detection of Keys, Controlling Machines and Wireless Sensing Via Mesh Networking Through Internet

Md. Nasimuzzaman Chowdhury [α] , MD. Mahbub Hossain Bhuiyan [σ] & Samiul Islam [ρ]

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I. Introduction

For centuries researchers are trying to develop home automation systems. But most of the automation system depends on the presence of the user. Some solutions made through voice recognition, some are sound alert systems. Like "A zigbee-based home automation system" by Gill, K. Shuang-Hua Yang; Fang Yao; Xin Lu [1]. But IOT is a breakthrough in the world of home automation. The IOT has the potential to change the entire world into a smarter world. Where automated dictions like when things needs replacing, repairing or recalling can be made easily and efficiently by using IOT. Consequently it would greatly reduce waste, loss and cost of things that we cannot monitor properly. Although, the research into the IOT is quiet in its embryonic stage There are also several projects using IOT but the overall cost for each automation is not effective. Researches like An Internet of Things Approach for Managing Smart Services Provided by Wearable Devices [2], The Applications Of WiFi-based Wireless Sensor Network In Internet of Things And Smart Grid [3], Design of Intelligent Internet of Things for Equipment Maintenance [4]. These are controlling limited devices and costly solutions. To reduce the cost of internet connected things this project is implemented. It not only about controlling devices from internet, it also helps to monitor our home from internet, finding little daily needed things through internet. And as in present time internet is available in smart phones, anyone can access internet from anywhere anytime.

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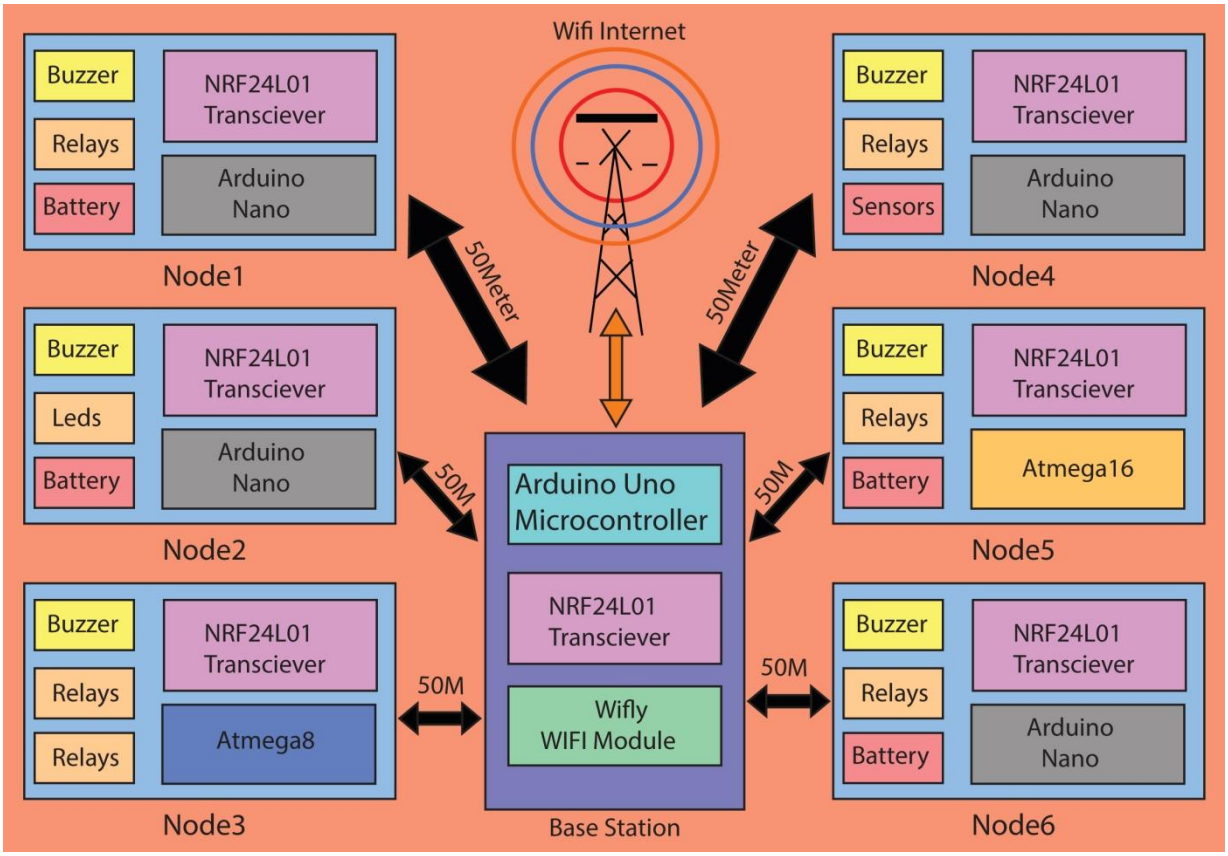

Figure 1 : Main Project Outline

II. Main Project Outline

In this project there are several nodes and one base station. Nodes are required to control, collect information and sense devices. Base station is used to transmit these data to internet. With one base station unlimited number of nodes can be connected. The communication between nodes and base station is through radio frequency. But each node has to be within a circle of around 50meter from the base station. Each node can communicate with each other if necessary. If two nodes communicate with each other then the distance between the nodes also have to be 50meter.

But if two nodes do not communicate with each other then they can be placed in any distance while maintaining specific distance from base station. Base station consists of a microcontroller, NRF transceiver, and an R171 wifly module. Nodes are largely categorized into three categories. Firstly controlling nodes (e.g Node 1, 3, 5, 6). Any node consists of relays to control ACs, fans, lights and NRF transceiver falls into this category. Secondly, sensing nodes like node 4 consists of temperature and humidity sensor. In this way this network can be used as wireless sensor network (WSN) also. Last but the most interesting node is called detection node. Lots of time we lost our important things like keys, sun glasses, small bags etc.

But we know that these things are somewhere near us. So these nodes contain leds, piezo buzzer and NRF transceiver. Whenever the important little thing is lost an alarm can be generated from internet and leds will start blinking, buzzer will start buzzing.

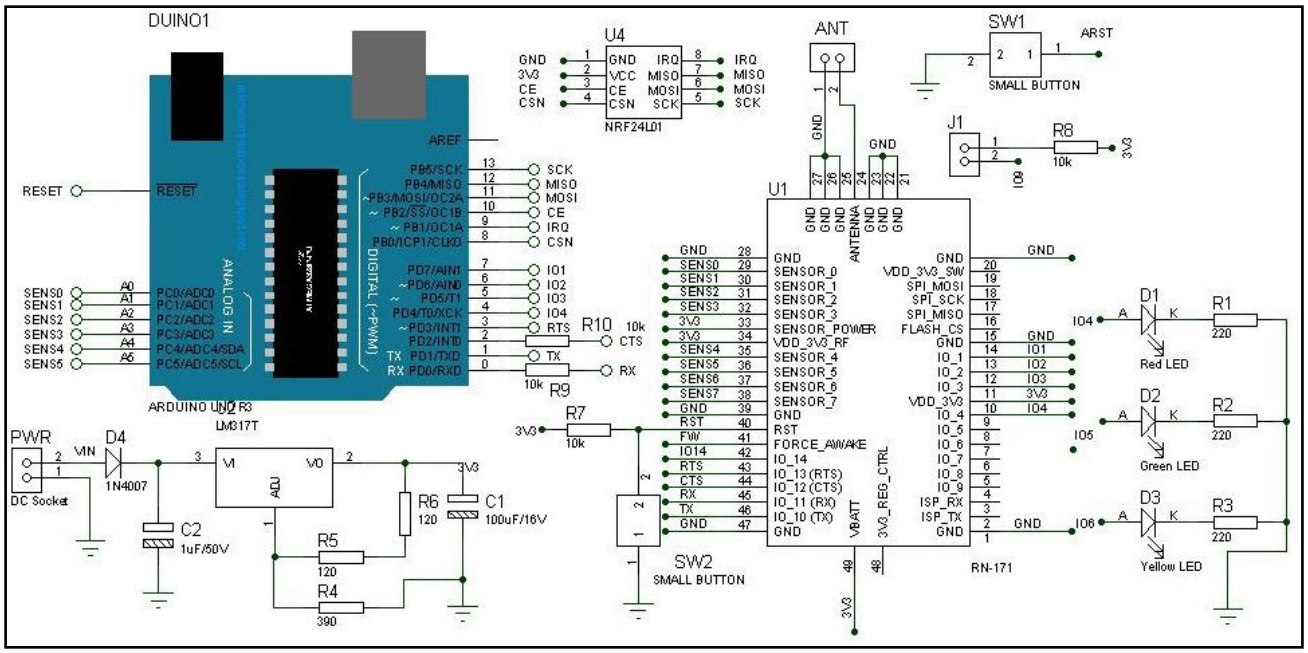

Figure 2 : Main Circuit Diagram

III. Main Circuit Description

The heart of the base station is arduino uno microcontroller. The Arduino Uno is a microcontroller board based on the ATmega328. Arduino Uno has serial peripheral communication pins also. With Arduino Uno NRF24L01 rf transceiver is connected. To connect the complete hardware with internet Wifly (Wifi module) has been used. In the simplest configuration the hardware only requires four connections (PWR, TX, RX and GND) to create a wireless data connection. Interface between arduino Uno and NRF transceiver is serial peripheral interface. MISO, MOSI, SCK & SS pins of arduino is connected with the same pins of NRF transceiver. Pin no 8, 9, 10, 11, 12, 13 of arduino uno is connected to 4,8,3,6,7,5 no pins of NRF transceiver. Here arduino is the master and NRF is the slave. NRF runs on 3.3v DC which collects from Vo pin of LM317T. Wifly module communicates through UART. And it also consumes 3.3v dc from Vo pin. For the purpose of UART communication Rx, Tx, RTS & CTS pins of wifly module connected with arduino uno. There are some other GPIO pins of wifly module which is also connected with arduino for different kind of gpio operations. The ability to go into deep sleep mode and automatically scan and associate to an AP when awake makes the RN-171 suitable for roaming applications. The RN-171 also includes a built in HTML client to automatically post serial uart data or sensor data to a web server. Both the device communicates at 9600 baud rate. Rx, Tx, RTS & CTS pins are connected with Tx, Rx, RTS & CTS pins of arduino respectively.

Different nodes consist of different hardware according to their purpose and application. Brain of node1 is arduino nano. The Arduino Nano is a small, complete board based on the ATmega328. The ATmega168 has 16 KB of flash memory for storing code (of which 2 KB is used for the bootloader); the ATmega328 has 32 KB, (also with 2 KB used for the bootloader). The ATmega168 has 1 KB of SRAM and 512 bytes of EEPROM [7]. It has 14 digital pins, one uart, two external interrupt, 6 PWM channels, 8-channel 10-bit ADC, Master/Slave SPI Serial Interface, Byte-oriented 2-wire Serial Interface and Six Sleep Modes. SPI of NANO used to interface with NRF transceiver. In 14digital I/O pins 14 relays can be connected to control 14 electronics devices like AC, fan, light, door etc. But in this project we used a single relay to control. Another node consists of atmega8 microcontroller. It has similar capabilities like arduino NANO. ADC pins of atmega8 are used to collect data from sensors. Thus this node is called sensing node. In this project temperature & humidity sensor is used in sensing node.

But in available 5 ADC pins different types of sensors can be used. Another node is used to detect devices. That node consists of a microcontroller, leds & buzzer. In any GPIO pin of microcontroller leds, buzzer can be connected.

The Circuit diagram of this system consists the following equipments:

a) *Arduino Uno Microcontroller :*

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button [5]. It contains everything needed to support the microcontroller; simply need to connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. It operates at 5V voltage and DC current in I/O pin is 40mA. The DC current in 3.3V pin is 50mA. The figure is given below

Figure 3 : Arduino Uno microcontroller

b) *NRF24L01 Transceiver:*

The nRF24L01 is a highly integrated, ultra low power (ULP) 2Mbps RF transceiver IC for the 2.4GHz ISM (Industrial, Scientific and Medical) band. With peak RX/TX currents lower than 14mA, a sub μA power down mode, advanced power management, and a 1.9 to 3.6V supply range [6]. The nRF24L01 integrates a complete 2.4GHz RF transceiver, RF synthesizer, and baseband logic including the Enhanced Shock Burst hardware protocol accelerator supporting a high-speed SPI interface for the application controller.

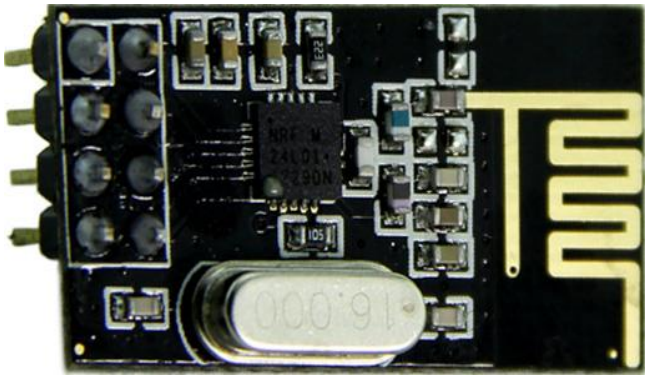

Figure 4 : NRF24L01 Transceiver

c) *Wifly Wi-Fi Shield:*

It"s a 2.4GHz IEEE 802.11b/g transceiver. High throughput - 921Kbps TX, 500Kbps RX data rate with TCP/IP and WPA2 over UART, up to 2Mbps over SPI slave. The RN-171 module is a standalone complete TCP/IP wireless networking module. [8]

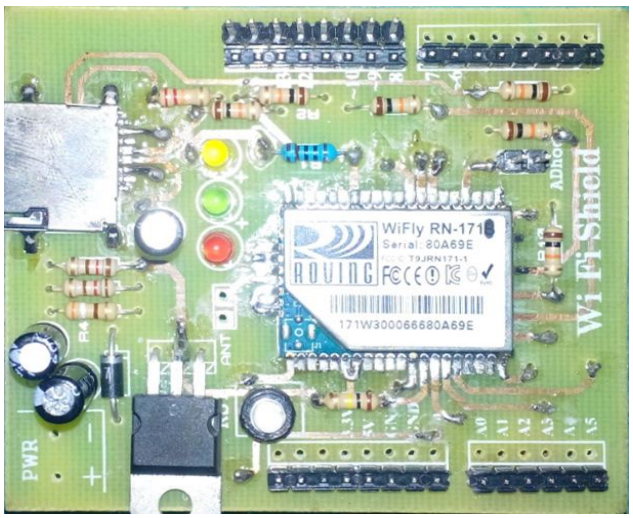

Figure 5 : Wifly Wi-Fi Shield

IV. Main Technology Used

Main purpose of this project is to reduce the overall cost to connect devices with internet. Here we used NRF transceiver to create a mesh network and connected the complete network with internet.

A NRF transceiver can communicate with 6 devices at a time as there are 6 different pipe lines each transceiver contains for communication. Each transceiver contains a Rx address and Tx address. But the Rx and Tx address are same. In order to send data to or receive data from the SPI port on the 24L01 the CSN pin on the 24L01 must be high to start out with. Then, bringing the CSN pin low to alert the 24L01 that it is about to receive SPI data. Once transmitted or read all of the bytes that needed, bringing CSN back high. To execute the R_REGISTER instruction on TX_ADDR register, which will read the contents of the TX address register out of the 24L01 and into micro. The TX_ADDR register is 5 bytes wide and 5-byte addresses is used. First, bringing CSN low and then send the command byte '00010000' to the 24L01. This instructs the 24L01 that needs to read register 0x10, which is the TX_ADDR register. Then five dummy data bytes is sent and the 24L01 will send back to you the contents of the TX_ADDR register. Finally, bringing the CSN pin back high.

The mesh network of nodes is shown below

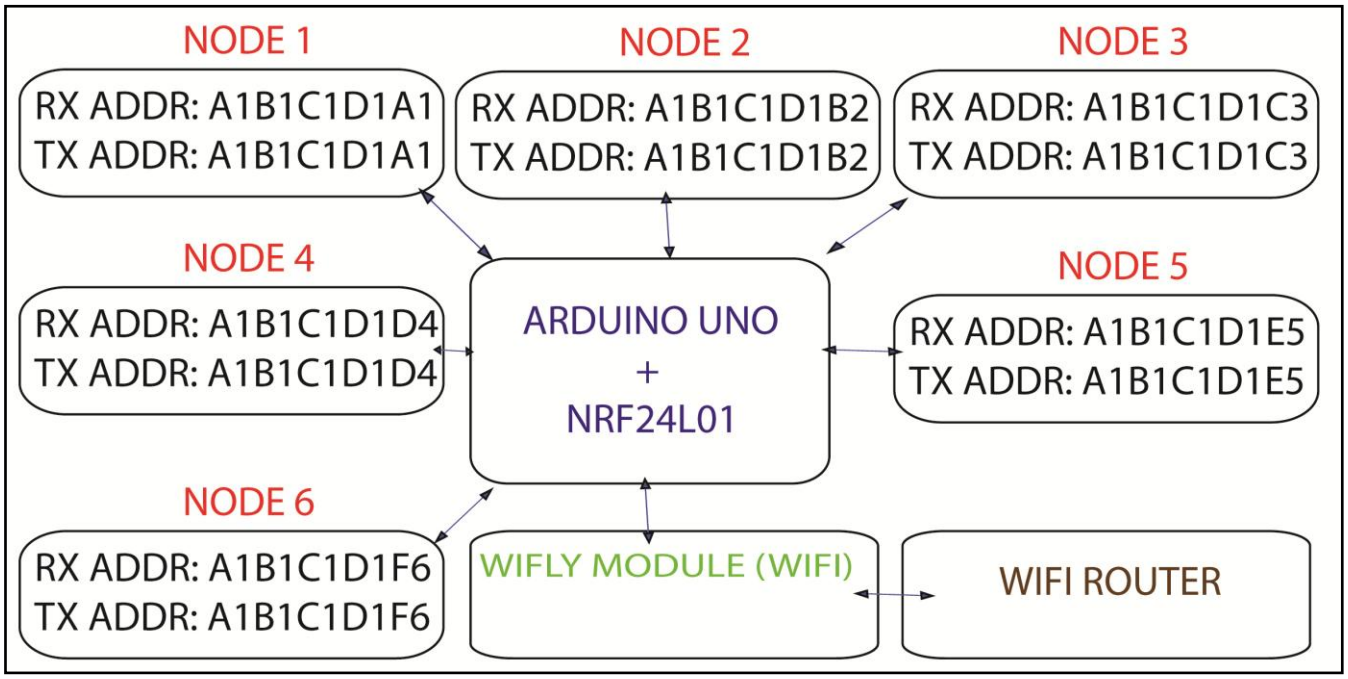

Figure 6 : Mesh networking of 6 nodes with base station

RN171 (Wifly) supports secure Wi-Fi authentication WEP-128, WPA-PSK (TKIP), WPA2-PSK (AES) [8]. To connect with Wi-Fi network WPA-PSK (TKIP) encryption is used.

