EMBEDDED MULTIPLE SOURCE REAL TIME MONITORING AND CONTROL BY BLUETOOTH SUPPORT WITH MASTER SLAVE ARCHITECTURE AND ALGORITHMS

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2018

CERTIFICATE FROM THE SUPERVISORS

This is to certify that the thesis entitled "**Embedded Multiple Source Real Time Monitoring and Control by Bluetooth Support with Master Slave Architecture and Algorithms**" submitted by **Ms. D. Sobya**, who got her name registered on 15**th** **September 2016** for the award of Ph.D. (Engineering) degree of Jadavpur University is absolutely based upon his own work under the supervision of Dr. Partha Sarathi Chakraborty and Dr. S. Nallusamy and that neither her thesis nor any part of the thesis has been submitted for any degree / diploma or any other academic award anywhere before.

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INDEX NO: $60/\frac{18}{16}/E$

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2. D. Sobya, SK. Muruganandham, S. Nallusamy and P.S. Chakraborty, "Development of IoT model for public distribution method in fair price shop", **International Journal of Computer Engineering & Technology**, 9(3), (2018), 270-278 [UGC Journal Listing Serial No. 45405]

3. D. Sobya, SK. Muruganandham, S. Nallusamy and P.S. Chakraborty, "Establishment of smart meter reading scheme for monitoring the power in residence using bluetooth", **International Journal of Electrical Engineering & Technology**, 9(1), (2018), 67-75 [UGC Journal Listing Serial No. 43685]

4. D. Sobya, S.K. Muruganandham, S. Nallusamy and P.S. Chakraborty, "Bit error and data transmission rate augmentation through MIMO diversity technique", **International Journal of Advanced Research in Engineering and Technology**, 9(2), (2018), 94-103 [UGC Journal Listing Serial No. 48673]

5. D. Sobya, SK. Muruganandham, S. Nallusamy and P.S. Chakraborty, "A proposed model for smart farming in rural areas using IoT advanced technologies", **International Journal on Recent Researches in Science Engineering and Technology**, 6(1), (2018), 61-67 [UGC Journal Listing Serial No. 45483]

6. D. Sobya, S. Nallusamy, P.S. Chakraborty and S.K. Muruganandham, "Design of multi functional electronic energy meter enabled with zigbee protocol intended for industrial applications", **International Journal of Current Advanced Research**, 6(10), (2017), 7029-7033 [UGC Journal Listing Serial No. 43892]

7. D. Sobya, S. Nallusamy and P.S. Chakraborty, “A proposed remote monitoring system by global system for mobile communication and internet technology”, **International Journal on Recent Researches in Science Engineering and Technology**, 5(11), (2017), 07-14 [UGC Journal Listing Serial No. 45483]

8. D. Sobya, P.S. Chakraborty and DK. Mandal, “Design and development of IoT based residential automation security system with bluetooth technology”, **International Journal of Application or Innovation in Engineering and Management**, 6(6), (2017), 62-72 [UGC Journal Listing Serial No. 47412]

9. D. Sobya, “Data compression analysis of rocket engines with vector quantization based on FCM algorithm”, **International Journal of Engineering Research in Africa**, 22, (2016), 135-140 [UGC Journal Listing Serial No. 2975]

4. List of Patents: None

5. List of Presentations:

1. D. Sobya, R. Varshni and P. Albinia, “MEMS based hand gesture wheel chair movement control with emergency alert”, **International Conference on Emerging Innovation in Engineering and Technology** at Christ Institute of Technology, Puducherry, March 25, 2017, ISSN NO: 2456-1983
2. D. Sobya, Arvind Kumar and Vicky Kumar, “Smart IoT based energy monitoring and controlling household appliances”, **International Conference on Emerging Innovation in Engineering and Technology** at Christ Institute of Technology, Puducherry, March 25, 2017, ISSN NO: 2456-1983

DEDICATED TO MY BELOVED PARENTS

ACHNOWLEDGEMENTS

First and foremost, I would like to express my wholehearted thanks to our esteemed Founder - Chancellor, Thiru. A.C. SHANMUGAM and our beloved President Er. A.C.S. ARUNKUMAR, Dr. M.G.R. Educational and Research Institute, Chennai, for the support they have provided to hope with the fateful event.

I express my sincere thanks to Prof. Suranjan Das, Vice-Chancellor of Jadavpur University for his moral support and encouragement.

I would like to express my deepest gratitude to the learned supervisors Dr. Partha Sarathi Chakraborty, Department of Adult and Continuing Education & Extension, Jadavpur University, Kolkata and Prof. Dr. S. Nallusamy, Department of Mechanical Engineering, Dr. M.G.R. Educational and Research Institute University, Chennai, Tamilnadu for their enduring supervision, constant guidance and encouragement during this research work.

I am also thankful to all the faculty members of Department of Adult and Continuing Education & Extension, Jadavpur University, Kolkata for their generous help and encouragement.

This thesis would not have been possible without the support of my family and friends. At last, but not at the least, I would like to thank my beloved father Mr. S. Devaraj and mother Mrs. M. Maria Thangam for their unstained moral support and understanding for completion of this thesis.

D. Sobya

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LIST OF ABBREVIATION

WPAN	- Wireless Personal Area Networking
IoT	- Internet of Things
ECG	- Electrocardiogram
Wi-Fi	- Wireless Fidelity
SR	- Strontium Ratio
MIMO	- Multiple-Input and Multiple-Output
GSM	- Global System for Mobile Communications
RMSSD	- Root Mean Square of the Successive Differences
SDNN	- Standard Deviation of Normal-to-Normal
RR	- R Wave to R Wave Interval
RRI	- Route Relay Interlocking
IBI	- Inter Beat Interval
ES	- Embedded System
3D	- Three Dimensional
CPU	- Central Processing Unit
RTOS	- Real Time Operating System
AMR	- Automated Meter Reading
SMR	- Smart Meter Reading
HTTP	- Hyper Text Transfer Protocol

LIST OF ABBREVIATION (Continued)

RPC	- Remote Procedure Calls
RF	- Radio Frequency
PDS	- Public Distribution System
FPS	- Fair Price Shops
WSN	- Wireless Sensor Network
UV	- Ultraviolet Radiation
PIR	- Passive Infra Red sensor
RPI	- Raspberry Pi Camera
DC	- Direct Current
RFID	- Radio Frequency Identification
IBM	- International Business Machines
MQTT	- Message Queuing Telemetry Transport
OS	- Operating Systems
EDF	- Earliest Deadline First
IDA Algorithm	- Iterative deepening A*
5G	- Fifth Generation
OFDM	- Orthogonal Frequency Division Multiplexing
WARP	- Wireless Open Access Research Platform
WMS	- Warehouse Management System

LIST OF ABBREVIATION (Continued)

OEM	- Original Equipment Manufacturers
I/O	- Input/Output
CD-ROM	- Compact Disc Read-Only Memory
ISR	- Interrupt Service Routine
TI-RTOS	- SYS/BIOS
BIOS	- Basic Input/Output System
IPC	- Instructions per Cycle
UDP	- User Datagram Protocol
ISR	- Intelligence, Surveillance and Reconnaissance
TCB	- Task Control Block
RM	- Rate Monotonic
DM	- Deadline Monotonic
LST	- Least Slack Time First
μC/OS	- Microcontroller Operating System
LCD	- Liquid Crystal Display
LED	- Light Emitting Diode
CPS	- Communicating Power Supplies
RISC	- Reduced Instruction Set Computer
UART	- Universal Asynchronous Receiver-Transmitter

LIST OF ABBREVIATION (Continued)

CAN	- Control Area Network
USB	- Universal Serial Bus
IP	- Internet Protocol
TCP	- Transmission Control Protocol
IDE	- Integrated Development Environment
LDR	- Light Dependent Resistors
DSP	- Defense Satellite Program
S	- Supply
R	- Relay
D	- End Destination
AF	- Amplify and Forward
RS scale	- Resilience Scale
BER	- Bit Error Rate
IHDF	- International Health Development Foundation
GPRS	- General Packet Radio Service
AT	- Attention
SPI	- Serial Peripheral Interface
RXD	- Receive Pin
TXD	- Transmit Pin

LIST OF ABBREVIATION (Continued)

API keys	- Application Programming Interface Key
AIDC	- Alternative Information and Development Centre
NC	- Normally Closed
NO	- Normally Open
ESP Modules	- Espressif Modules
6LoWPAN	- IPv6 Over Low-Power Wireless PAN
PAN	- Personal Area Networks
PCS	- Permanent Change of Station
PMD	- Physical Medium Dependent
NIC	- National Informatics Centre
PaaS	- Platform as a Service
WHO	- World Health Organization
ISE	- Ion Selective Electrode
RRI	- Risk Ratio Interval
GND	- Ground
ADC	- Analog-to-Digital Converter
SSID	- Service Set Identifier
MAC	- Media Access Control
CSV	- Comma Separated Values
VCC	- Voltage at the Common Collector

ABSTRACT

Embedded system is an emerging technology that comprises of hardware and is integrated with the electrical and mechanical components with Wireless Personal Area Networking (WPAN). In recent days, current metering technology has developed in an advanced manner with more reliable smart energy reading structure. The research work provides a mix up with design and development of wireless energy meter with low down cost that enables to collect the data as a whole with the help of Zigbee technology. The Zigbee technology reinstates the calculation method of current energy consumption and also the meter reading monitored periodically in each residential/industrial unit area. Zigbee technology helps to save the cost and time but this technology doesn't help to monitor and control the harmonic current and voltage. To avoid this differently a new technology was adopted for rectifying the problem with wireless bluetooth using MSP430F5529 microcontroller with master slave architecture. Existing billing system is an ineffective one hence, an innovative energy metering technique was developed by Bluetooth technology using MSP430F5529 microcontroller by means of master slave architecture.

The above said innovative ideas were used and tested in households with the help of another technology called IoT to monitor and manage the entire burning up of power and avoid wastage of energy consumption from anywhere by using WSN. IoT is up-and-coming method in an embedded system that is used to communicate with the machine world like vehicles, physical devices, buildings. Establishment of inhabited security system with Bluetooth technology based on IoT was also carried out. This system could be used to manage the unwanted problems that may occur during maintenance, while sending data to a destination there is a possibility of the data getting corrupted because of natural disasters. Hence, in order to avoid such kind of data loss a new technique was designed and implemented to check the data rate, information integrity and coverage of mobile networks.

Over the past decade, mobile network systems have experienced an exponential growth and the demand for improved quality in terms of data rates, information integrity and coverage has forced for a better mobile network technology for the future. In this work, different cooperative relay schemes were analyzed that could constructively forward signals during which wireless network capacity, throughput and coverage have been extensively improved. Incremental relaying protocol has been proposed for better spectral efficiency. The systems were analyzed under Rayleigh fading channel and for data integrity at destination turbo encoding at transmitter node and relay node and for turbo decoding at relay node as well as destination node were used. The error probability and data rate was further optimized by using multiple-input and multiple-output diversity technique on the basis of alamouti scheme.

In the previous technique the data were communicated from source to destination, while communicating the data there has been a loss in information. To find out the location where exactly the data were lost GSM technique was used. In global market, all manufacturers export their finished products to end users located in different places. Delivered product needs manufacturer's assistance in case of any fault. Remote monitoring of a product helps in getting the status of the product continuously from a remote location. This can be made by obtaining the status of the products, checking for any abnormalities and suggesting solutions based on the problems identified. Here remote monitoring system for machine controllers used in industries was proposed using global system for mobile communication and internet technology. Monitoring logic controllers exported from the manufacturing unit was done using 8051 microcontroller with master slave architecture and the status of the controller could be obtained by sending messages from the controller, connecting the controller to the cloud and accessing data from the cloud.

A study on a multi level public distribution system in a fair price shop in other words a ration shop was also carried out. A model was proposed to reduce the total overheads including ordering and reordering costs and inventory holding costs for smooth distribution of the products from mandal level stock points to fair price shops. In a public distribution system fair price shops are introduced for distributing the grains to the economically backward people. As it was observed that there is corruption and proscribed smuggling of goods in the current method of public distribution system, in this research an approach was suggested where in all the manual jobs in a ration shop could be mechanized and the entire operation thrashing is done with equipments and individuals are kept out of it. This will help in providing maximum consistency and bring straightforwardness for the benefit of true consumers. Further, as all the data maintenance and data allocation is prepared by the computer, it can keep track of all the data and the entire process of data maintenance is taken care of by the personal computer there could be no possibility of mistakes and manual work could be avoided.

In India about seventy five percentage of the population is directly or indirectly depending upon agriculture only. As per the latest statistics there are about twelve percentages of farmer suicides in India as they are unaware of the techniques that would help in achieving better cultivation. Due to unexpected sudden rain fall and in accurate weather forecasts, Indian farmers have been facing the problems such as damage to crops in their field as well as due to in-adequate knowledge about their soil condition. With a view to revamp our farming methods and also to save the life of the hardworking farmers a model using advanced technologies has been developed based on this research.

Recently, it has been observed that in the human health care scenario most of the people have been forms suffering due to arrhythmia which is a type of cardiovascular disease that occurs when a person has irregular or abnormal heart

rate. To diagnose such a condition, there ought to be continuous monitoring of electrocardiogram signal made available. In this research, wireless Electrocardiogram monitoring system using AD8232 signal conditioning module for real time signal acquisition has been proposed. The proposed system performs continuous ECG signal monitoring that integrates Wireless Fidelity technology which acquires the ECG signal and transmit it to cloud wirelessly. Also, a feature extraction algorithm was developed to extract the features such as RMSSD, SDNN, Mean RR, Strontium Ratio and slope of linear regression of IBI from ECG signal of BioVid Heat pain database for different pain levels. The same feature extraction algorithm can be applied on real time ECG signal to extract the features.

It could be concluded that, from the various research and studies made with regard to the meter reading system the cost of the reading technique can be reduced through our proposed research work. The developed system could be used to control the power supply with regular monitoring of the domestic devices. A comprehensive deliberation on the developed combined system of embedded technique and GSM has also been made in the study. From MIMO results it was noted that, the cooperative relaying mode outperforms the non-cooperative systems regarding bit error rate performance. GSM process has been formed to be cost effective, as the hardware has been engineered using simple components. From the results it was found that, the manufacturers can send solutions to control the device and based on the solutions, the controller can be programmed for rectifying the deviations. The results observed from the smart farming study showed that the farmers could be trained to get familiar to the new concepts of IoT and cloud computing once implemented, they would be able to share this knowledge with other farmers. This will certainly help farmers to adopt new modern methods in solving their farming problems. From the results on health monitoring applications study, it was clear that the proposed system could be advantageous to the physicians in providing their right health care to their patients without the necessity of remaining closer to them.

1.0 Introduction

In the modern day scenario embedded system (ES) acts as the key responsibility in an electronic industry. An embedded system is often deployed in applications where monitoring, data collection and control are essential. The systems that are based on mono task handling mechanism hardly satisfy the current requirements. ES helps in innovating ideas that could introduce new products like mobile phones, 3D printers, electronic calculators and video game devices etc. ES is nothing but CPU structure designed for particular job available in huge involuntary or electrical machine. This computer structure is regularly used for real time applications such as data collection, monitoring and controlling of a system. It can perform single or multitask applications based on the set of rules or programs which have been predefined.

Real Time Operating System (RTOS) is used for applications based on embedded system that is essential to assist high speed protocols and standards. RTOS based embedded systems facilitate high speed protocols and standards. Wireless network is a large network system with a primary objective to provide effective communication to everyone in the network and everywhere and share information among various trusted nodes in a secure manner. Wireless network is a large computer network system used for data communication between sources to destinations with the help of embedded system using master slave design. The intention of the wireless network is offering effective communication without data loss to the desired destination.

In recent days, current metering technology has developed in an advanced manner with more reliable smart energy reading structure. AMR system is used to monitor the meter reading for the amount of energy consumption only. Hence, a new technology of Smart Meter Reading (SMR) scheme erstwhile introduced for monitoring and controlling the consumption

of energy by using master slave architecture as well as to create the automatic billing which is directly send to the customer through wireless network for the payment at the right time.

Smart meter reading technique is an advanced method used to measure the power burning and also to provide supplementary information as compared to automatic meter reading. As the need for efficiency and reliability has increased the demand for smart meter has also increased more than ever.

To implement the energy monitoring and controlling, the new technique of IoT could be introduced. Control of power consumption for domestic devices is accomplished with the help of a web server controlled by the client. The web server is designed using Hyper Text Transfer Protocol (HTTP) for communication between client and server by establishing Remote Procedure Calls (RPC) between client and server.

IoT is used to control the unexpected incidents by intimating the appropriate authorized person by sending the pre-information. There may be loss or corruption in the data by means of any natural disturbances while forwarding to the authorized person. Hence, to avoid the data loss and to transmit right information at the right time a new technology of alamouti scheme in MIMO is used.

Cooperative diversity relay scheme is proposed for promising solution of improved data rate and coverage for future wireless technologies. Also, a three-terminal of relay channel for cooperative communication has been modeled where terminals are relay node, source and target nodule. Relay control interactions provide advantage of low transmit Radio Frequency (RF) power requirements. In cooperative system when an external node helps in

transmission of information between transmitter and receiver, it serves as a relay node.

For minimizing error in transmission and to optimize the speed and data integrity, a MIMO system is largely employed which consists of compound transmitters both transmission and last part of recipient. Alamouti space time coding techniques are used in relay strategy for co-operative wireless communication improving the coverage of a 5G wireless network.

MIMO is used to send the data through antennas, but we cannot find out whether the data is reaching the exact location or not. To indentify the right location the data needs to employ global system for mobile communication technology. In a global market, all manufacturers export their finished products to end users located at different places. This delivered product needs manufacturer's assistance if any fault occurs in it. Remote monitoring of a product helps the product continuously monitored from a remote location. This can be made possible by receiving the status of the products, checking for any abnormalities and suggesting solutions based on the problems identified.

In general, manufacturing units are located at different places based on the availability of resources for their production and suppliers of raw materials. After production they export the products manufactured to their sub units located at different places and also to their customers. Any problem found in a product should be given attention immediately by the service engineers to avoid material loss and production backlogs. It is difficult to have the presence of service engineers in all the places to monitor the products and solve any abnormalities occurred in those products.

Transportation is difficult to a remote location and in adverse climatic conditions. Even a small problem consumes more time and demand more

human efforts. To address these issues, it is essential to have remote monitoring facilities on the products exported from the manufacturing unit. The remote monitoring system should be simple, reliable and cost effective that avoids installation and maintenance overheads. It would report the abnormalities, as messages to the manufacturer and also the status of the controller is continuously updated to the cloud through a server and problems in it are identified by accessing the data from the server.

The above techniques are used in many applications and some of the applications were initiated in this research. Food grains are to be distributed to every eligible household under Public Distribution System (PDS) at a subsidized price with maximum efficiency in a clear mode through Fair Price Shops (FPS). The system of providing basic domestic commodities on subsidy to economically backward families in developing countries like India is an important aspect that meets the fundamental requirement of the people. The existing public distribution system in ration shops in India uses manual measurement of quantity and maintenance of record on the transactions.

The main objective of the Government is to offer the meant at items of food grains reasonable price. In this process several short companies can be noticed. One is that corruption by the people employed in the PDS since there is no proper method of acquiring the details on levels of consumption of food grains by the people.

Internet of Things being one of the most advanced and a new generation technology it includes a variety of areas like sensors, communication and storage. From the very beginning of our civilization farmers are the one who have been helping the world population to survive. India is an agricultural based country and about 50% of people are dependent on agriculture. Farmers of our country are those who work hard but do not get the desired yield from the crops, leading to poor income due to which they are

not in a position to repay their debts on time, which in turn makes them to commit suicide.

On account of this both the citizens and the economic condition of the country take a hit. Not getting the desired yield from the crops can be due to numerous reasons, such as lack of soil nutrients, polluted ground water, weather factor, over use of pesticides, poor knowledge of the field, etc. To avoid all these problems the IoT based solutions could help farmers to deal with the issues, in a better manner. IoT can change the ways by connecting real time objects. For better results wireless sensor networks could be applied, which can work on all weather conditions.

Nowadays, there is scarcity of water due to decreases rainfall. In order preserve water, we can adapt various irrigation techniques such as drip irrigation, sprinkler techniques through WSN with committed sensors for scrutiny and documentation. These sensor senses the different parameters such as humidity and nutrition in the soil, pesticide content for acidic content of the soil. The data sensed by these sensors are sent to central monitoring system using a network protocol. Central based monitoring system works like a base station where all details are recovered through sensors. Information is stored in a private cloud, using cloud computing. Cloud computing capacity can be scaled up or down easily, according to the need and it's free from high cost of hardware.

As we all know the population is increasing day by day. Increase in population requires the food production also to be increased. This requires better cultivation with minimum labour work. For that, with less effort farmers have to earn more profit. Smart agriculture is an automated and directed information technology implemented with the help of IoT. By introducing smart agriculture using modern technology, there will be a massive change in the farmer's life. Climate changes and many other

environmental variations lead to many problems in the field, which the farmers are not able to detect them easily. For that this smart technology approach will help them to put less effort to earn more yields. Agriculture plays a vital role in the life of an economy. In our project we are using raspberry pi-3 kit. Along with that we are using temperature and humidity sensor to detect the humidity and temperature of the soil. UV sensor, Ultrasonic sensor, CO_2 sensor, PIR sensor, RPI camera, DC motor, Servo motor, Battery and Cloud are also used, and finally mobile application to access the detailed information of the field.

It has been found in human health care scenario that most of the people suffer from arrhythmia which is a type of cardiovascular disease that occurs when a person has irregular or abnormal heart rate. To diagnose such conditions, there should be continuous monitoring of electrocardiogram signal irrespective of the location confined to the subject and the appropriate physician.

Commercial RFID system has elements of tag, reader and middleware software. RFID reader provides the connection between the RFID tag and the system software. The main tasks of RFID Reader is sending an interrogation signal, filtering and decoding data from tag, writing to selected tag. When RFID tag is placed in line of sight with RFID Reader, then the RFID Reader sends an interrogation signal. Middleware software processes the signal and all the data's stored are retrieved by the interrogation signal. Middleware software once again sends back interrogation signal to RFID Reader for decoding. Now a day's RFID tag plays a major role of encoding and decoding of data's in most of the wireless applications. The data's are stored by silicon chip in RFID Tag. RFID Tag with silicon chip results in larger size and high cost.

In the present domain, we find every person exposed to excessive work leading to exhaustion. If this condition prevails for a longer time and remains unattended, it may lead to cardiovascular diseases. During such emergency situations, if a person is not able to get immediate medical attention, the chances of losing his life becomes very high. Therefore a proper health care system that could monitor the ECG signal wirelessly and the machine learning process to classify ECG signals would serve as a smart way to diagnose the cardiovascular diseases such as arrhythmia.

In the proposed method the implementation of wireless monitoring of ECG signal based on Wi-Fi technology and features are extracted from the BioVid heat pain database which shall be used for high accuracy ECG signal classification. ECG signal monitoring system is portable with wireless transmission capabilities. ECG signal from the subject is acquired using data acquisition module and microcontroller. The acquired signal is transmitted to IBM Watson IoT cloud server using Message Queuing Telemetry Transport (MQTT) protocol and the real time ECG signal is monitored. Features such as mean of RR Interval, RMSSD, SDNN intervals, SR, slope of linear regression of Inter Beat Interval (IBI) are extracted from the ECG signal of BioVid heat pain database for five different conditions like BL - 1 and pain level - 1 to pain level - 4, which can be further used to perform classification in order to predict arrhythmia.

To meet real time constraints for scheduling a task, different scheduling algorithms are used in multitasking. Although sharing of resources among multiple tasks simplify the exchange of information in order to remain robust against security threats and avoid data corruption and contention. Protecting resources in computing environments has long been recognized as a difficult and daunting problem. Three important factors influencing optimized resource scheduling are:

- Time driven resource management to meet scheduling requirements
- Problem specific OS facilities
- Integrated system wide scheduling support

Hardware implementation of shared resource protection with security service enhancement remains unexplored and active research work is focused only on effective handling of priority based scheduling algorithms to meet desired requirements. This research employs schemes of interrupt enabling/disabling, global variable usage using priority based preemptive scheduling algorithms and central queue management model to give optimal efficiency for multiple tasks.

Scheduling algorithm in packet switching determines the packets that can be serviced at a time. Performance in terms of throughput, delays and fairness in delivering data packets depends on the scheduling decision. Maximizing performance requires the scheduler to solve some optimization problem, i.e., the scheduling decision must be taken in a very short time, not longer than the packet transmission time.

This research addresses real time monitoring for control system applications and real-time monitoring has been proposed to increase the reliability of time-critical applications. The implementation is studied on various linear control systems. Real time plant monitoring at a higher level as a supporting system is also intrinsically embedded into the application.

The thesis has been presented as follows. In chapter 2 the literature survey has been surveyed in five broad areas namely

(i) Wireless enabled ZigBee and Bluetooth energy monitoring system with µc/os-II Implementation
(ii) Monitoring of the household appliances using IoT

(iii) Improving data transmission rate with MIMO and queue based Earliest Deadline First (EDF) packet scheduling algorithm

(iv) Locating the resource using remote monitoring and GSM technique

(v) Performance wise comparative analysis of RTOS concepts.

Chapter 3 covers the objective of research and the major benefits.

The basic concepts of RTOS and applications for monitoring and controlling the data rate and comparative analysis of µc/os RTOS family has been discussed in chapter 4.

Chapter 5 takes on the basics of scheduling and its algorithms.

Chapter 6 presents the hardware implementation for fast motion system using system identification toolbox and implementation of master slave architecture using MSP430F5529 processor etc. It also discusses block diagrammatic/ graphical representation of central queue based EDF scheduling, metric wise real time comparison of EDF and RM scheduling algorithms.

Applications of the techniques and algorithms are briefly discussed in chapter 7.

Results and discussion with hardware set up, comparison plots and tabulations of Bluetooth based multi-tasking RTOS systems has been given in chapter 8.

The summary and conclusion with future scope has been laid out in the final chapter 9.

2.0 Prior Art

In the existing state of affairs meter reading system through mobile or personal computer is the right way to get the appropriate details. Wireless network is an advanced practice to reinstate the existing electrical power cable power system **Keerthi and Raju (63), Taghi and Hamid (156), Harukith et al. (48), Muruganandham et al. (93)** and **Santhosh Raikar et al. (125).**

We have achieved optimization of energy through (i) Network coverage i.e., how well a sensor network monitors its region of interest (ii) Optimal deployment of multiple base stations to overcome bottleneck in single base station and clustering scheme that is completely controlled by the base station (iii) The problem of transmitting a packet from one node to another node over a point to point link within a given time is the primary objective of optimal scheduling (iv) Solving dead end problem that results in high packet delivery ratio to the base station **Srilatha (152) and Alauddin Al-Omary (3)**, **Bharat Kulkarni (14), Kurkute et al. (68)** and **Muruganandham et al. (95).**

SMR procedure is used to collect and transfer the energy expenditure to the central data hub for analyzing the data and to create the bill for users to pay at the right time to avoid disconnection of power supply **Pantazis et al. (103), Sobya (140**), **Sharma and Sharma (130)** and **Bhavani and Alagamma (15)**.

The SMR system shall also provides different services to the public's and service providers for their regular monitoring and maintenance with interruption reporting **Sobya et al. (150), Ma et al. (76)** and **Homa Kesav and Abdul (50)**.

Energy-cluster algorithm has been introduced for the concept of the energy doorsill and a factor of distance for selecting the top of the cluster. The energy doorsill to establish whether nodule could be used as a precondition of the cluster head node, where as to select the smallest data transmission distance path the distance factor is used **Birajdar Pravin and Shaikh Meeravali (16), Kwang-il Hwang (69)** and **Shams et al. (128)**.

Optimization of network lifetime provides information about the life of all nodes in a network and how long it can operate, but it particularly won't indicates a group of routing features as problem limitations. In reality for an estimated lifetime, there are many existing multiple routing alternatives. Hence, there is a complication of more nodules in wireless sensor network and environment conditions. Also, many cases it is very complicated and even impossible to alter or recharge the existing batteries for the sensor nodes **Cherrier et al. (26), Sankpal and Patil (124), Farahani et al. (36), Sivasankari (138)** and **Shoeb S. Sheikh and Sharma (133)**.

IDA algorithm with obtainable Fuzzy logic algorithms was compared and the results stated that delay could be condensed from main sources to destinations when compared to existing data packets. In several cases, wireless sensor network life time is getting over as soon as the battery power in critical nodes is exhausted. Hence designers and developers of protocols and applications for WSN the main important factor is the availability of power, because life of the battery is considered as the total network life in sensor networks **Alex Q. Huang (4), Moni Silviya et al. (89), Padma Sravanthi Kattumulla et al. (100)**, **Sobya et al. (151)** and **Sobya (144)**.

Route locating and route Perpetuate. These techniques amalgamate in an improvised Network to allow the location and perpetuate of source Routes and are invoked only when the two nodes have to Send Packets to each other. Destination-Sequenced Distance Vector Routing Protocol furnishes

benchmark potent distance Vector algorithm for performance comparison. In destination- Sequenced distance vector routing, every route is traced with a series number which is generated by the terminus themselves. Each node has specific series Number and this is done by allocating two greater than the past one **Kharik Abhishek et al. (64)**, **Gubbi et al. (44), Fisher and Dewan (39), Mahesh and Jivani (78)** and **Mc. Nab et al. (83)**.

To create a smart home which improves energy management and efficiency, ZigBee technology, wireless sensor network are under investigation for implementation **Lee et al. (70), Lifen Li and Huaiyu Zhao (72)** and **Ahmed El-Shafee and Karim Alaa Hamed (1)**.

Lunetta et al. (75) and **Manoj Kumar Tyagi and Balanagu Raviteja (79)** have proposed automatic fire rescuing system for trains using ZigBee sensor network. ZigBee and sensor network both are cost effective monitoring system which helps the railway industry for both signaling and communication purpose. The system can transmit, receive and display warnings and emergency signals and for sensing the temperature in trains.

In the cooperative system when an external node helps in transmission of information between transmitter and receiver, it serves as a relay node. Target nodes integrates all the signal information obtained at its end through direct and indirect linkage using MRC **Wei Jiang (171), Il-Kyu Hwang and Jin-Wook Baek (54), Mohammad Galal Khafagy et al. (87)** and **Salleh et al. (122)**.

For minimizing the error in transmission and to optimize the speed and data integrity, compound key in and compound key out systems are largely employed which consists of compound antennas both transmission and recipient end **Pritam Som and Chockalingam (107), Marijeta Slavkovic and Dubravka Jevtic (81)** and **Sobya (142)**.

Alamouti space time coding techniques used to obtain spatial range as suggested by Alamouti. The relay strategy for co-operative wireless communication improves the exposure with 5G network. Decode and forward multi-hop MIMO network technique was proposed to enhance the overall outcome of the system **Vasileios et al. (162), Sobya et al. (147), Shiu Kumar (132)** and **Sobya (143).**

At transmitter and receiver, a multiple number of antennas are used in a technology called MIMO. By adopting OFDM and MIMO technologies, data rates can be reached up to several hundreds of megabits per second and spectral efficiency of several tens of bits per second per Hertz. OFDM can be combined with MIMO (Multiple Input & Multiple Output) for enhancement of the system. WARP (Wireless open access Research Platform) is a programmable wireless platform that is used for research on wide topics like multi-user MIMO, MIMO-OFDM, cooperative communications and many other **Gorlatova et al. (42)**, **Amit Jain and Mohnish Bagree (6), Hart and Murray (47), Sakamoto et al. (121)** and **Nikitin et al. (97)**.

