Department of Electrical and Computer Engineering
North South University

Senior Design Project

IoT Based Wireless Nurse Calling System

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LETTER OF TRANSMITAL

January, 2020

To

Dr. Mohammad Rezaul Bari

Chairman,

Department of Electrical and Computer Engineering

North South University, Dhaka

Subject: Submission of Capstone Project on "IoT Based Wireless Nurse Calling System".

Dear Sir,

With due respect, we would like to submit our **Capstone Project Report** on **"IoT Based Wireless Nurse Calling System"** as a part of our BSc in Computer Science & Engineering (CSE) program. The report deals with Wireless Based Nurse Calling System. This project was very much valuable to us as it helped us gain experience from practical field and apply in real life. We tried to the maximum competence to meet all the dimensions required from this report.

We will be highly obliged if you kindly receive this report and provide your valuable judgment. It would be our immense pleasure if you find this report useful and informative to have an apparent perspective on the issue.

Sincerely Yours,

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APPROVAL

Omar Faruk Riyad (ID # 1610634042), Arif Ur Rahaman Chowdhury Suhan (ID #1610437042) and Ahraf Sharif (ID #1511764642) from Department of Electrical and Computer Engineering of North South University, have worked on the Senior Design Project titled "IOT Base Wireless Nurse Calling System" under the supervision of Dr. Mohammad Monirujjaman Khan partial fulfillment of the requirement for the degree of Bachelor of Science in Engineering and has been accepted as satisfactory.

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DECLARATION

This is to certify that this Project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

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By kindness of the Almighty we have successfully completed our senior design project entitled "IOT Based Wireless Nurse Calling System"

Our deep gratitude goes first to our faculty advisor Dr. Mohammad Monirujjaman Khan, who expertly guided us in our senior design project throughout the whole CSE499A and CSE499B. His guidance helped us in all type of research, writings and completing the project.

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Abstract

The proposed system is an “IoT Based Wireless Nurse Calling System” consisting of 3 major parts: nurse calling device, local server and wireless wristband. A patient can call upon a nurse for an emergency case and the notification will be received in the nurse's wrist band. Most of the existing emergency calling system in the hospitals are based on hard-wired solution and a terminal which is a costly approach. The wireless solution that exists today is based on pager technology which is another costly approach. This project is based on a unified WiFi network which highly accessible and cheap to find thus making it one of the most minimalist approaches in this domain. The key component of this project is a microcontroller-based WiFi module ESP8266 and a local Server. This project can be used in any kind of scale depending on the need. This project promises to deliver much higher performance and coverage while it is closing the gap between the management and workers by monitoring calls real-time.

TABLE OF CONTENTS

Chapter 1 ..... *1*

Overview *1*

1.1 Introduction 2

1.2 Project Description 2

1.3 Purpose Of The Project 3

1.4 Project Goal 3

1.5 Summary 4

Chapter 2 ..... *5*

Existing Systems *5*

2.1 Introduction 6

2.2 Similar Existing Systems 6

2.3 Summary 8

Chapter 3 ..... *9*

System Design *9*

3.1 Introduction 10

3.2 System description 10

3.2.1 Patient Side 10

3.2.2 Nurse Side 10

3.2.3 Server Side 11

3.3 System Design 11

3.3.1 Patient Side 12

3.3.2 Nurse Side 12

3.3.3 Server Side 13

3.4 Summary 13

Chapter 4 ..... *15*

Technical Description *15*

4.1 Introduction 16

4.2 System Description 16

4.2.6 Battery Controller 22

4.2.7 Breadboard 22

4.3 Summary 23

Chapter 5 ..... *24*

Design Implementation *24*
5.1 Introduction **25**
5.2 List of necessary hardware components **25**
5.3 Principle of operation **26**
5.3.1 Patient part 26
5.3.2 Nurse Part 27
5.3.3 Server part 28
5.4 Summary **29**
Chapter 6 ..... *30*
Cost of Implementation *30*
Chapter 7 ..... *33*
Results& Analysis *33*
7.1 Introduction **34**
7.2 Results& Analysis **34**
7.3 Summary **35**
Chapter 8 ..... *36*
Compliance with standards *36*
Chapter 9 ..... *38*
Design Impact *38*
Conclusion *42*
11.3 Method of Productization & Marketing **46**
Bibliography *48*
Appendices *50*

List of Figures

Fig. No.	Figure caption	Page No.
1.1	Iot Based Nurse Calling System	4
2.1	WIRED NURSE CALLING SYSTEM, IEEE '2015	7
3.1	Complete design of the system	11
3.2	Working procedure of Server Side	13
4.1	Esp8266 Nodemcu D1 Mini	16
4.2	Esp8266 Nodemcu V2	17
4.3	RFID RC522	18
4.4	13.6 Hz RFID TAG	18
4.5	5-Volt Buzzer	19
4.6	Switch	19
4.7	0.96″ I2C OLED Display	20
4.8	5-Lithium Battery 500mAh	21
4.9	Breadboard	22
5.1	Structure of Patient part	26
5.2	Nurse Wrist Band	27
7.1	IP Initializations	33
11.1	The global market Share of Nurse Calling System	46