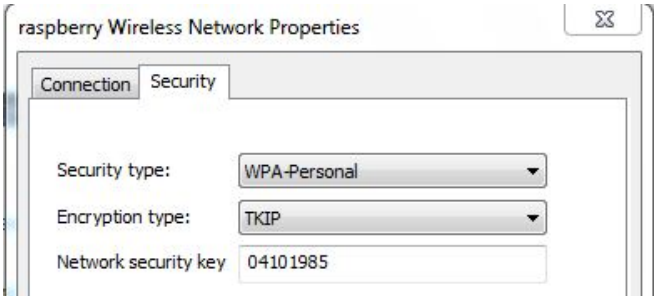

Figure 7: Encryption of wifi network.

For networks using WPA/WPA2 Personal encryption, the SSID and password is needed
SSID: Raspberry
Password: 04101985

At first the available network need to be searched. As the desired network found it is connected with arduino. Following few lines of codes used to search and connect with Wi-Fi network.

```
byte Networks = WiFi.scanNetworks();

char ssid[] = "Raspberry";

char pass[] = "04101985";

status = WiFi.begin(ssid, pass);
```

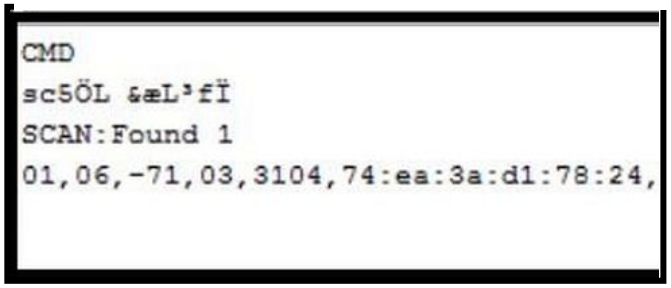

Figure 8: Network found to connect internet

Maximum length of 140 characters Tweet can be generated. To generate a tweet through arduino each account need to have a tweeter 'Token'. In this project

Tweeter account name: internetofkeys

Against this tweeter account an unique token is provided from twitter.com.

Figure 9: Token from Twitter

These are the few codes to setup twitter account with arduino

char msg[];

Twitter twitter("1867893906-rz9ZZWJvFCy8o6ciBRevQUqORBLycwGavEuaeKH");

twitter.post(msg)

Here different messages used for different tweet. User can control devices through re-tweeting also.

V. Hardware implementation

The base station is implemented in PCB design and Vero board. The figure is given below

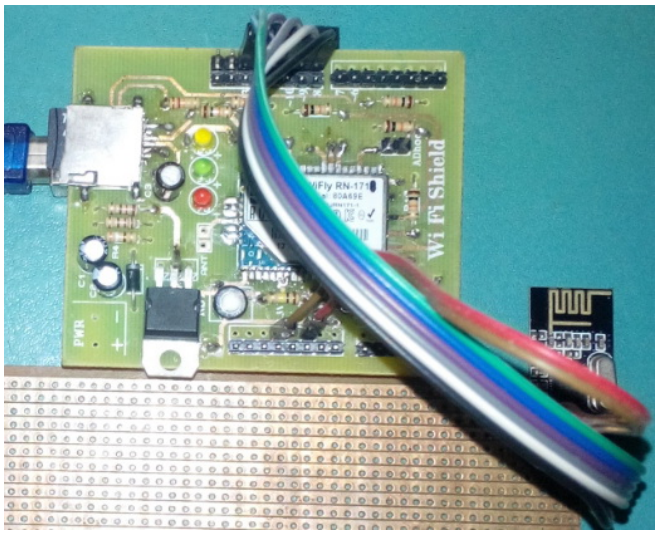

Figure 10. Hardware implementation of base station

There are three nodes implemented in the project. Those are shown bellow.

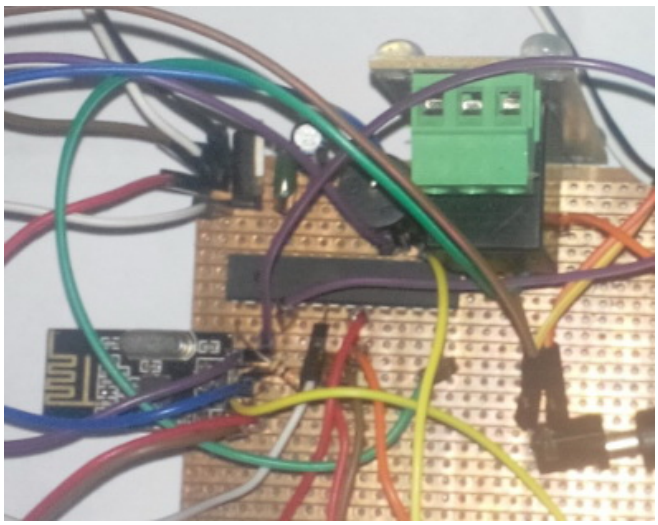

Figure 11: Control Node to control Machines

In this hardware atmega8 is connected with one relay, one buzzer and NRF24l01 transceiver. This node can be connected with machines and machines can be controlled from anywhere in this world through Internet.

In this node with an Arduino Nano, Led light , buzzer and NRF24l01 protocol is connected. This node PCB device can be connected with any necessary keys that helps to find the keys very quickly.

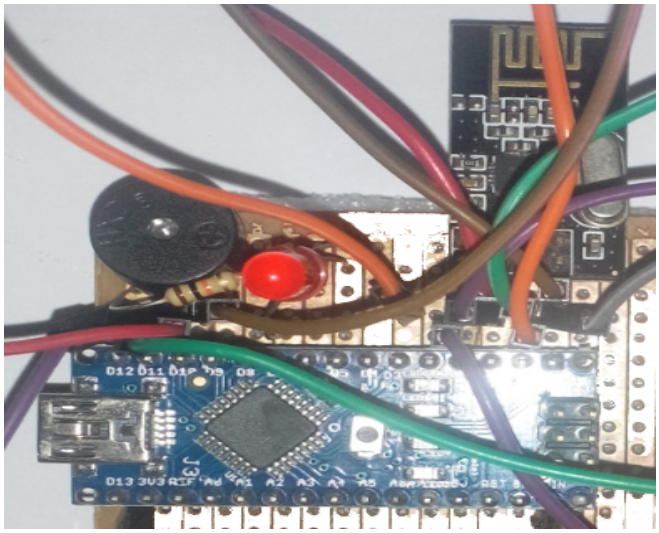

Figure 12 : Detection Node for Key detection

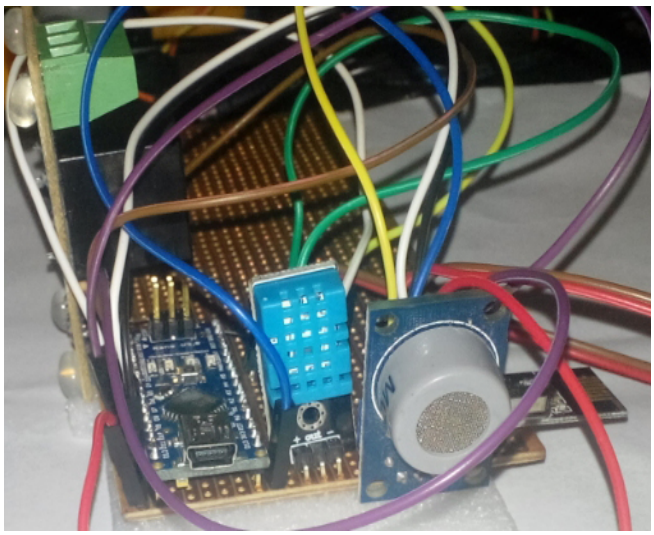

Figure 13: Sensing Node for sensing temperature and humidity

In this node with arduino nano temperature, humidity and gas sensor is connected. With this node device it's possible to sense any places temperature or humidity and the transmitted data can be viewed instantly via internet from anywhere.

VI. Output Results

All the outputs are shown in the tweeter. Here are some tweets transmitted from user account and re-tweet from base station. When connection establish base station tweet of connection establishment.

Figure 14 : Connection establishment confirmation

Here user is Md. Nasimuzzaman. So user can select a command to turn on or turn off lights, fans, Ac. This base station will accept tweets from @Md.Nasimuzzaman only.

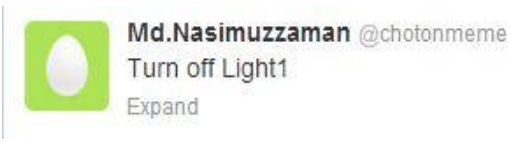

Figure 15 : Tweet from the user

If the operation completes successfully the base station execute the operation and re-tweet to user.

Figure 16 : Re-tweet and confirmation of task

The base station also tweet the temperature and humidity after an interval period of time. This time interval is selected by the user. By this node the system can give an update of temperature and humidity of anyplace this system is setup

Figure 17 : Output of Temperature and Humidity Sensor

VII. Further Application

a) Complete industry automation.
b) Wireless Control of any machine via Internet.
c) Wireless sensor networks.
d) Official Access & attendance systems.
e) Patient monitoring systems for doctors.
f) Internet of keys, moneybags, kids, toys etc.

VIII. Conclusion

For very small distance like 50meter NRF transceiver are reliable but if any movable object go beyond this distance its untraceable. There are other devices like Zigbee can be used for long networking. Here limited number nodes has been used but more than 6nodes are little complex through NRF24l01 transceiver. Overall we can say that through a mesh networking we connect the network with internet and our dream of connecting each component of this world with internet can be achieved very rapidly. It's a perfect present time solution until Wi-Fi modules comes in cheap with IPv6.

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Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 13 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

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Jawaharlal Nehru Technological University, India

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Keywords : fuzzy logic controller, indirect vector control, induction motor stator resistance estimation, FPGA controller.

GJRE-F Classification : FOR Code: 090699

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B. Mouli Chandra [α] & Dr S. Tara Kalyani [σ]

Abstract - In this paper online estimation of stator resistance in indirect vector control (IVC) of Induction motor (IM) is proposed using fuzzy logic controller (FLC). It is renowned that stator resistance of Induction motor which is sensitive to temperature rise in machine leads to performance deterioration as resistance used in controller is dissimilar from actual stator resistance. Here the effect of change in stator resistance is examined in terms of stator current, rotor flux and torque and corrected using fuzzy logic controller algorithm. The proposed algorithm was tested using MATLAB/SIMULINK software and practically implemented in Field programming Gate array (FPGA) Controller.

Keywords : fuzzy logic controller, indirect vector control, induction motor stator resistance estimation, FPGA controller.

I. Introduction

The superior performance of separately excited D.C motor in terms of dynamic control had become the work horses for an Industry. Later after development of power electronic converters Induction motors which are rugged in construction replaces the D.C motors even for Adjustable speed applications, i.e., D.C machine like performance was obtained by Induction motor by using vector control, where the three phase stator quantities has been resolved into d-q axes, one resembles torque producing quantities and other flux producing quantity. Therefore the independent control of torque and flux is possible in vector control. However flux position in vector control is essential. There are basically two types of vector control based on how the rotor flux is determined. In direct vector control it is found by direct flux sensors where as in indirect vector control it is found in feed forward manner. However rotor flux which is majorly affected by stator resistance variation which is dependent on temperature rises [40-50%] in machine. In [1] BEMF (Back Electromotive force Detector was proposed, in [2] calculation of flux including stator resistance was accounted, in [3] by treating the rotor speed and stator voltages and currents are the inputs to flux estimator was proposed. In [4] Stator resistance tuning based on error between actual and measured values proposed using full order observer. In [5] Model reference adaptive system (MRAS) based estimation of Rs. In this paper Flux estimated from the voltage model is compared with the flux estimated from the current model and error and change in error is given as inputs to the fuzzy controller and the output is taken as change in stator resistance and estimated stator resistance is found by adding the actual resistance.

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II. Induction Motor Model with Vector Control

Considering the modeling equation of Induction motor in stationary reference frame, the condition for ensuring vector control is

$$\left.\begin{matrix}\Psi_{dr} = \Psi_r \\ \Psi_{qr} = 0\end{matrix}\right\} \quad (1)$$

The decoupled stator voltages v_{ds} and v_{qs} are given by

$$v_{ds} = R_s i_{ds} + \sigma L_s \frac{di_{ds}}{dt} + \left(\frac{L_m}{L_r}\right)\frac{d\Psi_{r\,ref}}{dt} - \omega_s \sigma L_s i_{qs} \quad (2)$$

$$v_{qs} = R_s i_{qs} + \sigma L_s \frac{di_{qs}}{dt} + \omega_s \left(\left(\frac{L_m}{L_r}\right)\Psi_{r\,ref} + \sigma L_s i_{ds}\right) \quad (3)$$

$$\omega_{sl} = \left(\frac{L_m i_{qs\,ref}}{T_r \Psi_{r\,ref}}\right) \quad (4)$$

$$\omega_s = \omega_r + \omega_{sl} \quad (5)$$

Where R_s, R_r are stator and rotor resistance values and $Tr = \frac{Lr}{R_r}$ is rotor time constant, ω_{sl} the slip frequency, ω_s and ω_r the stator rotor angular frequency, L_s, L_r, L_m the stator and rotor mutual inductance, p the number of pole pairs, , $\sigma = 1 - \frac{{L_m}^2}{L_s L_r}$ is the leakage coefficient.

From equations (2) and (3)

$$R_s i_{ds} + \sigma L_s \frac{di_{ds}}{dt} = v_{ds} - \left(\frac{L_m}{L_r}\right)\frac{d\Psi_{r\,ref}}{dt} + \omega_s \sigma L_s i_{qs} \quad (6)$$

$$R_s i_{qs} + \sigma L_s \frac{di_{qs}}{dt} = v_{qs} - \omega_s \left(\left(\frac{L_m}{L_r}\right)\Psi_{r\,ref} + \sigma L_s i_{ds}\right) \quad (7)$$

From equations (6), (7) undoubtedly shows that decoupled rotor fluxes dependent on stator resistance which is assorted during running conditions of motor.

III. Effect of Stator Resistance

When the Stator resistance is deviated from its actual value during the running conditions of motor, primarily it effect on rotor flux calculation, and motor toque, and stator currents by treating the inductance variation is zero in steady state condition.

IV. Stator Resistance Estimation using Fuzzy Controller

It is evident from equations (6) and (7), the rotor flux estimation is affected by stator resistance variation. In order to minimize the error introduced because of stator resistance online stator resistance estimator must be integrated which is implemented by fuzzy logic controller. From the flux estimated by the voltage model equations, the current model equations are given by

$$\frac{d}{dt}\Psi_{dr} = \frac{R_r L_m}{L_r} i_{ds} - \omega_r \Psi_{qr} - \frac{R_r}{Lr}\Psi_{dr} \quad (8)$$

$$\frac{d}{dt}\psi_{qr} = \frac{R_r L_m}{L_r} i_{qs} - \omega_r \psi_{dr} - \frac{R_r}{Lr}\psi_{qr} \quad (9)$$

Adapting (6) and (7) equations in (8) and (9) we get reference values of decoupled stator quantities namely ids, ref and iqs, ref from which we can establish reference stator current as shown in Fig.1. ,and this reference current is compared with actual currents in motor and error in currents as well as change in error are inputs to fuzzy controller and output is taken as change in stator resistance. This change in stator resistance is added to the actual value of stator resistance which gives new estimated stator resistance which is further used in voltage model equations.