A dual-band MIMO Antenna is the stimulating task considering the fact that, in most of the cases, same isolation mechanism does not work at different frequency bands and it covers only WLAN (2.5 GHz & 5.6GHz) applications. The size of the dual band antenna is 24mm 2 is used. The dual band multiport MIMO antenna covers the WLAN (4.9-5.725GHz & 2.4-2.5GHz) applications. It can be obtain the low isolation (12dB) between the ports and also the size of the antenna is 4620mm2 is used in literature **Hughes et al. (52), Raqibull Hasan et al. (116), Faris and Mahmood (37)** and **Sanchez Iborra and Cano (123).**

The gain of the antenna is 3dB and the operating frequency is 5.02GHz & 5.58GHz. A Koch fractal snowflake annular ring slot antenna size is 4040mm2 and the resonance frequency is (2.38-3.03GHz & 4.45-5.06GHz).

Applying the third iteration to produce the fractal shaped annular slot and also it can be obtain the return loss of (~20dB). The dual band slot antenna is only cover the limited number of applications. So, we go for multiband slot antenna for different wireless applications. The triple band MIMO antenna covers the GSM 800/1800 MHz and LTE2600 MHz applications **Neha Sharma et al. (96), Eric Angel et al. (35), Shuenn Yuh Lee et al. (135), Rym Cheour (119)** and **Vinay and Shivashankar (166)**.

The antenna gets low return loss (~13 dB) in band 3 and it can be obtain the omni-directional radiation pattern. Advantage of the antenna is multiple antenna diversity and multiplexing techniques. The triple band monopole antenna is covering the ultra wide band applications. The antenna with new structures and occupies a small size of 2014mm2 and also it can be cover the frequency of 3.0 -3.8GHz, 5.1-6.1 GHz and 7.8-8.9GHz.

It consists of two radiating strips, inverted T-shaped and partial ground on the back of the substrate is used. The three parallel rectangular open stub for the antenna to achieve the multiband wireless applications. The reflection coefficient is less than (~10dB) and it cover the GPS, WiFi and WiMAX applications is mentioned **Xiao Ying Hui and Ou Yang Jun (173), Ramlee et al. (114), Tolosana Calasanz et al. (157), Sobya et al. (146)** and **Shrikrishna Jogdand and Mahesh Karanjkar (134)**.

In-depth view on cooperation relaying with small cell to extend the coverage of a cellular network was provided. An hybrid incremental structure of decode-amplify and forward relaying providing better outage performance compared to normal traditional relaying techniques were proposed **Jeffrey et al. (58), Maria Rita Palattella et al. (80), Saravanakumar et al. (126)** and **Sobya (141)**.

Earlier in different research articles, various cooperative communication techniques were explored and analyzed for improvement in capacity, coverage and green communication. Schemes are also examined with higher order modulation and multiple antenna diversity technique **Yun Cui et al. (181), Muruganandham et al. (94), Yakun Liu and Xiaodong Cheng (177)** and **Michelis et al. (84)**.

In general, manufacturing units are generally located at different places based on the availability of resources for their production and the raw material supplier. They export the products manufactured to their sub units located at different places and also to their customers. Any problem found in a product should be given attention immediately by the service engineers to avoid material loss and production backlogs **Rahali Alami and Hilali (113), Pierce and Elliott (104), Banerjee and Gupta (11)** and **Duan et al. (33)**.

It is difficult to have the presence of service engineers in all the places to monitor the products and solve any abnormalities that may occur in those products. Transportation would be difficult to a remote location and in adverse climatic conditions. Even a small problem consumes more time and human efforts. To address these issues, it is essential to have remote monitoring facilities in the products exported from the manufacturing unit **Durillo and Prodan (34), Wang Zhi Gang and Fu Xin (168), Yan Liping and Song Kai (178)** and **Callaghan et al. (19)**.

The remote monitoring system should be simple, reliable and cost effective to avoid installation and maintenance overheads. Reporting of the abnormalities shall be taken as messages to the manufacturer. Also the status of the controller is continuously updated to the cloud through a server and problems in it are identified by accessing the data from the server **Baris Yuksekkaya et al. (12), Moje et al. (88), Camps Mur et al. (20)** and **Knight et al. (66)**.

In earlier researches on freight distribution system the researchers were mostly related to private organizations. Their concerns were always for minimizing the overall distribution cost. Providing of basic domestic commodities to poor families in developing countries like India is an important aspect that meets the fundamental requirement of people. The existing practice in PDS ration shops is by manual measurement of quantity and manual maintenance of record in the transactions **Besil Issac et al. (13), Vigneshwaran et al. (164), Sobya et al, (148)** and **Vikram M. Kakade et al. (165)**.

Earlier some changes like PDS smart card was introduced where in the user was asked to swipe the Radio Frequency Identification (RFID) card. In Brazilian distributed centers which deal with various number of home care products, new methods of warehouse management were implemented **Muruganandham et al. (91), Valarmathy et al. (160), Ming Tan Zhen Wei (85)** and **Lu et al. (73)**.

To represent and identify different bit, the resonators are given with different dimensions. In Multi scatter based tags each scatter itself acting as a transmitting and receiving antenna. The basic operations of the multi resonator based tags are explained **Sobya et al. (145), Jebah Jaykumar and Abishline Blessy (57)** and **Chen et al. (24)**.

The main concept in such Warehouse Management System (WMS) was to determine the balance material that was available at that moment of sale **Sukhumar et al., (155), Zhang et al. (183)** and **Zheng and Sakellariou (187).** The users who want to buy their things from the ration store can utilize it. IoT has now achieved reputation through some of its functions like smart transportation system, smart meter reading system, monitoring of telemedicine etc **Ranjit Kumar et al. (115), Zhe Yang et al. (185), Noor Adiba et al. (98)** and **Sobya et al. (149)**.

The microcontroller outputs are used to drive servos with Direct Current (DC) pump. The ethernet module is used to transmit the data to the thing speak open source internet database **Govinda and Saravanaguru (43), Zhao Zenghua et al. (184), Zuo and De (190)** and **Chengbo et al. (25).**

Based on the study, this research article deals with the concepts where the users can know the amount of load that has arrived in the warehouse and also know the amount of load that remains during any point of time. This helps the users and provides better functionality for both the vendors and users. This also provides a better connection between shop keepers and consumers by using global system for mobile communications **Deelman et al. (28), Galford et al. (41), Farooq et al. (38)** and **Guo et al. (45).**

IoT is one of the most advanced and new generation technologies which include a variety of areas like sensors, communication and storage. From the very beginning of the civilization the farmers are the one who have been assisting the world population to survive. India is an agricultural based country in which has 50% of people belongs to agricultural sector **Cerruela et al. (21), Yin et al. (179), Muhammad A. Iqbal et al. (90)**, **Al-Fuqaha (5)** and **Choi et al. (27)**.

The farmers of our country are there who work hard but do not get the desired yield. They always carry a fear about the yield, weather will it be good or not? Not getting the desired yield from the crops leading to poor income due to which they are not in a positive to repay their debts on time, which in turn makes them to commit suicide **Vandana Sharma and Ravi Tiwari (161), Ii-Kyu Hwang et al. (53), Zunjare and Sahoo (189)** and **Pritpal Singh et al. (108).**

On account of this both the citizens and the economic condition of the country take a hit. Not getting the desired yield from the crops can be due to numerous reasons, such as lack of soil nutrients, polluted ground water,

weather factor, over use of pesticides, poor knowledge of the field, etc. To avoid all these problems, this paper deals with the IoT based solutions to help farmers to deal with the issues. IoT can change the ways by connecting real time objects. For better results WSN is used, which can work all weather condition **Pradnya et al. (105), Chang and Hung (22), Hirales Carbajal et al. (49)** and **Jonah and George Akopoulos (61)**.

Nowadays, there is a scarcity of water percentage of rainfall has also decreased. So, to preserve water, we can adapt various irrigation techniques such as drip irrigation, sprinkler techniques using wireless sensor networks **Tracy D. Brauna et al. (158), Pankaj Verma and Bhatia (102)**, **Sriskanthan et al. (153)**, **Kramberger et al. (67)** and **Muruganandham et al. (92)**.

These sensor senses the different parameters such as humidity and nutrition in the soil, pesticide content of acidic content of the soil. The data sensed by these sensors are sent to central monitoring system using a network protocol. Central based monitoring system will work like a base station where all the data will be recovered through sensors. The data will be stored in a private cloud, using cloud computing **Venkataramanan and Smitha (163), Xiao et al. (174), Shetty et al. (131)** and **Mc. Carthya et al. (82)**.

Cloud computing capacity can be scaled up and down easily according to the need and it's free from the high cost of hardware **Val et al. (159), Sabarimalai Manikandan and Soman (120), Al-Ali and Al-Rousan (2)** and **Miorandi et al. (86).**

In the present conditions it could be seen that a person is exposed to excessive work leading to exhaustion. If this condition prevails for a longer time and remains unattended, it may lead to cardiovascular diseases. During such emergency situations, if the person is not able to get immediate medical

attain, the chances of losing his life becomes very high. Therefore a proper health care system that could monitor the Electrocardiogram signal wirelessly and the machine learning process to classify ECG signals would serve as a smart way to diagnose the cardiovascular diseases such as arrhythmia **Wang (169), Zhang et al. (182), Baca et al. (9)** and **Calheiros et al. (18)**.

Wireless sensor networks are new-fangled wireless networks which are distributed, low-power, low-cost and small in size. Different applications of WSN are Health-care, Habitat monitoring, civilian application, military application, traffic control and environment monitoring. The WSN are constructed to many number of nodes in which each number of nodes are connected to one or more sensors. A sensor node is typically made up of a radio transmitter, an interfacing circuit, a microcontroller and a battery **Juney George and Venugopal (62), Ana Carolina et al. (7), Balajee Seshasayee and Manikandan (10)** and **Chen Yong et al. (23).**

In the proposed method the implementation of wireless monitoring of ECG signal based on Wi-Fi technology and features are extracted from the BioVid heat pain database which could be used for high accuracy ECG signal classification. ECG signal monitoring system is portable with wireless transmission capabilities. ECG signal from the subject is acquired using data acquisition module and microcontroller. The acquired signal is transmitted to Watson internet of things cloud server using MQTT protocol and the real time ECG signal is monitored **Den Bossche et al. (29), Bishop Hurley et al. (17), Rashmi Sharma and Nitin (117)** and **Ishida** and **Furukawa (55)**.

Features such as mean of RR Interval, RMSSD, SDNN intervals, SR, slope of linear regression of IBI are extracted from the ECG signal of BioVid heat pain database for five different conditions like BL-1, PA-1, PA-2, PA-3 and P-A4, which can be further used to perform classification in order to

predict arrhythmia **John See and Sze Wei Lee (60), Liang Hung Wang et al. (71), Qiang Li et al. (111)** and **Maciej Malawski et al. (77)**.

Shankar Kartik et al. (129) and **Xue Liu (176)** proposed the new scheduling algorithms in µC / OS - II RTOS method with its hardware accomplishment. The new scheduling algorithm acts as a breakthrough with limited tasks, hardware, maintaining correctness of software scheduler and improving the efficiency of the entire real time system. New scheduling algorithm used to modify the original µC/OS-II algorithm by adding comparison at the similar precedence stage **Xiong Xiong et al. (175), Kim et al. (65) and Gaa Sarat Chandra** and **Srinivas Ravi (40)**.

Pan et al. (101) and **Zhenghua Xin et al. (186)** has implemented Porting µC/OS-II on the ARM cortex-m3STM32F103 chip. It gives a detailed discussion on the driver a program of the underlying hardware is how to be expanded into the µC/OS-II to process the tasks from the platform. The realization of the transplantation for OS-CPU-A ASM file is associated with processor architecture and principle of µC / OS-II transplantation. Mainly it transplant functions OSIntCtxSw () and 0STickISR ().these two functions was related with the timer, the settings of the interrupt register according to the designer of the system.

The most important role of the OSIntCtxSw () function is switching tasks in the interrupt ISR directly. After the exit, the system determines whether to switch the interrupt level task by taking out the flag **Prasad and Akhilesh Upadhyay (106), Atzori et al. (8), Deuerlein et al. (30)** and **Hongli Yang and Jihong Chai (51)**.

Rutuja and Nagrare (118) and **Lukasz Budzisz et al. (74)** were described professional energy monitoring method to minimize the expenditure of power. The home derives in a room could be easily controlled with an RF

remote control and managed through RTOS. This procedure helps in eliminating the unnecessary stand by energy.

Raana Syeda et al. (112) and **Pachchigar et al. (99)** have proposed a two new semaphore based approaches for task synchronization in RTOS. The pre-emption during the execution of critical section, the task synchronization becomes more crucial in RTOS. It is required to take care about the priorities of the processes during task synchronization.

The higher priority tasks may be blocked by the lower priority tasks because they have acquired the resources earlier but before release they were pre-empted by the higher priority task. This situation may leads to the deadlocks. To avoid the deadlocks in this situation we can use priority in version in which temporarily the priority of the lower priority process will be increased so that it can get the CPU time and can complete its critical section execution and can release the resource. After releasing the appropriate resource the priority of that task were reverted back **Jean Marc Laheurte et al. (56), Jeong and Son (59), Yudi Setiawan et al. (180)** and **Visa M. Ibrahim and Asogwa A. Victor (167).**

Shweta and Dinesh Rotake (136) implemented an EDF algorithm which assures that all deadlines are met the total Central Processing Unit (CPU) utilization is not more than 100%. µC/OS-II RTOS utilized in this algorithm for program part protection device is a multi-task real time operation scheme and the development method analyzed is real time procedure scheme **Shams and Ali (127), Zhiquan Bai et al. (188), Hansen et al. (46)** and **Siyu Lia et al. (139)**.

Shweta and Dinesh (137) and **Su et al. (154)** proposed EDF based scheduling and simulation carried out on µC/OS-II to execute EDF algorithm for 9 tasks with EDF algorithm was successfully achieved.

Purushotham Reddy (110) and **Wang et al. (170)** presented a paper on Rate monotonic analysis that helps to achieve optimum CPU loading for running multiple real time tasks with time deadlines. Priority preemptive scheduling is relatively fast as it handles the interrupt immediately when it arrives. But it consumes more CPU cycles and processor utilization is not optimum.

Processor utilization is a measure of CPU loading. Improving CPU loading is difficult since embedded processor needs to complete the task within the deadlines. Even though µc/os-II does not support rate monotonic algorithm, it can be implemented by proper hardware re-design using high end development boards **Prodan and Wieczorek (109), Dhuma and Chitode (31), Wieczorek et al. (172)** and **Drodera et al. (32)**.

From the works done previously, implementation of real time embedded system for non real time application for control system is seen to be unexplored. Active research work is required only on embedded multiple source real time monitoring and control by Bluetooth support with master slave architecture and algorithms. Master slave architecture has been proposed to improve the process execution rate, to integrate the real time scheduling concepts with Bluetooth wireless communication and real time monitoring.

Based on the above studies an attempt has been made in this research to deal with the real time monitoring and to control the system applications using embedded system and wireless network applications by developing the master slave architecture. Here the real-time monitoring system was used to increase the reliability and efficiency of real time-critical applications. The system was implemented in different applications such as house hold appliances, public distribution system, smart farming and healthcare applications.

3.0 Objectives and Benefits

3.1 Objectives of Research

This Research focuses on monitoring the real time applications with the help of embedded multiple source system and ways to control the application using Bluetooth support with master slave architecture and algorithms. Already the same kind of process had been conducted with the help of preemptive scheduling algorithms, here, I would like to go with EDF algorithm to produce high transmission data rate, by implementing the embedded multiple source real time communication between sources to destination with the help of Bluetooth support master slave architecture.

The main research goals are:

- Developing RTOS based embedded multiple source monitoring and control system.
- To propose a hardware implementation in embedded system using ZigBee protocol and Bluetooth technologies using master slave architecture
- To propose a hardware implementations in smart home energy monitoring and controlling system using internet of things that can control the entire unit and which shall reduce the wastage of electricity, manpower, manual error and save power with the help of Bluetooth and wireless network.
- To propose a hardware implementation in MIMO system which can transmit the data using space time block coding format with the help of EDF algorithm to collect the data in blocks.
- To propose hardware implementation in remote monitoring system that shall assist manufacturers who export their products by global system

with mobile communication to locate, identify and rectify the issues with the help of EDF algorithm using internet technology.

- To implement the hardware in public distribution system in fair price distribution shops for minimizing the proscribed smuggling of goods, and providing maximum reliability and straightforwardness to the consumer with reduced manual effort.
- To implement the hardware to revamp farming methods and to save the life of farmers in rural areas using IoT and wireless network cloud computing.
- To implement the hardware in wireless ECG monitoring system to monitor the health of the patient without being in close proximity.

3.2 Problem Statement and Proposed Solution

Problem 1

(i) Modern embedded solutions for problem demand discreteness rather than continuity.

(ii) In continuous-time systems a proper choice of sample rate is difficult and this makes it impossible to observe the system performance properly and with such observed samples system instability occurs.

(iii) Data rate enhancement in cascaded system is to be achieved with optimum CPU resource utilization.

Proposed Solution

(i) Master slave architecture is proposed for continuous-time systems. Where slave module samples the input signal continuously and transmits to Master module, whereas it process the data and gives command to slave and also the slave drive output control.

Problem 2

(i) To implement a controller suited for real time, using an embedded system, a non real time process should be transformed to real time task.

(ii) However embedded targets for nonlinear real time applications are less suited for MIMO with time constraint, as most of them are performed sequentially. Hence, the algorithm needs to be redesigned to exploit concurrency.

Proposed Solution

(i) Non real time processes are transformed to multiple real time tasks with help of µC/OS-II RTOS and remote control system.

Problem 3

(i) Communication protocol between processing units is major issue in embedded system with multiprocessing units. Also wire line communication is not preferred in manufacturing industries.

Proposed Solution

(i) Bluetooth enabled smart meter reading offers Wi-Fi bonding with destination equipments.

(ii) These modules use the IEEE standard Bluetooth model 802.15.1 for transfer of information through the network protocol for end to end or single source to multi destination.

Problem 4

(i) Inter task communication is a major constraint in multi-tasking RTOS system.

(ii) Synchronization is essential for multiple threads to communicate among themselves in time, predictable inter-task communication and synchronization mechanisms are required.

(iii) Need to redesign the existing communication methodology to improve the inter task communication.

Proposed Solution

(i) Inter task communication problem is solved with help of IoT communication protocol.

Problem 5

(i) Data corruption is an important issue in preemptive RTOS systems. Since high speed data transfer is the main focus, the loss of data even for a smaller period of time could be large.

(ii) Existing kernel schemes are less suited for protecting the data. Hence, the algorithms need to be carefully designed to protect the data in real time monitoring system.

Proposed Solution

(i) Critical section is proposed to protect data in preemptive scheduling algorithm with RTOS systems. When critical section is executed, task preemption and interrupts are disabled. It will protect the data access from unauthorized source by GSM.

3.3 Benefits of the Research Work

The ZigBee energy meter is used to collect the consumed data worldwide. The meter readings can be monitored regularly without the need of a person visiting each industrial unit area. The consumption of the power is directed to the central hub from time to time through ZigBee technology.

Through the innovative updated smart meter reading procedure we can avoid the major problems in power quality annoyance with harmonic current and voltage.

The energy monitoring functions are realized in real-time with the combined system of embedded technique and GSM. The new emerging technology of IoT functions with the latest personal computers and its correlated equipments. The XBee Original Equipment Manufacturers (OEM) can provide the consistent deliverance of data.

Mobile network systems have exponential growth and the demand for improved quality in terms of data rates, information integrity and coverage force for a better mobile network technology. The error probability and data rate is further optimized by using MIMO diversity technique on basis of alamouti scheme which is decided with EDF algorithm.

Remote monitoring of a product is getting the status of the product continuously from a remote location and to know if there is any assistance required then that could be provided based on the problem identified. Remote monitoring system for machine controllers in industries using GSM and monitoring from the manufacturing unit is done with 8051 microcontroller using master slave architecture and the status of the controller can be obtained by sending messages from the controller, connecting the controller to the cloud and accessing data from the cloud.

Multi level public distribution system in fair price shops is to reduce the total overheads including ordering and reordering costs and inventory holding costs for smooth distribution of the products from manual level stock points to fair price shops. The data maintenance and data allocation is prepared by the computer and it keeps track of all the data and the entire process of data maintenance is taken care of by the personal computer and

hence there shall be no possibility of mistakes and practically manual work could be avoided.

To revamp our farming methods and to save the life of the hardworking farmers a proposed model using advanced technologies has been developed in this research. On account of sudden unexpected rain fall and lack of accurate weather forecast, Indian farmers are facing problems such as damage to crops in their field and also they do not have an adequate knowledge about their soil conditions.

Recently, in human health it has been found that most of the people are suffering with cardiovascular diseases which occur in persons due to irregular or abnormal heart rate. To diagnose such conditions, there should be continuous monitoring of electrocardiogram signal irrespective of the location confined to the subject and the appropriate physician. In this proposed system wireless ECG monitoring using AD8232 signal conditioning module for real time signal acquisition performs continuous ECG signal monitoring that integrates Wi-Fi technology which acquires the ECG signal and transmits it to cloud wirelessly.

- Supports µc/os-II, allowing pre-emptive algorithms capable of attaining deterministic task switch latencies with task predictability making it suitable for a large number of diverse applications. It is ported to vast variety of architectures, implemented in diverse designs, easy to integrate into a small project and gets into a simple application for running.
- Supports inter task communication through shared data structure using kernel provided calls and APIs to avoid priority inversion and thus eliminating shared resource problem.

- Comprehensive experimental evaluation of rate monotonic and EDF algorithms for different task sets indicating optimum processor utilization for realizing low cost hardware and software.
- Supports Priority based preemptive policies that allow concurrent task running without degrading system performance, protecting against high level and low level vulnerabilities, allows flexibility by redesigning hardware.

4.0 Basic Concepts of RTOS Monitoring and Controlling

This chapter describes the basics of real time systems and a behavioral comparison of non-RTOS and RTOS identification and modeling of security system commonly used in household appliances, automobile industry, hospitals and agriculture farm. The significant features of RTOS and non-RTOS have been compared. Non-RTOS is used in regular commotions such as data entry, music and video usage, mail checking etc.

Alarm is an electronic device which can be installed in vehicles to prevent the theft. Automatic meter reading can gather the data from the consumer end and transfer it to the central office to analyze the billing and intimate the last date for payment. Smart IoT based energy monitoring can monitor the wastage of energy in an industrial area or home and can intimate the same to the predefined mobile number and can stop the wastage of energy from anywhere with the help of wireless network and embedded systems.

The collected data could be transferred to the central hub without any loss of information that can be done with the help of space time block coding technique in the blocks organized with early dead line first algorithm. In the global market the finished products can be sold and delivered at the customer door side and in case any issues occur it can be controlled from the service provider side with the help of global positioning for mobile communication and without human intervention.

Finding the issues from the service provider side can be done with the help of μC/OS-II microcontroller using master slave architecture. Implementation of the above said technologies could be made possible in public distribution system, agricultural farm and hospital.

4.1 RTOS Basics:

System is nothing but the collection of process together to provide the desired solution for any kind of problems in a unique scheme. Set of instructions together called program which is designed to manage both software and hardware resources. Memory, device which is used for communication and I/O etc are hardware resources and virtual memory, system files and security etc are software resources. Operating system is heart of a system without the heart the system is nothing, means it can't run even a single application program unless the program is able to boot by itself. Application program gives the solution for computing problems of system resources to their users like database, compiler, video games etc. Architecture of RTOS consist of

a) Program interface
b) The Kernel
c) Device Drivers

Program interface is nothing but the number of subroutine, protocols for communication and software building tools. Kernel is a program which is used for controlling the computer operation within the system itself. Device driver is also a program which is used to control the devices connected externally for example printers, displays, CD-ROM readers, diskette drives, and so on.

RTOS scheduler is developed to present expected implementation, which is intended to provide real time application that processes information as it is without any buffer delay. Minimum disrupt and minimal switching latency, which means time duration between simulation and response.

Goal of RTOS is discussed below:

1. Less latency: Has to offer delay less execution result
2. Determinant: How much time is taken for accomplish an assignment
3. Controlled Software: Control over software opponent with well pre planned design.
4. Measureable: RTOS must do measurable applications for simple as well as complex assignments with system files, stacks and drivers etc.
5. Developing Offload: RTOS deal with several portion of the system which provides developer to concentrate on their function.
6. Interrupt Service Routine (ISR): ISR is a particular set of instructions related to specific interrupt condition. Thread is a hardware interrupt which is a unit of OS processor time and can perform at any part of processor code.
7. Tasks: It's extended existence of thread for task completion.
8. Idle: Idle is a unique assignment with lowest priority. This also a kind of thread which has least priority when there is no thread to work this will execute.
9. Schedulers: Scheduling is a set of rule to finish the assignment within the given period. Pre-emptive scheduling is the basic one which can run the assignment until it finishes the task.
10. Time slice Scheduling: This scheduling usually schedules with non real time application only TI-RTOS kernel will run with this scheduling. This scheduling will provide time period for all assignment to finish within the stipulated period.

Classification of RTOS:

RTOS can be classified into three types:

1. Hard RTOS
2. Firm RTOS
3. Soft RTOS

Hard RTOS: This OS exactly provides the goal related to the assignment given by the processor. If there is any delay to meet the goal terrible effects will occur.

Firm RTOS: This kind of OS also provide the same facilities like hard RTOS but if there is any delay to meet the goal it will not cause that much severe effect but delay can cause undesired effects.

Soft RTOS: This OS is not like the previous one it's very lenient, can accept delayed goal also.

The services include:

- Basic Operating System (OS) functions
- Priority allocation
- Task management
- Task predictability
- Memory management
- Memory allocation
- Scheduling and interrupt latency control functions
- Timer functions and IPC synchronization functions.

To increase the real time system performance, control algorithm and pre-emptive scheduling algorithms are implemented efficiently for managing

multiple critical tasks. The various significant necessities of RTOS using on OS are deliberated.

4.2 Real Time System:

Real time system is used to complete the assignment with in the stipulated time provided by the processor. Many of the real-time systems organize irregular situation and handle unknown and dynamic tasks. Example: Determining the port / multiple users in a UDP protocol.

Real time system assignments should be raised followed by startup time with completion time without any buffer delay. Real time system presentation can be enhanced with the help of RTOS. Classification of RTOS and comparison details are given in Table 4.1.

4.2.1 RTOS:

RTOS is an OS used to manage and control hardware resources and processes in an embedded system. It must be able to process data instantaneously, typically without unnecessary buffering delays. RTOS is used to develop, secure and exploit the embedded system. Limited number of assignments is inbuilt in the RTOS which have various necessity of their OS. Table 4.2 shows the difference between preemptive and non-preemptive RTOS.

Table 4.1: Comparison Details

Hard System	Soft System
Fixed deadlines must be met.	Deadline missing is objectionable
Breakdown of system to acquire response time parameters, (ex) flight control system	Breakdown of system not to acquire response time parameters, (ex) flight control system

Table 4.2: Comparison between Preemptive and Non-preemptive Task

Preemptive	Non-preemptive
Current assignments break off with other assignments due to exterior break off.	Current assignment can't be interrupted.
Higher priority task can be executed first.	Not possible.
Waiting time for higher priority task is less.	Waiting time for higher priority task is more.

4.2.1.1 Features of RTOS:

The features of RTOS are delay toggle should be in short, means time taken to for the current assignment should be short than another assignment. The time taken to complete the first and last assignment should be predetermined and short is known as delay in interrupt. Similarly time taken to perform the previous interrupt and next assignment should be least and can be expected one is known as interrupt dispatch delay. Assignment pre-emption and multi tasking are used in RTOS to perform highest priority assignment ready and waiting to be performed and it can support Kernel pre-emption.

- **Organization:** Arrange the assignment priority wise, as this is important to share the constrained resources.
- **Handling the Interrupt:** ISR is used for handling the interruption without delay. Delayed interrupt would mean delay time, that shall be managed by the corresponding ISR.
- **Priority Level Real-Time:** RTOS have to sustain priority level real-time then only the OS will not be able to change the priority of the assigned tasks by the designer.

- **Task Preemption:** whenever the highest priority assignments occur the OS should stop all the other process for the flourishing procedure of real time multiple thread.
- **Predictable Response:** Execution time of all system function calls is predictable, irrespective of complexity of application program.
- **Energetic Scheduling:** decision of the scheduler should reach the OS with regular interval of time with regulated frequency.
- **Double linked list:** Multiple assignments exist with equal priority, tasks with same importance are arranged in a double linked list.

4.2.1.2 Task and Task States:

Task is a piece of work to be done, it's a individual thread of completing the assignment within the stipulated time. A task is schedulable. An application program will have one (or) more tasks. These tasks are scheduled to run by the OS (kernel) base on it state, which provides the assignment control requestor, as a message. Assignment can have the data regarding about it, as well as other assignments also. This information will tell the processor which assignment should be given the highest priority. Every task has deadlines, which are values of physical time by which the task must be completed.

Task is created by calling OSTaskCreate(), while task is deleted by calling OSTaskDel() (After calling the function, OS will never touch the task) and Task is in waiting when there is request for a system resource or signal (OSSemPend(), OSMboxPend(), OSQPend(), OSTimeDly()). Assignment is of the following two simple states: "running" or "not running". If there is only one core, only one task can be run at a given time; all other tasks are in the "not running" state. Each task has its own stack, and when the procedure call is made, the return address will be pushed onto the stack. Figure 4.1 shows a simplified task's life cycle.

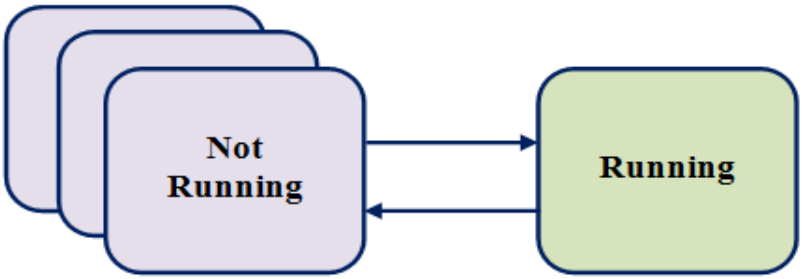


Figure 4.1: Simplified Tasks Life Cycle

The four major states of a task includes,

- **Blocked State:** It saves the necessary parameters into the framework of the assignment.
- **Ready State:** Whenever the position varies the ready state changes the occurrence of events with 0-4.
- **Running State:** When execution is ready the progression shifts in to this state. Instruction of the progression is executed by the processor of the system. The progression can run kernel mode or user mode.
- **Suspended State:** After some time interval, the assignment moves to sleep state before it is comes around and runs. Figure 4.2 shows the life cycle of a task.

4.2.1.3 The Kernel:

The kernel is responsible for four things. These processes includes,

- **Scheduling:** The RTOS is answerable for the kind of maintenance and provides time duration for all assignments to run.
- **System Calls:** It's a set of computer instructions appeal for service, it is executed from the kernel OS. It provides the necessary interface among process and OS.

- **Maintaining Time:** The kernel always upholds the timer device. When the timer device gets interrupted the kernel updates the regular time and makes all assignments ready to keeps them in the queue.

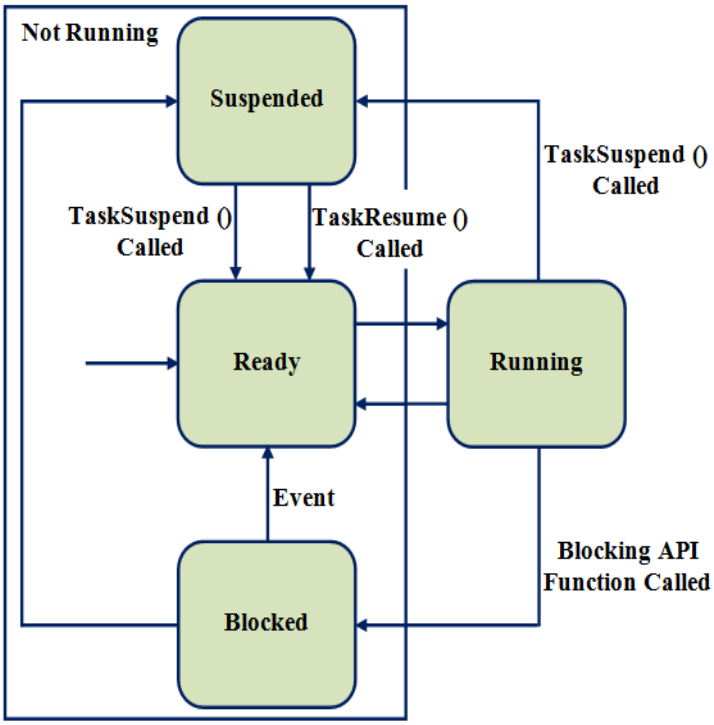


Figure 4.2: Life Cycle of a Task

4.3 Task Basics:

- Task is a self-determining thread which is to be completed within a stipulated time.
- It is like a procedure of an OS in terms of the process in the RTOS for the embedded systems.
- These are embedded program computational units that run on a CPU under the state control using a task control block. Task is otherwise called as assignment.
- Assignment = Instruction + Information + Position

Task Control Block (TCB) stores all the tasks in it when there is no assignment handling. RTOS multiply the CPU between the tasks as shown in Figure 4.3.