Chapter 1

Overview

1.1 Introduction

Day by day, the daily life of human is changing and getting more and more busier schedule. Busyness is now everywhere particularly in a hospital, a place of the busiest environments. Due to special care and professional treatment, hospital has become one of the most important places among society. Particularly a hospital ensures to have instant treatment during any emergency case of patients. So, every day many emergency events occur in the hospital and calling a nurse is one of the common tasks of the daily schedule. So, for proper patient caring by nurse time-to-time, we need a better system to make communication connection between nurse and patient which is known as nurse calling system.

1.2 Project Description

To close the gap between patient and nurse, a system of nurse calling is proposed by us where any patient can call a nurse for emergency case and the notification will be received in nurse's wrist band. Our project is based on a unified local WiFi network which is highly accessible and cheap to find thus making it one of the most minimalist approaches in this domain. This project can be used in any kind of scale depending on the need. Monitoring calls in real-time is also a significant of part of this project.

Choosing a wireless, cheap and fast nurse calling system for hospital is probably the trickiest part of the whole process. Since there are so many nurse calling systems out there, selecting the best, optimized and low cost one can be difficult. Moreover, not all existed work has a system, which is low cost based and has several features to provide maximum network range in for calling system.

1.3 Purpose Of The Project

Most of the current systems are hard-wire based that make it untraceable when it comes to identifying call delay. Our project handles this issue with a widely used network which is WiFi and making the call remote so that no nurse needs to wait in standby to see the incoming calls. This project makes the solution a lot cheaper than hard-wired solution where it also provides the feature of other facilities such as measuring time and delay depending on the call. This project promises to deliver much higher performance and coverage while it is closing the gap between the patient and nurse by monitoring calls real-time.

The purpose of this system is existed in ensuring every patient are getting proper treatment, time -to-time. Also, to make that nurses are present near patient bed after receiving calls, we used a RFID system. For the attendance of nurse, we have also used this system. Generally, for the sake of providing emergency nurse caring for patient, our system ensures to have facilities in every possible way.

1.4 Project Goal

Low, optimize and less troubleshooting nurse calling system is a need of every hospital management. Our system is able to achieve all of these requirements in every way. Therefore, we have few goals set initially which we achieved success upon completing the project. We tried our hard best to achieve the goals while upgrading the system when needed.

Fig. 1.1. IoT-Based Wireless Nurse Calling System

We came up with new and more improved plans for the betterment of the system. Goals are mentioned below,

- Low cost-based system to provide fast and secure communication.
- Real time monitoring and storing call data for optimized nurse scheduling.
- Less troubleshooting during connection break because of the wireless based system.
- Multi leveled security in calling steps.
- RFID to ensure nurse present.
- Tension free about nurse schedule.
- User-friendly.
- Budget- friendly.

1.5 Summary

In this chapter, we discussed the importance and the goals of our project. In a hospital, both hospital management and relatives are always concern for their patients. By having a wireless nurse calling system, patient can have treatment without any trouble or pain. Building a wireless and real time nurse calling system can also solve all the emergency case treatment problems. Especially in large hospitals, our system is essential to monitor or sending nurse to the patient's bed and to provide health service without worrying about the scheduling of nurses.

Chapter 2
Existing Systems

2.1 Introduction

Nurse calling system is not a new topic. In fact, there has been done a lot of projects on developing low-cost nurse call system like design development and implementation of wireless nurse call station.

2.2 Similar Existing Systems

In 2015, a research team worked on a wired nurse calling system which was published by IEEE also in that year. Their idea was basically on wired technology like RS-485, Modbus protocol, along with wireless technology of RF/ZigBee modules. The research work was all focused on an embedded system which made it more enclosed and not flexible for future development. And the main problem of their system is there is no backup when the wired will be disconnected or broken. Also, the network range of RF/Zigbee modules is too short and narrow.