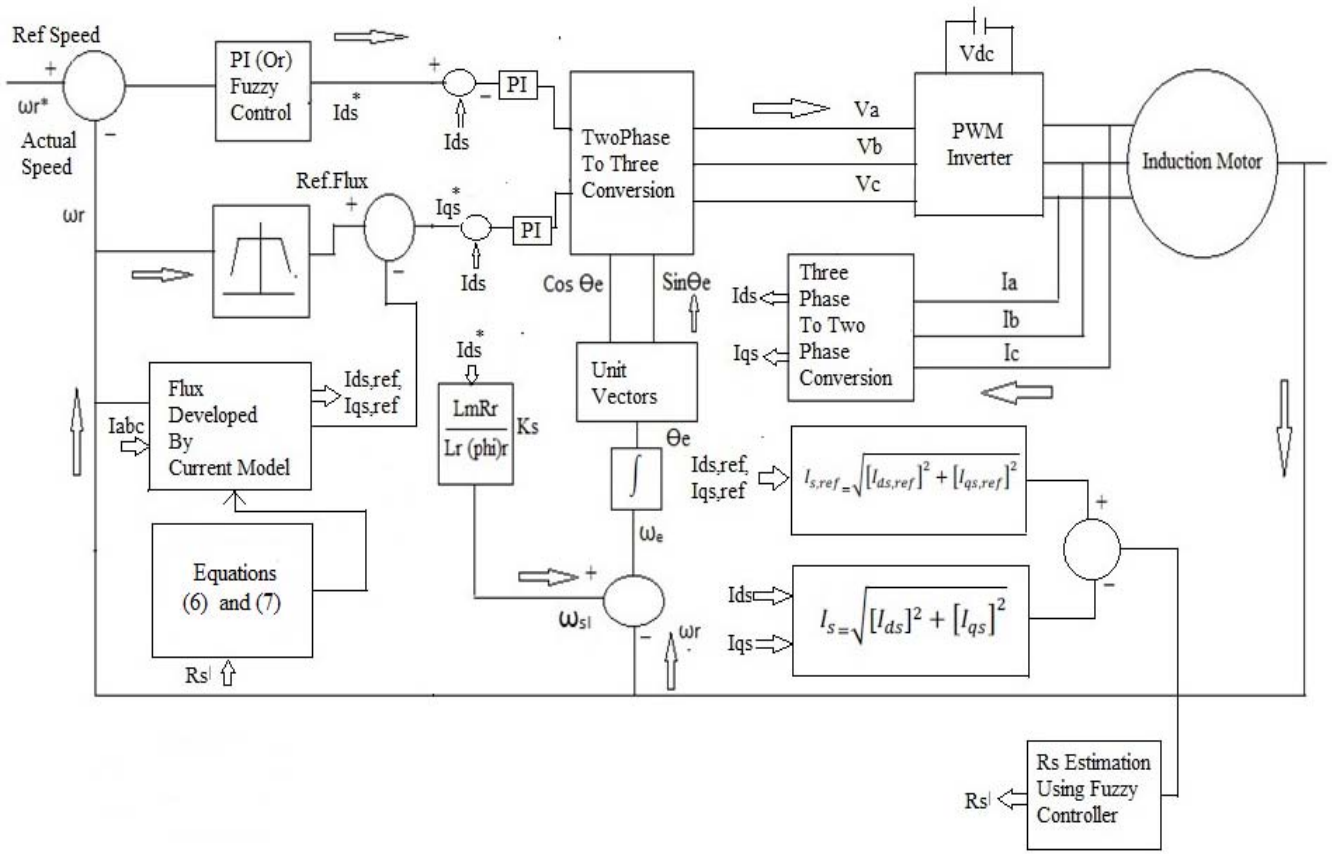

Figure 1 : Indirect Vector Control of Induction motor drive with Stator resistance Estimation

Examining the equation (8) and (9) which also dependent on Rotor resistance which also simultaneously varies with the temperature rise but in this case it with an effort to determine stator resistance variations by assuming rotor resistance effect is constant. An algorithm was developed for stator resistance estimation shown in Fig.2. In the present controller Mandani Fuzzy controller method was used for the estimation of stator resistance. It employs two inputs one is error produced by reference current generated by current model and actual feedback motor currents and the other is change in error produced by same. The rule base acts upon the inputs to produce the given outputs. The linguistic labels are divided into seven groups. They are Negative big, Negative medium, Negative small, Zero, Positive small, Positive medium, Positive big, which are generally expressed as NB,NM,NS,ZE,PS,PM,PB respectively. The rule base mapping of fuzzy inputs to derive require output is shown in table.1. Normally the output obtained produced is fuzzy in nature and has to be transformed into crisp value by using defuzzification method. Here Mean of Maximum method is used at the defuzzification stage.

Table 1 : Computation of outputs using fuzzy rules

e/Δe	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	ZE
NM	NB	NB	NM	NM	NS	ZE	PS
NS	NB	NM	NB	NB	ZE	PB	PM
ZE	NB	NM	NS	ZE	PB	PM	PB
PS	NM	NB	ZE	PB	PB	PM	PB
PM	NS	ZE	PS	PM	PM	PB	PB
PB	ZE	PS	PM	PB	PB	PB	PB

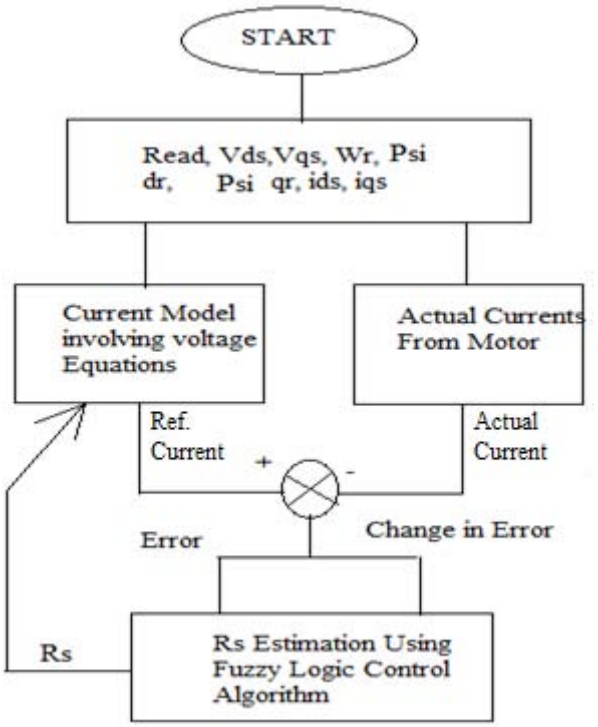

Figure 2 : Stator Resistance Algorithm

V. Simulation and Experimental Analysis

The performance of 1H.P 3-ϕ Slip ring Induction motor with Indirect Vector control is simulated using MATLAB/Simulink software. After obtaining the satisfactory results, with an effort to analyze the performance of Induction motor with stator resistance variation an additional resistance is added in terms of step manner the response of rotor flux, torque, and steady state stator currents were analyzed. Initial stator resistance 10.6 Ω, an additional resistance of 5Ω is added in step manner, the response in torque is decreased to be 32 N-m from 33.075 N-m, and similarly the rotor flux deviates to 1.08T from its actual value of 0.9T, correspondingly the stator current deviated to 2.1A from its rated value of 2.4A. Next the same results were analyzed experimentally using SPATRAN 3A FPGA Controller with the full rated torque of 33.075N-m. In this case to examine the effect of stator resistance variation an additional resistance of 5Ω is added abruptly in series with the star connected stator winding and abrupt changes in rotor flux, motor torque, and stator currents were experimentally verified and found to be similar to simulated results. Next by implementing Stator resistance algorithm using Fuzzy logic control stator resistance was estimated and adapted to current modeling equations, so estimated stator resistance was found to similar to actual resistance value and thus performance of machine was improved.

Table 2 : Induction motor parameters

3 phase voltage	415V
Rated Current	2.4A
Number of poles	4
Rotor resistance	18.1 Ω
Stator resistance	10.6 Ω
Stator Inductance	0.654H
Rotor Inductance	0.311H
Rated torque	33.075N-m

Figure 3 : Experimental Setup of Indirect Vector control with stator resistance estimation

VI. Results

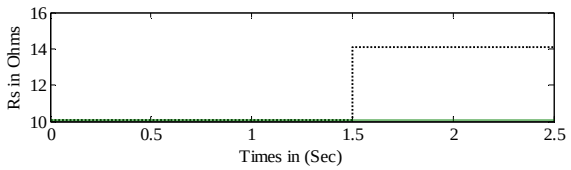

Figure 4 : Change in Stator Resistance at 1.5sec

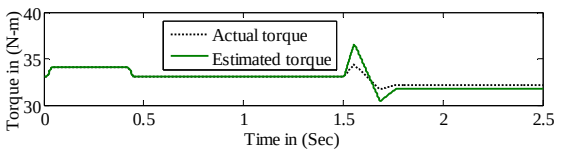

Figure 5 : Torque deviation at 1.5sec

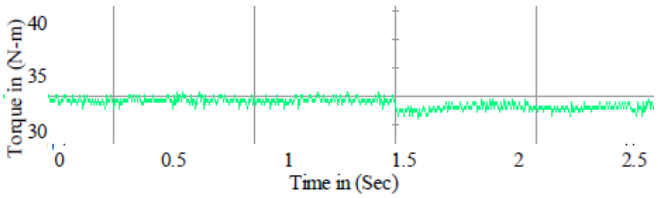

Figure 6 : Torque deviation (Experimental)

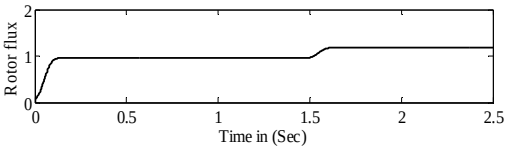

Figure 7 : Rotor Flux deviation at 1.5sec

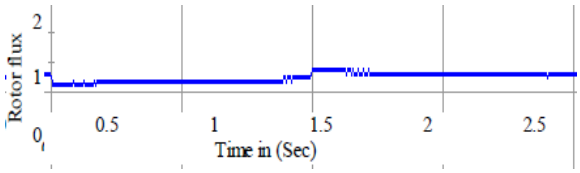

Figure 8 : Rotor Flux deviation at 1.5sec (Experimental)

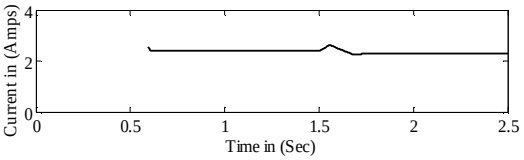

Figure 9 : Deviation in Current at 1.5sec

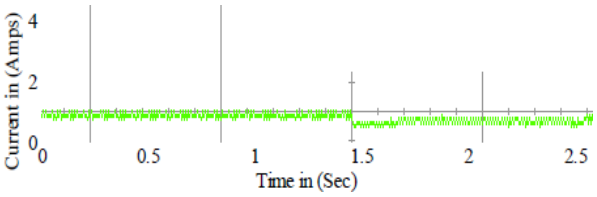

Figure 10 : Deviation in Current at 1.5sec (Experimental)

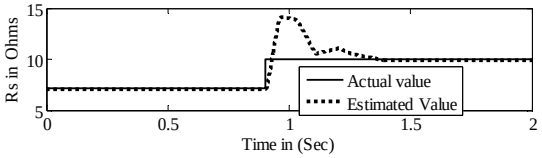

Figure 11: Estimated value converges to actual value adapted at 0.9sec

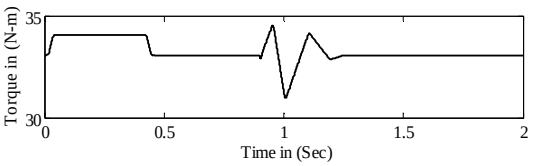

Figure 12 : Torque compensates at 0.9sec

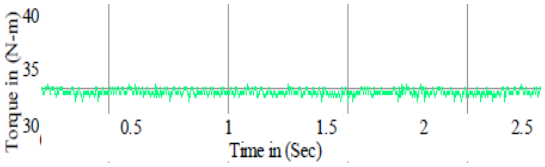

Figure 13 : Torque compensates at 0.9sec(Experiment)

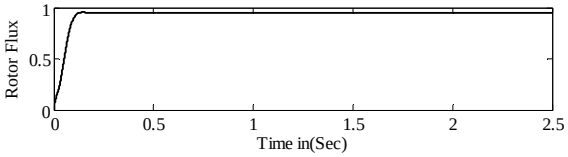

Figure 14 : Flux compensates at 0.9sec

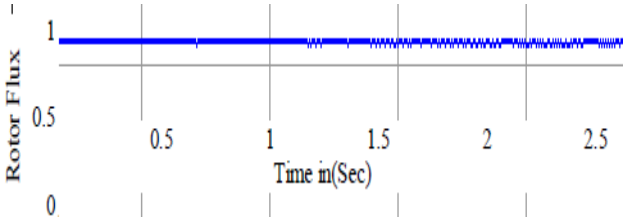

Figure 15 : Flux compensates at 0.9sec (Experimental)

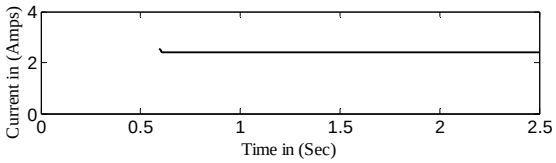

Figure 16 : Stator current compensates at 0.9 sec

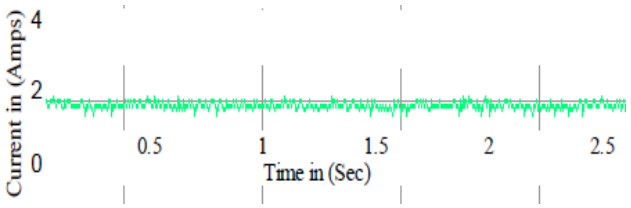

Figure 17 : Stator current compensates (Experiment)

VII. Conclusion

The main drawback of Indirect Vector control technique is stator and rotor resistance variations. In the paper the effect of stator resistance is investigated using MATLAB/Simulink Software as well as experimentally by using FPGA SPATRON 3A controller and also compensated by developing Fuzzy Algorithm.

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Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 13 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

BER Analysis of MIMO-OFDM System using Alamouti STBC and MRC Diversity Scheme over Rayleigh Multipath Channel

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Abstract - This paper represents a bit error rate performance analysis of multiple-input-multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) system with Alamouti Space Time Block Code (STBC) and Maximal Ratio Combining (MRC) diversity scheme over Rayleigh fading channel. Recently, Alamouti STBC has gained much attention as an effective transmit diversity scheme to provide reliable transmission with high peak data rates to increase the capacity of wireless communication system. In this paper, the analysis of Alamouti STBC is used in MIMO-OFDM system to assure transmit diversity and the receive diversity is resolved with MRC diversity technique. For a fixed number of transmit antennas, the performance of Alamouti STBC is analyzed in terms of probability of bit error and diversity gain for a Rayleigh fading channel. At the receiving end, the signals received from multiple paths are weighted and summed in accordance with MRC scheme which provides maximum performance improvement by maximizing the SNR of the MIMO-OFDM system. The simulated results depict that the proposed MIMO-OFDM system concatenated with Alamouti STBC and MRC outperforms conventional SISO-OFDM, MISO-OFDM with Alamouti STBC and SIMO- OFDM with MRC technique in a scattering environment.

Keywords : *Alamouti STBC, BPSK modulation, BER, MRC diversity, MIMO, OFDM, Rayleigh channel, SNR.*

GJRE-F Classification : *FOR Code: 090699*

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I. Introduction

Orthogonal frequency division multiplexing (OFDM) is an emerging technique for high data rate wireless communication systems over frequency selective channels and can be considered as one of the most promising techniques for future wireless system. However, it is well known that OFDM-based systems are sensitive to the inter-carrier interference (ICI) generated by a carrier frequency offset (CFO), which degrades the error probability performance for both single-antenna OFDM systems [1]. Moreover, in a multipath fading environment, performances of OFDM system in a wireless channel are severely degraded by random variations in the amplitude of the received signals as well as by the presence of inter-symbol-interference (ISI) and inter-carrier-interference (ICI) which also limit the OFDM system performance. To address these challenges, a promising combination has been exploited [2], namely, MIMO with OFDM which has already been adopted for present and future broadband communication standards such as LTE or WiMax.

Alamouti coded OFDM is one type of MISO-OFDM system using the Alamouti code proposed by Siavash M .Alamouti in 1998 as a space time block code for transmit diversity which uses two transmit antennas and one receive antenna [3]. A simple space-time coded orthogonal frequency division multiplexing (OFDM) transmitter diversity technique for wireless communications over frequency selective fading channels is presented in [4]. The BER performance of an OFDM system with diversity, in particular Orthogonal Space Time Block Code (OSTBC) systems have been analyzed including a broadband nonlinear power amplifier and closed-form expressions is analyzed in [5]. In [6], a detailed study of diversity coding for MIMO systems including Alamouti's STBC for 2 transmit antennas as well as orthogonal STBC for 3 and 4 transmit antennas was explored.

However, it is well known that MRC as receive diversity provides the maximum performance relative to all other diversity combining schemes by maximizing the SNR at the combiner output. Recently, in the advanced mobile systems, MRC scheme shows the best performance and it tends to be the mostly employed among other diversity schemes [7]. A BER of OFDM with MRC diversity and pulse shaping in Rayleigh fading environments was analyzed in [8].

Although, the performance of Alamouti STBC and maximal ratio combining has been investigated, their performance evaluation and application to OFDM system are not available in the literatures [4, 5, 7, 12]. The works in this paper are as follows: Firstly, the probability of error and hence effective SNR expressions are derived for a multiple-input-multiple-output (MIMO) OFDM system employing the MRC diversity technique as receive diversity and Alamouti Coded OFDM as transmit diversity. Secondly, MATLAB simulations are represented to evaluate the BER with respect to SNR to analyse the MIMO-OFDM system performance applying both Alamouti STBC and MRC diversity over Rayleigh fading channel. Thirdly, a comparison among the SISO, MISO, SIMO and MIMO in OFDM system is made that ensures MIMO-OFDM is the preferable technique for

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present and future broadband communication standards such as Long Term Evolution (LTE) or Worldwide Interoperability for Microwave Access (WiMax).

The rest of the paper is organized as follows: Section II-III represents OFDM system model with MIMO implementation. Section IV gives a simple overview about the Raleigh multipath fading channel. In section V-VI, Alamouti STBC and MRC diversity are discussed in OFDM application. The simulated results are represented and discussed in section VII. At last, a conclusion of the research work is made in section VIII.