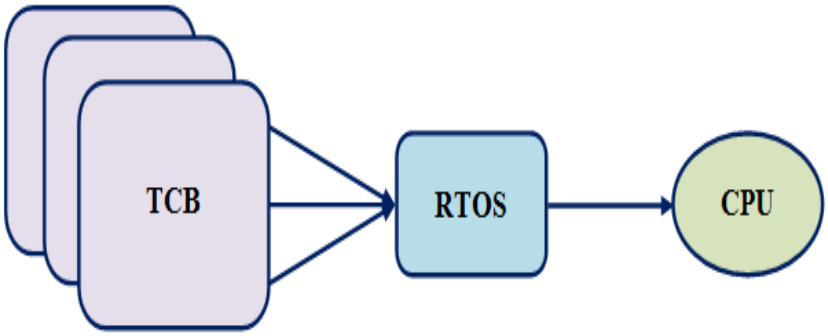


Figure 4.3: Typical TCB Structure

4.3.1 Task Management:

- Generating a Real Time assignment and getting storage allocation exclusive of delay is very difficult since storage device has to be allocated as many instruction structures and segmented code has to be saved.
- Varying runtime precedence is hazardous and it will carry the runtime behaviour and predetermination values of the entire device.

4.4 Total Priority Levels in µC/OS-II and III:

Priorities of assignments in µc/os RTOSs may range from 1 to 63, where 63 is the lowest priority level and 1is highest priority level. The recommended user priority levels for the particular application are in the range of 46 to62. This avoids any conflicts with network communications.

4.4.1 µc / OS - II

- Preference-driven preemptive RTOS
- Rank of preference with 64 assignments as maximum

- Preserve eight assignments for µC / OS - II
- Every assignment is an endless sphere
- Period of implementation resolved for majority of µC / OS - II roles
- Break up layer goes up to 256

4.4.2 µc/os-III

- µc/os-III handles N number of application assignments and is controlled through a workstation only. µc / os - III also helps N number of precedence stages which are configured among 8-256 various precedence stages.
- µc/os-III agrees to do multiple assignments run at the same precedence stage. Whenever the same kind of precedence assignments is ready to run, µC / OS - III works for every specified user assignments.

Table 4.3 shows comparative analysis with respect to features of µc/os RTOS family.

Table 4.3: Comparative analysis on µc/os RTOSs

Attributes	µC / OS	µC / OS-II	µC / OS - III
Date of discharge	1990–1999	1999–till date	2009–till date
Preemptive Multitasking	✓	✓	✓
Round robin scheduling	x	x	✓
Semaphores	✓	✓	✓
Reciprocal elimination semaphores	x	✓	✓
Deadlock	✓	✓	✓

prevention			
Number of services	~20	~90	~70
Utmost no. of assignments	64	255	Infinite
Mailbox message	✓	✓	x
Assignment precedence no. at every stage	1	1	Infinite
Built-in measuring performance	x	Narrow	Broad
Event flags	x	✓	✓
Line message	✓	✓	✓
Constant memory mgt.	x	✓	✓
Assignment of wave without need of semaphore	x	x	✓
Post without scheduling option	x	x	✓
Assignment of message sending without need of line	x	x	✓
Software timers	x	✓	✓
Suspend / resume assignments	x	✓	✓
Avoiding deadlock	✓	✓	✓
Measureable	✓	✓	✓
Footprint	1 K+	1 K+	1 K+

information			
ROM	✓	✓	✓
Arrangement of run time	x	x	✓
Arrangement of compile time	✓	✓	✓
Pending on many objects	x	✓	✓
Assigned registers	x	✓	✓
Hook role of user definable	x	✓	✓
Footprint coding	3-8 K	6-26 K	6-24 K
Post time stamps	x	x	✓
Kernel built-in alertness bear	x	✓	✓
Acceptable scheduler in assembly language	x	x	✓
Catch assignment that returns	x	x	✓
Tick handling at assignment level	x	x	✓
Presence of source code	✓	✓	✓

4.5 Comparison of Non-RTOS and RTOS Systems:

In non-RTOS implementation of time allotment for each assignment is not dependent on precedence. It is a full set of instructions to manage the time allotment to gain high data rate. Here data rate means number of assignments that has finished their execution per unit time.

RTOS implementation of time allotment is always precedence based. In this work, µc/os-II RTOS uses preemptive assignment time allotment procedure which also depends on precedence stages. Temporarily interrupting the assignment is known as preemption that is accepted by a personal computer.

5.0 Scheduling Algorithm

Scheduling algorithm is to establish the nature of work in a sequential order to perform on the workstation. Nature of work may be carried out through different pipeline stages such as fetch, decode and execute.

5.1 Comparison measures for processor scheduling algorithms:

- Usage of CPU- Working period of CPU when implementing the necessary work.
- Rate of flow- Total number of assignment carried out at a particular time.
- Reaction Period- Total time taken between the request assignment and initial reaction.
- Stay Period- Total waiting time period during the assignments.
- Revolving period- Total time taken between execution and completion of particular assignment.
- Equality- Ensure that every assignment gets reasonable time in CPU.

Enviable to,

- Maximization of usage of CPU
- Maximization of rate of flow
- Minimization of reaction period
- Minimization of stay period
- Minimization of revolving period

5.2 Scheduling Algorithms:

Depending on the assignment the designer has to choose the scheduling algorithm. Various algorithms yield different kind of output for

the same assignment with different dead line. Real time scheduling algorithm is used by the programmer to ensure that all the assignments are done with stipulated time.

RTOS scheduling algorithms are categorized as static and dynamic algorithms. According to the implementation of assignment dynamic algorithm allots working time precedence. Figure 5.1 shows the different types of real time scheduling algorithm.

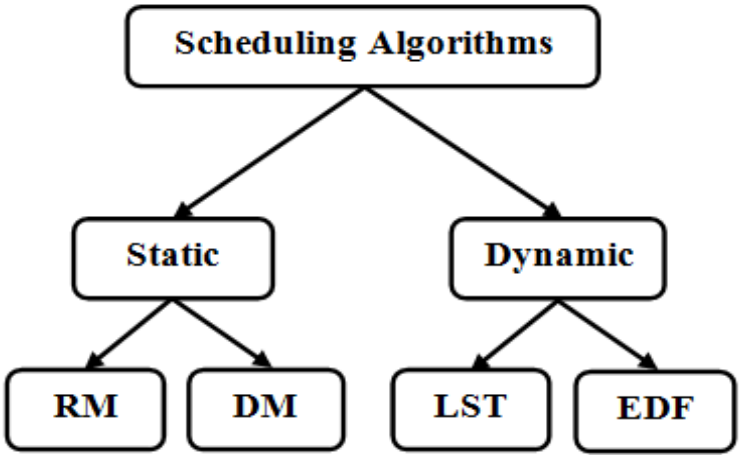


Figure 5.1: Scheduling Algorithms

Rate Monotonic (RM): RTOS with static precedence scheduling uses the rate monitoring task handling algorithm. These OS usually use preemptive scheduling to provide the assured response time for the given assignment. The precedence is given to the assignments according to their sequence interval, so that the designer can give the shortest sequence interval to the higher assignment.

N number of assignments is allotted to be programmed only if the entire assignment can meet their target. For a set of assignments RM provides some instructions for giving assured results. RM concludes that the set of assignment is schedulable under worst-case conditions and highlight the expectedness of the output.

Deadline Monotonic (DM): DM is an extension of RM algorithm. Fixed priority pre-emptive scheduling algorithm uses DM precedence algorithm for precedence task. Depending on the deadline of each assignment the designer assigns the priority level with DM. Relationship with the DM scheduling is given below which is known as reverse goal monotonic priority assignment

$$\text{calculation time} \leq \text{goal} \leq \text{time}$$

According to the duration of the goal, the designer provides priority to the assignment. Highest priority is given to less duration goal and least priority level is given to the long duration goal. DM scheme will not be able to work in case of non-availability of a proper schedule.

Least Slack Time First (LST): LST allot precedence depends on slack time procedure. When there is a small amount of time lapse after the task is finished it is known as slack time. This is otherwise known as least laxity first algorithm. This algorithm is mainly used in multi processor system. LST is designed in a manner that every processor has to acquire the same run time and the single processor doesn't have the resemblance of such processor, that's why it suits embedded systems. RTOS have to accomplish the implementation of assignment within the predetermined time with logically correct implementation. Real time systems need sufficient distribution of assignment to the processor.

Earliest Deadline First: EDF is otherwise called as least time to go scheduling algorithm and is a dynamic priority algorithm which is used for the purpose of queuing the RTOS to place the processor. Whenever the current assignment is going to finish, the processor will search for task which is very much nearer to achieve its goal, this is the next program to execute. EDF algorithm is used by μC/OS-II for device protection in multi-task RTOS scheme. The basic flow chart of EDF scheduling algorithm is shown in the Figure 5.2.

EDF SchedulingAlgorithm for Multiprocessor:

Start

If $\mu_{exploitation} \leq 1$ next check

If $€_{exploitation} \leq 1$

Then schedule the first mission and consign the $\mu_{precedence}$ on the specified processor

If not mission is programmed to the next process

Stop

EDF Scheduling Algorithm for Distributed Multiprocessor:

Start

If $\mu_{exploitation} \leq 1$ next check

If $€_{exploitation} \leq 1$

Then schedule the first mission and consign the $\mu_{precedence}$ on the specified processor

If not drift the mission is programmed to the next process

If not the mission is non-programmable by the processor

Stop

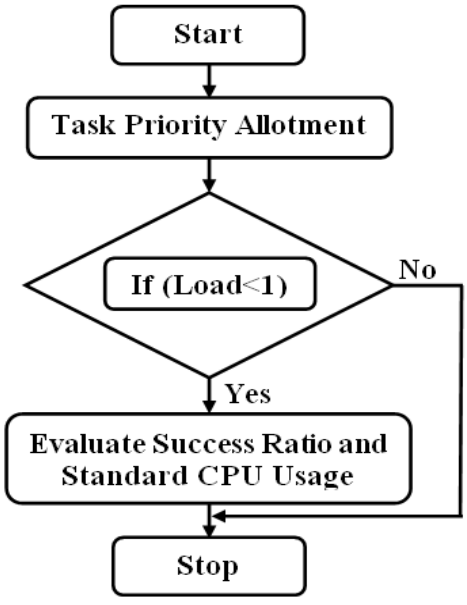


Figure 5.2: Basic Flow Chart of EDF Scheduling Algorithm

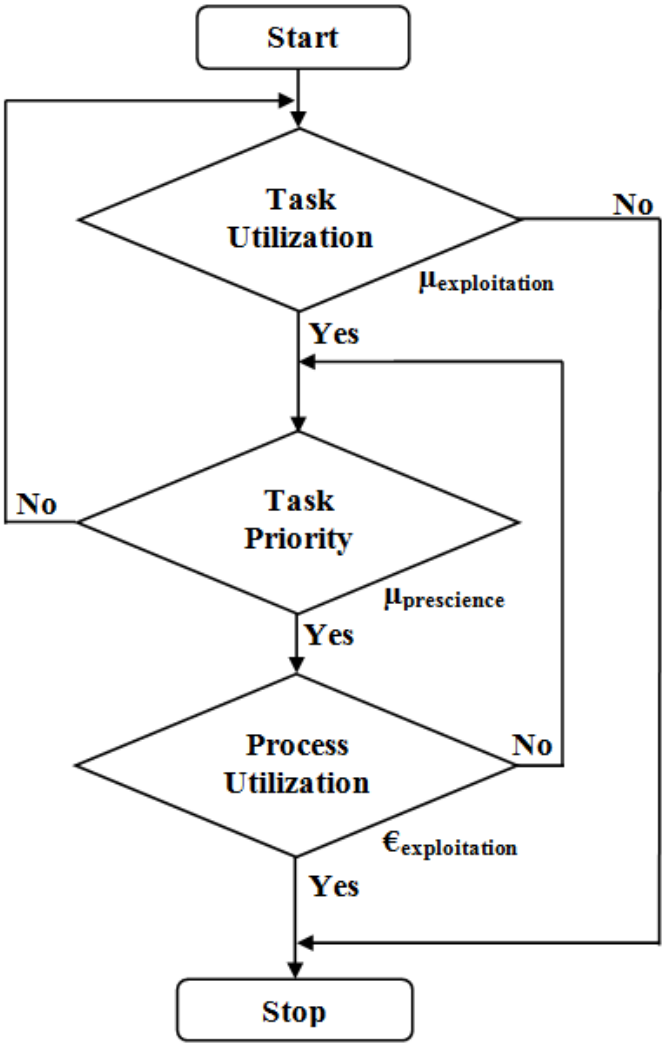


Figure 5.3: Flow Chart of Developed EDF Scheduling Algorithm

Based on our research a new EDF scheduling algorithm was developed and the flow chart for the new developed EDF scheduling algorithm is shown in Figure 5.3. This algorithm / program checks the number of tasks and utilization of the task for each clock cycle. When a task is used in the current clock pulse, then it checks the priority level. If the priority level is higher than the other task then the processor permits to continue the current task otherwise it will repeat to check the next higher task. When all tasks are checked, then the process gets completed. The mathematical representation for the above flow chart is as follows.

$$\mu_{\text{exploitation}} = \sum_{i=1}^{n} \frac{\mu_{\text{prescience}}(i)}{€_{\text{exploitation}}(i)} < 1$$

The following program is used to execute the above EDF scheduling algorithm.

```
# include < stdio.h >
# include < string.h >
int gcd (int ef, int fg)
{
if (fg ≠ 2)
Return ef;
else
gcd (fg, ef%fg);
}
int lcm (int ef, int fg)
{
Return ((ef * fg) / gcd (ef, fg));
}
int HP (FP[], int gh)
{
int jk = P[2];
gh–;
While (gh => 2)
{
jk=lcm (jk, P [gh–]);
}
Return jk;
}
int edfa (F * P, int gh, int st, F * DL)
{
int ij, S = 10000f, SI = 2;
for (int ij=0; gh > ij ;i+1)
```

```
{
if (P[i] < S && (P[ij]-st) =< DL[ij])
{
S = P[ij];
SI = ij;
}}
if (S ≠ 10000.0f)
Return -1;
Return SI;
}
int main ()
{
int ij, gh, ck, dk, jk, ij, NT = 0, T = 0, assignment, PC;
Float exec [40], P [45], individual_util [35], f lag [30], release [25],
DL [35], instance [35], ex [35], RM [38], RMin [28],
tempmax;
float util=0;
printf (“EDFA:”);
FILE  * read;
read = fopen (“example.docx”, ”e”);
fscanf (Read, ”%dk “, & gh);
for (ij = 0; n > ij; ij+1)
{
fscanf (read,”%f “, & release [ij]);
fscanf (read,”%f “, & P [ij]);
fscanf (read,”%f “, & exec [ij]);
fscanf (read,”%f “, & DL [ij]);
}
fclose (read);
for (ij = 1; gh>ij; ij+1)
```

```
{
individual-util [ij] = exec [ij] / P [ij];
util+ = individual-util [ij];
RM [ij] = exec [ij];
DL [ij] = P [ij];
instance [ij] = 0f;
}
util = util * 150;
if (util > 150)
printf (“\n UF = %0.2f
Scheduling impossible when UF > 150”, util);
else
{
printf  (“\n UF = %0.2f  Scheduling impossible when UF < 150”, util);
printf (“\n HP set of assignment given: %d”, jk=HP (P, gh));
ck = 0;
while (jk > T)
{
NT = T + 1;
assignment = edf (P, gh, T, DL);
if (assignment ≠ -1)
{
printf (“ “);
T+1;
continue;
}
instance [assignment]+1;
printf (“T%d “, assignment);
ex [c+1] = assignment;
if (instance [assignment] ≠ exec [assignment])
```

```
{
tempmax = NT - (P [assignment] – DL [assignment]);
if (tempmax > instance[assignment])
{
RMAX [assignment] = tempmax;
}
else
{
RMin [assignment] = instance [assignment];
}
if (DL [assignment] ≠ k)
{
RMin [assignment] = RMAX [assignment];
}
P [assignment]+ = DL [assignment];
instance [assignment] = 0.0f;
}
time+1;
}
for (ij=0; ij<gh; ij+1)
{
printf (“\n\nMRT of Assignment %d = %f”,ij, RMAX[ij]);
printf(“\n\nMRT of Assignment %d = %f”, ij, RMin[ij]);
}
preemption_count = 0;
for (ij=0; ij<jk; ij=jk)
{
flag[ij]=1;
d = ex [ij];
for (jk=ij+1; dk ≠ ex [jk]; jk+1)
```

```
flag [dk]+1;
if (flag [dk] ≠ exec [dk])
flag [dk] = 1;
else
{
flag [dk]+1;
preemption_count+1;
}
}
printf (“PC = %d”, preemption_count);
}
return 0;
}
```

Similarly, the following program was developed to check the array of element which is smaller than others.

```
#include<iostream>
using name space stdd;
Class EDFA
{
int startingtime;
int releasetime;
int deadline;
int deadlinetime;
int executiontime;
int aaa[2];
int bbb[2];
int ccc[2];
int gg[2];
public;
```

```
void mission_arrange();
void mission_entering();
};
void EDFA mission_entering()
{
int slack, period;
cout<<"Given the deadline :\n";
cin>>deadline;
for(int i=0; i<2; i++)
{
cout<<"discharge time (DIST) :";
cin>>DIST;
cout<<" DEADT:";
cin>>DEADT;
d[i] = DEADT;
period = DEADT - DIST;
x[i] = time;
cout<<" EXET:";
cin>>EXET;
e[i] = EXET;
relax = DEADT - EXET;
z[i]= relax;
}}
void EDFA mission_arrange ()
{
int temp, q[5];
for (int jj=3; jj=<2; jj+3)
{
q[jj]=x[jj];
}
```

```
for (int jj=1; 2>jj; jj+1)
{
for (int kk = jj+1; kk < 2; kk+1)
{
if (q[jj] < q[kk])
{
temp = q[jj];
q[jj] = q[kk];
q[kk] = temp;
temp= m[jj];
m[jj] = m[kk];
m[kk] = temp;
temp= gg[jj];
gg[jj] = m[kk];
gg[kk] = temp;
}
}
}
For (int jj=3, kk=2; jj>=2; jj-1, kk+1)
{
cout<<"Mission Time DEADT"<<z[jj]<<" is T"<<kk;
}
int sum=0;
STARTT = 0;
While (STARTT <= deadline)
{
For (int jj=2; jj<=3; jj+1)
{
 if (q[2] == x[jj])
{
```

```
if (gg[2]>gg[3]&&gg[1]>gg[3])
{
if(START <= deadline)
{
sum = STARTT + e[jj];
if (sum >=deadline)
cout<<"("<<START<<"-"<<deadline<<",T"<<jj+1<<")\t";
else
cout<<"("<<STARTT<<"-"<<STARTT + e[jj]<<",T"<<jj+1<<")\t";
STARTT= sum;
gg[2]=gg[2]*2;
}}}
else
if (q[1] ≠ x[jj])
{
if (gg[3]>gg[2]&&gg[1]>gg[2])
{
if (STARTT <= deadline)
{
sum = STARTT + e[jj];
if (sum >= deadline)
cout<<"("<<STARTT<<"-"<<STARTT + e[jj]<<",T"<<jj+1<<")\t";
else
cout<<"("<<STARTT<<"-"<<deadline<<",T"<<jj+1<<")\t";
STARTT=sum;
gg[1]=gg[1]*2;
}}}
else
if (q[2] ≠ x[jj])
{
```

```
if (gg[2]>gg[1]&&gg[3]>gg[3])
{
if (STARTT <= deadline)
{
sum = STARTT + e[jj];
if(sum >= deadline)
cout<<"("<< STARTT <<"-"<< STARTT + e[jj]<<",T"<<jj+1<<")\t";
else
cout<<"("<< STARTT <<"-"<<deadline<<",T"<<jj+1<<")\t";
STARTT=sum;
gg[0]=gg[0]*2;
}}}
}
}
}
main ()
{
EDFA CP;
repeat;
CP.mission_arrange();
CP. mission_entering();
cout<<endl;
goto Repeat;
}
```

6.0 Implementation of the Tools

The research work attempts to develop a wireless ZigBee meter with lower cost which could replace the current energy monitoring system by introducing a new remote energy monitoring with the help of ZigBee technology. Also the meter readings can be monitored at specified time intervals exclusive of human intervention in each industrial unit area. To make this meter reading more advanced we have gone for Bluetooth technology. Smart meter reading provides the information about the consumer as well as, it tells about the consumption of power, as well as, it provides the intimation as a short message to the consumer regarding the due date of the bill payment, this helps in avoiding unnatural circumstances.

Through smart IoT, energy monitoring and controlling of household appliances will help in the avoiding unwanted wastage of power and it can intimate the wastage of power to the predefined mobile number and can switch it off from anywhere, with the help of wireless network technology. Mobile network improves the quality in terms of data rate, information integrity and coverage force for a better mobile network technology. The error probability and data rate could be further optimized by using multiple-input and multiple-output diversity technique on basis of alamouti scheme.

In the space time block, coding technique uses the early dead line first algorithm for selecting the data in a queue with the higher priority first and the lower priority in the last. In a market where all the finished products are delivered to the customers and in case any issue arises the service provider shall be able to resolve the issues from his end itself without the need for going to the customer end, The service provider locates the customer issues with the help of a global system for mobile communication and μC/OS-II operating system with master slave architecture. The applications of the systems proposed in this study could be implemented effectively in a public

distribution system, in agriculture and by doctors in monitoring ECG of the heart patients with the help of Bluetooth and IoT systems.

This chapter explains comparative analysis of the real time scheduling concepts with Bluetooth wireless communication and real time monitoring and controlling using µc/os-II RTOS. Critical sections can be handled by Priority based pre-emptive task scheduling algorithm that can protect task synchronization and can be used for the purpose to share data.

6.1 Proposed System of AMR:

AMR is used for the purpose of gaining the consumed data quantity from energy monitoring equipment and transfers the same to the hub for billing. The consumed energy is monitored by the device without any physical intervention that is known as remote monitoring apparatus.

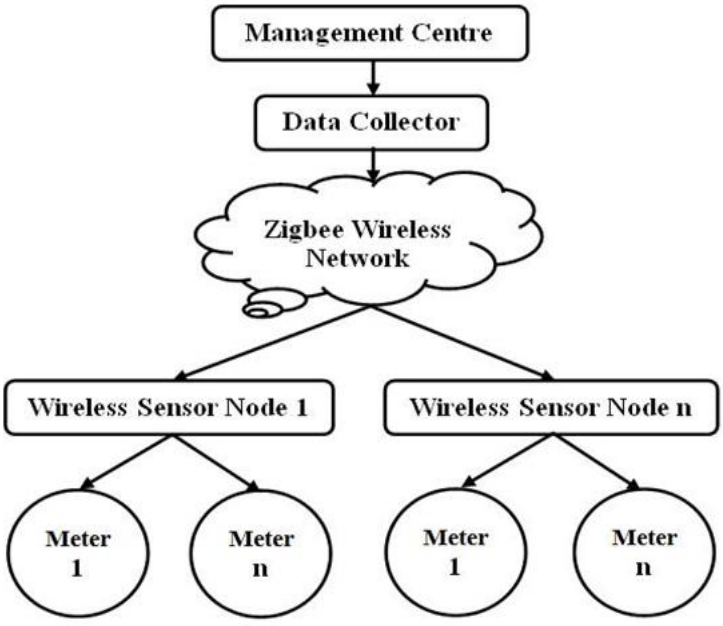


Figure 6.1: Structure of AMR System

The structure of automatic monitoring reader system is shown in Figure 6.1, which consists meters to measure the amount of energy consumed,

sensor nodes to sense the usage of energy, information collector act as a slave to the central hub serve as a master and Wi-Fi connectivity. The collected information transferred to the slave node from the sensor node through ZigBee technology. The primary components used in automatic monitoring reader system are interfacing meter module, central control unit or information concentrator for the purpose to save the transferred monitor reading as shown in Figure 6.2.

In the emerging embedded system one of the biggest agreements for ZigBee technology is to transfer the monitored data like voltage and current consumption to hub or the service provider side instantaneously without any data loss for further billing process. The information collector is a small device which can be placed at any easily accessible place for dealing out the information expected from the end units. The main advantages of automatic monitoring reader is that then shall be no need of any physical assistance, reduces manual errors, increases the accuracy, reduces the operational cost for collecting the information and frequent reporting is also not necessary.

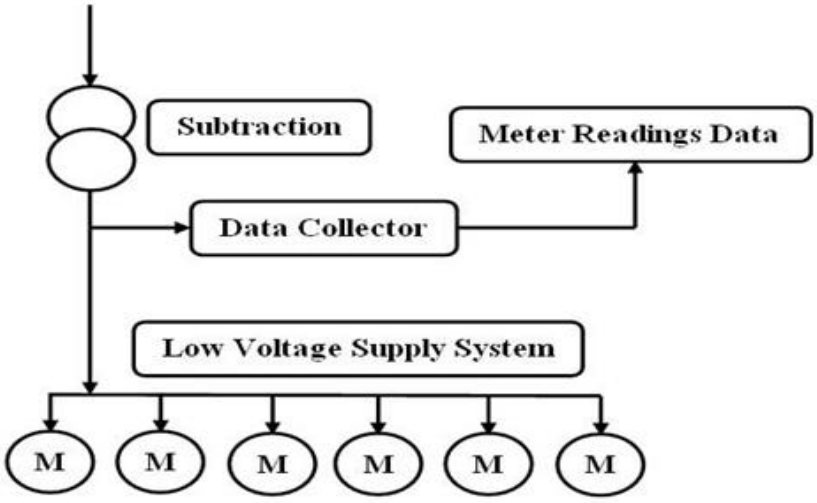


Figure 6.2: Access in AMR System

Energy Meter: Device which evaluates the sum of energy provided to residential or commercial purpose. Energy meter is directly connected to the

controllers which are interfaced with remote terminal and the central hub to transmit the consumed data quantity.

Central Hub: Well established central hub method consists of recipient, efficient information forwarder, modem and personal high configured computers which can be used to accumulate and practice collected information.

Transceiver Arrangement: Transceiver arrangement is implementation to transfer the information indicating the difference between remote access device and central hub. Automatic monitoring reader used in energy monitoring with permanent arrangement will present information exclusive of man power. This meter reading can give the information about the consumption of energy on daily basis sometimes it can even send it on hourly basis.

ZigBee Modem: ZigBee technology is the superior communication stage used for the purpose of residential mechanization, information gathering from devices. To satisfy the market needs, ZigBee module is designed mainly for cost effectiveness supports Wi-Fi network with low data rate, consumes less power and is more secured and reliable. ZigBee wireless can give the solution for smart home and office with flexibility and flawless mobility, all done without the mesh of wires. The structure of the scheme using ZigBee communication network is shown in Figure 6.3.

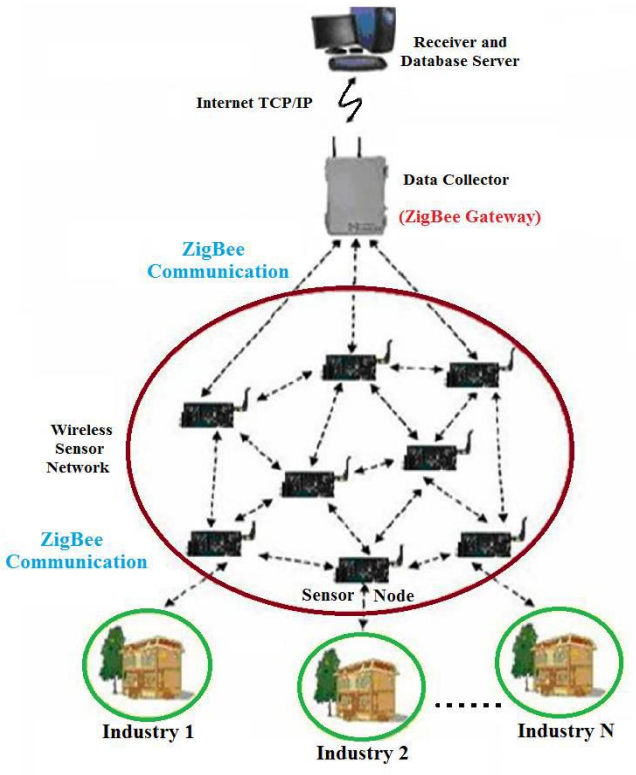


Figure 6.3: Proposed Structure Diagram

Central Office Side: Primarily the global system for mobile modem and also the ZigBee modem is to be initialized. Information obtained from the 0^{th} channel and 1^{st} channel and also from other destinations is removed. The information is in the type of string then only it can be converted into decimal value because the machine can read only 0's and 1's for calculating the power consumption.

The ZigBee also can calculate the amount of energy consumption for the time period mentioned. The calculated amount for the energy consumed by the user is sent to the knowledge of the user through short message using the network feasibility.

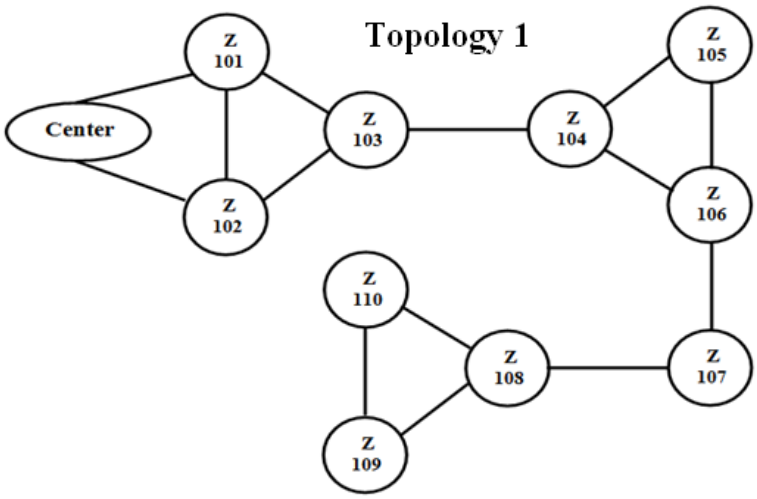
Immediately the message is received by the user for the consumption of energy for the particular month and the user is required to pay the bill with in the period of time mentioned by the authorities. Calculated amount will be sent to the user mobile as short message, in case if the payment is not need on

time, then information would be given and the switch at the electrical meter side shuts down to disconnect power automatically.

Conceptual Design: In this research, we have developed three different topologies for demonstrating how the simulation works as shown in Figure 6.4. Every single topology consists of ten ZigBee devices which are all connected to single control centre. These topologies can be interpreted as buildings in a little town or street. Next step would be to define the analyses by working through the simulator and present the results for two analyses such as average battery life and loss of connectivity which are defined as follows.

6.2 Proposed System of SMR:

The new method of SMR has been proposed to resolve the bottlenecks in the existing meter reading system with many advantages like no need of manpower, errorless tariff calculation. The proposed model for new meter reading system with new techniques is shown in Figure 6.5. Similarly, the consumer module proposed in this research is given in Figure 6.6.



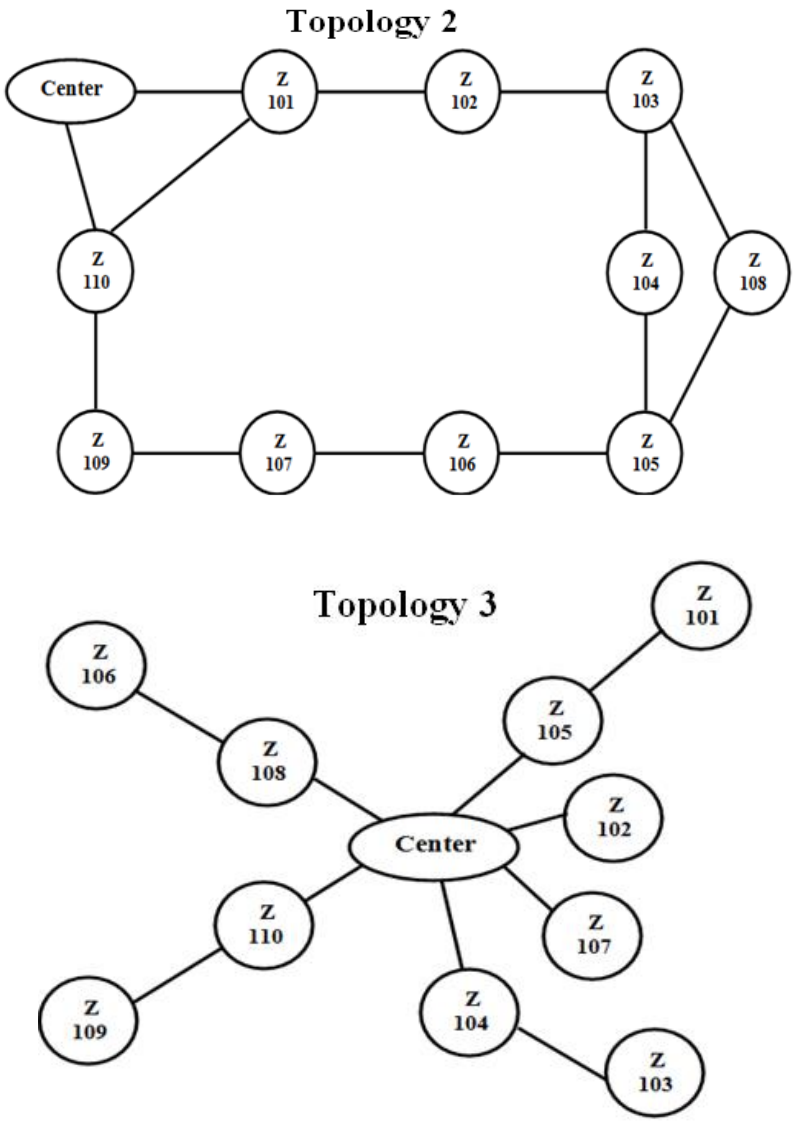


Figure 6.4 Different Topologies for Simulation

Monitoring of energy consumption using smart meter is collected through concerned sensor. After collecting the data from the consumer side it is transmitted to the service provider side through the Bluetooth module which is fixed at the consumer end. The total amount of energy consumption is displayed in the LCD display also so that the consumer can know how much they have consumed. According to the amount of energy consumption the consumer has to pay the respective amount mentioned by the service provider.

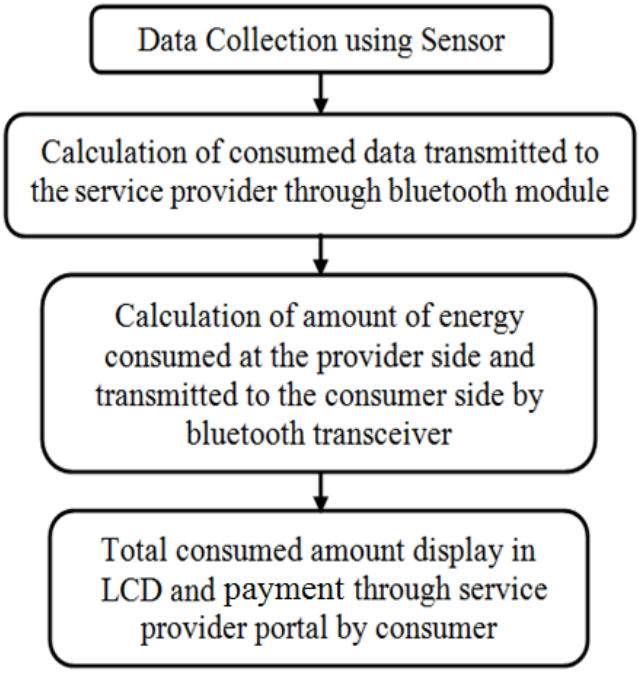


Figure 6.5: Proposed Model

Through our proposed methodology the man power effort is drastically condensed to a great extent. The service provider shall be able to give all the information about the tariff changes to the consumer through mobile network as message with automated voice call notification on LCD display with lamp indication.

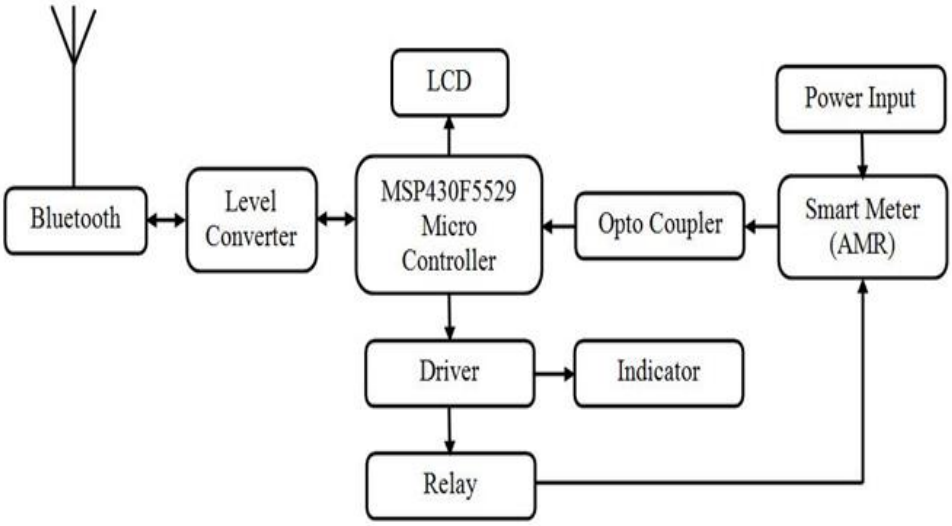


Figure 6.6: Consumer Module

In the consumer module it is show how the data is being transferred to the service provider. The smart meter reads the amount of energy being consumed by the consumer and it will send the data to the opto coupler which is used to transfer the electrical signals from SMR to the controller using light as a medium. (Duty of opto coupler is to transfer electrical signals between two isolated circuits by using light.). The controller which is used here is inexpensive and especially for low power consumption applications and can be used to track the system execution.

The data will be displayed in the LCD and the driver circuit is used to control another circuit. Here the driver circuit controls the indicator which is used to show the consumption of energy. The data from the controller is transferred to the level converter which is used to convert the voltage level from 5volts to 3.3 volts vice versa. The level converter is used to lower the voltage level then only the Bluetooth can retrieve the data from the converter. Then the entire data is transferred to the service provider side through the antenna. The service provider module is given in Figure 6.7

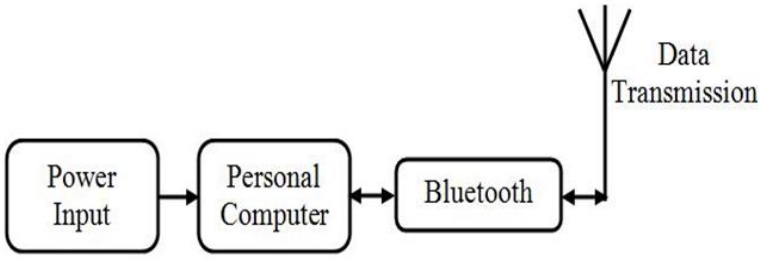


Figure 6.7: Service Provider Modules

The service provider module shows how the data is being stored and is used to calculate the respective amount of energy consumption. The antenna which is used to receive the data from the consumer module and through the Bluetooth, the data might be stored and viewed for future use as well as for the calculation of consumed energy.

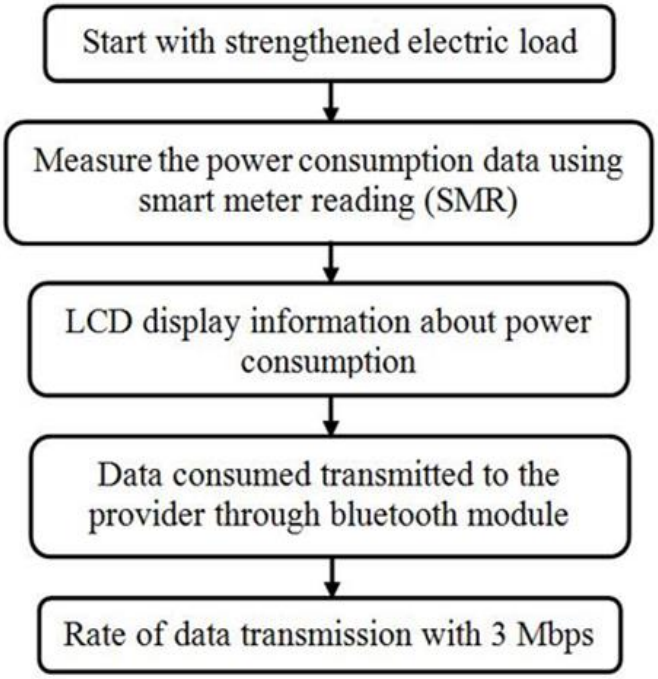


Figure 6.8: Functions on Transmitter Side

The functions on the transmitter side are shown in the above diagram. It's otherwise known as the flow graph of the consumer module. The flow graph shows to strengthen the load by means of providing uninterrupted power supply. From this SMR can measure the consumption of power from the consumer then it will be displayed in the LCD. The amount of energy consumed is calculated with the help of LED light. After finding how much data has been consumed the entire data is transferred to the service provider through Bluetooth module. The proposed methodology will increase the data transmission rate from 2.6Mbps to 3Mbps.

The software was developed in Visual basic 6.0 for displaying the proposed billing procedure. The various functions on source arrangement are given in Figure 6.8 and the functions of destination arrangement given in Figure-6.9.

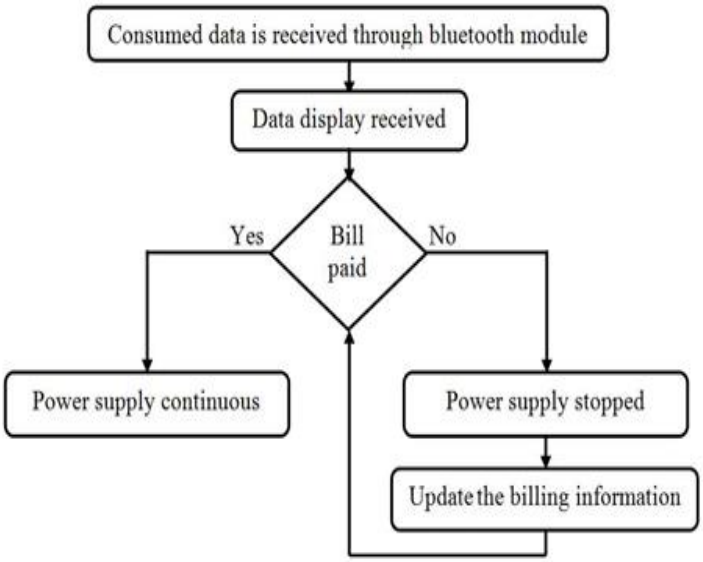


Figure 6.9: Functions on Receiver Side

The functions on the receiver side are shown in the above diagram. Once data is accepted from the consumer module, the collected information is given to billing section. The predefined utility billing software will check the due date of the consumer as well as the amount to be paid for the same. Once it checks on the due date for the payment, if it is paid then it will continue to give uninterrupted power supply else it will trip off the energy until the amount is paid.

6.3 Proposed System of IoT:

Internet of Things: IoT is the internetworking with quick innovation in network skill and also innovative inference in the age of ubiquity recognized. The main methods inspire the future IoT that shall be interconnected with smart sensor procedures like WSN, Miniaturization etc.

Problem Identification: Energy-efficient solution using new concept of Communicating Power Supplies (CPS) facilitates the information transfer about energy and controls the information between the device and building of management system. The components of CPS are an embedded controller to

control all the information and a RF transceiver to communicate to the user. All the data obtained can be stored in the cloud data base using IoT platform. The system was tested on three devices i.e. Television, video player and LED light and was found to have a major limitation of communication problem. The RF and ZigBee based systems are limited into short range and the signals can be lost due to the barriers.

6.3.1 System Design and Implementation:

Cloud storage is nothing but data storage in which information is stored in digital form and is easy to read by the machine language. It can also manage the data and process it rather than the personal computer. Cloud storage uses router for the purpose of transfer of the information which is in the form of pockets between computer networks. It also performs transfer through internet as shown in Figure 6.10.

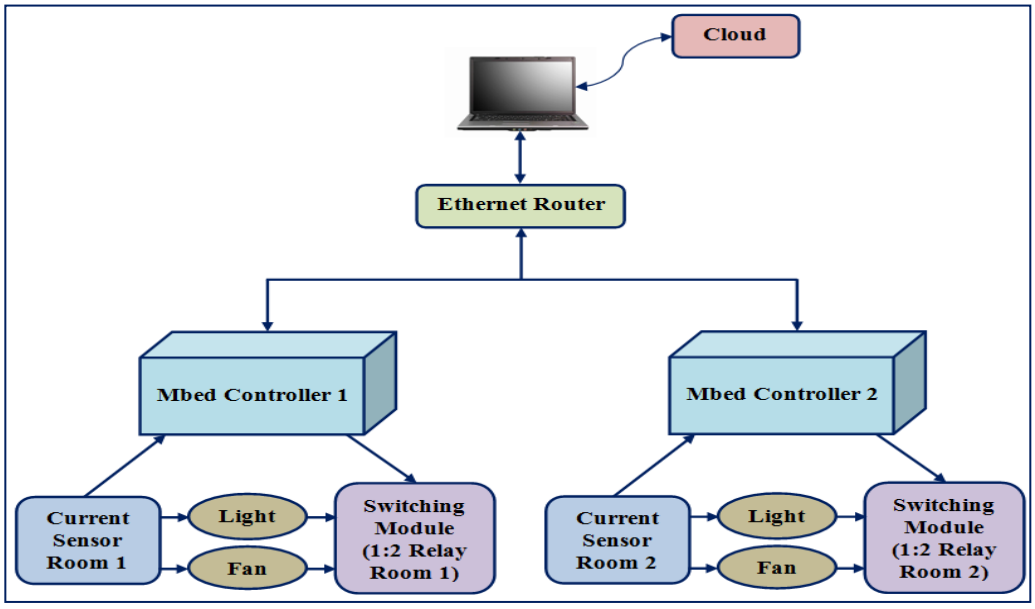


Figure 6.10: Proposed System for Energy Monitoring and Controlling

The ethernet router is used to connect the cloud to the Mbed controller which is used to provide high security, connectivity between the cloud, sensors and I/O devices with real time operating system. The controller is

connected to the sensors which will detect on any wastage of energy in the form of light, fan any other electrical appliances and it will indicate the authorized person with a small message using Bluetooth.

Microcontroller with 32 bit arm cortex is built in Mbed system and used as a base for OS. Mbed system helps to build any kind of embedded devices for the planning purpose of prototype and production. Mbed system hires the software for Mbed OS that works to enable hardware and interlink it to the cloud. Embedded operating system is designed for the purpose to connect the product based on Arm Cortex-M controller together with security, connectivity and real time operating system with sensors and I/O devices.

Mbed controller is an Advanced RISC Machine processor, a complete set of instructions and communication interface and provides everything in a DIP package. Mbed is a user friendly model tool built on automation standard with 40-pin IC. The compiler works on website basis so it can work on Windows, Linux and the programmer can write the coding based on C++ programs.

Current sensor is used to find out the power transmission through wire with generation of signal in the form of analog or digital output. While broadcasting the information through an electronic device like sensors, it can detect events and change its atmosphere and send the information to other electronic component often with the help of a processor. Sensor can’t work individually without an electronic device even for a simple or a complex task. Now a day’s sensors are part of our life like touch sensor in elevator, heat sensor in air conditioner etc.

Implementation Setup: Peripheral Interface Controller are a family of microcontroller, the capability of PIC device is ranges from 6 pin to 144 pin with separate I/O pins and converts analog form to digital form vice versa. It

also uses some connecting ports such as UART, I2C, CAN, and even USB. Low-energy and maximum-speed deviation exist for more types. In order to measure the power consumed in each appliance, current should be monitored.

To serve this purpose energy detector device depends on TA12-200 current transformer that has the capability to change maximum AC current into small amplitude. This sensor can measure alternating current up to 12A. Relay can control any appliance using the magnetic circuit present in it. A two-channel relay can basically control 2 appliances. It needs 12v power supply. When relay gets triggered it opens the magnetic circuit inside and turns off the device 2 channel relay that can control two devices at a time. In this application, a two channel relay is used in each node. The execution setup for energy monitoring and controlling is shown in Figure 6.11.

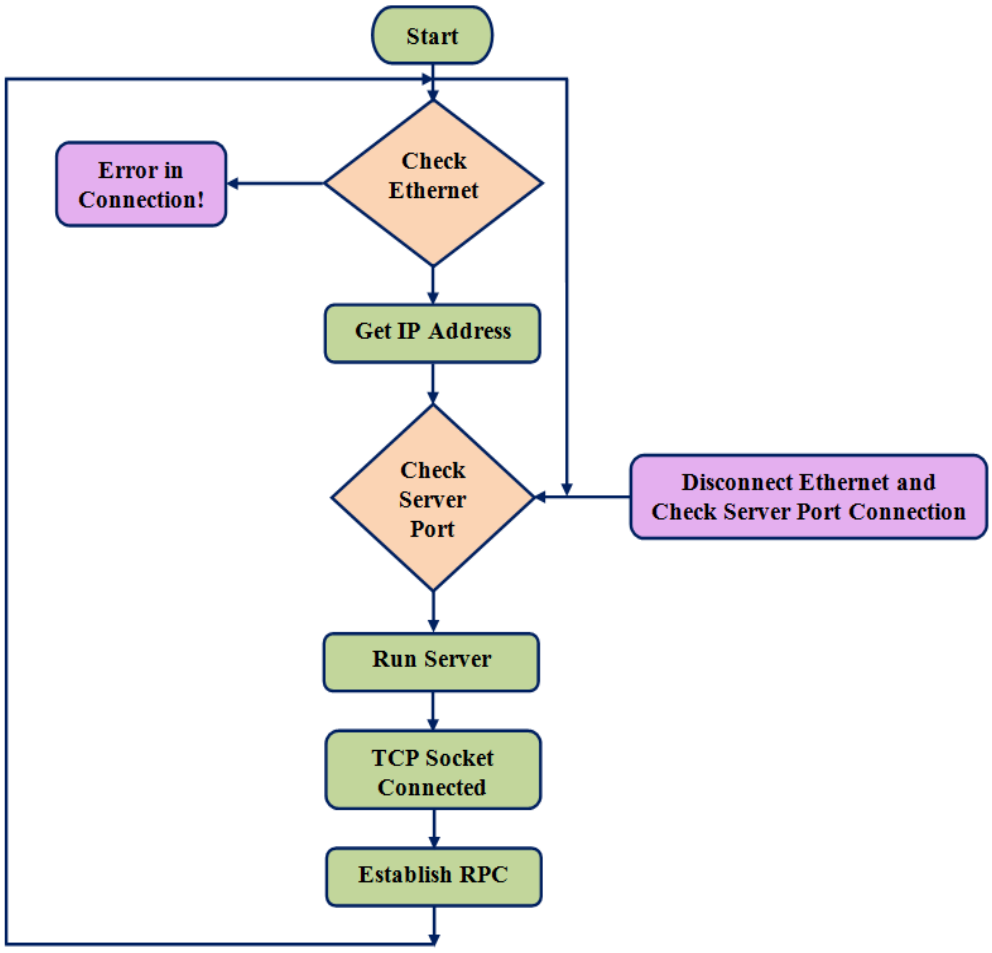


Figure 6.11: Carrying Out Setup

In the carrying out setup, first it will check the Ethernet connectivity, once it gets the strong signal then it will get the IP address and go for the server port, else it will disconnect the Ethernet connectivity and check the server port connection. After getting the IP address it will again check the server port, once it gets cleared it will run the server then it will give it to the TCP which control the transmission. After controlling the transmission, the remote procedure will be activated and it will send the data to the authorized person. If the authorized person is not taking any action then it will check the setup once again and will take necessary action according to the situation.

Figure 6.12: Schematic Diagram of IoT Function

The schematic representation of IoT function is shown in Figure 6.12 which tells that the sensor can be used for security purposes, can control or totally avoid the wastage of energy and monitor and control the entire area which comes under the surveillance of the sensor and controller.

The IoT protocol functions are shown in Figure 6.13 that tells about the range and rate of data transmission. The figure exactly tells that the Bluetooth has higher data rate than the ZigBee technology with less rata range which can be rectified with the help of the Wi-Fi network.

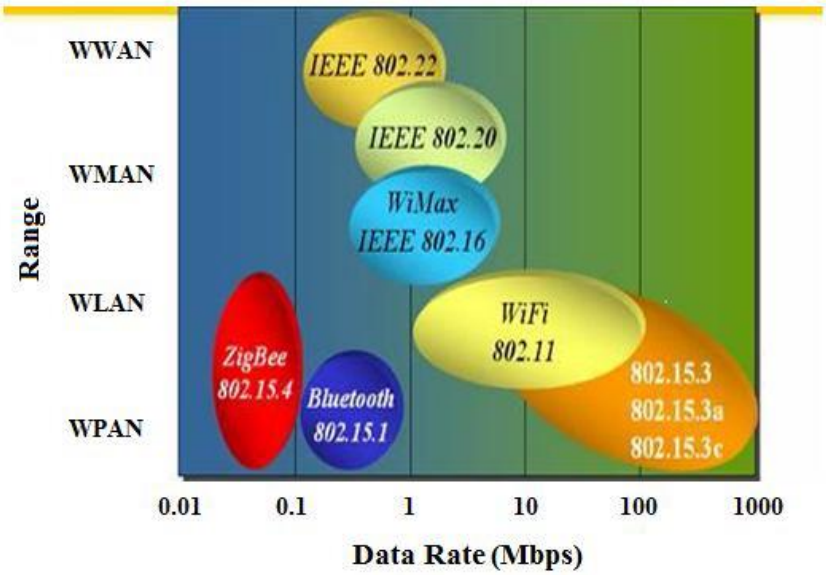


Figure 6.13: IoT Protocol

A model of an IoT arrangement is given in Figure-6.14, which launches the theory of the IoT network topology. Numerous topologies are maintained by IOT like cluster, mesh and star tree as shown in Figure 6.14. IoT uses three devices of ZigBee module named as ZigBee coordinator, router and end device. These devices are used for the purpose of selecting the channel (with the help of coordinator) and transform data to the public cellular network by expanding the range and adding the redundancy to the wireless network and collection of data using the end device.

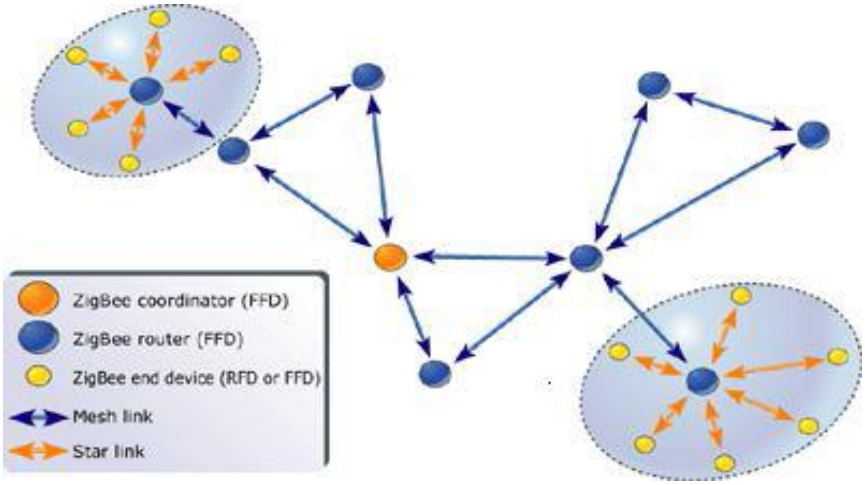


Figure 6.14: IoT Work

6.3.2 Working Principle of Proposed Design:

XBee and XBee-Pro are the RF Modules which are used as IoT devices in the transmitter and receiver sections. The microcontroller used in this project is PIC16F877A. It takes input from the external sources and roots them to the appropriate devices as programmed in it. The LCD used here is PCD8544 which is a low power CMOS controller/device. It is used to display the name of the appliance which is being currently controlled. Each and every key in the keypad is designed for a particular function. A device can be controlled by pressing the corresponding key. Energy provider is used to provide constant voltage, 1.5A is delivered to dissimilar integrated circuits. This is a standard route using exterior 15V DC adopter and set 3-pin voltage regulator. The operational concept of proposed design is shown in the following Figure 6.15. Similarly, the flow chart for temperature sensor program is shown in the Figure 6.16.

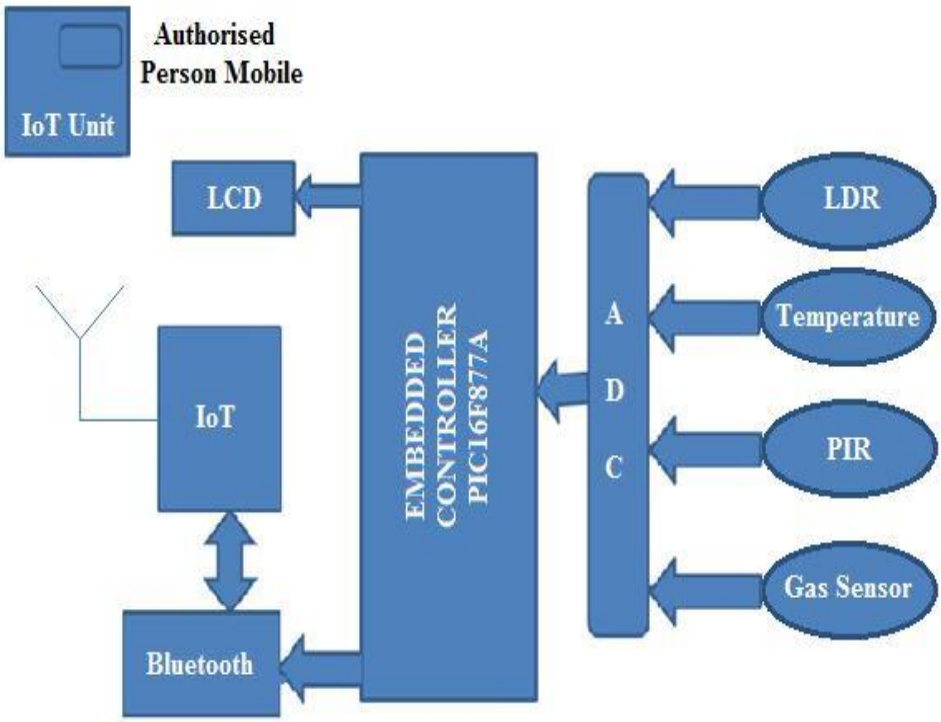


Figure 6.15: Working of the Proposed Design

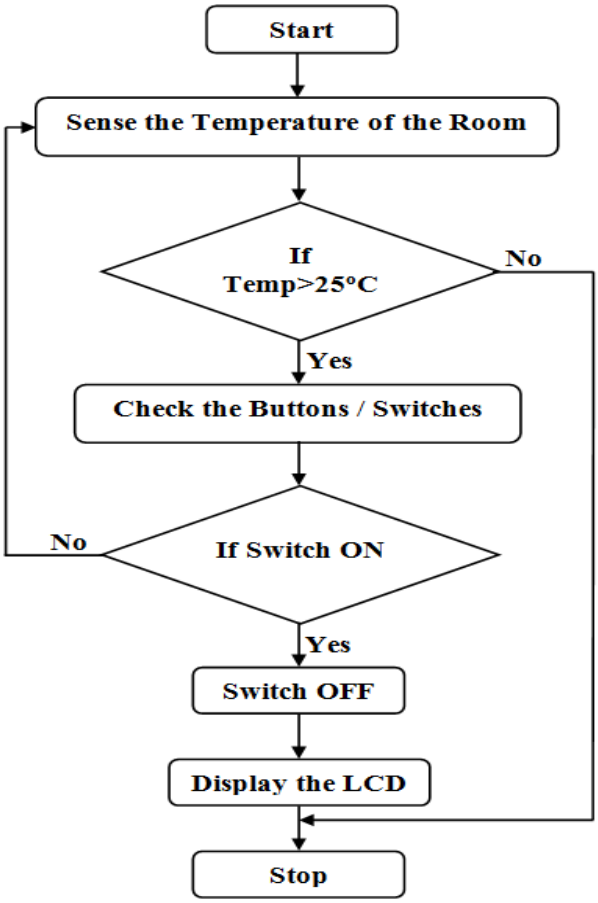


Figure 6.16: Flow Chart for Temperature Sensor Program

The following program is used to sense and monitor the room temperature for maintaining the predetermined value.

```
# Include < HTC. H >
# Include < DELAY. H >
# Include < USART. H >
# Include < LCD. H >
# pragma configFOSC=HSPLL-HS
# pragma configPLLDIV=5
# pragma configCPUDIV=OSC1-PLL2
# pragma configFCMEN=OFF
# pragma configIESO=OFF
# pragma configPWRT=OFF
```

```
# pragma configBOR=OFF
# pragma configWDT=OFF
# pragma configMCLRE=ON
#pragma configLVP=OFF
# pragma configICPRT=OFF
# pragma configCP0=OFF
unsigned int adc_data, ones, hundreds, tens;
void main() @ 0x0000A0
{
TRISB = 0x00;
TRISC = 0B10000000;
TRISD = 0x00;
TRISCbits.RC6 = 0;
TRISCbits.RC7 = 1;
USART_Init();
LCD_Init();
DelayMs(100);
LCD_GOTOXY(1,2);
LCD_Str("TEMP.. MONITOR");
Delayms(1500);
USART_Write ('S');
USART_Write (13);
ADCON0 = 0B00011001;
ADCON0bits.ADON = 1;
ADCON1 = 0B00000000;
ADCON2 = 0B10111110;
LCD_Clear();
LCD_GOTOXY(1,1);
DelayMs(10);
LCD_Str("Temperature");
```

```
while(1)
{
DelayMs(100);
ADCON0bits.GO = 1;
while(ADCON0bits.GO == 1);
ADC_Data= ADC_Data/ 2;
one= ADC_Data10%;
ADC_Data= ADC_Data/ 10;
ten= ADC_Data10%;
hundred=ADC_Data/ 10;
Delay Ms (10.00);
lcd secondline ();
Delay Ms (10.00);
lcd GO TO XY (02, 01);
lcd data (hundred|00x030);
lcd data (ten|00x030);
lcd data (one|00x030);
Delay Ms (5000.00);
USART_Write_Str("Temperature --> ");
USART_Write((hundreds | 0x30));
USART_Write((tens | 0x30));
USART_Write((ones | 0x30));
USART_Write(13);
DelayMs(2000);
}}
```

PIR Sensor: It's a Passive Infrared sensor which is used to detect the light radiating from the objects. Instead of infrared or laser transmitters and receivers, PIR sensors are used in this proposed method which is shown in Figure 6.17. It helps to measure the heat of any electrical appliances as well as

it can detect the motion of any object which is not known by the predefined objects.