II. OFDM System Model

OFDM is simply defined as a form of multi-carrier modulation where the carrier spacing is carefully selected so that each subcarrier is orthogonal to the other subcarriers. The architectures of a typical OFDM transmitter and receiver are shown as an OFDM transceiver in Fig-1. In the transmitting end, the incoming modulated serial bits are converted into parallel streams by using a serial to parallel converter. These parallel bit streams are subjected to Inverse Fast Fourier Transform (IFFT) block for baseband OFDM modulation. To prevent overlapping of the data at the receiver, Cyclic Prefix (CP) is inserted whose duration is one fourth of the total OFDM symbol duration. The modulated data are sent to the channel through a digital-to-analog converter. At the receiver side, firstly the data is received through N linear receivers followed by a linear combiner. This linear combiner is designed in such a way that the output SNR is maximized at each instant of time. Then this data is converted again to the digital domain by passing it through an analog to digital converter. After removing the cyclic prefix, data are again converted into serial to parallel by a serial-to-parallel converter. These parallel bit streams are demodulated using Fast Fourier Transform (FFT) to get back the original data by converting parallel bit streams into a serial bit stream.

Denote X_l *(l=0, 1, 2,…… N-1)* as the modulated symbols of the light transmitting subcarrier of OFDM symbol at the transmitter, which are assumed to be independent, zero-mean random variables, with average power σ_x^2 . The complex baseband OFDM signal at output of the IFFT can be written [13] as:

$$X_n = \frac{1}{N}\sum_{l=0}^{N-1} X_l e^{j\frac{2\pi}{N}nl} \quad (1)$$

where N is the total number of subcarriers and the OFDM symbol duration is T seconds. At the receiver the received OFDM signal is mixed with local oscillator signal, with the frequency offset deviated from the carrier frequency of the received signal owing to frequency estimation error or Doppler velocity, the received signal is given by [13]:

$$\overline{x_n} = (x \otimes h_n)e^{j\frac{2\pi}{N}n\Delta fT} + z_n \quad (2)$$

where $h_n e^{j\frac{2\pi}{N}\Delta fT}$ and z_n represent the channel impulse response, the corresponding frequency offset at the sampling instants. Assuming that a cyclic prefix is employed; the receiver has perfect time synchronization. Then the output of the FFT in frequency domain signal on the k^{th} receiving subcarrier becomes [13]:

$$\overline{X_k} = \sum_{l=0}^{N-1} X_l H_l Y_{l-k} + Z_k$$

$$= X_k H_k U_o + \sum_{l=0, l\neq k}^{N-1} X_l H_l Y_{l-k} + Z_k \quad (3)$$

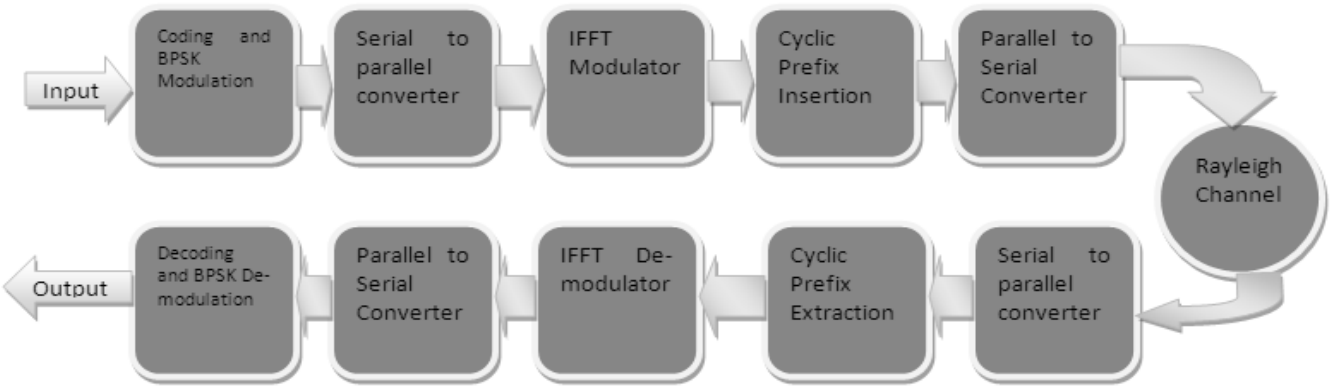

Figure 1 : Block diagram of an OFDM transceiver system over Raleigh multipath channel

The first term of (3) is a desired transmitted data symbol X_k. The second term represents the ICI from the undesired data symbols on other subcarriers in OFDM symbol. H_k is the channel frequency response and Z_k

denotes the frequency domain of z_n. The term Y_{l-k} is the coefficient of *FFT* (*IFFT*), is given by:

$$Y_{l-k} = \frac{1}{N}\sum_{n=0}^{N-1} e^{j\frac{2\pi}{N}n(l-k+\Delta fT)} \quad (4)$$

When the channel is flat, Y_{l-k} can be considered as a complex weighting function of the transmitted data symbols in frequency domain.

III. MIMO-OFDM System

Consider a MIMO-OFDM system as shown in Fig-2 which uses N subcarriers with N_T antennas at the transmitter and N_R antennas at the receiver. We assume independent channel coefficients in the $N_R \times N_T$ channel matrix, H_k, for all subcarriers k. We assume that the sampled impulse response of the channel is shorter than the cyclic prefix. After removing the cyclic prefix, the channel for the k-th subcarrier after the DFT, can then be described as a $N_R \times N_T$ complex channel matrix, H_k. The received vector of the k-th subcarrier can be written as

$$R_K = H_k S_k + n_k \quad (5)$$

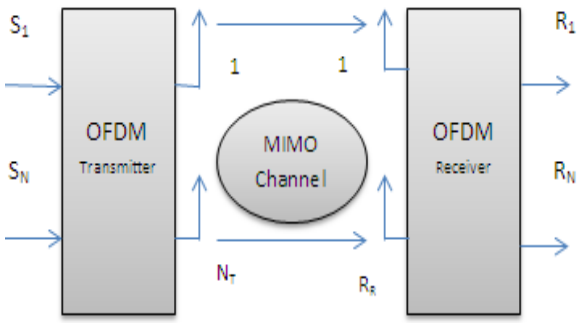

Figure 2 : MIMO-OFDM System Model

Where the channel matrix for the *k-th* subcarrier, H_k is a $N_R \times N_T$ channel matrix defined by

$$H_k = \begin{bmatrix} H_{11}^k & H_{12}^k & \cdots & H_{1N_T}^k \\ H_{21}^k & H_{22}^k & \cdots & H_{2N_T}^k \\ \vdots & \vdots & \ddots & \vdots \\ H_{N_R1}^k & H_{N_R2}^k & \cdots & H_{N_RN_T}^k \end{bmatrix} \quad (6)$$

The entries, H_{ij}^k, are the (narrow band, flat fading) complex channel gains between the j^{th} transmit antenna and the i^{th} receive antenna.

IV. Rayleigh Fading Channel Model

In this investigation, we assume that the channel is flat fading. In simple terms, it means that the multipath channel has only one tap. Rayleigh channel is modeled with a circularly symmetric complex Gaussian random variable having the following form:

$$h = h_{re} + jh_{im} \quad (7)$$

The real and imaginary parts are zero mean independent and identically distributed Gaussian random variables with mean 0 and variance σ^2. The probability density function of the magnitude h of complex Gaussian random variable has been defined which is expressed [14] as

$$P(h) = \frac{h}{\sigma^2} e^{\frac{-h^2}{2\sigma^2}} \quad (8)$$

The received signal in a Rayleigh fading channel is of the form,

$$y = hx + n \quad (9)$$

Here y is the received symbol and h is the complex scaling factor corresponding to Rayleigh multipath channel, x is the transmitted symbol and n is the Additive White Gaussian Noise (AWGN). The channel is randomly varying in time. It means that each transmitted symbol gets multiplied by a randomly varying complex number h. Since h is modeled as Rayleigh channel, the real and imaginary parts are Gaussian distributed having mean 0 and variance ½.

V. Alamouti Space Time Coded OFDM

A single-user Alamouti coded OFDM system with two transmit antennas and one receive antenna is shown in Fig. 3. Two SISO channels from the two transmit antennas to the receive antenna are assumed to be both time- and frequency selective. They both have a maximum channel delay spread that is smaller than the OFDM cyclic prefix (CP) length L.

We assume the OFDM system has N subcarriers, N_A of which are active. The remaining $N_V = N - N_A$ virtual subcarriers are used as frequency guard bands, with $N_V/2$ virtual carriers on both ends of the spectral band. The bit streams at the transmitter are grouped and mapped into complex symbols. Since we assume the channel delay spread is smaller than the CP length L, after removing the CP at the receiver, it is enough to consider only the two consecutive OFDM symbols which constitute an Alamouti code word.

Assume S_i, $i = 1, 2$ are the two consecutive OFDM symbols which can be written as

$$s_i = \left[O_{N_V/2\times 1}^T \; \bar{s}_i^T \; O_{N_V/2\times 1}^T \right] \quad (10)$$

where the 0's indicate the guard bands and $\bar{s}_i$ is the data vector of length $N_A = N - N_V$, which yields of a set of data symbols with power σ_s^2. During the first OFDM symbol period, s_1 and s_2 are sent from transmit antenna *1* and *2* respectively. Then, $-s_2^*$ and s_1^* are sent from transmit antenna *1* and *2* respectively during the second OFDM symbol period. The IFFT operation converts the frequency-domain signal to a time-domain signal. After the parallel / serial conversion, the CP is added and the overall *N+L* length vectors are sent from the two transmit antennas simultaneously. At the receiver, after removing the CP, the received signals in

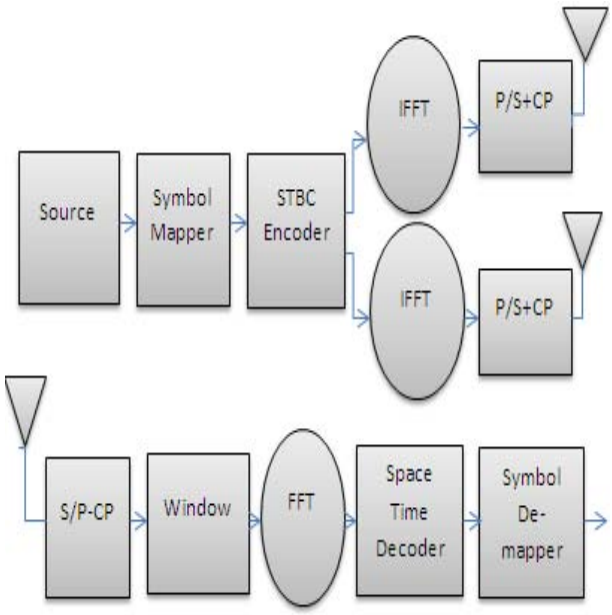

Figure 3 : Alamouti Coded OFDM System Model

two consecutive OFDM symbol periods can be written [9] as

$$y_1^\circ = H_{1,1}^\circ F^H s_1 + H_{2,1}^\circ F^H s_2 + n_1^\circ \quad (11)$$

$$y_2^\circ = -H_{1,2}^\circ F^H s_2^* + H_{2,2}^\circ F^H s_1^* + n_2^\circ \quad (12)$$

where y_i° is the received $N \times 1$ vector in i^{th} symbol period, $H_{i,j}^\circ$ is the time domain $N \times N$ channel matrix between transmit antenna *i* and the receive antenna in symbol period *j* and n_i° is the $N \times 1$ circularly symmetric zero-mean white complex Gaussian random noise. After the serial/parallel conversion, the FFT operation converts the received time-domain signal back to the frequency domain. Before the FFT, a time-domain receiver window is often used to make the frequency-domain channel matrix more banded [10]. In that case, we obtain.

$$y_1 = FWy_1^\circ + FWn_1^\circ \quad (13)$$

$$y_2 = FWy_2^\circ + FWn_2^\circ \quad (14)$$

where *W=diag(w)* with w the time-domain receiver window. Note that for classical OFDM, we have $W = I_N$. Stacking y_1 and y_2^* in one vector, we obtain.

$$\begin{bmatrix} y_1 \\ y_2^* \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{2,1} \\ H_{2,2}^* & -H_{1,2}^* \end{bmatrix} \cdot \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2^* \end{bmatrix} \quad (15)$$

In order to allow for low-complexity equalization, we approximate the frequency domain channel matrix $H_{i,j}$ by its banded version

$$B_{i,j} = H_{i,j} \otimes \theta_Q \quad (16)$$

where θ_Q is the $N \times N$ Toeplitz matrix.

The parameter *Q* is used to control how many off-diagonal elements should be included to give a good approximation of the banded frequency-domain channel matrix. As shown later, tuning *Q* allows for a trade-off between equalizer complexity and performance. Usually we take $1 < Q < 5$ which is much smaller than the number of subcarriers N.

Rewrite (15) as

$$y = Hs + n \quad (17)$$

where H is a 2×2 block matrix of $N \times N$ approximately banded matrices with band-width parameter *Q*. Using a specific permutation matrix, we can now turn *H* into an $N \times N$ approximately banded block matrix of 2×2 matrices with block bandwidth parameter *Q*. Let us therefore define the permutation matrix $P_{M,N}$ as a $MN \times MN$ matrix. Left multiplying *y* in (17) with the permutation matrix $P_{2,N}$, we obtain.

$$y_P = P_{2,N^y} = P_{2,N} H P_{2,N}^T P_{2,N^s} + P_{2,N^n} = H_{PSP} + nP \quad (18)$$

where $H_P = P_{2,N} H P_{2,N}^T$, and $y_P = P_{2,N^y}$ and $s_P = P_{2,N^s}$ are the permuted received and transmitted signal, in which the data from the same subcarriers of different transmit antennas are grouped together in s_P and the received data from the same sub- carriers in two consecutive OFDM symbol periods are grouped together.

VI. MRC Receiver Diversity

In MRC, the signals received from multiple paths are weighted according to their individual signal

voltage to noise power ratios and then summed. Here, the individual signals must be co-phased before being summed. A simple OFDM system with MRC is shown in Fig-4(a) and 4(b). Maximal ratio combining produces an output SNR equal to the sum of the individual SNRs. Thus, it has the advantage of producing an output with an acceptable SNR even when none of the individual signals are themselves acceptable. The signals at the output of the receivers are linearly combined in MRC to maximize the instantaneous Signal-to-Noise Ratio (SNR). In the assumed system, the complex envelope of the received signal of the l^{th} diversity branch, which is defined in [7] by.

$$\bar{s}_l(t) = a_i e^{j\theta_i}\bar{S}(t) + \bar{w}_l(t) \qquad (19)$$

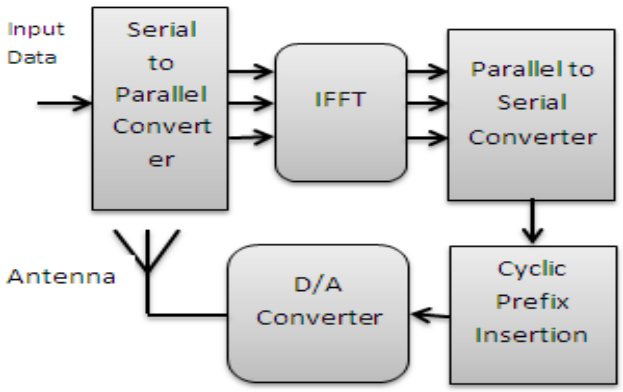

Figure 4(a) : OFDM Transmitter

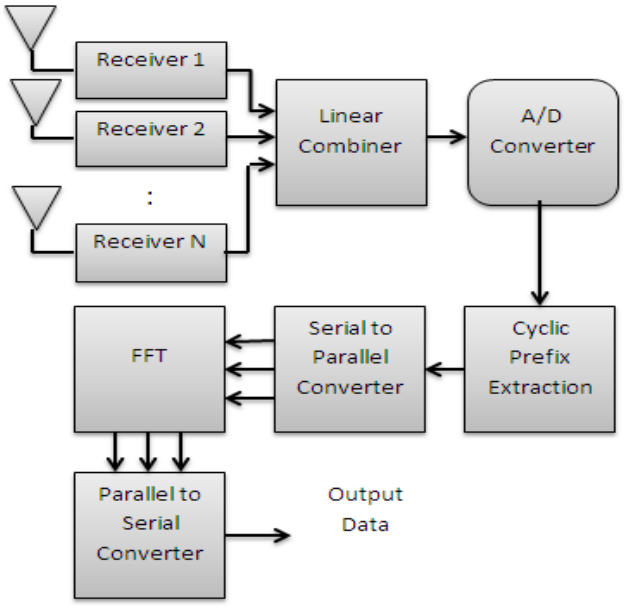

Figure 4(b) : OFDM Receiver with MRC Diversity

where $\bar{S}(t)$ denotes the complex envelope of the modulated signal transmitted during the symbol interval $0 \le t \le T$ for the l^{th} diversity branch, the fading is represented by the multiplicative term $a_i e^{j\theta_i}$ and the additive channel noise is denoted by $\bar{w}_l(t)$. Now, at the receiver end the maximal-ratio combiner consists of N linear receivers followed by a linear combiner. Using Eq. (20) the corresponding complex envelope of the linear combiner output is defined by [7].

$$\bar{y}(t) = \sum_{i=1}^{N} a_i \bar{x}_l(t)$$

$$= \bar{S}(t)\sum_{i=1}^{N} a_i e^{j\theta_i} + \sum_{i=1}^{N} a_i \bar{w}_l(t) \qquad (20)$$

a) Effective E_b/N_o with Maximal Ratio Combining

The effective symbol energy to noise ratio is the sum of N random variables. Earlier, we noted that in the presence of channel h_i, the instantaneous bit energy to noise ratio at i^{th} receive antenna is

$$\gamma_i = \frac{|h_i|^2 E_b}{N_o} \qquad (21)$$

Given that we are equalizing the channel with h^H, with the N receive antenna case, the effective bit energy to noise ratio is,

$$\gamma = \sum_{i=1}^{N} \frac{|h_i|^2 E_b}{N_o} \qquad (22)$$

b) Error Rate with Maximal Ratio Combining (MRC)

Effective bit energy to noise ratio in N receive antenna case is N times the bit energy to noise ratio for single antenna case. In case of a two-fold diversity scheme, the combining equation is given by:

$$z_k = r_{1k} z_{2k} + r_{2k} z_{2k} \qquad (23)$$

where, r_{1k} and r_{2k} represent the instantaneous envelopes of the signals received at each of the diversity branches. The SNR per bit at the output of the maximal ratio combiner can be written as:

$$\gamma = \sum_{k=1}^{N} r_k = \frac{E_b}{N_o}\sum_{k=1}^{N} R_k^2 \qquad (24)$$

where, $k = R^2 \frac{E_b}{N_o}$ is the instantaneous SNR in the k^{th} diversity branch. The pdf of the output SNR can be written as:

$$f_\gamma(\gamma) = \frac{1}{(N-1)!\gamma_c^N}\gamma^{N-1} e^{\frac{-\gamma}{\gamma_c}} \qquad (25)$$

where γ_c is the average SNR per channel. Now the conditional P_e for BPSK must be averaged

over all the possible values of γ to obtain the final expression for the probability of error, i.e,

$$P_e = \int_0^\infty P_e(\gamma) f_\gamma(\gamma) d\gamma \qquad (26)$$

For large values of N, a closed form expression does exist for this problem given by [11]:

$$P_e \approx \left(\frac{1}{4\gamma_c}\right)^N \frac{(2N-1)!}{(N-1)!N!} \qquad (27)$$

From the above equation it can be inferred that the P_e varies as γ_c raises to the N^{th} power. Thus, with MRC, the BER decreases inversely with the N^{th} power of the SNR.

VII. Simulated Results

In order to make an investigation of performance analysis of the MIMO-OFDM system with Alamouti Space Time Block Code as the transmit diversity and MRC diversity technique as the receive diversity over a Rayleigh fading channel, we deal with MATLAB simulation using the parameters based on IEEE802.a standard. BPSK modulation was used to determine the BER versus SNR performance of the system. We consider an MIMO-OFDM system with N = 64 subcarriers, CP length L =16 over Rayleigh fading channel.

a) Simulated BER of OFDM without diversity

Here we represent the BER performance of BPSK digital modulation with a simple OFDM system over Rayleigh fading channel. The result involved with this SISO-OFDM system shows the BER performance as a function of the energy per bit to noise ratio. Fig-5 shows the BER Vs SNR curve for the OFDM system with one transmit antenna and one receive antenna (i.e., SISO-OFDM) for a Rayleigh fading environment. However, it is seen from the figure that as the energy per bit to noise ratio increases in the system, a decrement in the bit error rate is encountered.

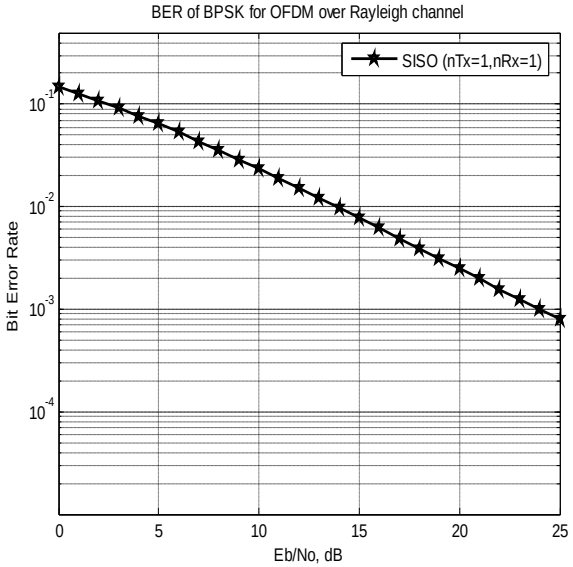

Figure 5 : BER of SISO-OFDM system over Rayleigh Fading Channel

b) Simulated BER Vs SNR of OFDM with Alamouti STBC

Alamouti Space Time Code is a simple Transmit diversity that offers a simple method for achieving spatial diversity with two transmit antennas. Using two transmit antennas and one receive antenna the scheme provides the same diversity order as maximal-ratio combining (MRC) with one transmit antenna, and two receive antennas. The Alamouti STBC as a transmit diversity associated with OFDM system forms a MISO-OFDM system we are calling here so far. The channel experienced by each transmit antenna is independent from the channel experienced by other transmit antennas. For the i^{th} transmit antenna, each transmitted symbol gets multiplied by a randomly varying complex number h_i. As the channel under consideration is a Rayleigh channel, the real and imaginary parts of h_i are Gaussian distributed having mean $\mu=0$ and variance $\sigma^2 = 1/2$. The channel experienced between each transmit to the receive antenna is randomly varying in time. However, the channel is assumed to remain constant over two time slots. The simulated BER versus SNR performance of Alamouti STBC as a transmit diversity involved with OFDM system has been shown in Fig-6 in a multipath fading channel. It is depicted from the figure that to keep a BER at $10^{-4,}$ the SNR gain is 17dB and with BER at 10^{-3}, the SNR gain is 12dB. Hence the simulated result shows that the more the bit error rate decreases, the curve moves more downward.

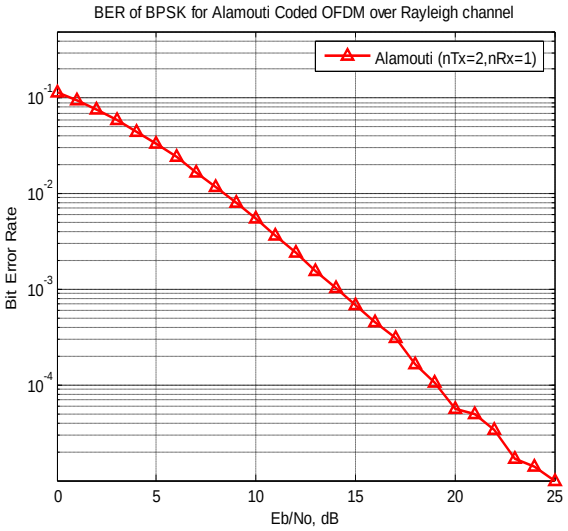

Figure 6 : Simulated BER Vs SNR of OFDM with Alamouti STBC (MISO-OFDM)

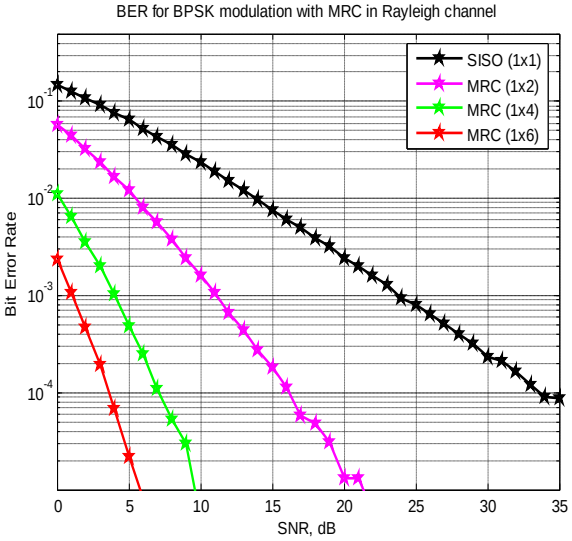

Figure 7(b) : BER for OFDM with MRC (SIMO-OFDM) in Rayleigh Fading Channel

c) Simulated Result with MRC Diversity

i. *SNR Improvement with MRC Diversity*

The effective bit energy to noise ratio in N receiving antennas is N times the bit energy to noise ratio for single antenna case. Actually the gains are same as the improvement in receive diversity for Rayleigh fading environment which are shown in Fig-7(a) for MRC techniques respectively.

This figure shows that the effective SNR gain increases with increasing number of receiving antenna. It also illustrates that the gain increases at a high rate till the number of receiving antenna be eight.

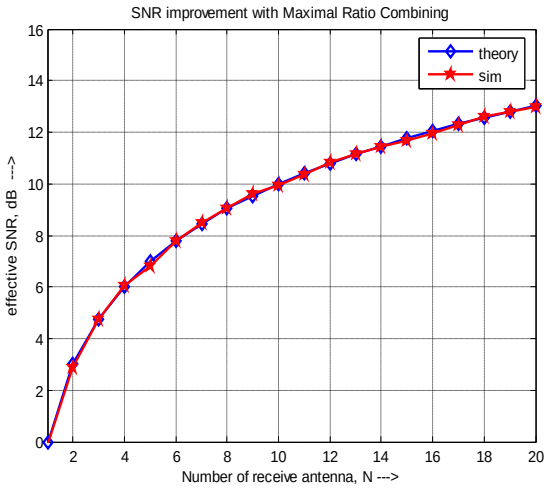

Figure 7(a) : SNR Improvement with MRC Diversity

ii. *Simulated BER Vs SNR of OFDM with MRC Diversity*

Here different antenna configurations such as *1x1, 1x2, 1x4* and *1x6* are used to show the Advantages in terms of BER of 1x6 antenna configuration over other configurations. BER Vs SNR plots for BPSK modulation over Rayleigh fading channel in this SIMO-OFDM system with MRC technique employing different antenna configurations are presented in Fig-7(b). From these simulated results, it is clear that applying MRC technique in SIMO-OFDM system, the BER keeps on decreasing when the number of receiving antenna is increased. It is depicted in the figure that to maintain BER at 10^{-4}; SISO(*1x1*), MRC(*1x2*), MRC(*1x4*) and MRC(*1x6*) configurations should have to keep SNR values at 34dB, 16dB, 7dB and 3.5dB respectively.

d) Simulated BER Vs SNR of OFDM by Alamouti STBC and MRC diversity

In Fig-8, we investigate the performance analysis of MIMO-OFDM system employing both the transmit diversity and receive diversity over a Rayleigh fading channel. In the transmitting end, we incorporate with Alamouti STBC as the transmit diversity with two transmit antenna and one receive antenna. With the help of simulation result, it is pointed out from the figure that the proposed Alamouti STBC gives a BER of 5.5×10^{-2} to obtain the diversity gain of 5dB. In the receiving end, the MRC diversity has been used as the receive diversity with various antenna configurations. Comparing with the Alamouti transmit diversity, the MRC with its 1×2 antenna configuration provides a diversity gain of 5dB at BER of 10^{-2} which is 3dB better improvement than the two branch Alamouti STBC. This 3-dB penalty is incurred because each transmit antenna radiates half the energy in order to ensure the same total radiated power as with one transmit antenna. If the BER was drawn against the average SNR per transmit antenna, then the performance curves for the new scheme would

shift 3 dB to the left and overlap with the MRC curves. In the latter case, we examine the performance of the MIMO-OFDM system improved by both the schemes. The Alamouti STBC is confined to two transmit antenna while at the transmitter the number of receiving antenna is increased in accordance with MRC scheme.

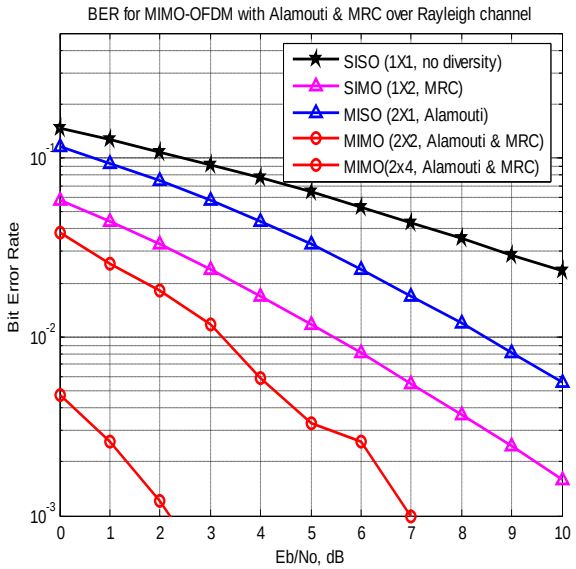

Figure 8 : BER for MIMO-OFDM with Alamouti STBC and MRC Diversity over Rayleigh Fading Channel

However by doing so, the system performance is increased significantly. It is seen from the figure that to obtain a SNR gain of 3dB with the antenna configuration of $(2\times1, Alamouti)$, $(1\times2, MRC)$ and $(2\times2, Alamouti\ \&\ MRC)$; the BERs are 7×10^{-2} , 3.5×10^{-2} and 1×10^{-2} respectively. This comparison represents that the proposed MIMO-OFDM system concatenated with Alamouti STBC and MRC diversity provides maximum SNR improvement with minimum BER as compared to both MISO-OFDM or SIMO-OFDM with either Alamouti or MRC diversity respectively. The simulation result also shows us that for the antenna configuration of $(2\times4, Alamouti\ \&\ MRC)$, to obtain the same SNR gain i.e. , 3dB; the BER could be maintained at 7×10^{-4} which provides better performance than any other configuration described so before.

VIII. Conclusion

In this paper, the performance of the MIMO-OFDM system has been analyzed with the use of Alamouti STBC and MRC technique as the transmit and receive diversity respectively over a Rayleigh multipath fading channel. The Alamouti STBC is the only STBC that can achieve its full diversity gain without needing to sacrifice its data rate, this property usually gives Alamouti's code a significant advantage over the higher-order STBCs even though they achieve a better error-rate performance. Maximal Ratio Combiner is the optimum combiner for independent Rayleigh fading and AWGN channels. The simulation result represents that the performance of the Alamouti scheme with two transmitters and a single receiver is 3 dB worse than MRC diversity with one transmit and two receive antenna. However, the 3-dB penalty is incurred because the simulations assume that each transmit antenna radiates half the energy in order to ensure the same total radiated power as with one transmit antenna. If each transmit antenna in the new scheme was to radiate the same energy as the single transmit antenna for MRC, however, the performance would be identical. From the simulation result, it is clear that the proposed MIMO-OFDM system concatenated with Alamouti STBC and MRC diversity provides maximum SNR improvement with minimum BER as compared to both MISO-OFDM or SIMO-OFDM system with either Alamouti STBC or MRC scheme respectively.

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Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 13 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Designing Solar and Biogas based Renewable Energy System on University Campus and its Impacts on Energy Cost after Renewable Energy Interconnection on University Campus Grid Network

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Abstract - In Bangladesh power crisis is one of the great problems. The whole of the probable sector is affected by it. The effects of power crisis is destroyed our economic growth. The total development of a country's depends on the power generation. On the other hand when the load shedding is occurred, then the students of the university are basically affected, then they do not attain their lesson attentively and study their lesson attentively. Even they do not able to complete their laboratory works, complete their thesis and their class notes and so on. But, there is a huge opportunity to back up the load shedding using Solar and Biogas energy. This paper presents a design and analysis of Solar based power plant using sunlight and Biogas based plant using Human and Kitchen waste of the University for Load shedding Backup and the cost analysis results that, the system is economically feasible for University campus.

Keywords : *solar power, biogas energy, renewable energy, university campus, load-shedding back up, economical system.*

GJRE-F Classification : *FOR Code: 850599, 850505*

Strictly as per the compliance and regulations of :

Designing Solar and Biogas based Renewable Energy System on University Campus and its Impacts on Energy Cost after Renewable Energy Interconnection on University Campus Grid Network

Ummay Habiba [α], Sujan Kumar Talukdar [σ] & Md. Rabiul Islam [ρ]

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I. Introduction

Bangladesh is endowed with plentiful supply of renewable source of energy [1]. Out of various renewable sources solar, wind, biomass can be effectively used in Bangladesh. Renewable energy practices in Bangladesh are [2]-

- Solar energy
- Biomass energy
- Wind energy
- Hydro power energy

Wind & Hydro power have a limited scope of success in Bangladesh, but could solar & biogas provides a viable solution to our existing energy problems [3].

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Solar power is not new in Bangladesh. Since, 1996 different companies have tried to market solar energy systems to the public [4]. Yet in a technologically backward country like Bangladesh the ides took a fair while to gestate. Solar and biogas energy is a renewable energy without causing pollution to the environment. Grameen Shakti and few other companies are working to provide solar biogas energy to the villages in Bangladesh. The Government of Bangladesh is working to provide more energy to its people to accelerate economic growth, social development and reduce poverty [5]. On one hand, government is working to promote the use of renewable energy technologies. On the other hand, the government works with industry public sector power utilities and private households to increase the use of energy efficient appliance and production processes and promote energy generation. Renewable energy and energy efficiency is a priority area of Bangladeshi–German development co-operation [6].