Figure 6.17: PIR sensor

Gas Sensor: It's a device which is used to detect the presence of any gas as well as it can tell about the concentration of the gas. In the proposed methodology this sensor will help us to detect any leakage in the LPG which is used at home as well as if there is any toxic or explosive gases, humidity and odor can be detected. Gas sensor is a subclass of chemical sensor which is shown in Figure 6.18.

Figure 6.18: Gas sensor

Temperature Sensor: Temperature sensor is a device that provides measurement of temperature through an electrical signal and is shown in Figure 6.19. If the voltage of the electrical appliances increases then automatically the room temperature also increases. If the room temperature crosses the limit then the device will send the notification to the authorized person to take necessary action.

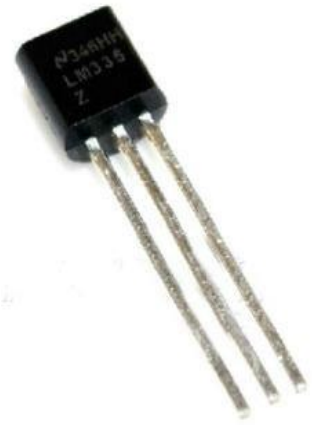


Figure 6.19: Temperature sensor

The XBee and XBee-PRO OEM radio frequency component were developed to assemble IEEE 802.15.4 standards and maintain the unique needs of low-price and low-power wireless sensor networks which are shown in Figure 6.20.

Figure 6.20: XBee™/XBee-PRO™ RF module

6.3.3 Evaluation of Keil Software:

The Keil software is a development tool which is used to solve the complex problems faced by the software developer especially for these who are involved in the platform of embedded system. Keil µVision is an Integrated Development Environment (IDE) tool which automatically compiles, links, locates and assembles the embedded data. Compilers are the program which is used to convert the machine level language to the lower

level program then only the computer can read and execute the program given by the programmer. Linker or locator both are a type of computer program which is used to link or locate one or more object modules into a single executable program from the compiler then it's very compact to execute at the receiver end. Assembler is also like a compiler, here the assembler is used to translate the assembly level program to machine level language.

6.3.4 Light Dependent Resistors Sensor:

The Light Dependent Resistors (LDR) sensor used in this project is shown in Figure 6.21. LDR is a light sensing circuit, which has a variable resistor that changes whenever the light falls on it. Since LDR is a light sensitive device it's also called as photo conductors. Whenever the light falls on this sensor the LDR exhibits the photoconductivity. Then the sensor will indicate there is a presence of light to the authorized person, if that light is unnecessary, necessary action will be taken by the authorized person. The Figure 6.22 shows the flow chart for the light sensor program.

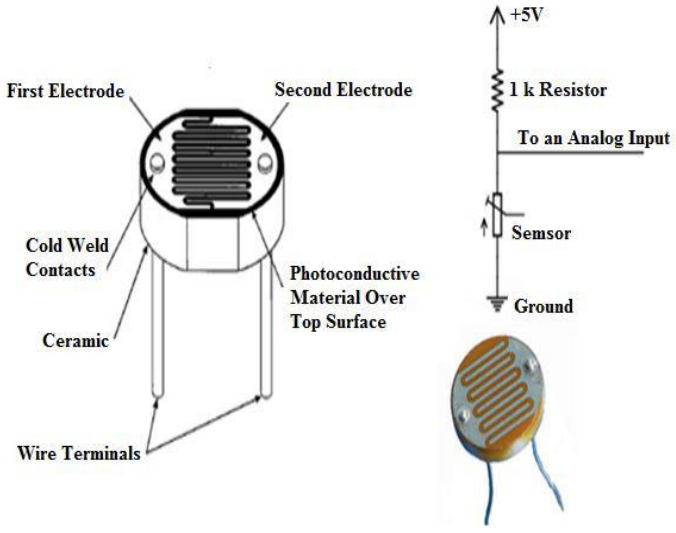


Figure 6.21: LDR sensor

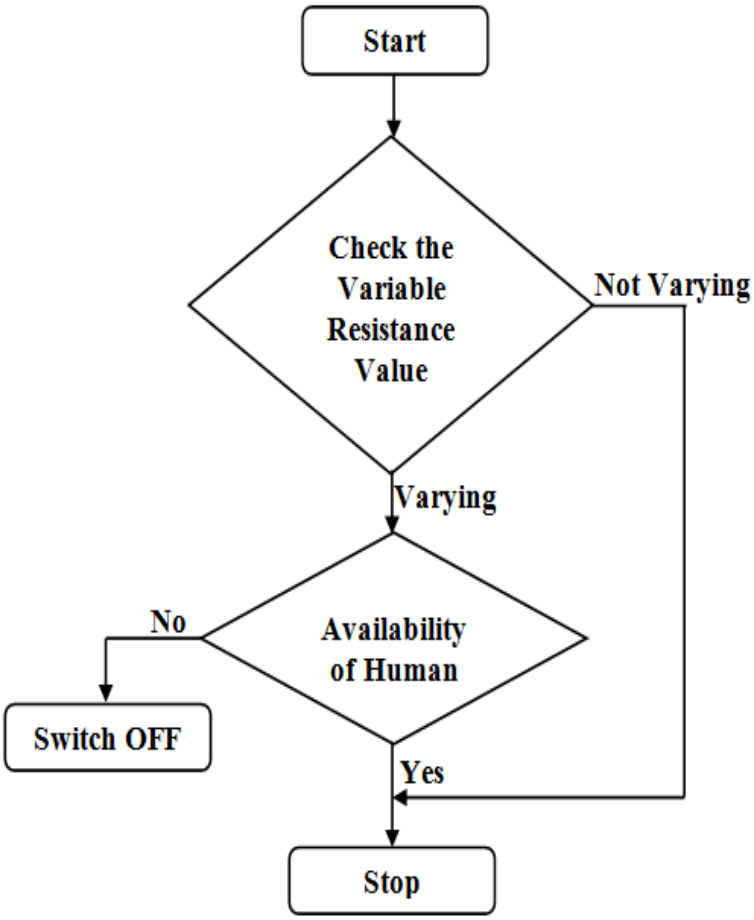


Figure 6.22: Flow Chart for Light Sensor Program

The following program has been used to sense the lighting effect and to intimate through wireless sensor networking by which the usage of unwanted power may be stopped through IoT.

```
intLDR = X0;
intLED = 7;
intLDRReading = 00;
intLEDBrightness = 00;
intthreshold_val = 600;
Void setup ( )
{
serial. begin (9600);
pin mode (LED, OUTPUT);
```

```
}
Void loop ( )
{
LDR Reading=analog Read (LDR);
serial println (LDR Reading);
if (LDR Reading>threshold_val)
{
LED Brightness=map (LDR Reading, 00, 1023, 00, 255);
Analog write (LED, LED Brightness);
}
Else
{
Analog write (LED, 00);
}
Delay (150);
}
```

The non-inverting input of the 741 Op-Amp has been connected to the LDR and a variable resistor or a fixed value resistor in a voltage divider configuration as shown in Figure 6.23.

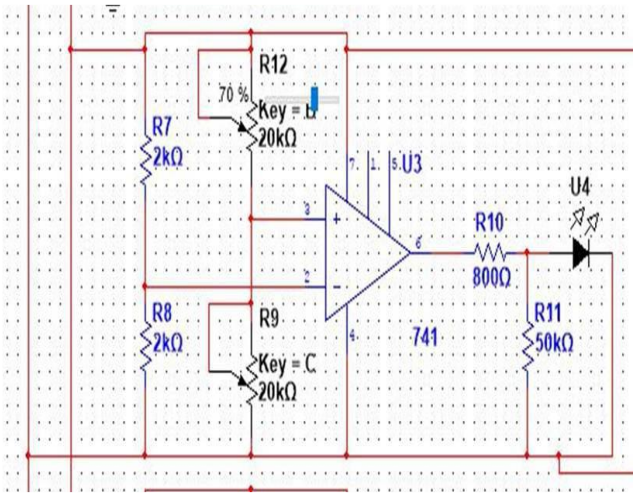


Figure 6.23: Circuit diagram of LDR sensor

Further, the comparison of proposed analog comparator based design with a current digital DSP based design in terms of price and resolution shows that the trend goes in favor of proposed analog comparator based design as the price differences are quite high. At a low resolution, the price of analog comparator based design has been found to be lower than the digital DSP based design by a margin of 900 INR. As the resolution increases, the margin of price difference between the proposed design and current digital design still remains high. At average resolution, the price of digital based LUX meter is 2600 INR while for the same resolution, proposed design costs only 1500 INR. At high resolution, cost of the proposed design is 2500 INR only while for the same resolution, the cost of DSP based digital LUX meter is 5000 INR i.e. double than that of the proposed design.

6.4 Proposed System of MIMO:

An incremental hybrid detect-decode forward cooperative relay scheme has been proposed for improved capacity and throughput using turbo channel coding for information integrity with MIMO channel modeling. Three terminal half duplex cooperative relaying system model which consists of Supply (S), Relay (R) and end Destination (D) node employed for analysis under Rayleigh fading channel model consideration are shown in Figure 6.24.

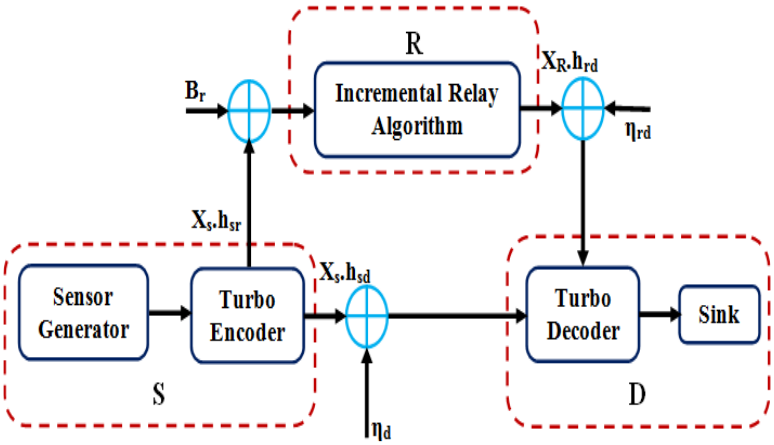


Figure 6.24: Three-Terminal Relay System Model

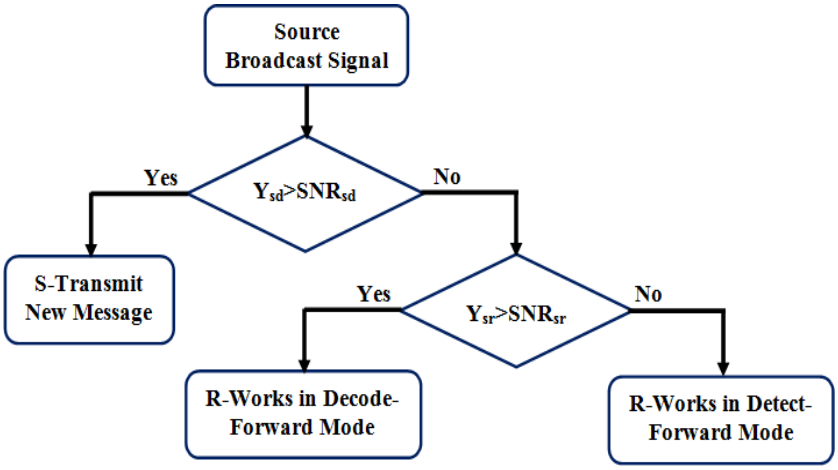


Figure 6.25: Signal Process Flow of IHDDF Protocol

Information about the channel capacity is available in relay node and destination node with the help of training sequences. In addition to their every node is assumed to equip with uni- directional transmitter. The signal process flow of IHDDF protocol is shown in Figure 6.25. Cooperative mode operation is processed in two phases. At the beginning phase, the Starting place S transmits the signal to the R and D concurrently. Destination node is to find out the reliability of message send by the starting point which depends on SNR and SNRsd of the transmitted end.

6.4.1 Relaying Protocol's and Modeling of Channel:

The idea of cooperative communication allows effective utilization of communication resources by allowing relays to cooperate with each other. Resource sharing between the multiple points in arrangement between source and destination is major idea by which the node between the transmitter and receiver acts as relaying channel between them, auxiliary to the direct channel. Under cooperative mode, multi path transition of information bit is converted as an advantage by relaying and data is reconstructed using relaying protocols and forwarded to destination. Destination receives information transmitted from two independent paths and hence achieves

transmission diversity of order two. Cooperative relay in wireless network is capable of amplifying a weak signal due to fading or path-loss effect in channel and hence extend the coverage. Specialized assistance tactic can be represented by two perpendicular phases avoiding intrusion between these phases of transmission. For the first phase, transmitter sends information to receiver and relay node receives information at the mean time. First phase can be modeled as given in equation 1 and 2.

$$R_{sd} = \sqrt{P_s}\, H_{sd} X + \eta_{sd} \quad \ldots\ldots\ldots \quad (1)$$

$$R_{sr} = \sqrt{P_s}\, H_{sr} X + \eta_{sr} \quad \ldots\ldots\ldots \quad (2)$$

In second phase, the switch transfers a development version of the transmitter to receiver, and this can be modeled as equation 3.

$$R_{rd} = \sqrt{P_R}\, H_{rd} Q(R_{sr}) + \eta_{rd} \quad \ldots\ldots\ldots \quad (3)$$

Q (·) depends on processing or relaying protocol executed at R knob. The Rsd, Rsr and Rrd are received power at destination and relay nodes respectively. Hsr, Hsd and Hrd are the different communication gateway among S, R and D respectively based on Rayleigh communication gateway. The conditions of ηsr, ηsd and ηrd are noted as stabilizer white Gaussian noise with zero mean and variance number.

6.4.2 Magnify and Onward Communication Practice:

Amplify and Forward (AF) practice, RS scale received version of signal along with noise from source and retransmit the same as amplified version to the end point. Relay acts as a switch to increase the signal strength from transmitter to receiver which balances the outcome of the communication gateway together with S and R. Basically R is used to measuring the acknowledged indication through a factor β_T given in the following equation 4,

$$\beta_T = \frac{\sqrt{P_r}}{\sqrt{P_s \mid H_{sr}|^2 + N_0}} \quad \ldots\ldots\ldots \quad (4)$$

Waves transformed by R is thus $\beta_T * R_{sr}$ and has power P_r and SNR gained at the receiver is the addition of the SNR from the transmitter and relay links.

6.4.3 Decode and Forward Relaying Protocol:

Decode and forward protocol relay involves in decoding the resource transformation from R node and it retransmits the Decryptor waves after re-encoding them as given in equation 5, possibly compressing or adding redundancy.

$$X_{rd} = \text{Encode (Decode (detect\_info } (R_{sr}))) \quad \ldots\ldots\ldots \quad (5)$$

Where, R_{sr} is the signal received at relay from source

X_{rd}, information transmitted to the destination from relay

The decoded signal can be incorrect due to poor SNR condition of the channel and forwarding incorrect signal to the end point which is insignificant.

6.4.4 Detect and Forward Relaying Protocol:

Detect and forward relaying scheme include detecting the information at relay node from source and transmitting them to the destination node given in equation 6.

$$X_{rd} = \text{detect\_info } (R_{sr}) \quad \ldots\ldots\ldots \quad (6)$$

Where, R_{sr} is the signal received at relay from source

X_{rd} information detected from received signal using maximum-likelihood

It is transmitted to the destination from relay. Since at low SNR detect and forward protocol doesn't decode the noise detected for transmission to destination, hence has more significant Bit Error Rate (BER) performance than decode forward in poorer strait condition.

6.4.5 Incremental Relay Technique:

There is a feedback path from receiver to relay by increasing the amount of relay i.e. relay-receiver channel information known at both relay and destination. The destination will send back the information of getting data to relay node if it can receive information from transmitter correctly so those relays don't have to resend same information to the destination, hence radio resource can be used efficiently. Relay is employed when the direct transmission signal to noise ratio is lesser than the minimum threshold as given in equation 7 to 9.

$$\gamma_{i,j} = H_{ij} * SNR \quad \ldots\ldots\ldots \quad (7)$$

$$\text{Min } (\gamma_{i,j}) < SNR_{threshold} \text{ Relay assisted} \quad \ldots\ldots\ldots \quad (8)$$

$$\text{Min } (\gamma_{i,j}) \geq SNR_{threshold} \text{ Non-Relay assisted} \quad \ldots\ldots\ldots \quad (9)$$

Where,

$\gamma_{i,j}$ is instantaneous SNR of the channel from transmitter i to receiver j

6.4.6 Alamouti Coding for 2x2 MIMO

The 2x2 MIMO antenna technology has two antennas at transmitter and two antennas at receiver side of the node as shown in Figure 6.26.

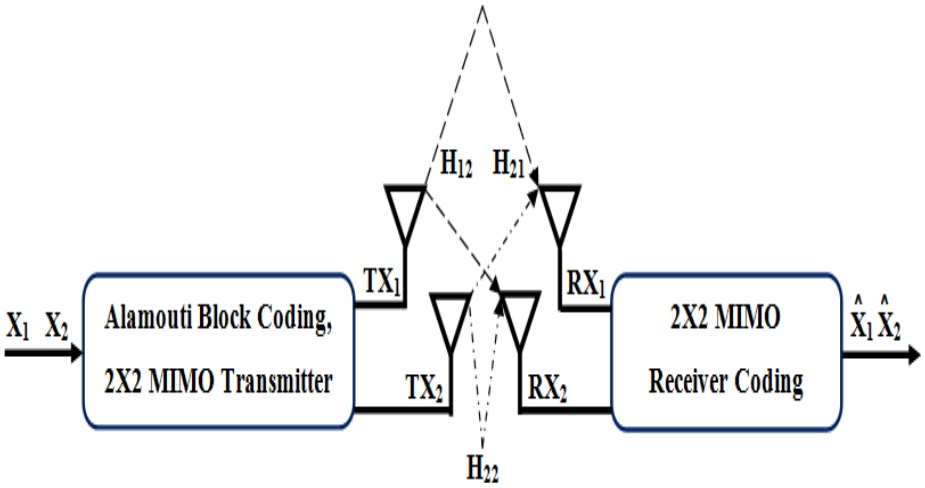


Figure 6.26: 2x2 MIMO System

Consider two sets of data to be transmitted {x_1, x_2}. In normal transmission, x_1 would be transmitted in the initial slot period and x_2 is final slot period. Alamouti suggested transmitting a pair of data at a time using transmitter diversity. The x_1 and x_2 value of both antennas send by initial slot and x_2^ and x_1^ of both antennas send by final slot. At receiver, received vector R can be represented by the following equation. For first time period, received symbol is,

$$R^1 = \begin{bmatrix} r_1^1 \\ r_2^1 \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{bmatrix} * \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \eta_1^1 \\ \eta_2^1 \end{bmatrix} \quad \ldots\ldots \quad (10)$$

For second time period, received symbol is,

$$R^2 = \begin{bmatrix} r_1^2 \\ r_2^2 \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{bmatrix} * \begin{bmatrix} -x_2^* \\ x_1^* \end{bmatrix} + \begin{bmatrix} \eta_1^1 \\ \eta_2^1 \end{bmatrix} \ldots\ldots\ldots \quad (11)$$

Received signal in first and second time slot, equation 10 and equation 11 can be combined to form the net received signal at receiver as given in equation 12,

$$R = \begin{bmatrix} R^1 \\ R^{2*} \end{bmatrix} = \begin{bmatrix} r_1^1 \\ r_2^1 \\ r_1^{2*} \\ r_2^{2*} \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \\ H_{12}^* & -H_{11}^* \\ H_{22}^* & -H_{21}^* \end{bmatrix} * \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \eta_1^1 \\ \eta_2^1 \\ \eta_1^2 \\ \eta_2^2 \end{bmatrix} \text{..(12)}$$

This is of the form R = H * X+ η

So estimate of Xcan be found from equation 13,

$$\hat{X} = \begin{bmatrix} \widehat{x_1} \\ \widehat{x_2} \end{bmatrix} = (H^H H)^{-1} H^H * R \qquad \text{.....} \qquad (13)$$

6.4.7 Simulation Analysis

The simulation results for the proposed relaying technique are presented, where communication over Rayleigh channel using MRC technique with threshold has been considered. Performance of the proposed system is represented by the MATLAB simulation. The flow chart for program of data transceiver without loss is shown in the Figure 6.27.

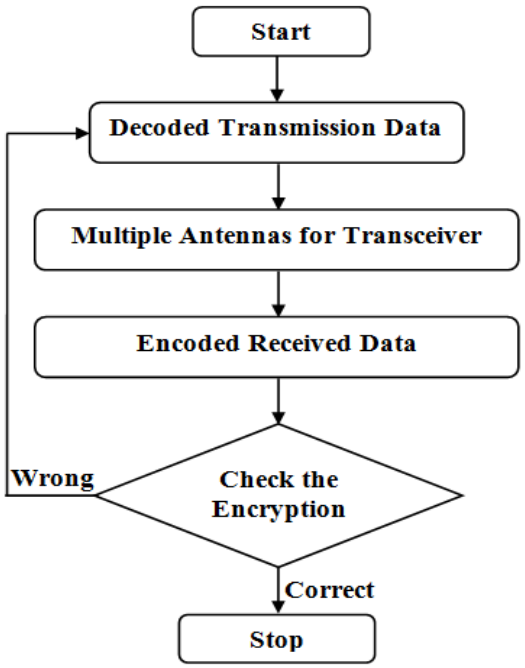


Figure 6.27: Flow Chart for Program of Data Transceiver without Loss

The following program is established using MATLAB for direct data transmission without data loss while using multiple antennas.

```
%V;
%Mt;
 %Mr;
 %Mrsel;
 %Iterr;
 %Hsel;
%Halaa;
%hMRC;
%PeAla;
%Pesel;
%PeMRC;
clc;
CloseAll;
ClearAll;
Mt, Mr, Mrsel=02, 02, 04;
Snrdb=(0:12:1);
Snr=5(Snrdb/ 5);
Pesel= Peala=Pemrc=zero (01, Length Snr);
Iterr=(1000.00);
For (Iterr=1)
IterrHsel=(J * Randn (Mt, Mrsel)+Randn (Mt, Mrsel))/ Sqrt (2);
Halaa=(j * Randn (Mt, Mr)+Randn (Mt, Mr))/ Sqrt (2);
hMRC=(j * Randn (Mt x Mrsel, 1)+Randn (Mtx Mrsel, 1))/ Sqrt (2);
for (K=-1)
Peala (K), Length (Snr)= Q (Sqrt (Snr (K) x Normal (Halaa, 'fro')^2))+
Peala (K);
Pemrc (K)= Q (Sqrt (Norm (hmrc)^2 x Snr (K) x 2 )) + Pemrc (K);
nH=Flipud (Abs (2: Hsel)^2) + Sort (Abs (1:Hsel)^2);
```

```
nH=Sum (Q (Sqrt (Snr(K) * nH) + nH (1 : 2) ; Pesel (K)=Pesel (K));
Peala=Peala/ Iterr;
Pemrc=Pemrc/ Iterr;
Pesel=Pesel/ Iterr;
Semilogy (Snrdb, Pemrc, 'K-O', Snrdb, Pesel, 'R-*', Snrdb, Peala, 'B');
Legend ('Alamouti_Selection', 'Alamouti', 'mrc');
XLable (Snrdb);
YLable (Bit error rate);
Title ('Alamouti ( 2 x 2 ), Relay Assisted Vs Direct Transmission and MRC(1x8)');
grid;
```

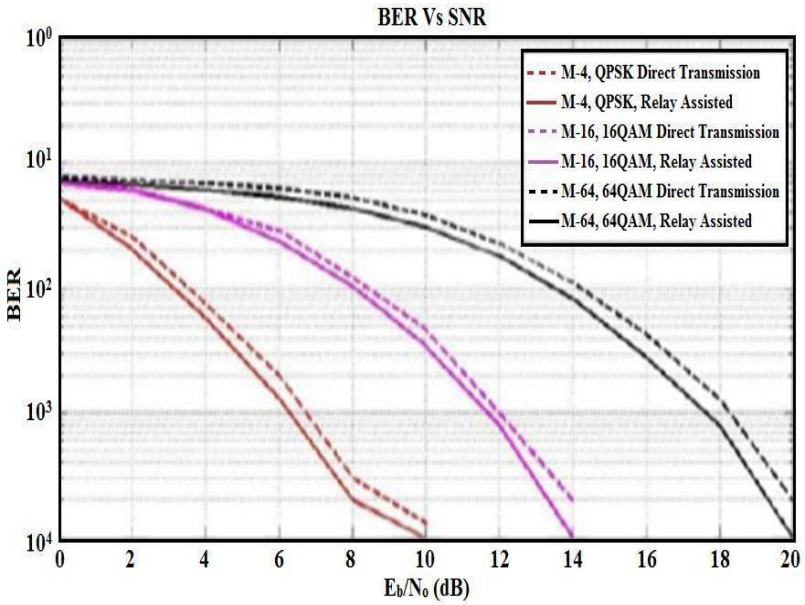


Figure 6.28: Relay Assisted Vs Direct Transmission

Figure 6.28 shows the bit error rate for various modulations of 2x2 MIMO systems with cooperative and non-cooperative modes under Rayleigh fading channel conditions. From the simulated comparison between direct transmission and relay assisted transmission in Figure 6.26, it could be inferred that relay assisted transmission provides more satisfactory bit error

performance than direct transmission which could enable more number of users to transmit at the same rate with increased accuracy.

Table 6.1: Bit Error Comparison for Cooperative & Non-Cooperative Mode

BER VS. SNR	QPSK		16QAM		64QAM	
	Relay	Direct	Relay	Direct	Relay	Direct
0dB	0.0519	0.053	0.07	0.076	0.0735	0.0778
2dB	0.0202	0.0255	0.0608	0.0616	0.0675	0.0736
6dB	0.0013	0.002	0.0235	0.0287	0.0536	0.063
10dB	0.0001	0.00013	0.0034	0.0046	0.0308	0.0384
14dB	0.00003	0.00005	0.0001	0.0002	0.0082	0.01
20dB	0.000005	0.000007	0.000009	0.00001	0.0001	0.0002

Bit error for each modulation scheme at various signals to noise ratio instance from Table 6.1 shows that cooperative relay scheme always has an upper hand in bit error performance compared to non cooperative mode.

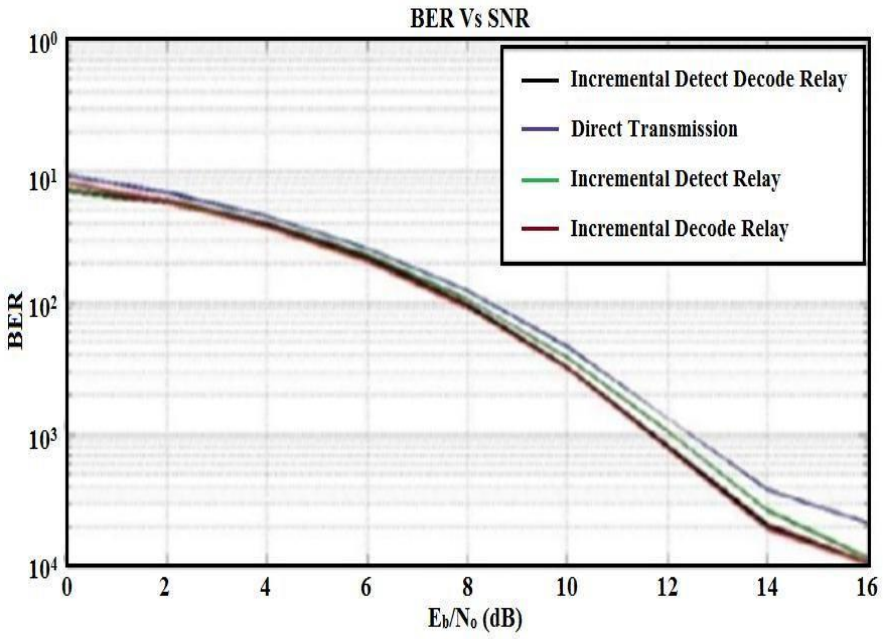


Figure 6.29: Incremental Relay Scheme

Table 6.2: Bit Error Performance of Incremental Relaying

BER Vs. SNR	Incremental			Direct
	Detect & Decode	Detect	Decode	
0dB	0.0712	0.0709	0.081	0.0925
2dB	0.0583	0.0606	0.0583	0.068
6dB	0.0217	0.0231	0.0205	0.0258
10dB	0.0032	0.0038	0.0031	0.0046
14dB	0.0002	0.0003	0.0002	0.0004

Figure 6.29 shows the bit error performance between incremental relaying protocols like incremental decode-forward, incremental detect-forward, International Health Development Foundation (IHDF) and direct transmission under Rayleigh fading channel conditions.

6.5 Proposed System of GSM:

Remote monitor acting is a major task in most of the applications. If a problem occurs in the product exported, the manufacturer has to visit the particular industry to provide the solution. This consumes time and human efforts. There is an increase in need for monitoring products delivered to a remote location. The main goal of the mission is to extend a system to detect the problem immediately so that the manufacturer can provide a solution to fix the problem. The status of the machine should be continuously monitored and any change identified should be sent as an alert to the manufacturer so that attention is given during product maintenance. An overview of the remote monitoring arrangement is shown in Figure 6.30.

Overall structure contains several key components. The implementation of the remote monitoring system for machine controllers has been discussed here. The two methodologies used for implementation are

global system for mobile communication and internet technology. GSM module SIM900A is interfaced with the 8051 microcontroller using UART serial communication. Alert messages to the customer are sent from the modem using AT commands. Wi-Fi module ESP 8266 is interfaced with microcontroller. Status of the device is continuously updated to the cloud using thing speak platform.

The status of the product is continuously updated to cloud through server. The manufacturer will continuously monitor and retrieve the product status via cloud. If there are any abnormalities found, the manufacturer will provide solution through the cloud and the user can retrieve the solution via cloud. Similarly the status of the device is sent as an alert message to the manufacturer with the help of GSM module through UART serial communication. The complete flow chart of the proposed system is shown in Figure 6.31.

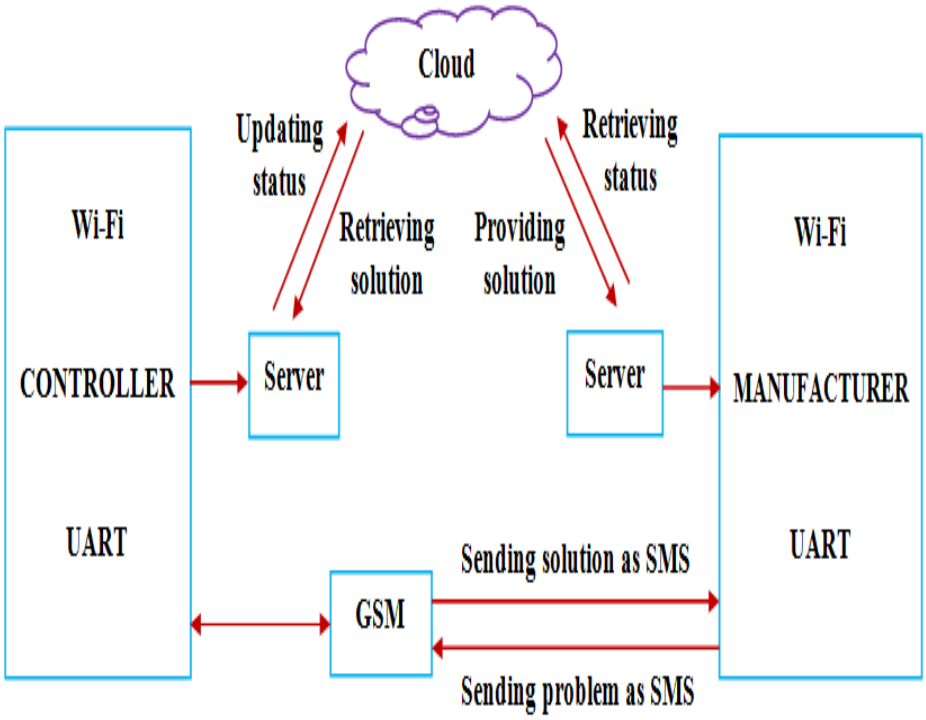


Figure 6.30: Schematic Sketch of Proposed Prototype

The above systems monitor the status of the 8051 microcontroller. Here two types of monitoring are done with help of GSM module and 8051 microcontroller such as ON status monitoring and periodic monitoring. The ON status of the device is monitored using the microcontroller 8051 and GSM module. Whenever the device is turned ON, this will be indicated through a message with the help of GSM module SIM900A. The status of the device (both ON and OFF) is continuously monitored using microcontroller 8051 and GSM. For every 30 seconds the status of the device gets indicated through a message with the help of GSM module SIM900A.

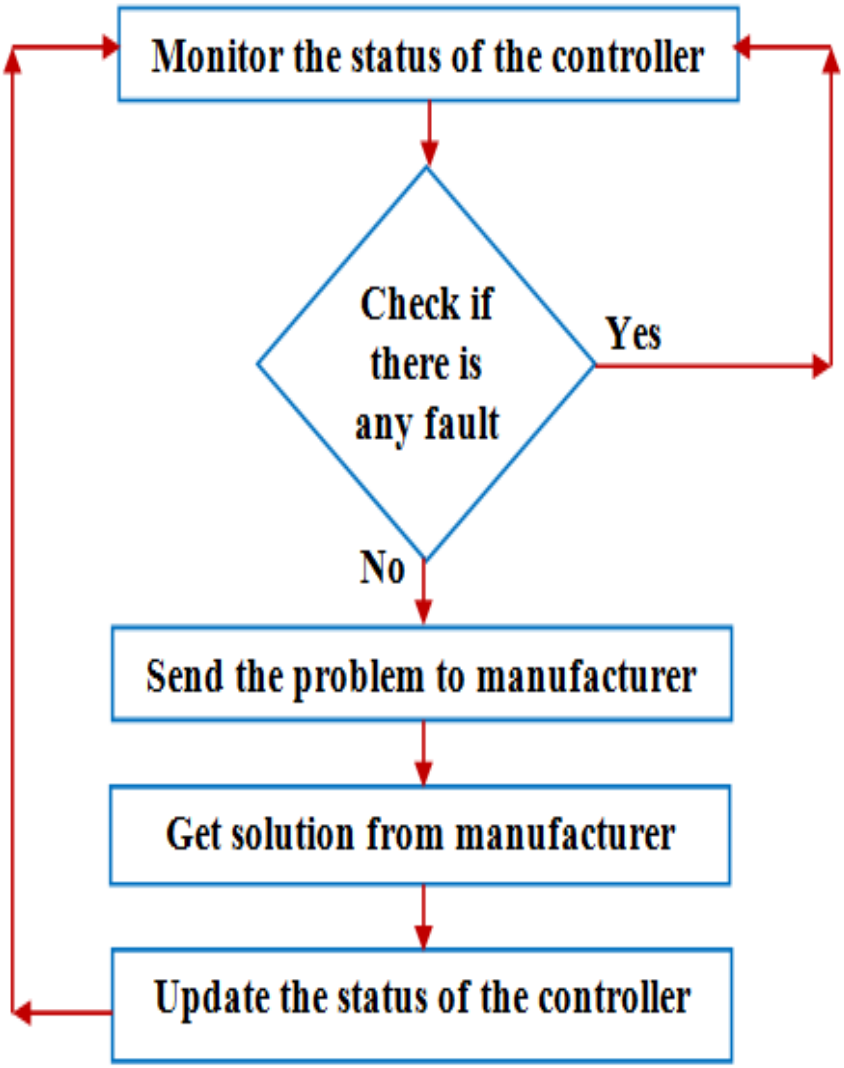


Figure 6.31: Flow Chart of the Proposed System

6.5.1 Interfacing GSM with 8051 Microcontroller

SIM900A is an absolute Quad-band GSM/GPRS explanation in a Surface Mount Technology component which can be incorporated in the customer application. It can be operated in four different frequencies as 850/ 900/ 1800/ 1900MHz. The path is very simple by approval of a mobile phone component of Simcom SIM900. This modem is unique to perform data links without access to the GPRS network or to the Internet. Some of the features of the module are the baud rate can be configurable from 9600-115200 through Attention (AT) command, operation temperature: -30 °C to +80 °C, low power utilization, deliver voltage range 3.4 to 4.5V, Serial Peripheral Interface (SPI), serial interface and antenna pad and I2C. AT commands are used to interface GSM module with the microcontroller and some of the AT commands are planned as shown in Table 6.3.

Table 6.3: AT Commands

AT Commands	Description
AT+CMGS	Sending SMS
AT+CMGR	Read the SMS
AT+CMGD	Delete the SMS
AT+CMGF	Set to text mode

The different steps for interfacing GSM with 8051 shall be when the four switches of the microcontroller are considered as four devices that are to be monitored and connected to Port 0, the transmit pin of controller (P3.1) is connected to Receive Pin (RXD) of GSM modem and the receive pin of controller (P3.0) is connected to Transmit Pin (TXD) of GSM modem and using AT command message is sent to a particular number whenever the devices are in ON state. Through periodic monitoring the Port P0 pins are considered to be the monitoring device and when the pins are connected to

Vcc-On state and Gnd-Off state, alerts should be monitored for every 30 seconds.

The voltage needed to work a GSM modem is 12V and the microcontroller is 5V. Due to this voltage variation in both of these devices we may not be able to connect it directly. The GSM modem can be co-related with 8051-microcontroller through MAX-232 with the help of RS-232 cable for serial announcement as shown in Figure 6.32. The RS-232 is a device which acts as a interfacing together with information fatal tools and data communication equipment using serial binary data exchange. MAX-232 device is used to convert Transistor-Transistor Logic level to RS-232 level during serial communication of microcontroller to the GSM modem. The RS-232 cable is commonly used with 9 or 25 brooch wiring and has jumpers to afford handshaking brooches for those devices that requires them. The flow chart for interfacing of GSM with microcontroller program is shown in the Figure 6.33.

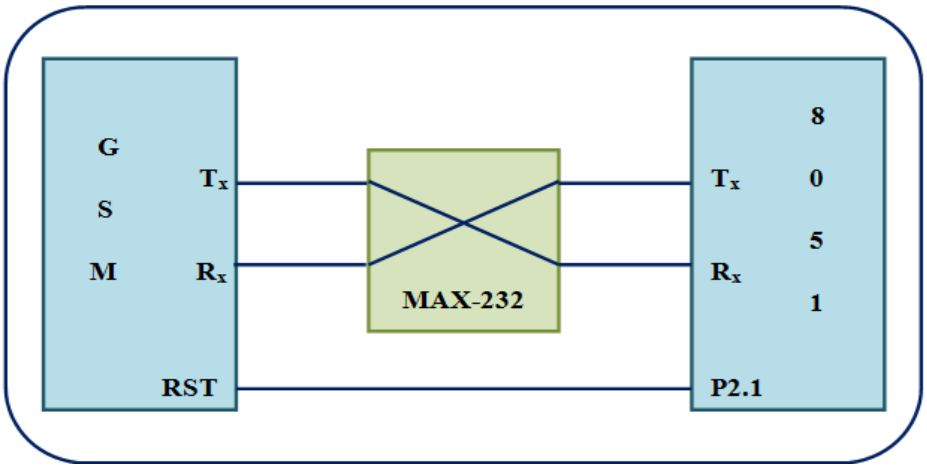


Figure 6.32: Interfacing of GSM with Microcontroller

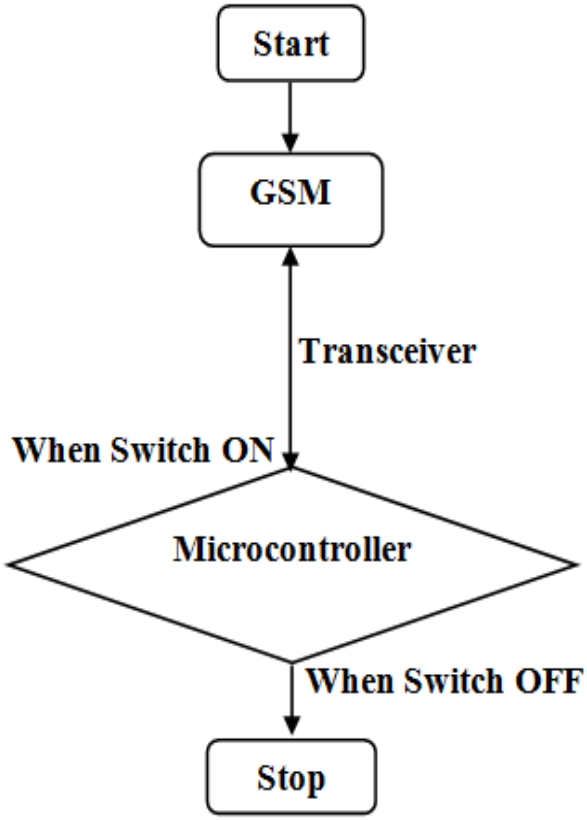


Figure 6.33: Flow Chart for Interfacing of GSM with Microcontroller

Program

The following program is developed to transmit and receive the word from the interfacing kit.

- Single character transmission
- Word transmission
- Character receiving

```
#include<reg51.h>
voidinit_RS232();
voidTx_Char(unsignedharch);
voidTx_String(unsignedchar*str);
voidRx_Char();voidinit_RS232()
{
TMOD|=0×20;
```

```
TH1=0XFD;
SCON=0×50;
TR1=1; }
voidTx_Char(unsignedcharch)
{
SBUF=ch;
While (!TI);
TI=0; }
voidTx_String(unsignedchar* str)
{
While (* str)
Tx_Char (str+1); }
Void Rx_Char ()
{
For (RI≠1);
Ch=SBUF;
RI=0; }
```

6.5.2 Updating Status to Cloud

Cloud storage acts as a hub to store the collected information in a remote physical location and to be easily accessed by network.

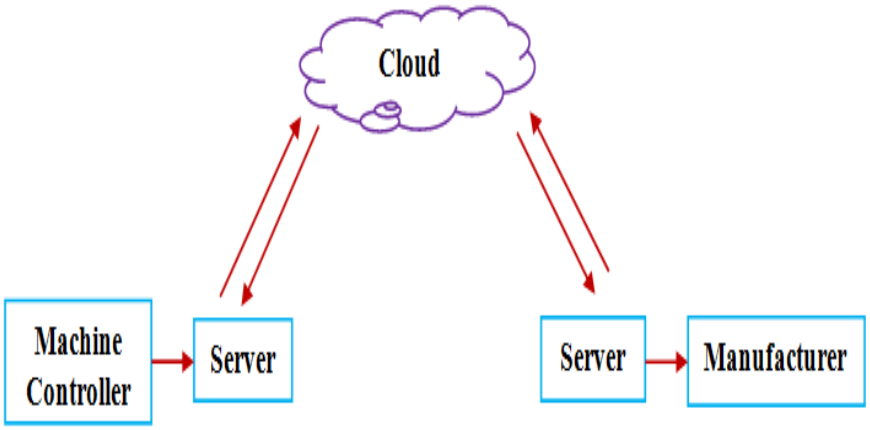


Figure 6.34: Updating Status to Cloud

The Figure 6.34 shows the status of the machine controller being sent to the server and then updated to cloud using, Things peak platform. The updated status is retrieved by the manufacturer at any time by using the Things peak.

To access the Things peak platform the following steps shall to be followed.

- Create new account in Things peak platform and create the new channel.
- Then create the required fields to store data. Each channel consists of eight fields.
- Each channel has on unique identification called API keys.
- Write API key is used to write the information and read API key is used to read information.
- Through write API key the data is send to the cloud and can be seen in the channels with the field name.
- After setting up the connections the data is send to the cloud from machine controller.

6.6 Performance Metrics:

Through the implementation of different technique the following performance metric could be obtained.

Throughput: Throughput refers to maximum production rate or some information processes at the prescribed data rate.

Turnaround Time: Turnaround time is the difference among the time taken for the process completion and process submission time.

Turnaround time = Process completion time - Process submission Time

Waiting Time: Waiting time is total time taken by a process to wait in the complete row.

Waiting time = Scheduled Process Time = Ready to execute process time

Latency: Latency is time delay between cause and effect of a particular task, and it's quite often a focus for real time developers. For a taskτ_i, the maximum input-output latencies is defined as, $L_i=max_i$ (finish-time-start-time)

Interrupt Latency: Interrupt latency is the time slip away from when an interrupt is generated to when the source of the interrupt is examined. Whenever the critical section is executed, interrupts in all real time system will be disabled. Longer the interrupt are disabled the maximum interrupt latency, defined as higher the value of time break up disabled.

Interrupt Response: It is the time between reception of interrupt and start of user code in handling the interrupt. It is denoted as follows,

Interrupt response = Interrupt delay + CPU's context save time

Queuing Delay: Queuing delay is the work wait in a queue until it should be executed. Network delay is a solution for queuing delay.

Transmission Delay: In packet switching scheme, transmission delay is the sum of time mandatory to drive all the packet's bits into the link.

Response Time: It's a time taken by the system or a functional unit to react or respond for the given input data.

Response time = Received Response Time – Task submitting time

Bluetooth technology can be implemented in industrial, scientific and medical (ISM) field in the frequency bandwidth range of 2.4GHz.

7.0 Applications Implemented

The food grains entitled to the households under public distribution system are distributed to every eligible household at subsidized knowledgeable price with maximum efficiency in a clear mode through fair price shops. Distribution of food grains, kerosene and other necessary groceries to the public through the ration shop is one of the biggest policies of the Indian government. The system of providing basic domestic commodities at a subsidy to poor families in developing countries like India is an important aspect to meet the fundamental requirement of the people.

The existing public distribution system in ration shops requires manual measurement of quantity and maintenance of the record of the transactions. The main objective of the government is to supply the groceries such as sugar, wheat, rice and kerosene etc. to the eligible public at reasonable prices. Central government distributes the ration throughout India with the help of State Government and is monitored and controlled by the authorities of the Government.

Many scams arise on account of the ration shopkeepers. The shopkeepers maintain many fake ration cards using those fake cards the dealer receives extra ration from the Government and sells them of a higher price in the open market also the public are not provided with the exact amount of the quantity recommended by the Government. The public are also not aware of the availability of the ration goods in the shop due to poor communication.

The dealer at times sells the ration products at higher prices than what has been is recommended by the Government. These kind of problems are faced by the public in the public distribution system. In the absence of an efficient system the Government fails to get an idea on the quality of consumption of food grains by the public as well as the on the availability

status. To eradicate the above mentioned problems the proposed new innovative scheme would make the public distribution system more effective.

7.1 Methodology:

In this proposed system, changes have been proposed to make the PDS smart, by initially asking the user to swipe the RFID card. At the time of arrival of the stocks, the details about the stock would be entered in the database and messages are sent to all the users through the registered mobile number. Concepts such as proper system controls by the warehouse personnel as well as with correct material handling equipments can be operated to generate tasks for users. After a particular period of time, stock details as available at that time could also be sent to the users through RFID transmission using ethernet module. The users who arrive at the shop shall use their RFID card for drawing their ration.

Radio Frequency Identification is a technology which uses electromagnetic field and high frequency signals to convey information as well as automatically identify and track the data or object as shown in Figure 7.1. RFID is a passive component which doesn't have a battery so the only possibility is that the power supply to be available with the communicator.

When the high frequency waves obtained from the communicator are run into an inactive radio frequency identity card which is in the form of a coil and this forms a magnetic field around the tag. Then the card sends the encrypted data to various service sectors.

The collected information that is passed through radio frequency identity card is one among the Wi-Fi AIDC technique that could instantly raise significant attention for dealing and for use in industrial purposes. Every identity card has a particular data which varies from the other and has an

unique number containing the different production date, details about the shipment of goods, date of expiry etc according to the proposed users. The components of the radio frequency identification card are reader, antenna and tag.

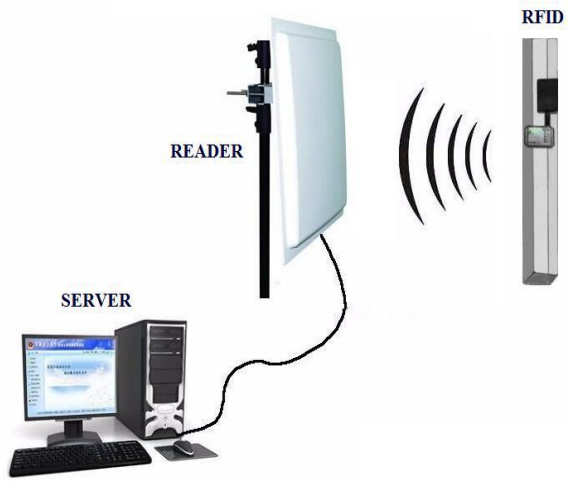


Figure 7.1: Radio Frequency Identification System

AIDC is automatically identifies the objects collects and enters the data directly in the computer system without any human help. Automatic identification technique consists of three principle apparatus that comprises of chronological steps such as, information encoder, Machine reader and RFID. Information encoder encodes the original information which is in the forms of a set of secret codes with alphanumeric characters. Whenever the data are programmed the symbols are converted into a low level language code and a label or tag containing the programmed data is attached to the item that is to be identified. Machine reader examines the programmed data by transferring it to another structure generally an electrical analog signal and the data decoder transfer the electrical signal into digital information and finally returns to its original alphanumeric font.

Relay: Relay is a switch which is used to open or close the circuit electronically or electromagnetically. It is also used to control the circuit by opening one circuit by closing another circuit. Normally Closed (NC) contact

is closed and Normally Open (NO) contacts are open. In NO terminology, switches are normally open condition and don't have any current conduction. NC is just the opposite of NO where the switch changes from open to closed mode when the input is supplied of current conduction.

Arduino Mega 2560: The Arduino software integrated development environment is programmed in Arduino MEGA 2560 which is a microcontroller as shown in Figure 7.2. It consists of 16 analog pins and 54 digital input and output pins.

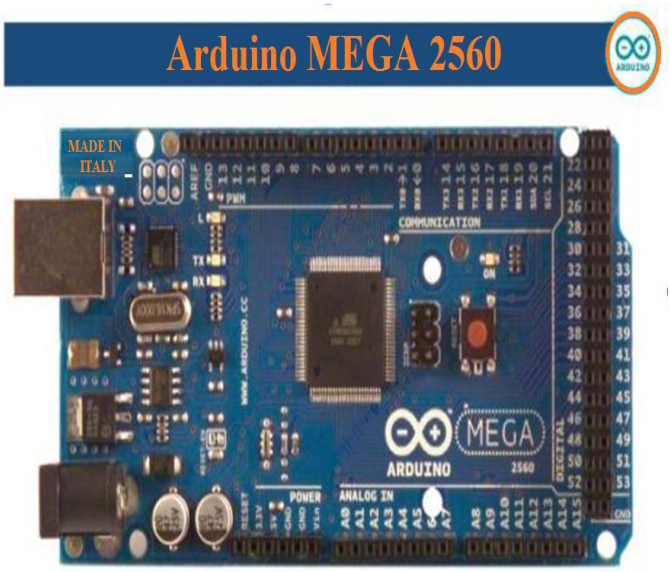


Figure 7.2: Arduino Mega 2560 Microcontroller

The output pins, 14 pins are used for pulse width modulation output. Along with the above pins it also has four universal asynchronous receiver and transmitter and crystal oscillator, universal serial bus connection, etc. Microcontroller itself with in the Arduino will give all the necessary support. Technical specifications of Arduino MEGA 2560 Microcontroller are as follows:

- Microcontroller = ATmega-2560
- Working Voltage = 5V

- Recommended IV = 7-12 Volt
- IV Limit = 6-20 Volt
- Digital Input / Output brooch = 54
- Pulse width modulation output = 14
- Analog IP brooch = 16
- DC power / IP / OP brooch = 40MA
- DC power for 3.3 Volt brooch = 50MA
- Flash Memory = 256 KB
- Boot loader = 8KB
- Static RAM = 8KB
- Electrically Erasable Programmable ROM = 4KB
- Clock rate = 16MHz

Level Sensor: Level sensor detects the level of liquids and other fluids. There are two types of level measurements-continuous and point level measurement. Continuous level sensors are used for measuring levels to a specific limit but provide accurate results. Point level sensors only determine if the liquid level is high or low. Point level sensor has been used in this research as shown in Figure 7.3.

Figure 7.3: Schematic Arrangement of Point Level Sensor

Level sensors are usually connected to an output for transmitting the results to a monitoring system. It is used to measure the liquid details here and used for kerosene measurement. The variation in the range of kerosene is noted time to time and the message will be sent to the users about the kerosene details. The power supply to the ARDUINO mega 2560 is given through the USB port or any peripheral device.

Weight Sensor: It is also called as Load Cells that are very commonly used to weigh, in an industrial environment. It is a sensor which converts load into an electrical signal. There are two kinds of transducers namely resistive transducers and capacitive transducers. The working principle of resistive load cell is piezo-resistivity which is used to covert current in the form of energy such as heat. The working of capacitive load cell is change of capacitance. In this, weight sensor is used to sense the weight of stocks such as rice, sugar, wheat, etc. It will sense the weight of the stocks and update the time to time variation of the stock.

7.2 Ethernet Module-ESP 8266:

IoT kit is classified as GSM slot and ESP Wi-Fi modules. In this research ESP 8266 module has been used which has an inbuilt Wi-Fi module in it with 32 bit controller inbuilt in the system itself. Ethernet module is used for the transmission of information to the user and also while retrieving the user's details from their RFID card at the time of swiping in the ration store.

7.3 Database and Video Transmission:

Database is a data collection which stores all the information that can be retrieved in future. In this, the database stores the users contact number, name, and also the stock details on its arrival. At the time of arrival of the stock, each and every stock detail should be uploaded in the cloud storage and

is send back to the user who buys from the ration shop about the stock details through the user's mobile number which has been registered.

Video transmission is the process of viewing the number of people there in the ration shop. The registered mobile will have an application and by using the application the customers can view the number of people in the store. This makes the customer to decide whether he/she can go that day or the next day. Internet protocol webcam has to be installed in the sender and also in the receiver as shown Figure 7.4. The sender starts sending the video by clicking in the start server option. The receiver uses the IP address in their google so that he can view and find how much crowd is there in the ration store.

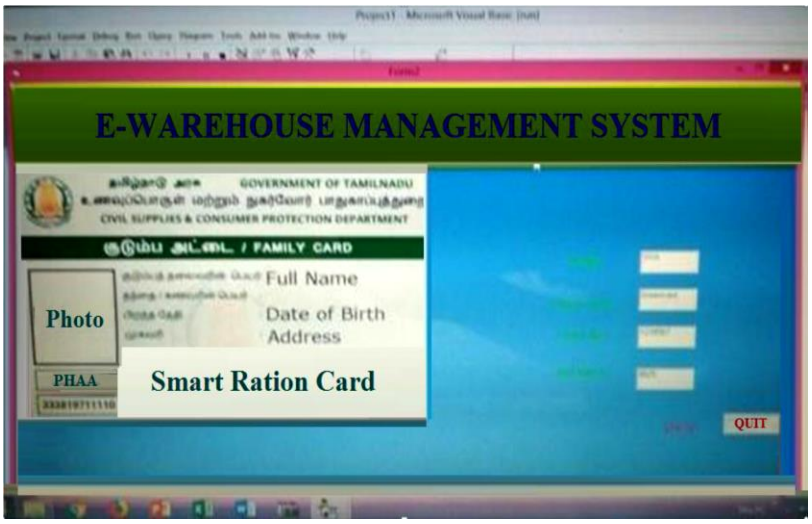


Figure 7.4: Web Cam Video Transmission System

7.4 Proposed Methodology for Smart Farming:

In this research, the idea of smart farming in rural areas using IoT has been proposed as shown in Figure 7.5. The sensors present in the module such as temperature sensor, humidity sensor and nutrition sensor will intimate the information to the personal cloud. The village panchayat would be provided

with an internet connection through the Bharat Net project, a Government of India's initiative to provide internet connectivity to every village.

A private cloud will be created, information from the sensor will be accumulating in the cloud and through the internet connection the weather forecast information can also be retrieved. By all this information a farmer would be able to know on which season s/he has to grow his/her crop and after how much time s/he has to harvest it.

This research work proposes an architecture which uses 6LoWPAN over ZigBee protocol which is a short form for IPv6 over low-power wireless PAN. Both protocols are build on the top of IEEE 802.15.4 layer, but the utilization of 6LoWPAN can be better than low power protocol hence, smallest among smallest device can also be connected through the IoT.

Intension of internet protocol is to provide the low power radio communication which requires wireless connectivity with low data rate for very limited form factor.

Advantage of using 6LoWPAN over ZigBee is that the former one can run on other physical layer. A physical layer device typically includes both PCS and PMD layer functionality. PCS is responsible for the data encoding / decoding / scrambling / descrambling.

PMD provides the details of the transmission and reception of individual bits on a physical medium. It encompasses bit timing, signal encoding and interacting with the physical medium. Therefore, adding physical layer security is a reasonable next step towards thwarting wireless network intrusion. 90KB is a full featured code size for ZigBee and for 6LoWPAN is 30KB. This module contains four kinds of sensors like, temperature sensor, humidity sensor, nutrition sensor, water sensor used to

measure arsenic and fluoride content. Temperature in the soil will affect the climate, plant growth, timing of budburst or leaf fall and decompose the organic material and other biological, chemical, and physical processes that take place in the soil. Like in spring season the soil is heated up by the warm air and sun radiations but in winter season it is opposite of the former one. Sensors will be connected in a star topology.

The main advantage in this topology is that if any node dysfunctions the other nodes will not get affected and also, the management is centralized which helps in monitoring the system more efficiently. Fertility of the soil is measured by three elements nitrogen, phosphorous and potassium. The percentage of these elements will determine how much content of extra nutrition has to be added to the soil.

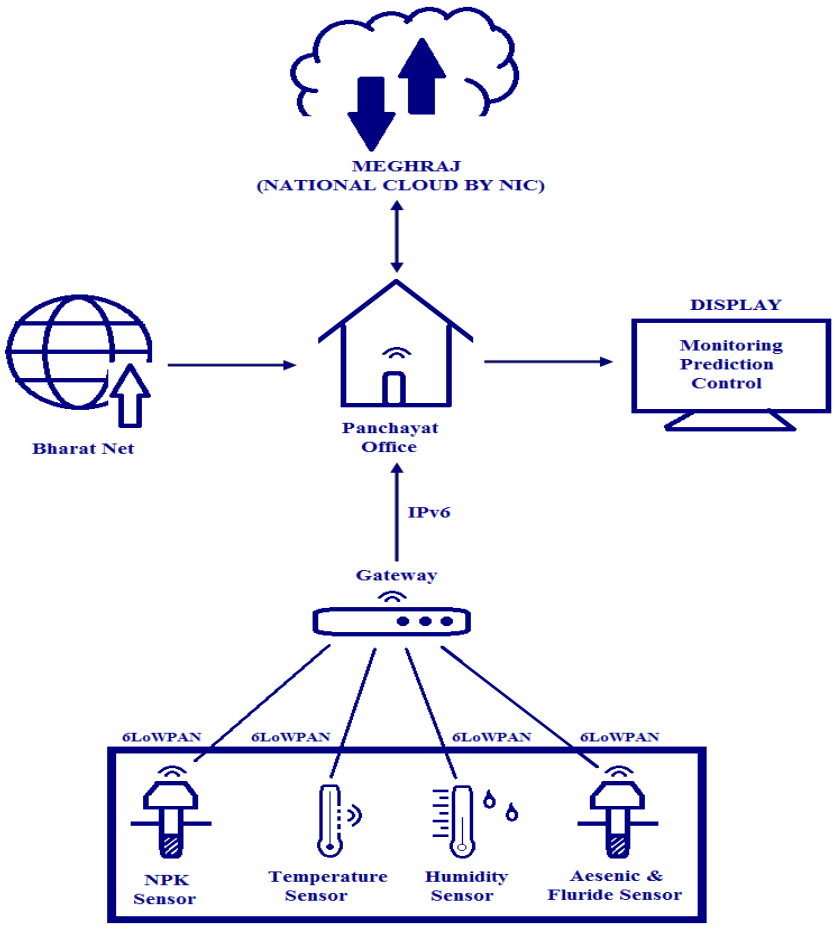


Figure 7.5: Proposed Concept

Our Government is just setting up the connection point for optical fibers in each panchayat. Common service centers are established in each panchayat where the internet connection through optical fibers is provided. Hence weather forecasting reports can be easily monitored. Information from these reports will be taken and send to the cloud-based storage systems. All the sensed data can be stored in a private cloud.

Cloud computing will provide the utilities of NIC, the leading knowledge and expertise organization of the Indian Government. It provides a lot of services to provide our websites, portals and network use with velocity and scalability.

A NIC cloud service provides a variety of service models like, PaaS, fundamental facilities, software and storage as a service. PaaS provides environments and tools to create own web applications similar to google that has its google app engine on which anyone can develop their own web application on google infrastructure. In this there is no requirement of any kind of hardware or to manage and it is adaptable with respect to the circumstances. If there is a need to change something it can be easily changed.

7.4.1 Hardware Required:

Temperature sensor measures hotness level by RTD which controls domestic hot water heating system that can control complex process control furnace plants. Moisture sensor sense and determines the dryness level of the soil. Dry soil will conduct electricity in a very poor manner so the system must maintain less amount of moisture in the soil to resist the conductivity. The WHO has identified that Arsenic and fluoride has more inorganic

contaminants present in normal drinking water which affects the human health severely.

The contaminants can be measured by simple voltammetry technique that allows user to detect both highly toxic As (III) and less toxic As (V) below ten parts per billion. The sensor measures approximately for ten minutes and can be reused with very little maintenance. Fluoride can be measured by dipping an ion selective probe into contaminated water. Nitrate, Phosphorous, Potassium sensors, contains Ion Selective Electrode (ISE). ISE contains different membranes, or pH based colorimetric soil contains the ion concentration of all these elements and electrochemical sensors are used to measure the ion concentration.

7.4.2 Gateway Design:

Mother board is an essential part of the computer hardware part in which the mainframe and other apparatus of the system are plug and join wireless sensor network through IPv6 arrangement wirelessly. ARM cortex-7 has been chosen as the motherboard for the gateway. The ARM CPU is Reduced Instruction Set Computing (RISC).

RISC instructions sets are smaller, more atomic means each instruction roughly translates to a single operation that the CPU can perform. Little architecture has introduced heterogeneous computing in which cores can be different in terms of presentation and authority. When gateway is not busy, a low energy core can be used but in case of extreme conditions high performance cores are used. In this the processing is regarding the data transfer on a network. So ARM Cortex-7 can be used because of its low cost effective property, hence, it can be easily installed in villages. The gateway is connected to the ethernet cable from the panchayat office and wirelessly with WSNs as shown in Figure 7.6.

The proposed method of gateway is used with the help of ARM CORTEX 7 controller which is the essential hardware connected to other apparatus. Cloud storage is used to hide the data on the controller which can be contacted from any gadgets by means of the internet. Temperature sensor measuring level of hotness in cold storage area because too much of goods present inside means the heat will be more. The other sensors will give the information regarding the presence of contaminants in it. The controller collects all the information and gives the alert to the authorized person as short message and necessary action will be taken by the authorities.