II. Literature Review

Sun is the richest source of energies like light and heat. Huge amount of energies are available for us to take and make big impact on our electricity requirements [7]. Our sun throws as much amount of energy on earth in one day which is equivalent to the energy requirement for the entire year. Sun surface is about 109 times bigger than surface of the earth [8]. It takes millions of years for energy generated from the center of the sun to reach to the surface of the sun [9]. Our mother earth is about 149.63 * 106 kilometers away from the sun, and light takes about 8 minutes and 31 seconds to reach to the surface of the earth. Light from the sun travels 186,262 miles per second to reach to earth [10] [11]. Energy emitted from the sun which reaches earth is in massive amount and can be extremely dangerous for mankind on earth if direct exposure is made.

a) Solar Energy

Solar electricity is the energy which is extracted by Sun using solar power plants.

i. *Photovoltaic or Solar Cell*

It is possible to convert solar energy directly into electrical energy by means of silicon wafer photovoltaic cells, also called solar cells, without any intermediate thermodynamic cycle [12]. The solar cell operates operate on the principle of photovoltaic effect, which is a process of generating an EMF as a result of the absorption of ionizing radiation. Thus a solar cell is a transducer, which converts the sun's radiant energy directly into electrical energy.

ii. *Storage Device*

The electricity produced by the PV modules is stored in batteries for later use when there is no sun [13]. Charge controllers regulate the rate of flow of electricity from the modules to the battery or the loads or to both simultaneously. It keeps the battery from overcharging or overloading thus prolonging its life.

iii. *Inverters*

The inverter converts the DC electricity produced by the solar modules into alternating current (AC) since most electrical appliances and equipment run on AC electricity [14].

b) Biogas Energy

Biogas originates from bacteria in the process of biodegradation of organic material under anaerobic (without air) conditions [15]. The natural generation of biogas is an important part of the biogeochemical carbon cycle. Methanogens (methane producing bacteria) are the last link in a chain of micro-organisms which degrade organic material and return the decomposition products to the environment. In this process biogas is generated, a source of renewable energy.

i. *Hydraulic Retention Time (HRT)*

The retention time is the theoretical time that a particle or volume of liquid added to a digester would remain in the digester [16]. It is calculated as the volume of the digester divided by the volume of slurry added per day and it is expressed as days. The solids retention time (SRT) represents the average time that the solids remain in the system. The solids retention time can be determined by dividing the weight of volatile solids in the system by the weight per unit time of volatile solids leaving the system. The hydraulic retention time (HRT) is equal to the solids retention time in completely mixed non-recycled digester systems.

ii. *Total Solid (TS)*

The amount of solid material without considering the liquid part is termed as Total Solid (TS) [16]. Total solid is the material unit that indicates the production rate of Biogas. The favourable total solid value for smooth fermentation is 8%.

iii. *Fresh Discharge*

Fresh discharge is the total amount of manure including moisture content directly obtained from the com, chicken, human etc. [16].

iv. *Liquid Part*

Liquid part is the amount of water to be added with fresh discharge to make the TS value is 8% [16].

III. Research Methodology

We have designed a biogas plant with respect to human and kitchen waste of four hostel and a dormitory at a university campus and according to area of roof space of a academic building and four hostel, & We are establishing a solar panel which act as an ideal model for reducing load shedding and at the absence of load shedding it will provide electricity at national grid.

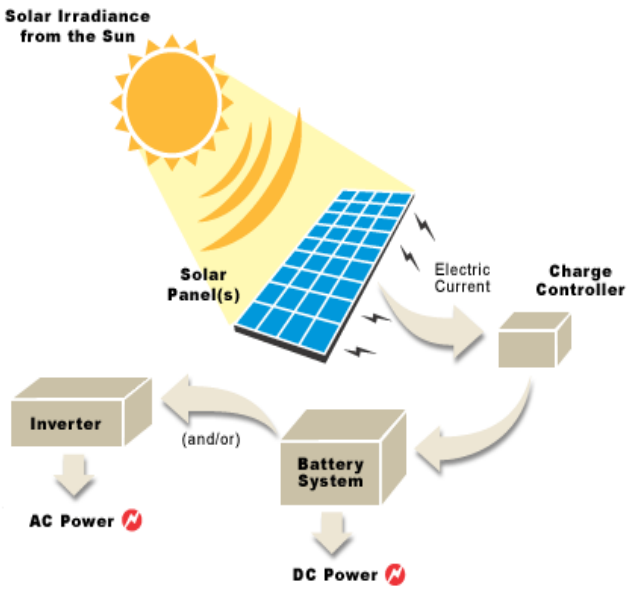

Figure 1 : Solar energy generation method

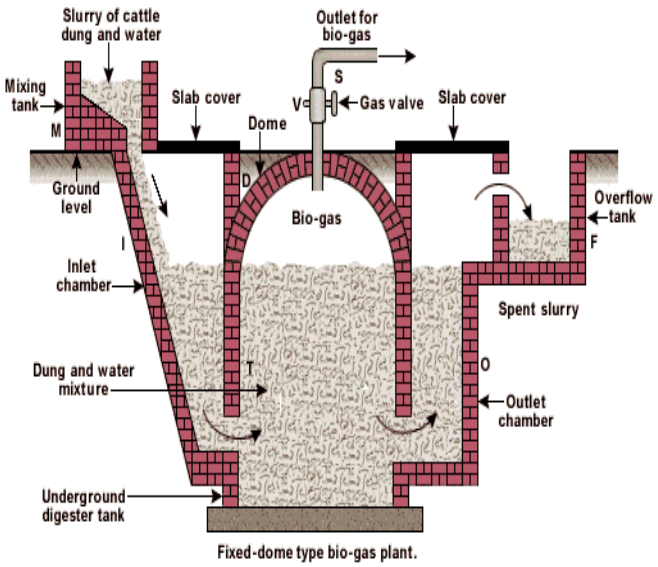

Figure 2 : Biogas based power plant design

The conversion of sunlight into electricity is defined as the solar power. It has done with the help of directly using photovoltaic (PV), or indirectly using concentrated solar power (CSP). CSP use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic Cell converts light into electric current using the photoelectric effect which is the basic principle of solar power generation.

IV. Solar Panel & Biogas Plant

The determination of Solar panel requirements and the composition of Biogas are provided below.

a) Determination of Solar Panel Requirements

For 100 Watt Solar Panel required area is = 7.392 square ft. Consider, Four Student Hostel and One Academic Building where roof space of each hostel is 4000 sq.ft. and Academic Building is 5000 sq.ft. respectively. For 4000 square ft. of every hostel 54.11 KW power can be generated and total panel required in every hostel = 540 pieces. For 5000 sq. ft. of Academic Building 67.64 KW power can be generated and total panel required in every hostel = 670 pieces.

Building Name	Load Emergency KW	Quantity of Light KW	Rating per light (Watt)	Quantity of Fan	Rating of Fan (Watt)
Student hostel 1,2,3,4	22.82	992	23	–	–
Teacher Dormitory	11.60	200	23	100	70
Academic Building	7.615	115	23	71	70
Server	15				

b) Composition of Biogas based Plant

The average composition of biogas is shown in table with respect to percentage 55%-75% biogas is methane gas.

Table 1 : Composition of Biogas

Matter	Percentage (%)
Methane (CH_4)	55-75
Carbon-dioxide (CO_2)	25-45
Carbon mono-oxide (CO)	0-0.3
Nitrogen (N_2)	1-5
Hydrogen (H_2)	0-3
Hydrogen sulphide (H_2S)	0.1-0.5
Oxygen (O_2)	0.1-0.8

V. Calculation of Digester Volume

a) Calculation of Digester Volume for Hostel from Human Waste

Digester volume for student hostel-1:

Let, HRT= 40 day (for temperature 30° C).

We know, From every person 0.5 Kg waste is obtained per day.

Total discharge for human waste = (496×0.5) Kg = 248 Kg.

TS of fresh discharge = (248×0.2) = 49.6 Kg.

To make the TS value of 8% for favourable condition we have to mix some additional water with fresh discharge. The required water added can be calculated by the following way.

8 Kg solid equivalent of influent.

49.6 Kg solid equivalent $= \frac{100 \times 49.6}{8}$ Kg = 620 Kg .

Working volume of digester = Q × HRT =620×40= 24.8 m^3.

From geometrical assumption,

$V_{gs} + V_f = 80\%$ of V

or, 24.8 = 0.8 × V

or, $V = \frac{24.80}{0.80} = 31\ m^3$

Similarly, For hostel 2, V=31 m^3

& For hostel 3, V= 31 m^3

& For hostel 4, V= 31 m^3

Parameter of digester volume for hostel 1 from human waste:

Since, V= 31 m^3

$D = 1.3078\ V^{(1/3)}$

Or, D= 4.10 m

Again, $V_3 = (3.14 \times D^2 \times H)/4 = (3.14 \times 4.10^2 \times 0.5)/4 = 6.6\ m^3$

Here, H= 0.5m(Calculated).

Then, $f_1 = D/5 = 4.10/5 = 0.82$ m

$f_2 = D/8 = 4.10/8 = 0.50$ m

$V_1 = 0.0827\ D^3 = 0.0827 \times 4.10^3 = 5.60\ m^3$

$V_c = 0.05\ V = 0.05 \times 31 = 1.55\ m^3$

Respectively, we can find these data's for Student Hall-02, 03 & 04.

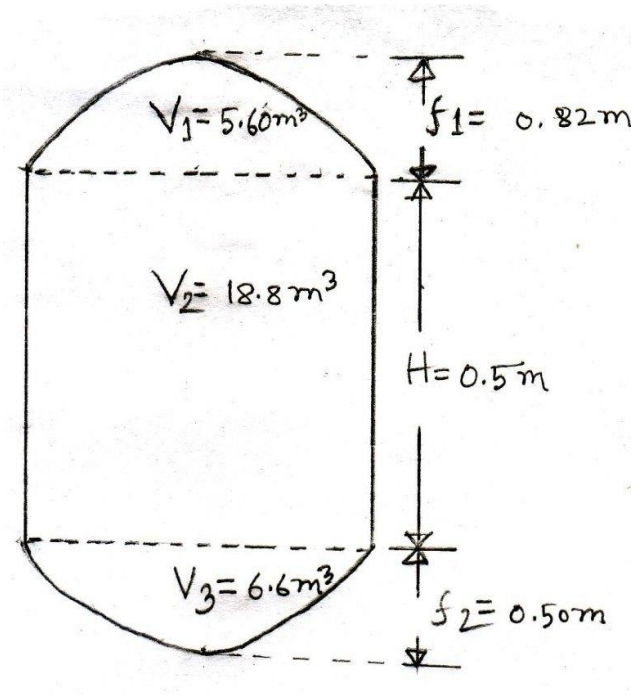

Figure 3 : Design of Digester Volume of Student Hall 1, 2, 3 & 4

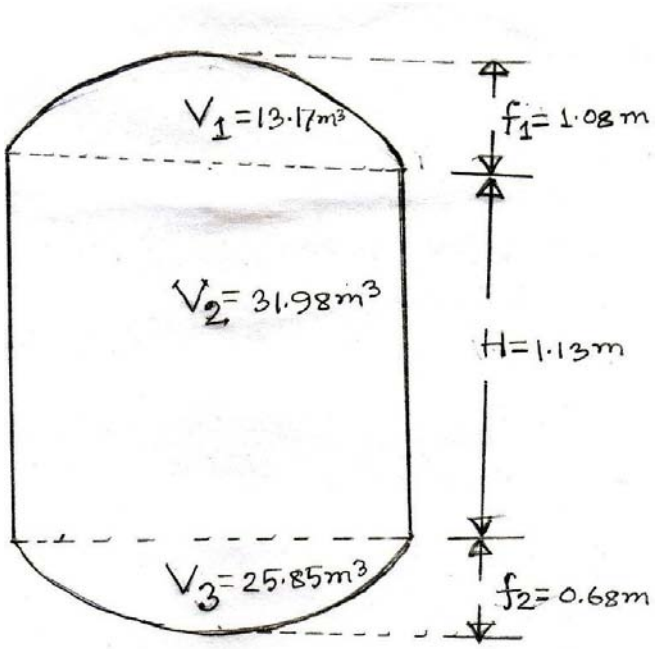

Figure 4 : Design of digester volume for Kitchen waste

b) Calculation of Digester Volume for Kitchen

Digester volume for kitchen:

Let, HRT= 40 day (for temperature =30° C) .

We know, From every household 0.10 Kg waste is obtained per day .

Total discharge for kitchen waste = 2184×0.10Kg =218.40 Kg.

TS of fresh discharge = (218.40×0.52) = 113.568 Kg.

To make the TS value of 8% for favourable condition, we have to mix some additional water with fresh discharge. The required water to add can be calculated by the following way.

8 Kg solid equivalent of influent.

26.624 Kg solid equivalent $= \frac{100\times113.568}{8}$ Kg = 1416.60 Kg .

Working volume of digester = Q × HRT =1416.60 ×40=56.784m^3.

From geometrical assumption,

$V_{gs} + V_f$ = 80% of V

or, 56.784= 0.8 × V

or, V = $\frac{56.784}{0.80}$ = 70.98 m3 =71 m3

Parameter of digester volume for Kitchen:

Since, V=71 m^3.

D=1.3078 $V^{(1/3)}$

Or, D= 5.42 m

Again, V_3= (3.14×D^2×H)/4 = (3.14×5.42^2×1.13)/4 = 25.85 m^3

Here, H= 1.13m(Calculated).

Then, f_1 = D/5 = 5.42/5 = 1.08 m

f_2 = D/8 = 5.42/8 = 0.68 m

V_1= 0.0827 D^3 = 0.0827 × 5.42^3 = 13.17 m^3

V_c= 0.05 V = 3.55 m^3

c) Calculation of Digester Volume of Teacher's Dormitory

Digester volume for teacher's Dormitory:

Let, HRT= 40 day (for temperature 30° C).

We know, From every person 0.5 Kg waste is obtained per day .

Total discharge for human waste = (200×0.5) Kg = 100 Kg .

TS of fresh discharge = (100×0.2) = 20 Kg.

To make the TS value of 8% for favourable condition we have to mix some additional water with fresh discharge. The required water to added can be calculated by the following way.

8 Kg solid equivalent of influent.

6 Kg solid equivalent = $\frac{100\times20}{8}$ Kg = 250 Kg .

Working volume of digester = Q × HRT =250×40= 10.00 m^3.

From geometrical assumption,

Vgs + Vf= 80% of V

or, 10.00 = 0.80 × V

or, $V = \frac{10.00}{0.80} = 12\ m^3$.

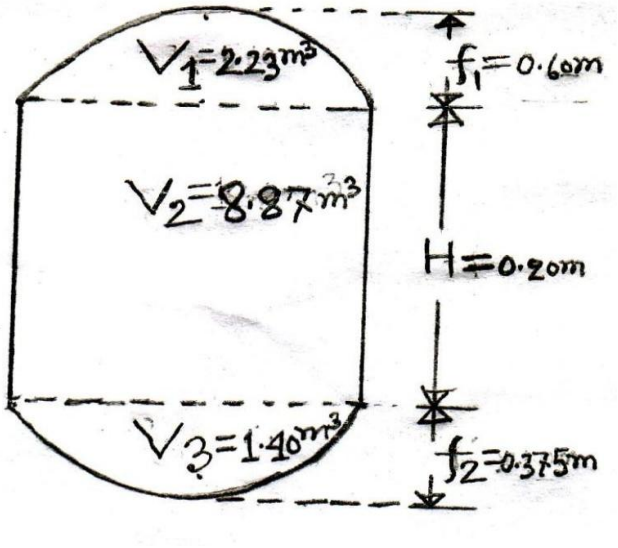

Figure 5 : Design of digester volume of Teachers' Dormitory

d) Parameter of Digester Volume for Teachers Dormitory

Since, V=12.50 m^3

Then, $D=1.3078\ V^{(1/3)}$

Or, D= 3 m

Again,

$V_3 = (3.14\times D^2\times H)/4 = (3.14\times 3^2\times 0.20)/4 = 1.40\ m^3$

Here, H=.20 m(Calculated).

Then, $f_1 = D/5 = 3/5 = 0.60$ m

$f_2 = D/8 = 3/8 = 0.375$ m

$V_1 = 0.0827\ D^3 = 0.0827 \times 3^3 = 2.23\ m^3$

$V_c = 0.05\ V = 0.05 \times 12.50 m^3 = 0.62\ m^3$

VI. Electricity Generation Capacity & Load Distributions

The total generation capacity from human waste, kitchen waste and solar energy is given in the table-2 shown in below.

Table 2 : Total Generation Capacity from Human waste, Kitchen Waste, and Solar Energy

Position	Type	Waste Type	Power (KW)
Student hostel 1,2,3,4	AC	Human	8.54*4 = 34.16
Teachers Dormitory	AC	Human	3.41
Student hostel 1,2,3,4 & Teacher's Dormitory	AC	Kitchen	50.29
Student hostel 1,2,3,4	DC	Solar energy	54*4 = 216
Academic Building	DC	Solar energy	67
		TOTAL	370.86

Table 3 : Identification of Important Loads

Position	Type	Waste Type	Power (KW)	Volume and Roof space respectively of Biogas and Solar
Student hostel 1,2,3,4	AC	Human	8.54*4 = 34.16	31m of each Digester
Teachers Dormitory	AC	Human	3.41	12m of Digester
Student hostel 1,2,3,4 & Teacher's Dormitory	AC	Kitchen	50.29	71m
Student hostel 1,2,3,4	DC	Solar energy	54*4 = 216	4000 sq. ft. of each Hostel
Academic Building	DC	Solar energy	67	5000 sq. ft.
		TOTAL	370.86	

The important loads are listed as the table-3 as shown. Now, the distributions of the loads are given below:

- *Load-1 :* Teacher's room (60) = 60× (23(Light) +70(Fan)) = 5.58 KW
- *Load-2 :* Chairman Room (11) = 11× (23(Light) +70(Fan)) = 1.00KW (Approximately)
- *Load-3 :* Server= 15 KW
- *Load-4 :* Classroom (22) = 22× (2×23(Light)) = 1KW
- *Load-5 :* Student Hostel 1,2,3,4 and teacher's dormitory: For student hostel 1,2,3,4 = 992*23 (light) = 22.80 KW. For Teachers dormitory = (200*23(light) + 100*70(fan)) = 11.60 KW, Teachers Dormitory+ Hostel = 11.60+22.80 = 34.40 KW.

The duration of the operation of the loads are shown in the table-4 in below.

Table 4 : Operation time of loads based on priority of loads

Time of Day	00:00 – 06:00	06:00 – 08:00	08:00 – 14:00	14:00 18:0	18:00 – 24:00
Running Load			Load1	Load	Load1
				Load	Load2
	Load3	Load3	Load2	Load	Load3
			Load3		
	Load5		Load4	Load	Load5
Total Load (KW)	49.40 KW	15 KW	22.58 KW	22.5 KW	55.98 KW

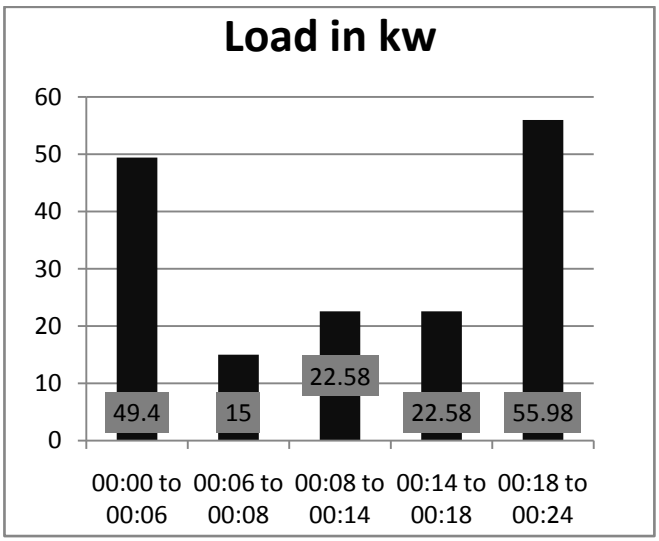

Figure 3 : Distribution of Renewable energy

VII. Cost Benefit Analysis & Savings

Since, 1 Unit= 1 KWh=5 Taka

From the time duration table:

In time (00:00-06:00) = 49.4×8*5=1482Taka

In time (06:00-08:00) = 15*2*5= 150 Taka

In time (08:00-14:00) = 22.58*6*5=677.40 Taka

In time (14:00-18:00) = 22.58*4*5= 451.60Taka

In time (18:00-24:00) = 55.98*6*5=1679.40 Taka

The total per month savings

=1482*30+150*30+677*30+451.60*30+1679.40*30

= 1, 33,212 Taka.

Table 5 : Total demand of load on University campus

Building name	Load in KW	Quantity of light	Rating per light (watt)	Quantity of fan	Rating per fan (watt)
Student hostel 1,2,3,4	92.256	992	23	992	70
Teachers dormitory	11.6	200	23	100	70
Academic building	115.32	1240	23	1240	70
Server	25				

a) Load Distributions

- *Load A :* Teacher' room (60) =60*(23(light) +70(fan)) =5.58 KW
- *Load B :* Chairman Room (11) =11*(23(light) +70(fan)) =1.00 KW
- *Load C :* Server=25KW
- *Load D :* Classroom (22) = 22*(3*23(light) + 3*70 (fan)) = 7.678KW
- *Load E :* Student hostel 1,2,3,4 & teacher's dormitory :

  Student hostel 1, 2, 3, 4 = 992*(23(light) +70(fan)) = 92.256 KW

  Teacher's dormitory=200*23(light) + 100*70(fan) =11.6 KW

  Student hostel 1,2,3,4 + Teacher's dormitory = 92.256+11.6=103.856 KW

Table 6 : Time Duration Table

Time of day	00:00 – 06:00	06:00-08:00	08:00-14:00	14:00 – 18:00	18:00 – 24:00
Running load			Load A	Load A	Load A
			Load B	Load B	Load B
	Load C	Load C	Load C	Load C	Load C
			Load D	Load D	
	Load E				Load E
Total Load (KW)	128.856 KW	25 KW	39.258 KW	9.258 KW	135.436 KW

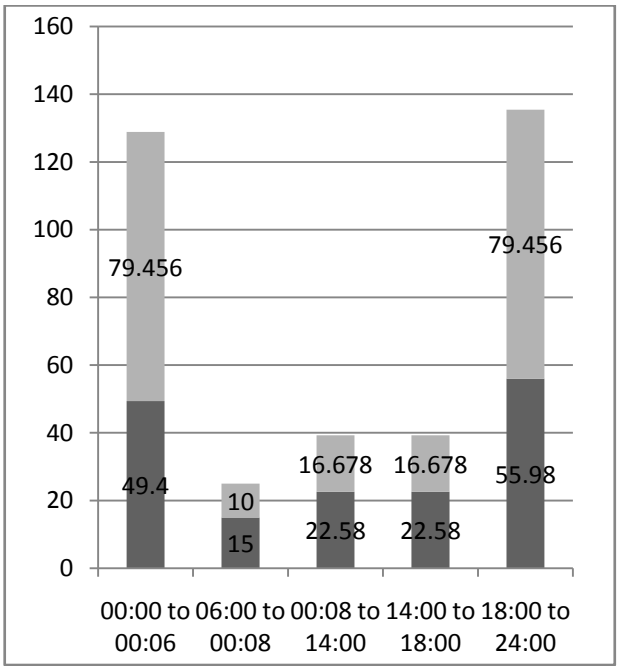

Figure 4 : Distribution of Renewable energy assuming no load-shedding

Table 7 : Cost Analysis during on no load-shedding

Time of Day	Load in KW (from renewable energy)	Load in KW (from BPDB)	Total cost (from renewable energy) in Taka	Total cost (from BPDB) in Taka
00:00-06:00	49.40	79.456	49.40*6*5=1482	79.459*6*5=2383.68
06:00-08:00	15.00	10.000	15*2*5=150	10*2*5=100
08:00-14:00	22.58	16.678	22.58*6*5=677.4	16.678*6*5=500.34
14:00-18:00	22.58	16.678	22.58*4*5=451.6	16.678*4*5=333.56
18:00-24:00	55.98	79.456	55.98*6*5=1679	79.456*6*5=2383.68
			Total cost= 4440 TK/Day	Total cost= 5701.26 TK/Day

Total cost= 4440 Taka (R.E) + 5701.26 Taka (BPDB) =10141.26 Taka. Total per month cost= 10141.26*30= 304,237.8 Taka.

From renewable energy,

Per month cost= per month saving= 4430*30 = 133,200 Taka.

Assumption of load shedding period: During the load shedding, only the emergency load is connected:

Table 8 : Demand on Load-shedding period

Load shedding period	Demand (KW)
11 am – 12 pm	22.58
03 pm- 04 pm	22.58
07 pm – 09 pm	55.98

During on load shedding, Total per day cost = (22.56*2*5+55.98*2*5) Taka= 785 Taka. Per month saving = 785*30 Taka = 23568 Taka. During the load shedding time, total saving per month on a University campus = (133200-23568) Taka = 109632 Taka.

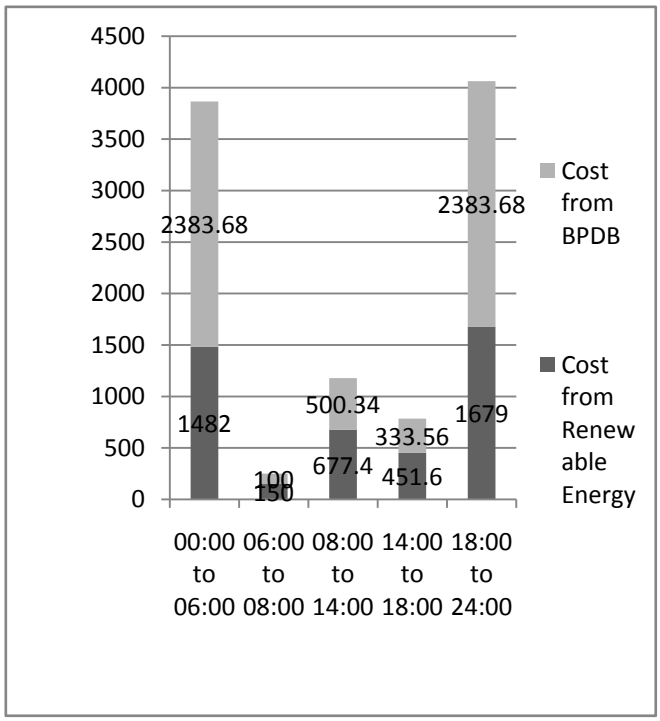

Figure 5 : Cost Analysis Curve

VIII. Conclusion

Bangladesh has a great opportunity to generate biogas and solar based power plant with the help of human waste, kitchen waste and sun shine. This renewable energy sources can be used for generating electricity and removing load shedding problems in Bangladesh. As the load shedding problems may not be removed in near future, this is the best alternative source to generate electricity. Our thesis paper represents the back-up source during load shedding at a University Campus according to biogas and solar based where human waste, kitchen waste and sun-shine is used as new materials. Complete design including system specification has been worked out. To remove load shedding problem, our represented thesis paper can be used as an ideal model for every University Campus in Bangladesh.

IX. Acknowledgment

The authors would like to thanks the department of Electrical & Electronic Engineering (EEE), Pabna University of Science & Technology (PUST), Pabna for providing full support in order to accomplish this thesis work successfully. The required information has collected from various NGO's, Firms and Grameen Shakti. Also, the authors are really grateful to them who helped by providing information. Finally, Almighty Allah helped to successfully complete this research work.

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Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 13 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Raspberry Pi Image Processing Based Economical Automated Toll System

By Md. Kawser Jahan Raihan, Mohammad Saifur Rahaman, Mohammad Kaium Sarkar & Sekh Mahfuz

American International University, Bangladesh

Abstract - The highway toll system has already been developed and widely used in many developed countries. But most of them use Radio Frequency ID. In developing countries RFID for each car does not exist. And using RFID is still a costly solution. Some of the developing countries use image processing technique to detect license plate for auto toll system. But the problem is not solved yet due to high price of host device (e.g. computer) to run. Implementation of image processed toll systems are only limited in some places. Keeping these problems in mind we have developed this project where raspberry pi will be used as host. This minicomputer has the ability of image processing and control a complete toll system. A camera will be used to take picture of the vehicle's name plate to sort the toll charge according to vehicles category. Along with multiple automatic tolls taking booth there will be a manual booth with operator also who will handle those vehicles which experience issues with any of the automatic toll taking booth.

Keywords : *raspbeery pi, image processing, toll system, electronic toll collection, intelligent transportation system, vehicle identification, vehicle classification.*

GJRE-F Classification : *FOR Code: 080106, 290903*

Strictly as per the compliance and regulations of :

Raspberry Pi Image Processing Based Economical Automated Toll System

Md. Kawser Jahan Raihan [α], Mohammad Saifur Rahaman [σ], Mohammad Kaium Sarkar [ρ] & Sekh Mahfuz [ω]

Abstract - The highway toll system has already been developed and widely used in many developed countries. But most of them use Radio Frequency ID. In developing countries RFID for each car does not exist. And using RFID is still a costly solution. Some of the developing countries use image processing technique to detect license plate for auto toll system. But the problem is not solved yet due to high price of host device (e.g. computer) to run. Implementation of image processed toll systems are only limited in some places. Keeping these problems in mind we have developed this project where raspberry pi will be used as host. This minicomputer has the ability of image processing and control a complete toll system. A camera will be used to take picture of the vehicle's name plate to sort the toll charge according to vehicles category. Along with multiple automatic tolls taking booth there will be a manual booth with operator also who will handle those vehicles which experience issues with any of the automatic toll taking booth.

Keywords : raspbeery pi, image processing, toll system, electronic toll collection, intelligent transportation system, vehicle identification, vehicle classification.

I. Introduction

In developing countries likes Bangladesh the amount of vehicle is increasing rapidly. According to 3rd-EST-Forum Bangladesh Country Paper, annual growth of vehicle is more than 10% and most of them are motor vehicle [1]. So the manual toll system has become a real concern in Bangladesh. Being one of the leading developing countries, Bangladesh is not able to implement automated toll system due to its vast vehicle amount and high cost of implementation on a large scale. At present Bangladesh government has taken steps to digitalize all the vehicles license plate number. So, countries with digitalized license plate numbers can use this project to implement at a negligible cost for automated toll system. There are several countries like china has developed RFID based toll system [2]. There are some researches on developing image processing based toll system like Vehicle Number Recognition System For Automatic Toll Tax Collection by Shoaib Rehman [3] but it's based on computer dependent image processing system. In this system raspberry pi based image processing system depending automated toll system has been proposed. Raspberry Pi will take picture through Wifi camera and process the image of license plate. It will connect with database and subtract the toll from user account. When the toll is received the barrier will be moved automatically and after the car has passed the barrier will be placed again automatically.

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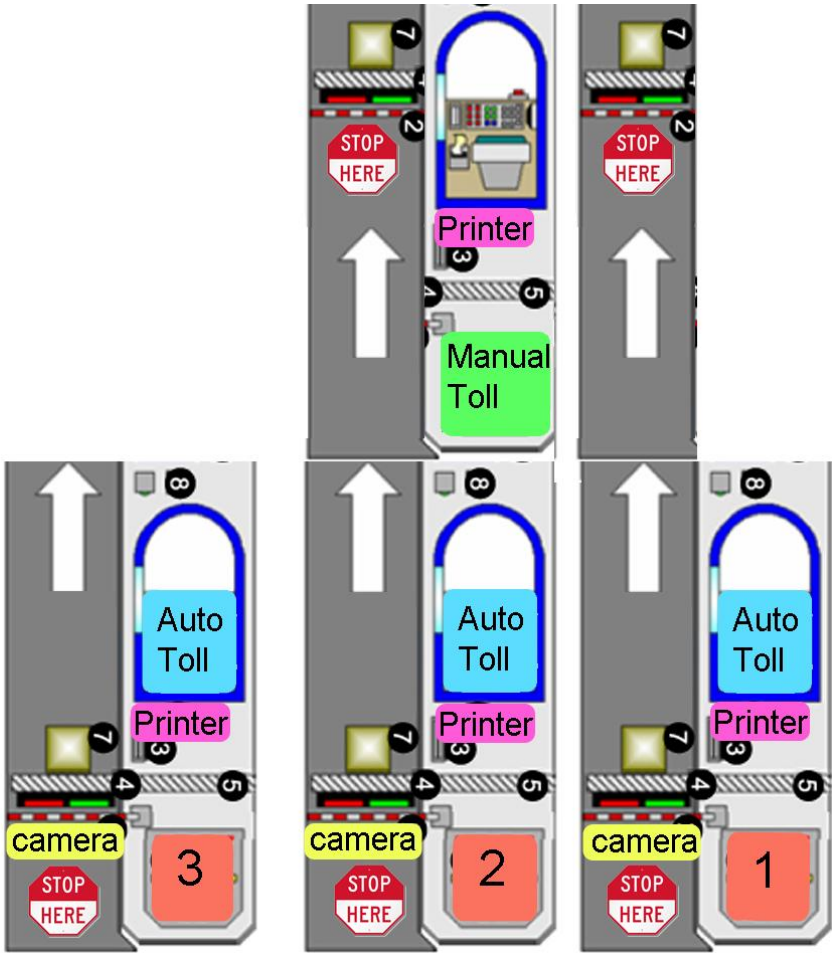

Figure 1 : Complete project outline of Automated toll system

II. Hardware Diagram

There are two types of unit in this system. One is automated toll unit and another is manually toll collecting unit. Both these units are connected internally through RF transceiver. If automated unit face any obstacles like unauthorized vehicle number, insufficient balance etc then the vehicle needs to pay toll through manual system.

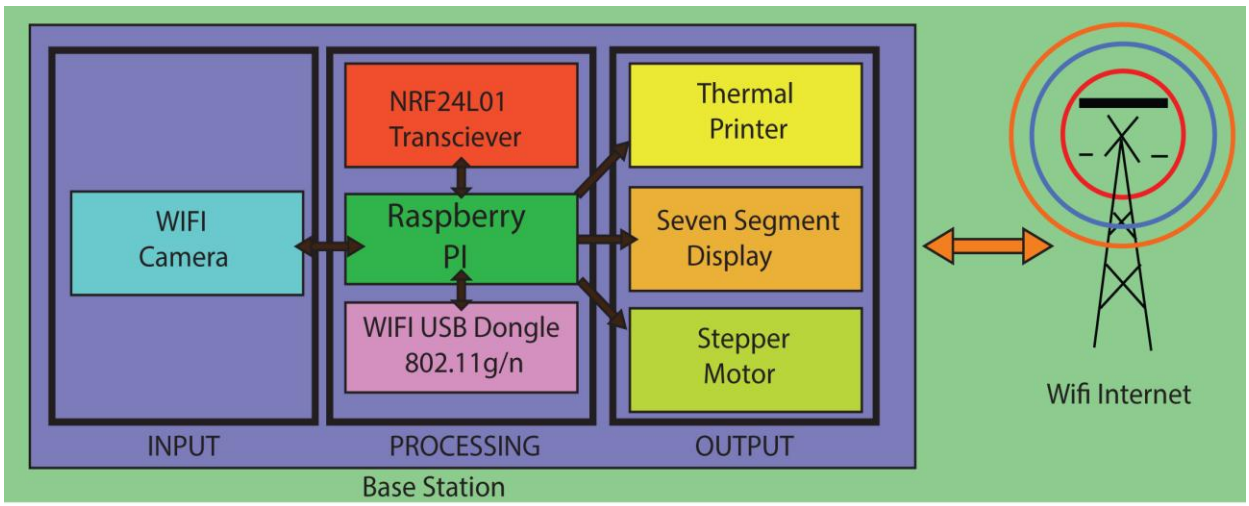

Figure 2 : Automated toll processing unit

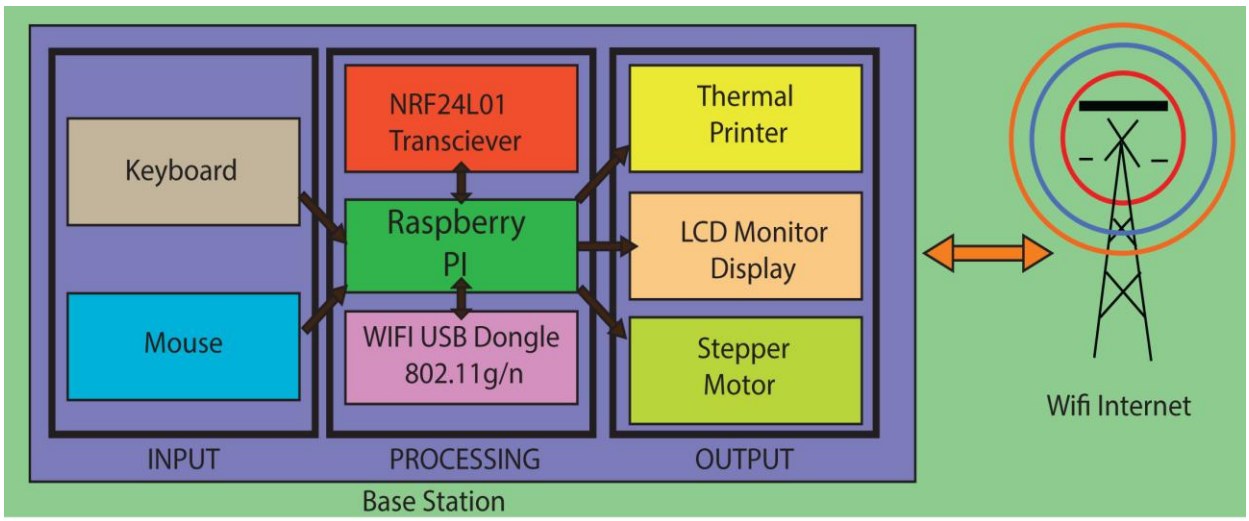

Figure 3 : Manually toll processing Unit

An automated toll processing unit consists of wifi camera to capture the license plate number. In processing there are Raspberry Pi, NRF24L01 transciever & Wifi USB dongle. In output section thermal printer, seven segment display & stepper motor is connected. Raspberry Pi receives the image from wifi camera through wifi network. And through optical character reading algorithm it identifies the license plate number. As the pi is connected with internet it transmits the number to server for matching and subtraction of toll from users account. When successful transaction occurs the stepper motor rotates 90degree clockwise and opens the barrier. Seven segment display starts back counting of 20seconds. Within 20seconds vehicle needs to pass the barrier and after 20s stepper motor again rotates 90degree anti clockwise and close the barrier. Thermal printer prints the toll token and the system is ready for the next vehicle.