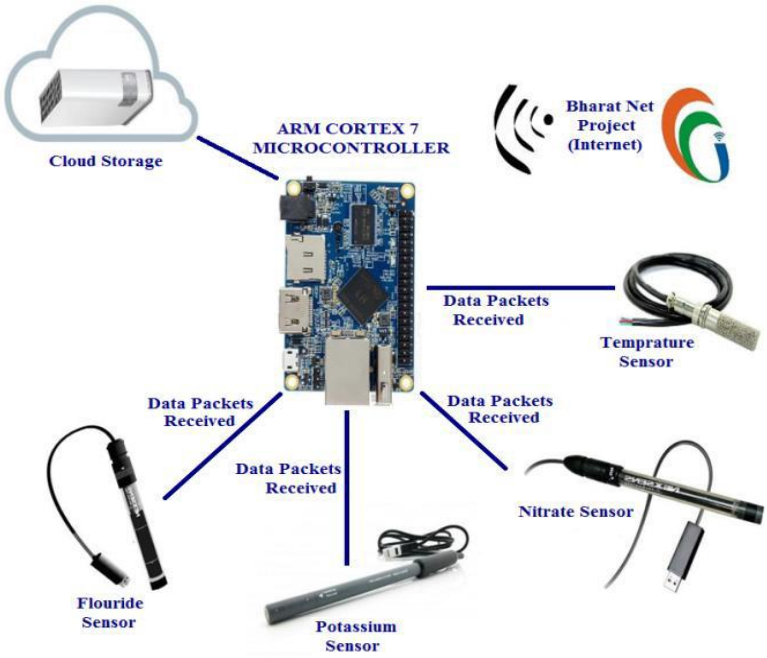


Figure 7.6: Proposed Gateway Design

7.5 Data Collection and Analysis: (ECG)

The ECG signal in BioVid heat pain database was recorded for 5.5 seconds long and is digitized at 512Hz. It consists of five different conditions BL - 1 and pain level - 1 to pain level - 4. From the results, it was found that, BL - 1 indicates no pain condition and the series indicates the increase in pain level from pain level - 1 to pain level - 4. Each pain and no pain condition consists of twenty recordings and totally one hundred recordings are present.

The recording for each condition of ECG signal is concatenated and plotted accordingly. R-peaks are located in the plotted ECG signal from which Risk Ratio Interval (RRI) is obtained and by means of RRI, features are extracted using the standard equations.

7.5.1 Technique Proposed:

Execution of Wireless ECG Monitoring System: The proposed method involves the execution of wireless ECG signal monitoring system and feature extraction from ECG signal in BioVid heat pain database. The ECG monitoring system consists of several modules like ECG signal conditioning module, data acquisition and wireless component and cloud storage. The initial part of the system contains three ECG electrodes located on arms and legs of a human. The corresponding electrode jack is connected to ECG AD8232 signal conditioning module. The analog output from AD8232 is fed to 12bit resolution ADC of CC3200 IoT kit which operates at maximum of 1.46V.

The value of ECG signal inferred from AD8232 ranges from 1.65V-2.25V hence, the signal value is down converted to 1.46V by designing and implementing a voltage divider circuit. Voltage divider circuit is designed with the specifications as R1=1KΩ, R2=1KΩ, Vin=1.65V and Vout=0.82V. The output signal from the AD8232 is given to one end of resistor R1 and common GND is given for the circuit. The output voltage from voltage divider circuit is given to ADC. The digital values are displayed in serial monitor of Energia integrated development environment tool.

The CC3200 IoT kit is programmed using MQTT protocol in Energia IDE to transmit digital values of ECG signal to IBM Watson cloud platform. In MQTT protocol, a particular network Service Set Identifier (SSID) and password is defined along with the baud rate and IBM IoT foundation link is

activated. Attempt of network connection generates the Media Access Control (MAC) address and device identification. If the network is connected, a Quick start link is obtained along with the generated device identification.

7.5.2 Characteristic Withdrawal

BioSPPy is a toolbox for biomedical signal processing and it is written in Python. ECG signal in BioVid heat pain database is processed and R-peak detection is done using signals.ecg module from BioSPPy library. RRI is nothing but the time interval between two successive R-peaks. Using RRI, features are calculated and extracted. In feature extraction method, the features extracted are as follows.

Mean of RRI: The ratio between the sum of RRI and the number of elements of RRI.

RMSSD: Root Mean Square of the Successive Difference will provide the information about the consecutive variation among nearby NNs

SDNN: Standard Deviation of NN intervals gives the changes if any that occurs in the heart rate no longer than 5 minutes.

Ratio SR: It is the ratio between SDNN and RMSSD.

Slope of Linear Regression of Index of Biotic Integrity: It is the slope of regression which is used to test the significance of a linear relationship between the range of length of RRI and RRI. All the above set of features calculated using the appropriate equations are given in Table 7.1. The algorithm for the extraction of features such as RMSSD, SDNN, Mean RR, Ratio SR and Slope was developed as follows.

- Import Pandas, Neurokit and Numpy libraries
- Load ECG signal data from Comma Separated Values (CSV) file using the pandas read function
- ECG signal is processed and R-peaks are detected using BioSPPy toolbox in Neurokit
- RRI is calculated in array format from the time interval between two successive R-peaks using
- Numpy library
- Features such as RMSSD, SDNN, Mean RR, Ratio SR and Slope are calculated using standard equation along with the parameters: RRI and range of length of RRI

Table 7.1: Features with its Corresponding Equation

Features	**Equation**
Mean	$\frac{\sum_{i=1}^{n} RRI}{n}$
SDNN	$\sqrt{\frac{1}{N-1}}$ x $\sqrt{\sum_{i=1}^{n}(RRI_i - (RRI))^2}$
RMSSD	$\sqrt{\frac{1}{N-1}}$ x $\sqrt{\sum_{i=1}^{n-1}((RRI)_{i+1} - (RRI)_i)^2}$
Ratio SR	$\frac{SDNN}{RMSSD}$
Slope	$\frac{n\,X\,\left(\left(\sum_{j=1} len(RRI)\right)X\left(\sum_{i=1}^{n} RRI_i\right)\right) - \left(\left(\sum_{j=1} len(RRI)\right)X\left(\sum_{i=1}^{n} RRI_i\right)\right.}{nX\left(\sum_{j=1} len\,(RRI)^2\right) - \left(\sum_{j=1} len(RRI)\right)^2}$

8.0 Results and Discussion

The simulation on average battery life and loss connectivity analyses outcomes have presented herewith.

8.1 Average Battery Life:

An analysis of the results as observed on the average battery life is shown in the following Figure 8.1. As the battery life mostly depends on the energy consumed it could be seen that in topology routing of the packets require more devices, more energy for data transmission. In Topology 2 it could be seen that, the farthermost device connects to the control centre via 4 hops, as compared to 6 hops in, Topology 1. Where as in Topology 3 field and do not need any hops in order to transmit data it was the best results come where most of the devices are in the control centre's signal we could see the best battery life.

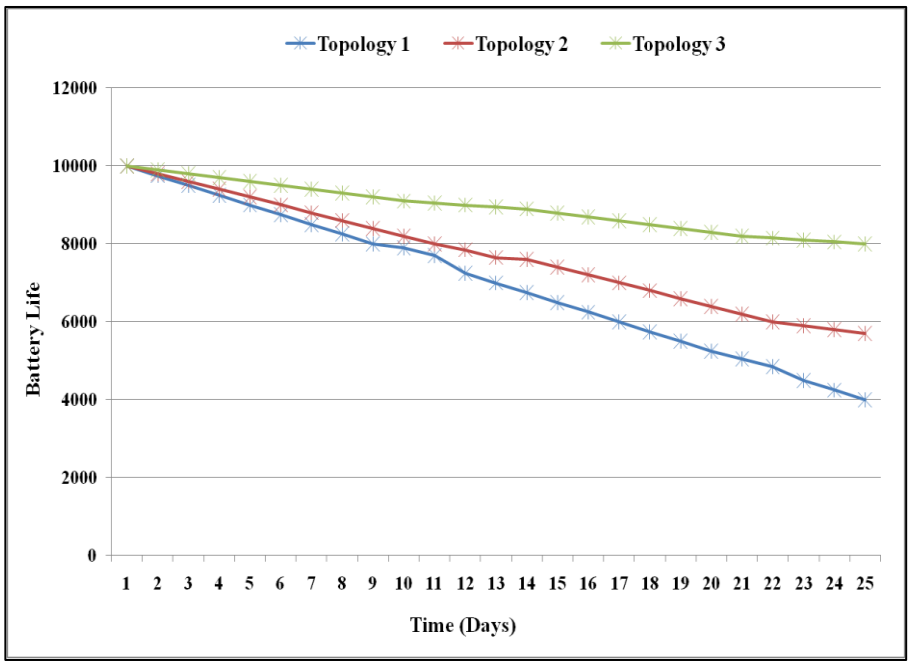


Figure 8.1: Result of Average Battery Life

8.2 Loss of Connectivity:

Figure 8.2 shows the results on the loss of connectivity and how a fault in the network affects the connection between control centre and other devices. It was observed that in Topology 2, a device fault does not affect any other device. In Topology 2, a device fault in either of the devices 4, 5, 8, or 10 will cause 20% of the network to stop functioning and the worst results come from the topology, where 80% of the network is affected by a broken device in the worst case.

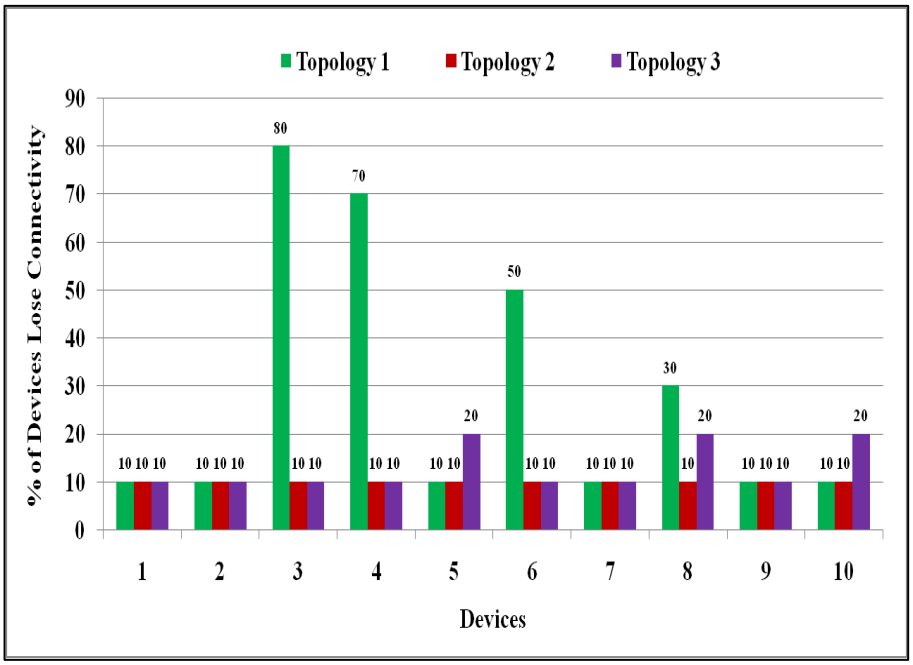


Figure 8.2: Result of Loss of Connectivity

Figure 8.3 shows the hardware's that are met in the system. We have a smart meter connected to the micro controller and a bulb to indicate the power supply. The LED shall indicate the consumption of units. As per the display in LCD available on the consumer side the micro controller drives all the collected details to contributor. The total amount of units consumed is calculated by the service provider and the tariff rate will be formulated to the consumer through SMS as well as automatic call. Figure 8.4 shows the testing done with Bluetooth based hardware module.

In the earlier system the ZigBee protocol using the data rate of 240 kbps, was used for AMR for degrading data at transceiver. Wherever in the proposed SMR system with Bluetooth module it was developed at both the ends with data transmission rate of 3 Mbps avoiding any degraded data at transceiver. The details available on the display of the consumer end can be now sent through both mail as well as message.

Figure 8.3: Hardware Microcontroller based Circuit

Figure 8.5 shows all details like identification, bill month, year, total bill amount and payment gateway as seen on the display at the customer side. Whereas Figure 8.6 shows the SMS to the customer side with details of identification, bill month, year, total units etc.

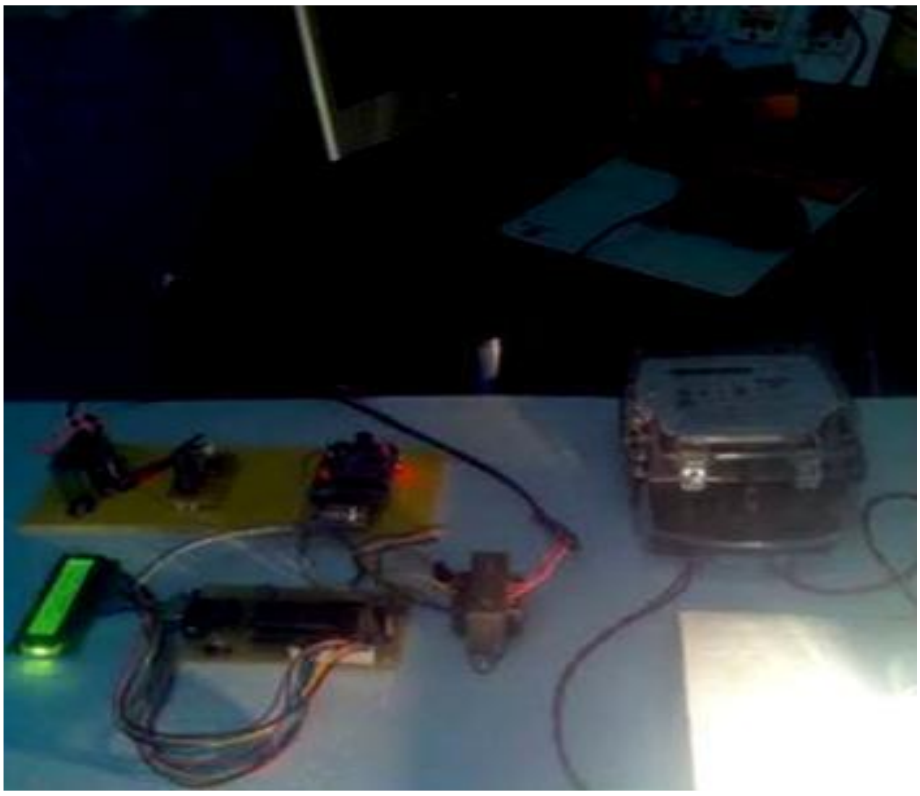


Figure 8.4: Testing with Bluetooth based Hardware Module

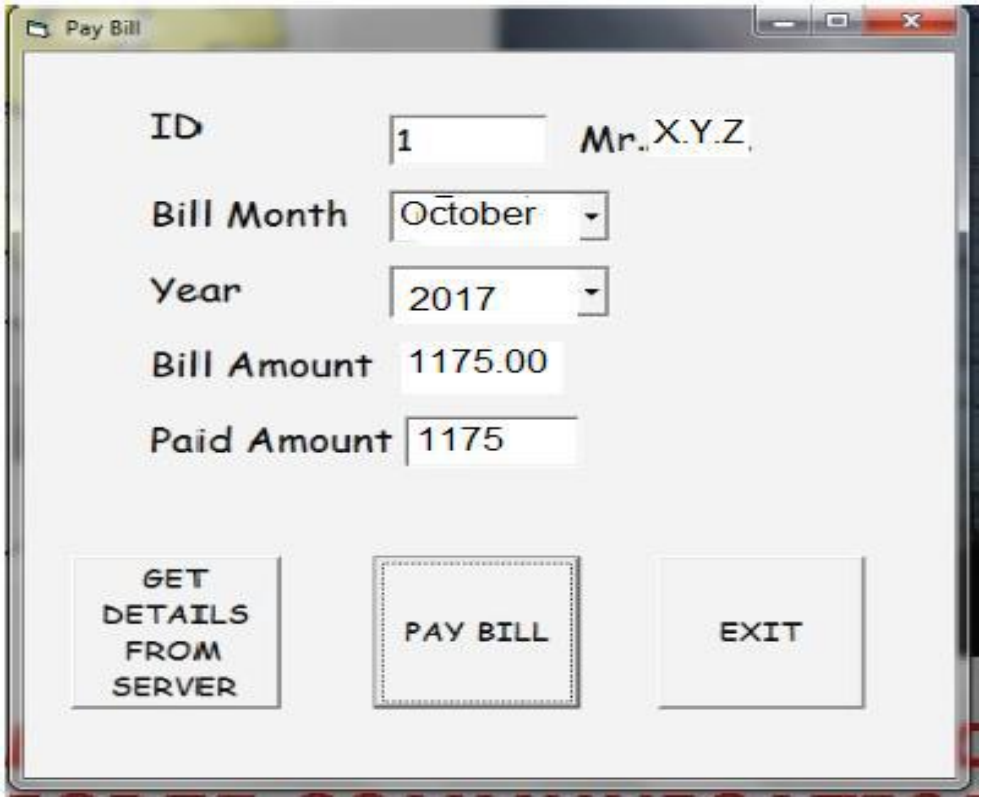


Figure 8.5: Display Details on Consumer Side

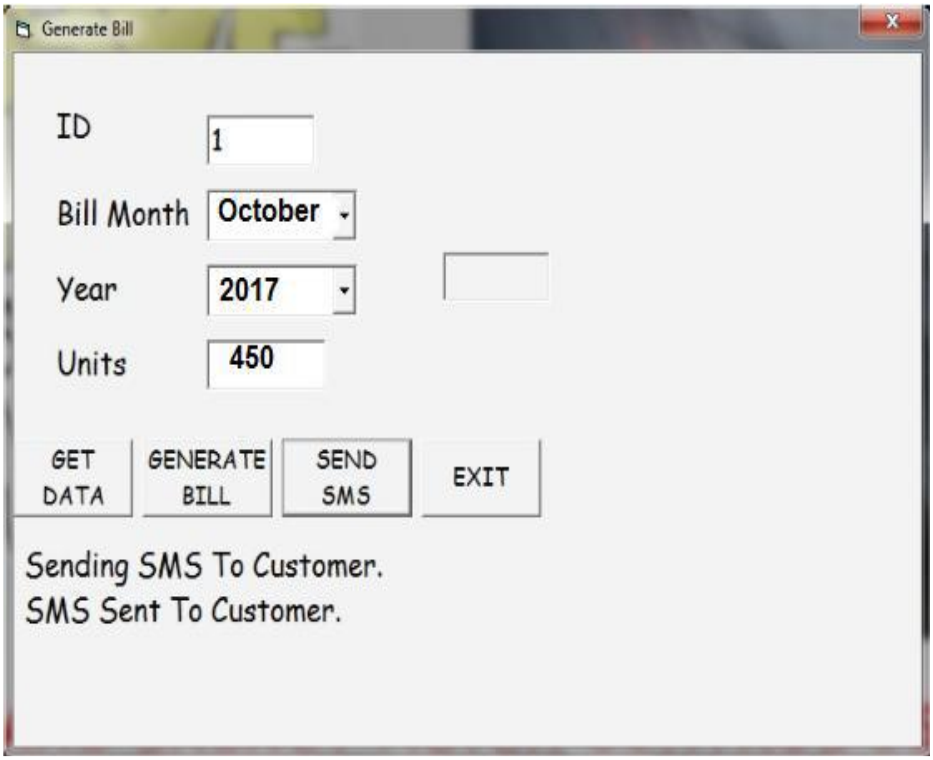


Figure 8.6: SMS to the Consumer

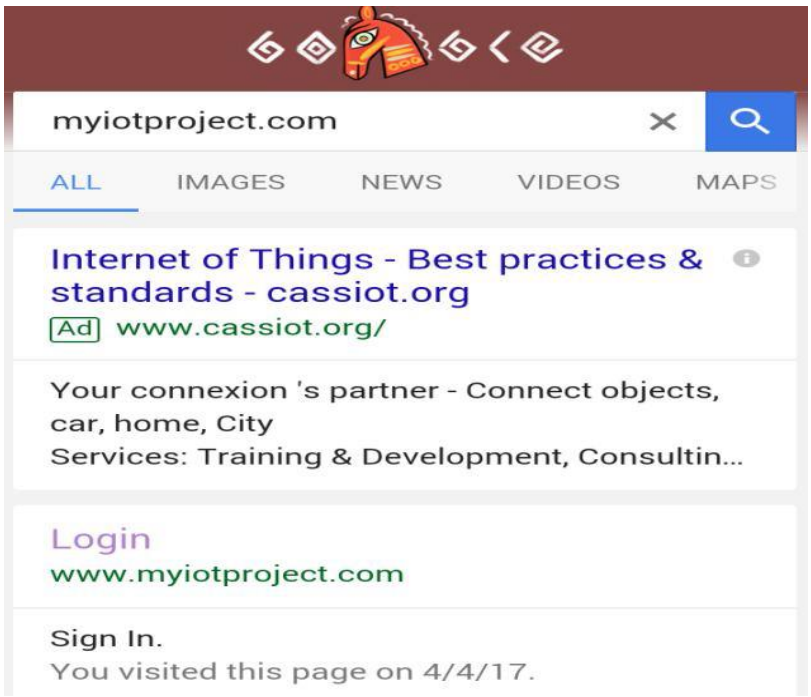


Figure 8.7: Web Page

IoT network helps in creating useful and advanced improvements in technology in many ways like sensors to actuators and can work in single

function devices to complex devices along with the help of wireless. It has the features of artificial Intelligence, Connectivity integrating making possible effective engagement because the users and also manages the resources significantly. IoT has the ability to work both in single function devices and complex devices. For this study where a single function mode was selected one sensor with wireless devices was preferred. A box containing a CPU, Battery and sensor was prepared. The developed web page, login page and the output results obtained are shown in the Figures 8.7, 8.8 and 8.9 respectively.

Figure 8.8 shows the developed login webpage using IoT in cloud under the name of myiotproject.com. By using registered user ID and password the login page shall be possible to be opened to access the results. After signin in the login page, it directly goes to the results window as shown in Figure 8.9.

From the results it was found that, window comprises 8 numbers of buttons which shows/tells about the utility of 8 different electrical appliances. By using the webpage the electrical appliances could be controlled from anywhere.

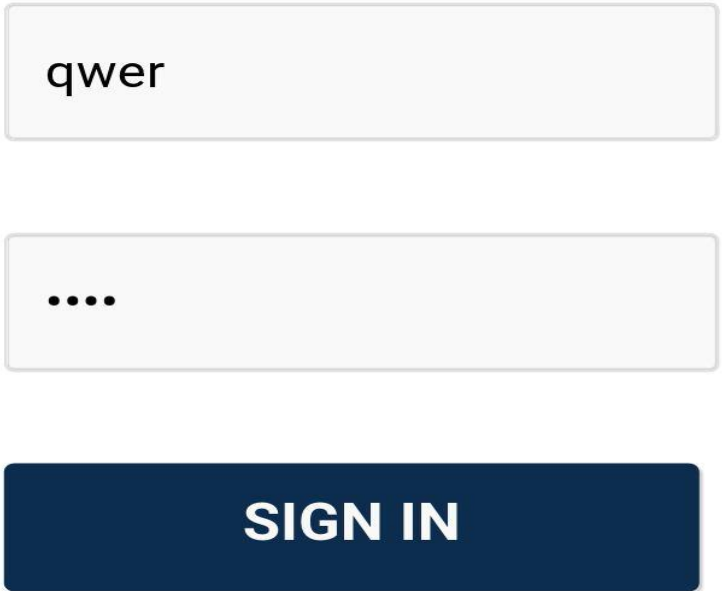


Figure 8.8: Log in Page

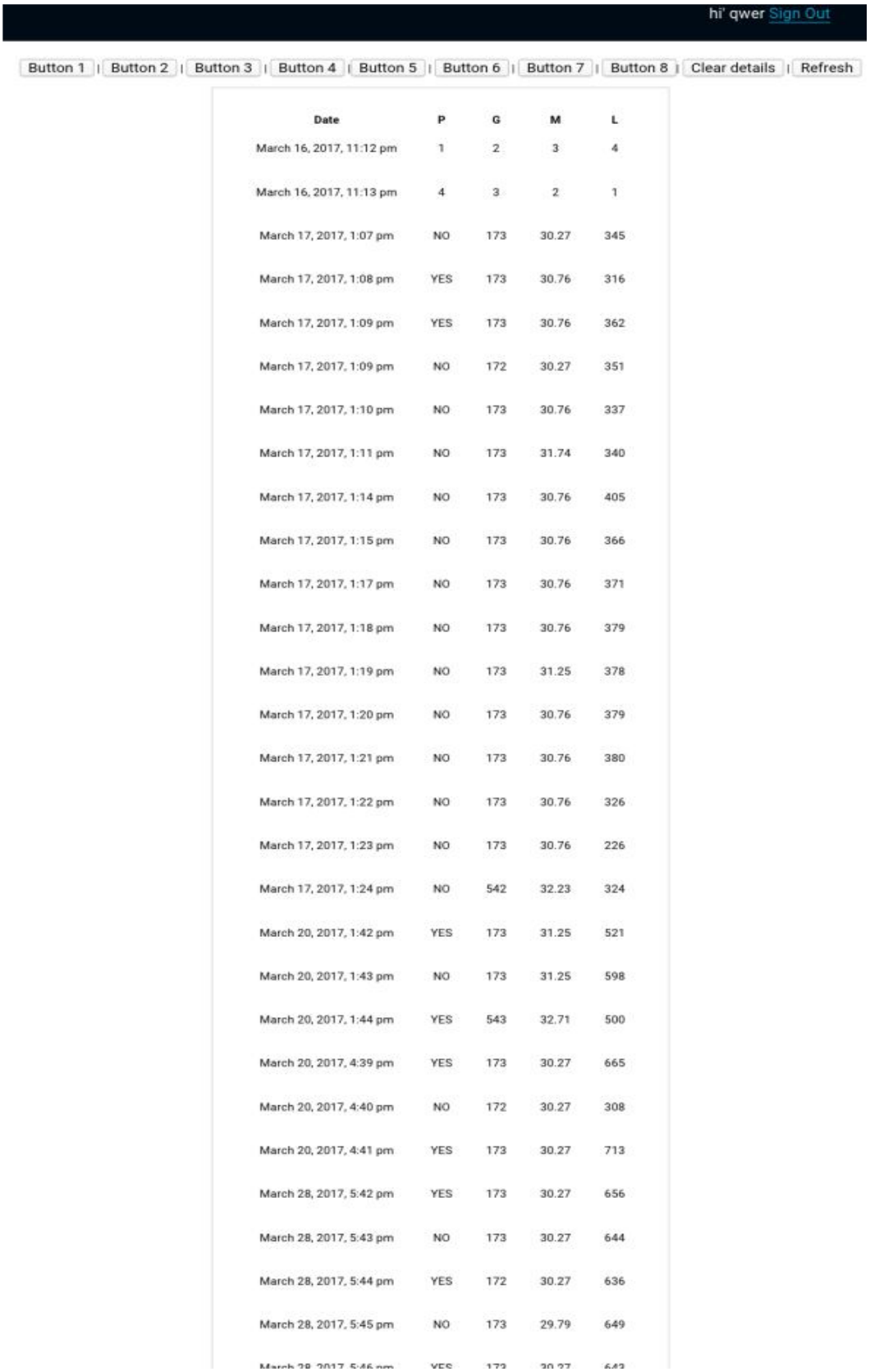


Figure 8.9: Output Result

The setup was tested for four devices, and the results have been shown below for one device. The experimental set up of the prototype model is shown in Figure 8.10. The ON status monitoring and periodic monitoring results are exposed with the following Figures 8.11 and 8.12. Figure 8.11 gives an observation when switch 1 is connected to the port P0^0. Normally the switch will be in high position. Whenever the switch is pressed it indicates that the device is turned ON and it will be intimated with a message "DEVICE 1 IS ON" to a particular number. Figure 8.12 gives the experimental setup and alert message when device 1 is in ON state and device 2 is in OFF state. The Port P0^0 is considered as device 1 and Port P0^1 is considered as device 2. Device 1 associated to supply 5 volt pin and device 2 associated to ground brooch so that the alert message is sent as "Device 1 is ON and device 2 is OFF" to a particular number.