If any problem occurs the vehicle is indicated to go to manual terminal for manual toll payment. Manual system also consists of Raspberry Pi, as input here keyboard and mouse is used. Operator will enter the license plate number manually. The toll amount will be entered manually and printer will print the token.

All three auto terminal is connected with manual terminal through NRF24L01 transceiver. If any problem occur auto terminals indicate that to the manual terminal. All the terminals are connected to a tweeter account. They keep updating car number, amount of toll taken or any other issue it faces on tweeter through wifi.

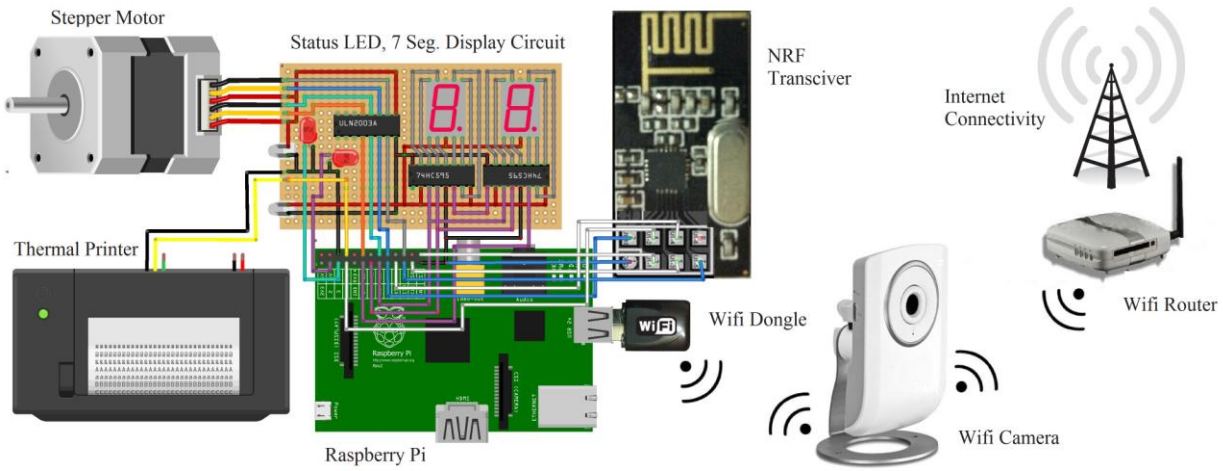

Figure 4 : Prototype Design of auto toll unit

III. Hardware Prototype

Raspberry Pi Model B has 512Mb RAM, 2 USB ports and an Ethernet port. It has a Broadcom BCM2835 system on a chip which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and an SD card. It has a fast 3D core accessed using the supplied OpenGL ES2.0 and OpenVG libraries. The chip specifically provides HDMI and there is no VGA support. The foundation provides Debian and Arch Linux ARM distributions and also Python as the main programming language, with the support for BBC BASIC, C and Perl.

Figure 5 : Raspberry Pi model B

Thermal printer is a serial printer which is used in several places like credit card machines, bus ticket counters etc. A printer has power, ground, RX & TX.

Figure 6 : Thermal Printer

IV. Circuit Analysis

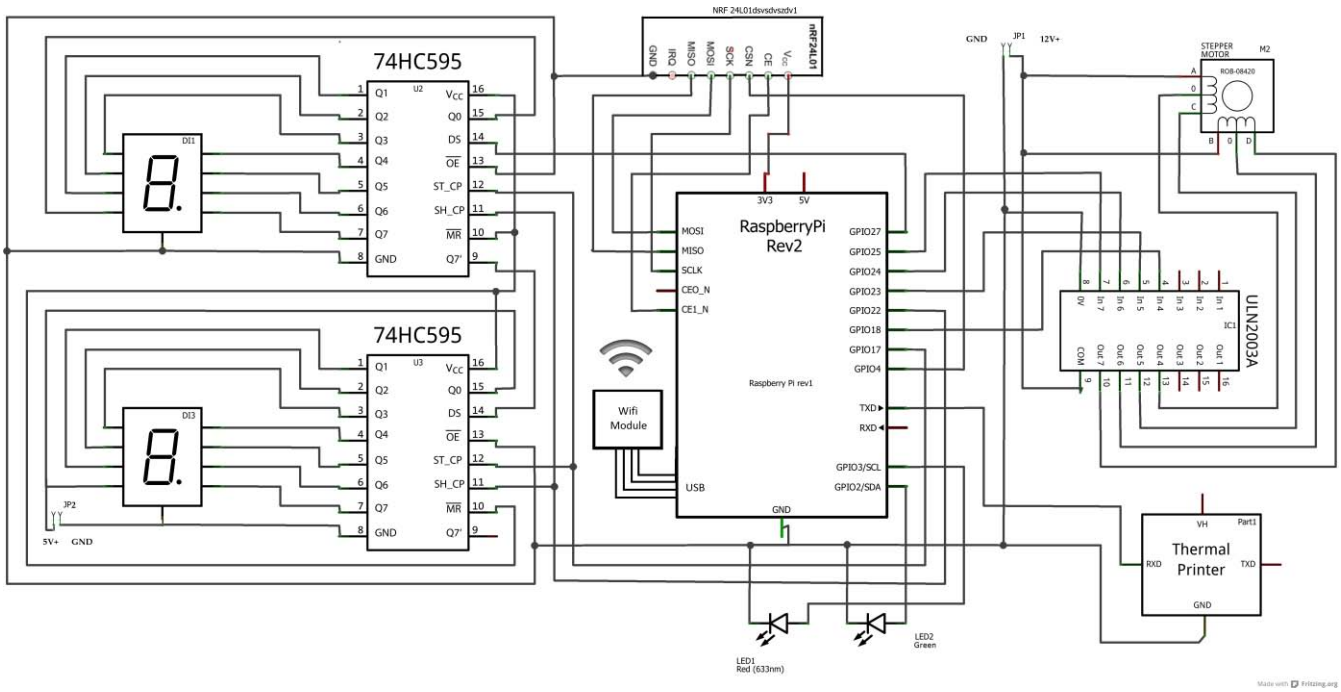

Figure 7 : Schematic diagram of auto toll section

Heart of this project is raspberry pi minicomputer. To interface with NRF24l01 raspberry pi has SPI. MISO, MOSI, SCK & SS pins of NRF transceiver is connected with MISO MOSI, SCK & SS pins of raspberry pi. Uart is used to communicate with thermal printer. Rx of raspberry pi is connected with Tx of thermal printer. The tx of thermal printer is not needed. Wifi dongle is connected through USB port. Other parts like seven segment display, stepper motor are controlled through GPIO pins. In manual entry section keyboard and mouse is connected in USB port of raspberry pi. As display 24' tv is used which is connected through a AV cable. The complete system is running on Linux ARC platform.

Two shift register (74HC595) is used to control seven segment displays. The shift register holds what can be thought of as eight memory locations, each of which can be a 1 or a 0.

To set each of these values on or off, we feed in the data using the 'Data' and 'Clock' pins of the chip. The clock pin needs to receive eight pulses, at the time of each pulse, if the data pin is high, then a 1 gets pushed into the shift register, otherwise a 0. When all eight pulses have been received, then enabling the 'Latch' pin copies those eight values to the latch register. This is necessary; otherwise the wrong LEDs would flicker as the data was being loaded into the shift register. The chip also has an OE (output enable) pin, this is used to enable or disable the outputs all at once.

The ULN2003 is a high voltage, high current darlington array containing seven open collector darlington pairs with common emitters. Each channel rated at 500 mA and can withstand peak currents of 600 mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout. 4 GPIO of raspberry pi is needed to drive the stepper motor.

V. Main Technology used

Image processing is the key factor of this project. In this project matlab is used to process the image [4]. In this project template matching algorithm is used. Here is the flow chart.

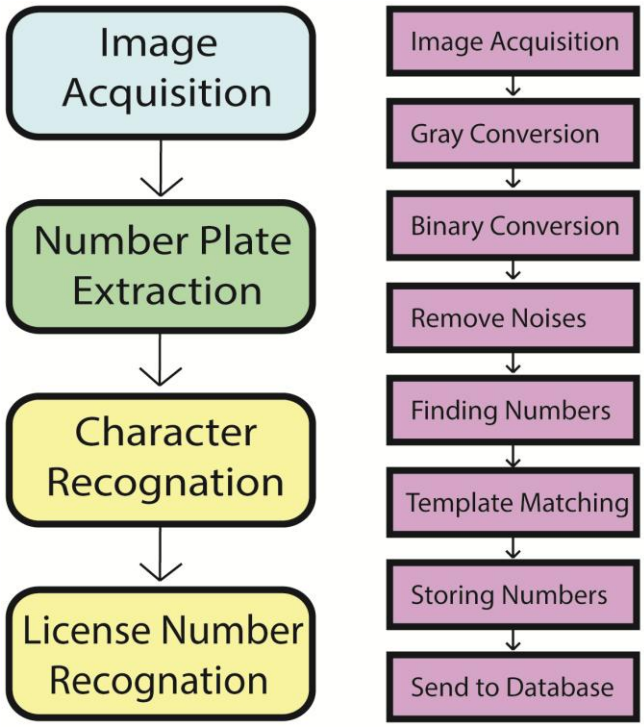

Figure 9 : Algorithm of optical character recognition

At first the front license plate number is captured through webcam and it crops an approximate area where the license plate could exist as the car stand stationary in front of the camera. Matlab code for these operations is

```
vid = videoinput('winvideo', 1, 'YUY2_640x480');
vid_src = getselectedsource(vid);
vid.ReturnedColorspace = 'rgb';
start(vid)
image=getsnapshot(vid);
imshow(image);
imagen= imcrop(image,[655 1153 560 85]);
```

Figure 10 : Cropped image of license plate

After converting it to grayscale & then binary image it looks almost same. Then the noise as the high pen is removed from the image.

Figure 11 : binary image removing noise

Through template matching in bangle the letters are saved in English in excel file. Here is the image of the output optical read digits.

	A	B	C
1	license number		
2	232813		
3			
4			

Figure 12 : License plate numbers stored in excel

Now this license plate number is sent to database for finding its toll amount and subtract the toll amount from users account.

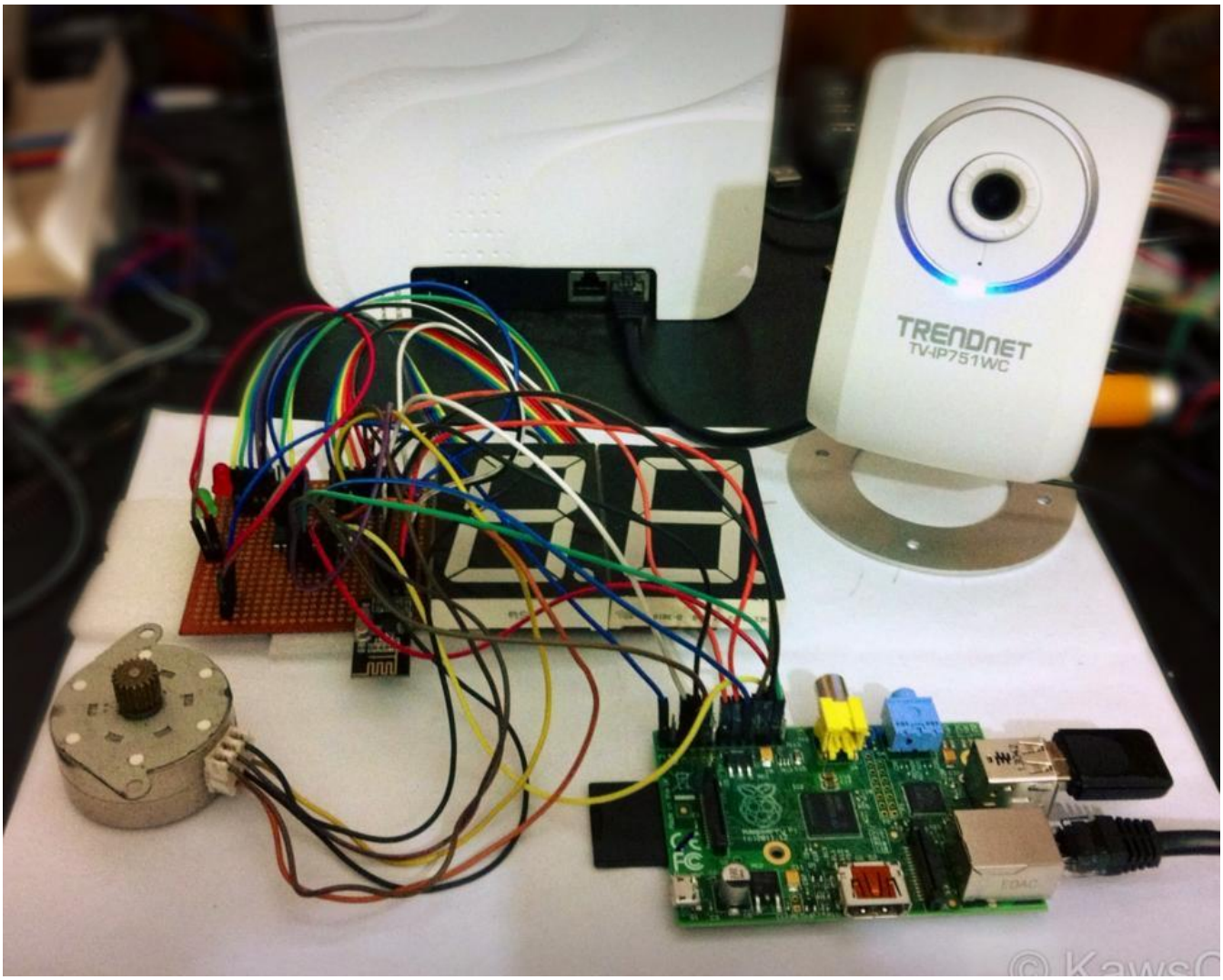

Figure 13 : Hardware implementation of complete toll system.

VI. Outputs & Update of Status

The complete system is connected with internet. Each toll both transmits an update to tweeter. All the errors or users information is stored in data base also. But for repair, hardware faults or user fault each booth sends a tweet to main toll head office tweet account.

First we need to install some required packages, open up a terminal on the Raspberry Pi, install the Python development headers and the ip package manager:

sudo apt-get install python-pip python2.7-dev.

Whenever a vehicle passes the system update its information on tweeter. Image of tweets are shown bellow:-

Figure 14 : Confirmation of payment from Tweeter

VII. Further Application

- Automated train ticket system.
- Automated bus ticket system.
- Unauthorized vehicle detection system.
- Traffic signal breaking detection system.
- Parking lot automation.

VIII. Conclusion

Raspberry pi based image processing is an new and advance technology which can open an era of computer vision. Other gestures and different types of image processing systems can be implemented in raspberry pi which will dramatically reduce the price of the system. But still there are some drawbacks like it has very limited memory which makes it difficult to store data and process database into it [6]. If these obstacles are overcome then it will become a great standalone embedded platform for different solutions.

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

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

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

4. MANUSCRIPT'S CATEGORY

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

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

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

Research articles: These are handled with small investigation and applications

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

5.STRUCTURE AND FORMAT OF MANUSCRIPT

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

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

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

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

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

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

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

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

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

(h) Brief Acknowledgements.

(i) References in the proper form.

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

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

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

Format

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

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

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

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

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

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Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

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

Key Words

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

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

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

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

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

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

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

Acknowledgements: Please make these as concise as possible.

References

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

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

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

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

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

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

Preparation of Electronic Figures for Publication

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

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

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6. AFTER ACCEPTANCE

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

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(Free of charge) from the following website:

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TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

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

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

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

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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.

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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
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- 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
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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.

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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.
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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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ISSN 9755861