Figure 8.10: Circuit Set Up of the Prototype

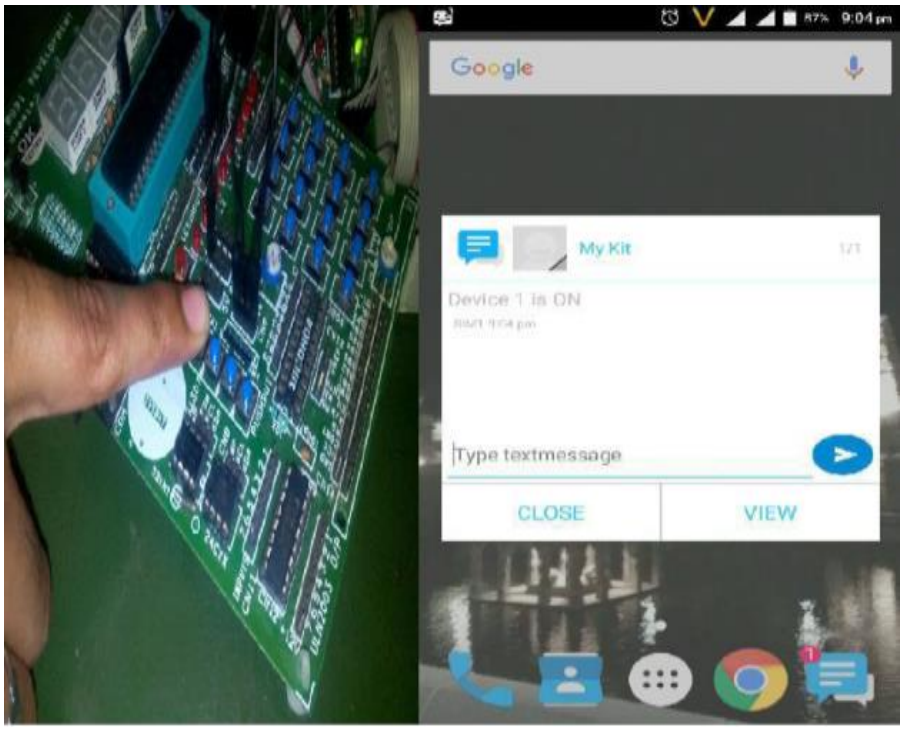


Figure 8.11: ON Status Monitoring of Device-I

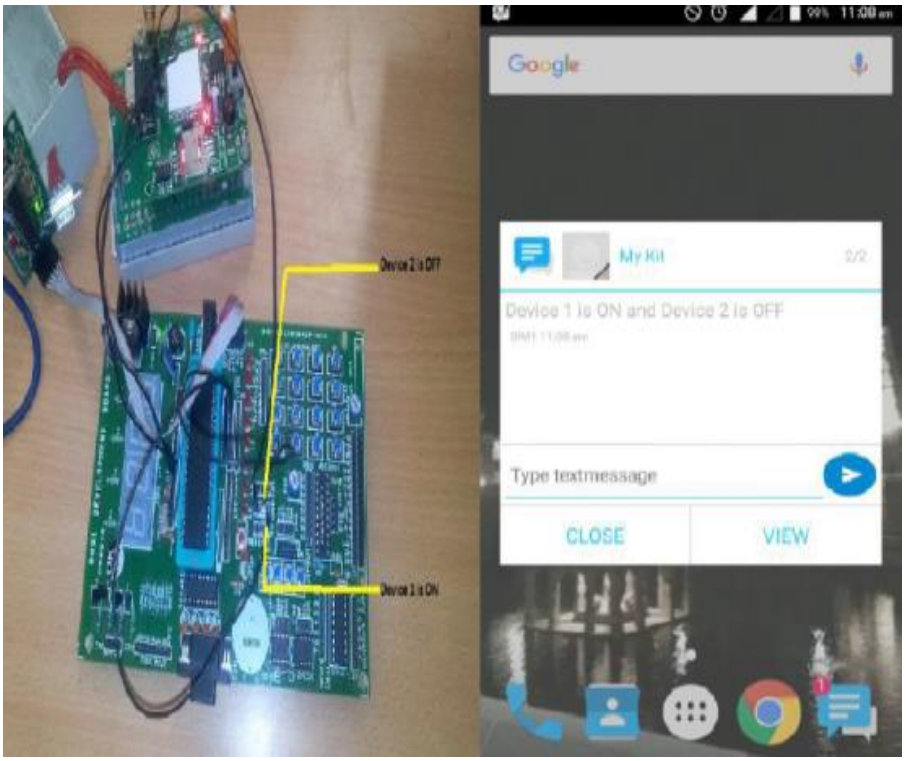


Figure 8.12: Periodic Monitoring

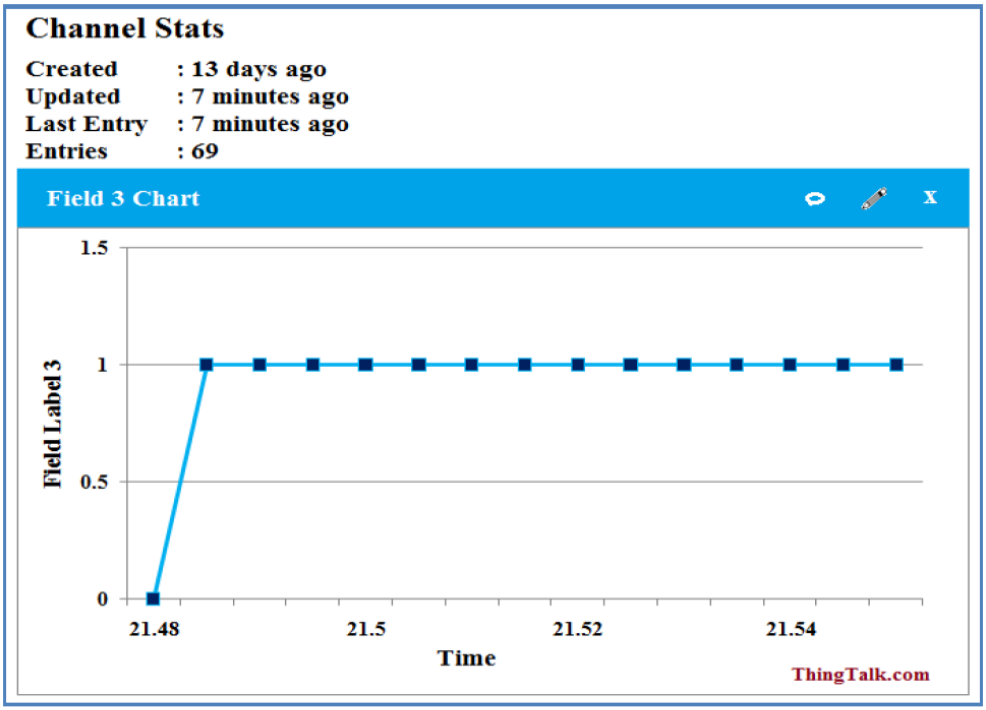


Figure 8.13: Monitoring the Device under Stable Condition for Long Period

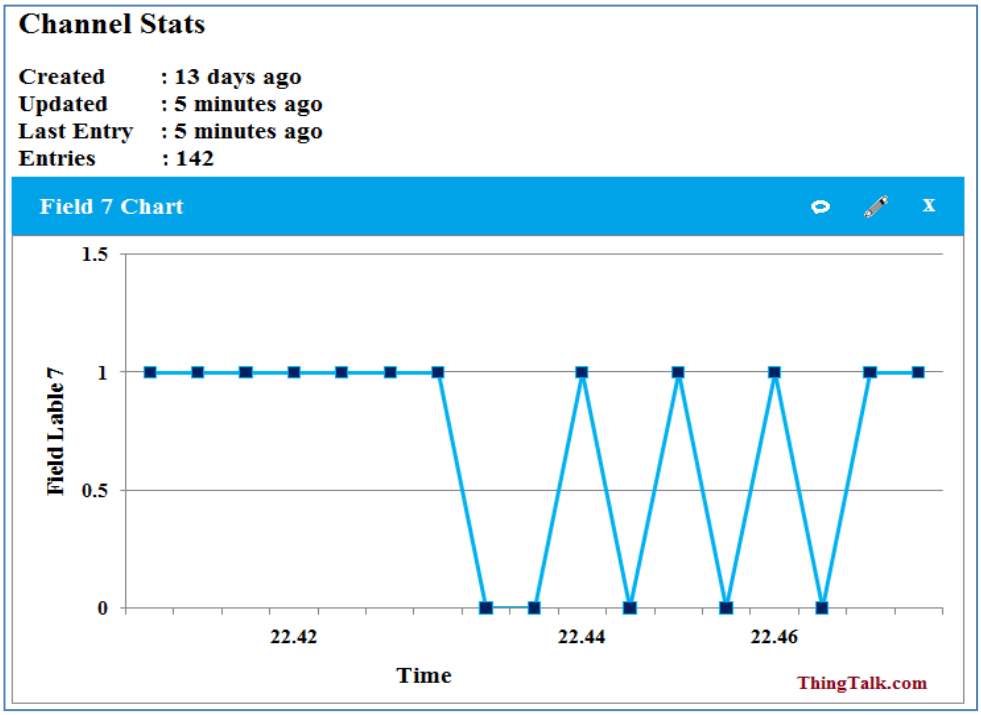


Figure 8.14: Monitoring the Device under Stable Condition for Shorter Period

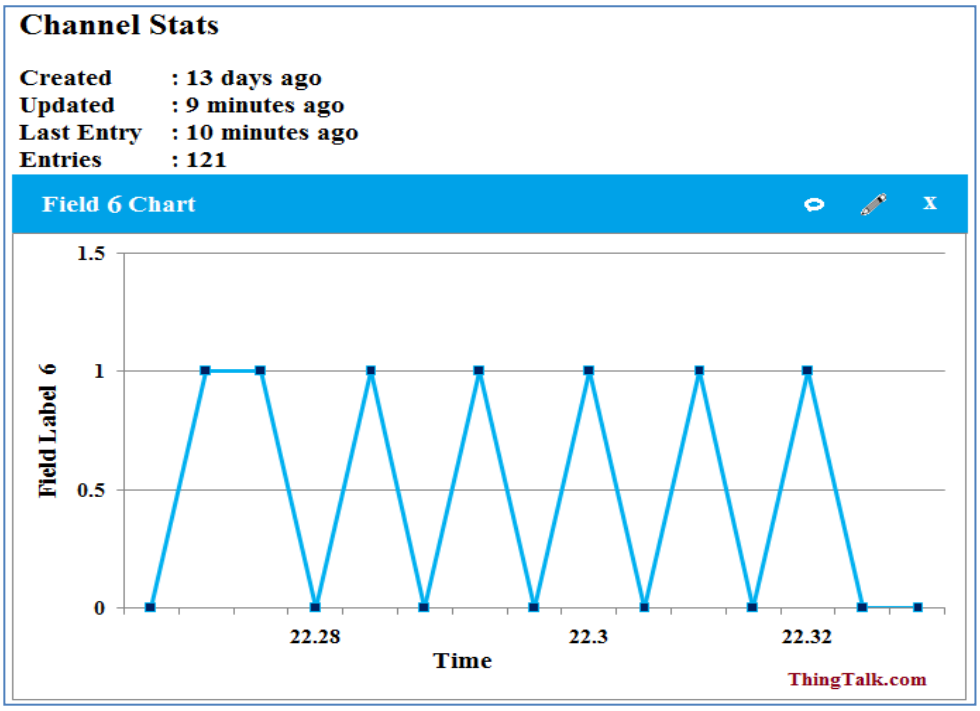


Figure 8.15: Monitoring the Device under Fluctuating Condition

The Figure 8.13 shows that the device is in off state initially. The pin which has to be monitored is connected to the VCC, the device becomes ON state. The above graph shows that there is No voltage variations hence the device is in stable condition for a long period. Figure 8.14 gives the observation for monitoring a device under stable condition for a shorter period. Initially the device is in stable state. After some time the device fluctuates between ON and OFF state. Figure 8.15 gives the observation for monitoring the device under fluctuating condition. Initially the device is in OFF state. Then the device fluctuates between ON and OFF states. There are more voltage variations and the device is in fluctuation condition for a longer period.

Data Acquisition and Transmission: In wireless ECG monitoring system, AD8232 signal conditioning module is interfaced with CC3200 IoT kit using the designed voltage divider circuit to acquire ECG signal. The digital values are displayed in serial monitor of Energia IDE tool. The MQTT protocol is used for the transmission of digital values of ECG signal from the serial

monitor to cloud server. The Hypertext Transfer Protocol (HTTP) comment which is viewed in serial monitor is copied to the web and by accepting the terms and conditions of the IBM Watson cloud platform, the digital values are plotted in the dashboard.

The transmitted ECG signal using MQTT protocol and TI CC3200 IoT kit is plotted in the dashboard of IoT Platform. The CC3200 IoT Kit uses the 12-bit resolution ADC that returns12-bits of data per sample. The acquired ECG signal is plotted as time versus ADC values. The P-wave in the electrocardiogram indicates the depolarization of the atria, the QRS complex represent the depolarization process of the ventricles and T-wave represents ventricular repolarization. The RRI is the one in which the interval form of the peak of one QRS complex to the peak of next QRS complex is measured and from the values of RRI, a person's heart rate can be classified as normal and abnormal.

Characteristic Withdrawal: ECG signal plotted for BL1 is called no pain condition as shown in Figure 8.16. Similarly, ECG signal is plotted for pain conditions. R-peaks are detected using BioSPPy toolbox which is written in Python and RRI is calculated and plotted using the R-peaks. For a single database, the simulation of the developed algorithm calculates RRI values for five different conditions from the R-peaks that have been detected using BioSPPy toolbox and plotted in Figure 8.17 to Figure 8.21 respectively. Similarly, RRI values are calculated from the successive differences in time interval between R-peaks from 50 databases and it is plotted. The developed algorithm is simulated using Spyder 3.2.5 to extract features such as RMSSD, SDNN, Mean RR, Ratio SR and Slope RR using the calculated RRI values for five different conditions and the observed values are given in Table 8.1. Similarly, features are extracted from 50 databases that can be further used for classification of ECG signals to predict arrhythmia.

Table 8.1: Characteristic Withdrawal

ID	SDNN	RMSSD	MEAN RR	RATIO SR	SLOPE RR
BL1	65.42	80.64	711	0.811	-0.096
PA1	37.35	34.78	706	1.076	-0.102
PA2	37.38	42.95	711	0.871	-0.251
PA3	32.28	28.53	696	1.131	-0.227
PA4	42.79	41.32	684	1.036	-0.381

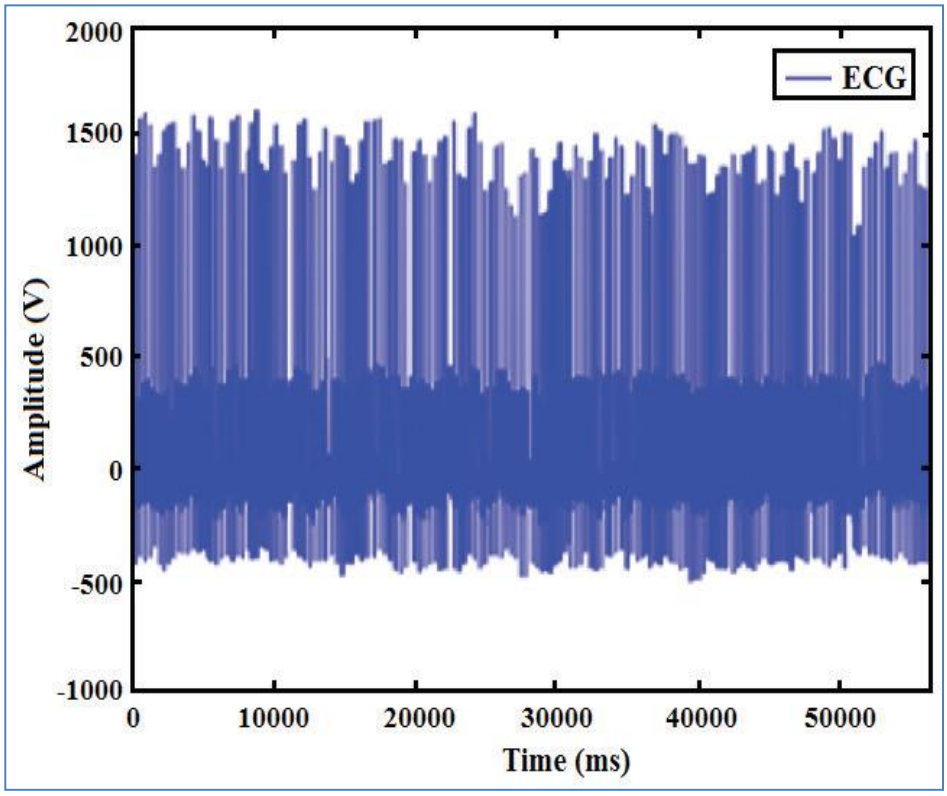


Figure 8.16: ECG Signal Plot for BL1

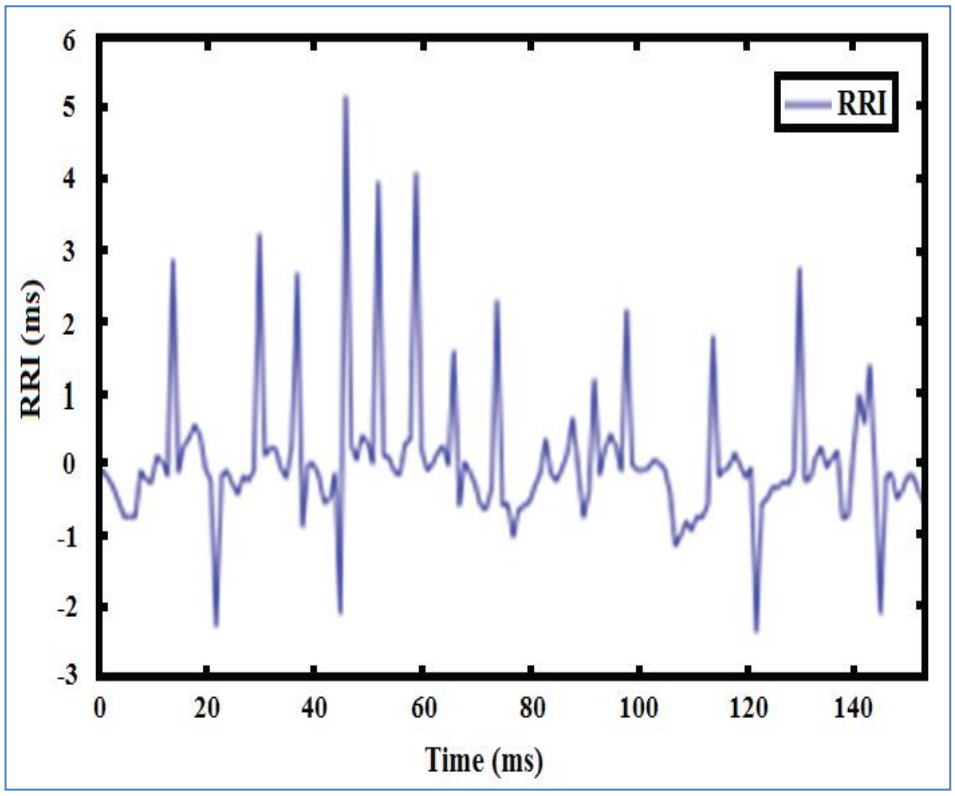


Figure 8.17: RRI Plot for BL1

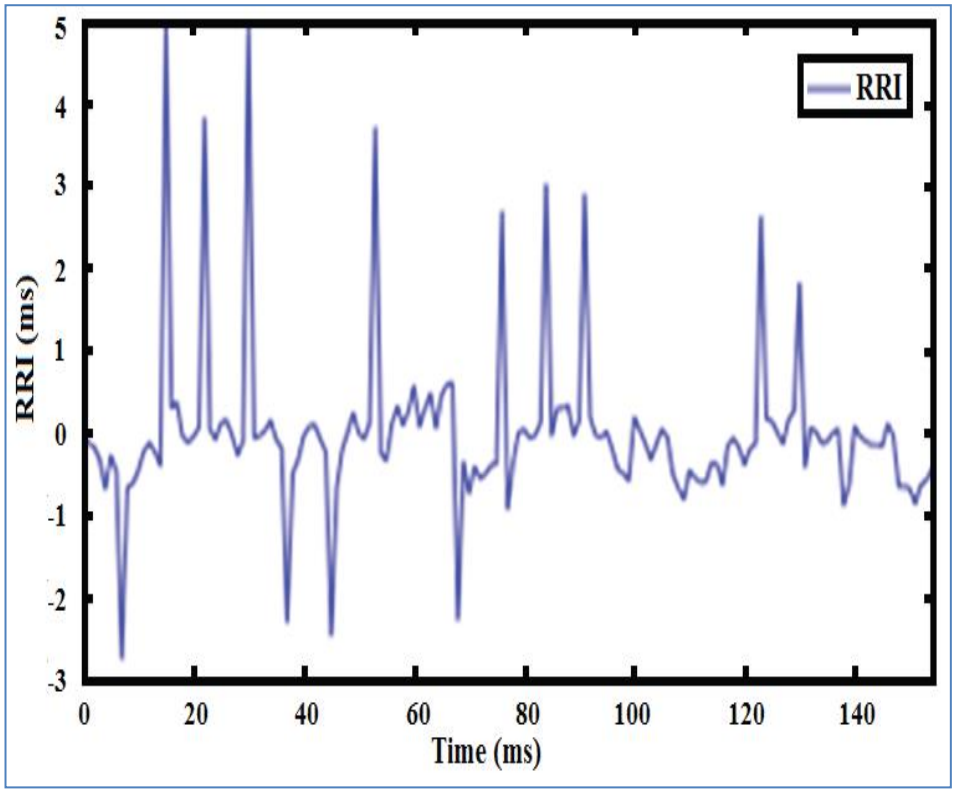


Figure 8.18: RRI Plot for PA1

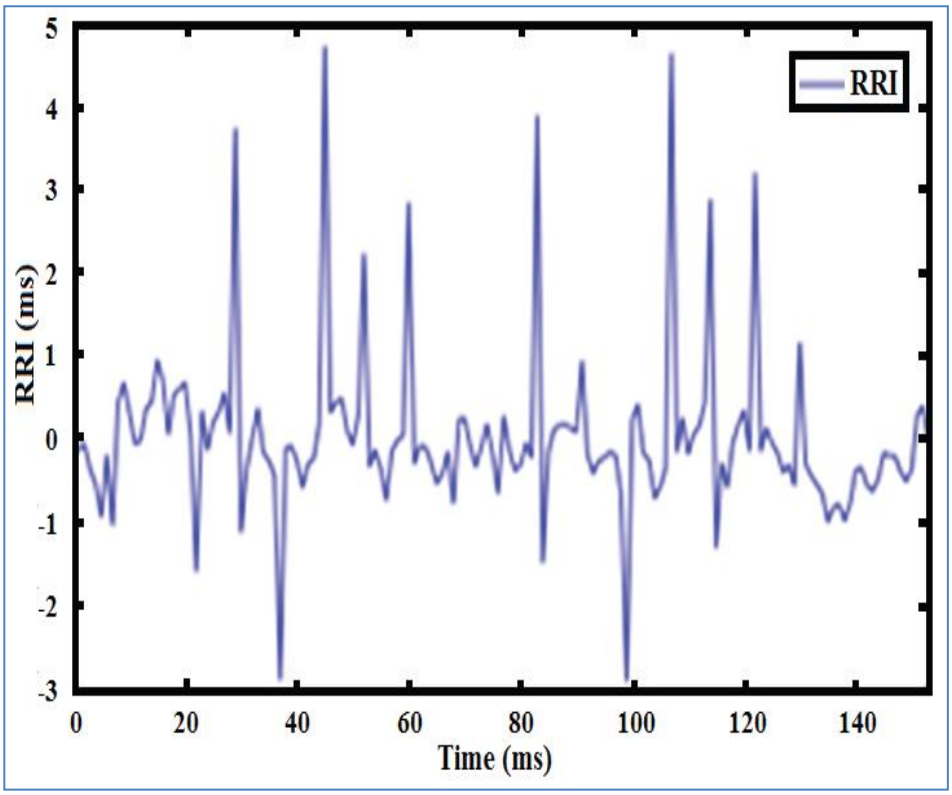


Figure 8.19: RRI Plot for PA2

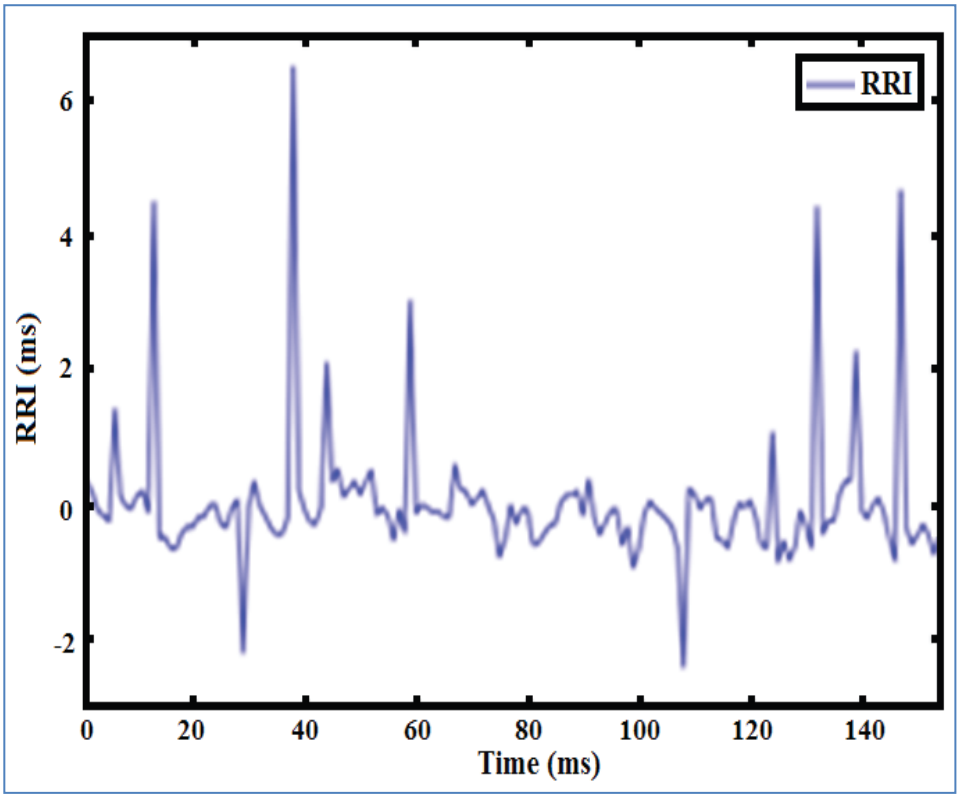


Figure 8.20: RRI Plot for PA3

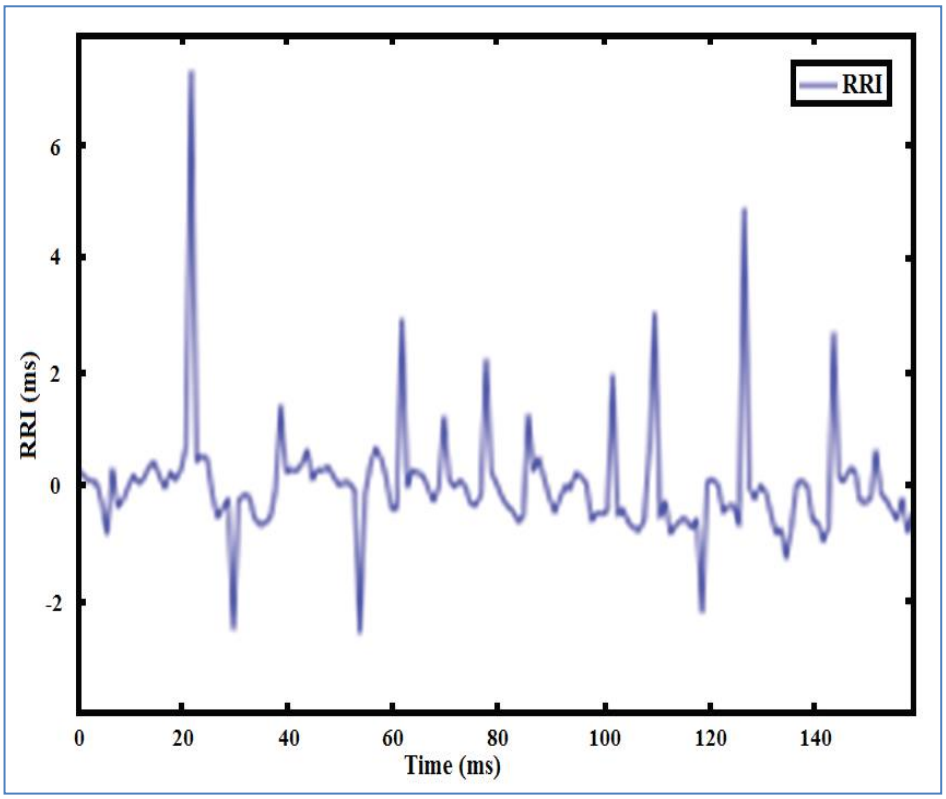


Figure 8.21: RRI Plot for PA4

9.0 Conclusion

From the research studies made, the following conclusions which were arrived at are placed below:

In the present system the consumption of electricity is manually read from the electric meter by persons deployed by the Electricity supply agency to each and every place that consumes electricity. This is a cumbersome system in which me may not be able to avoid the errors that might occur while taking the reading as well as there will be occasions when the customer is not available due to which the person may find it difficult to take the reading. In addition to the above problems there would have been certain periods of breakdown of energy consumption for which information may not be available at the time of taking the reading and then there are times when the paper on the meter reading itself gets misplaced or lost.

- To overcome the above issues, in this research a wireless ZigBee enabled energy meter was designed and developed that could provide the automatic meter reading.
- This system used not only with collection of the usage of electricity, also monitoring the data connected and forwards the data so connected to control data base for billing purpose.
- With a view to avoid any loss of the readings and arising due to misplacement or getting rubbed off sufficient provision has been designed to forward through messages the entire details which will consist of the name of the consumer, his registration number and actual consumption in units.
- In the AMR system it has been made possible save and call back the meter reading without the help of any individual.

- This system has proved to be both cost effective and time saving vis a vis the earlier method.

We have been discussing in this study the ways in simplifying the process in energy meter reading with this in view energy meter reading using Bluetooth technology that could continuously monitor the reading at the customer end. In case the bill has not been paid within the permitted time period, it is possible for the service provider to do disconnect the power supply automatically the consumer can be alerted through e-mails and messages on their usage and consumption.

By introducing this system the service provider shall be able to avoid using huge man power for collecting the meter reading as well as can be time saving. Accurate reading is possible with obtaining error-free information. The customer satisfaction is achieved.

- As the total energy consumption is continuously monitored it shall be easier to control the usage.
- The power consumption could be reduced in a single day for home appliances.
- During a whole year up to 15 percentage of energy could be saved in residential building by implementing smart power monitoring and control system through IoT.
- The monitored values from sensors could be continuously stored and updated in a cloud database.
- Our proposed designed system will be helpful in reducing the energy wastage by continuously monitoring and controlling the home electrical appliances.

IoT is more on expansion of Internet services connecting the real world which contains of various objects. Internet of Things controls a monitors any

physical device be it electronics, mechanical, automobile that is connected to the internet. In this study this concept of IoT was designed and developed to provide a smart wireless home security system by linking of appliances for monitoring and controlling them through an intelligent network.

- IEEE 802.15.4 standard which is a new protocol that operates is personal area net work as well as in device to device networks with the maturing IoT specification defines the wireless profiles for low data rate monitoring and controlling of the applications.
- It is a technology with low power, consumption, inexpensive. This can be put to use in residential and industrial services that have low complexity application.
- The study shows the cost of the digital based LUX meter to be 100% more than the analog proposed design.
- With IoT is shall be simpler to communicate between point-to-point or point-to-multipoint with the devices implemented.
- IoT remote could very well be used from outside the residences also for managing the residential approaches in this proposed design.

The data transmission for different modulation scheme with cooperative and non cooperative relay protocol was simulated and analyzed in this study.

- Results reveal that, the cooperative relaying mode outperforms the non-cooperative systems in terms of BER performance.
- DF decode and transmit noise in lower SNR while detect-and- forward protocol just detect and transmit the received signal.
- Detect and forward outperforms DF in lower SNR but at higher SNR's DF has more satisfying bit error performance than detect and forward.

- IHDF relaying protocol has the advantages of both detect-forward and decode-forward cooperative scheme has more spectral efficiency and outperforms the later in regards to capacity and throughput capability.

During this research work an attempt was also made on remote monitoring system for machine controllers used in industries by proposing the using of GSM and internet technology. GSM module SIM900A was interfaced with the 8051 microcontroller using UART serial communication. Alert messages to the customer could be sent from the modem using AT commands. Wi-Fi module ESP 8266 was interfaced with microcontroller. Status of the device was continuously updated to the cloud using Things peak platform.

Device's status could be accessed at any time by logging on to Things peak platform and the methodologies proposed were easy to implement and cost effective. A further extension of the prototype could be possible by controlling the device based on the problems identified in the controller and the status obtained from the server. Solutions are possible to control the device by the producers and based on the solutions, the controller can be programmed to take necessary decisions to rectify the abnormalities.

From the study, it can be seen that the basic needs of the people and the rate of implementing this concept are very low when compared to any other system. The following conclusions show the above to be true.

- This scheme helps on reducing the workers burden and in maintaining the stock details more accurately.
- Before going to the ration shop, the users also to know about the stock availability details based on IOT.

- The stock details are maintained in database and the details are updated regularly and keeping track of all the items correction within the warehouse is possible.
- By implementing this concept any illegal activity by the workers in the ration shops could be arrived and also it reduces the customer's time in visiting the shops.
- It leads to cutting down as the cost due to lessening of the movement of the items stored as well as it saves on the worker, tools and area that is put to use.

A proposed model for smart farming in rural areas using IoT advanced technologies was developed which should that.

- Once the model is implemented this idea could become very economical and useful.
- Keeping in consideration the various government initiatives for weather monitoring, internet facilities, and cloud storage, this model would gain its place in our country much faster.
- The data collected from the sensors and weather department, will be helpful in achieving a better and smart approach in farming by identifying the nature of the soil and what will grow best on it.
- Also, the crops harvesting time can be calculated by taking all-natural factors into consideration. This will in turn help farmers grow quality crops.
- The intention is to use internet of things technologies to solve most of the issues in agriculture. Internet of things could be used to reduce the issues in the areas of farming. It will help for in knowing the soil quality/capabilities and in developing reliable weather forecasts.

At the outset, farmers are to be trained to get familiarized to these systems. The proposed system once implemented will benefit farmers in

learning newer technologies and take a modern approach in solving their farming problems.

Wireless ECG monitoring system by means of AD8232 signal conditioning module for real time signal acquisition was carried out as an another attempt in this study. With CC3200 IoT kit for analog to digital con version and Wi-Fi module of IoT kit for transmission of ECG signal to IBM Watson cloud platform. This portable and reliable system would help the physicians in giving immediate medical care irrespective of the patient's location. R-peaks were detected using BioSPPy toolbox and features such as RMSSD, SDNN, Mean RR, Ratio SR and slope of linear regression of IBI were extracted from 50 databases using the developed algorithm. R-peak detection using BioSPPy toolbox and feature extraction algorithm could be further applied on the real time acquired ECG signal to extract the features.

10.0 Future Scope

In case there is variation in the energy consumption occurring every month then the entire module system has to be changed, otherwise it will show the previous reading only and this will affect the billing. More over the energy provider does not provide any information regarding over consumption of energy to the consumer. To overcome these issues the AMR through Bluetooth with MSP 430 microcontroller can be used in the future.

Using this new design of framework, we could execute more inexpensive security systems with the help of wireless sensor networks for monitoring and controlling different equipments available in a remote place from a remote server.

New concepts could be attempted and presented for achieving further reduction in the cost of moving the stock available and also to help for reducing the worker, tools, area and time for effective cost management.

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