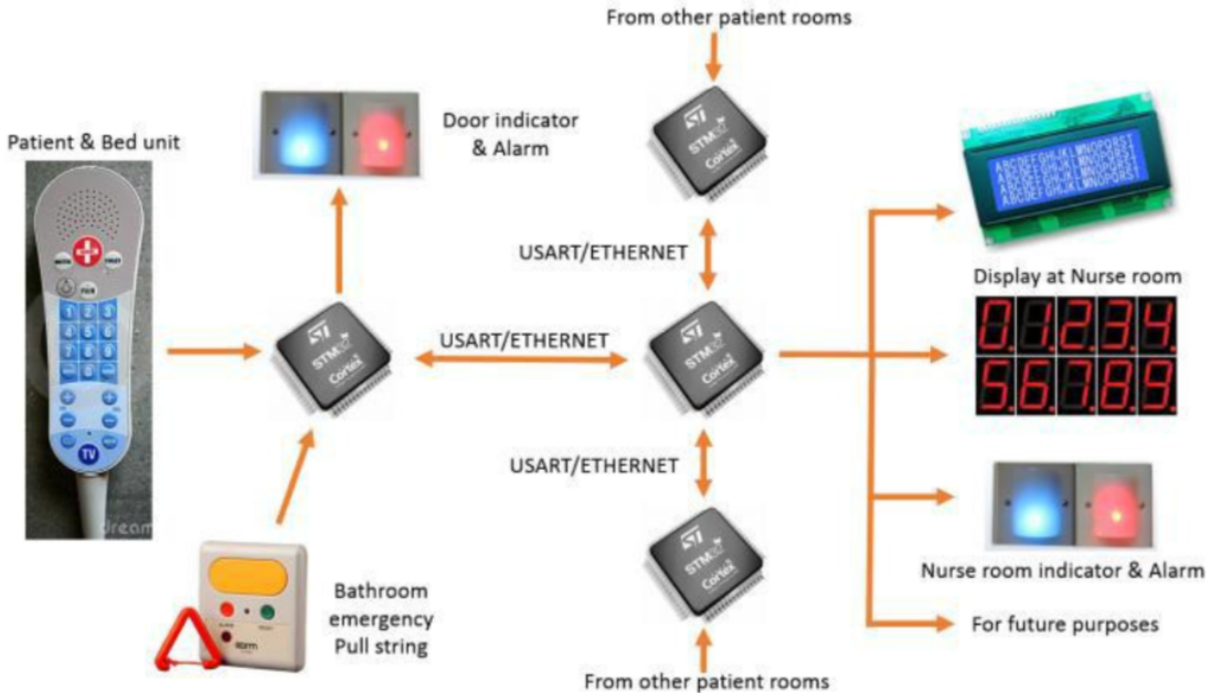

Fig.2.1. WIRED NURSE CALLING SYSTEM, IEEE '2015

Work has been done by Purdue University, Bangladesh in 2016 where they have produced a low-cost wireless nurse calling system. However, the work was only done on the calling side but not on receiving side and the work didn't have any other iteration at all. The project only posted to the server using WiFi and left the other side empty. Their work has some other problems too. A lot of improvements are needed to develop these like nurse presence button, adding blue code alert etc. This system is also not suitable for any critical patient. For the critical patient, the system needs to be wired because it is possible to lose the wireless link. Additional circuitry needs to be added to implement an alert if any node is not found or lost. To build a low-cost project, they didn't work on the whole system. Rather they have just focused on some particular features and finished it which can't be called a worthy low-cost project.

2.3 Summary

In this chapter, we discussed about the similar systems that are being invented before by researchers or that are already existing in the society and being sold in markets for higher prices. There are various kinds of nurse calling systems, which are mainly invented to get calling system just in old way that costs a good amount of money. These nurse calling systems are focused on various features and all these features are made to ensure the calling systems between patient and nurse rather than focusing on all the features that one needs.

Chapter 3
System Design

3.1 Introduction

Our system is designed to make easy communication between nurse and patient. The design of the system will make communication more easy, fast and wide range. If there is any kind of disturbance and unwanted line broke, this system is enough to recover within some seconds and informing the abnormality going on to the server of hospital management via nurse calling system. Such features make the system easy to troubleshoot, low cost and unique at the same time.

3.2 System description

The system is divided into three parts. They are patient side, nurse side and server side. All are described in details below:

3.2.1 Patient Side

This part contains Esp8266 Nodemcu, button, switch, buzzer, power supply 5v and RFID chip. Here, switch, button and RFID chip are the inputs of the system. Buzzer is the output of the system. This part works using *Esp8266 Nodemcu* microcontroller. It is integrated with RFID Receiver to ensure the presence of nurse beside patient's bed.

3.2.2 Nurse Side

This part contains Nodemcu D1 mini, OLED, button, switch, buzzer, battery and RFID chip. Here, switch, button and RFID chip are the inputs of the system. OLED display and buzzer are the output of the system. This part works using *Nodemcu D1 mini* microcontroller. It is integrated with RFID Transmitter to track down the activities of nurses. Besides, to enhance the security level, we have used a hash code during call time.

3.2.3 Server Side

This part contains web server where we have used an HTML, CSS and BOOSTRAP in the frontend part. In backend, a web framework named Django is applied for maintaining all kinds of call receiving, processing and sending to patient side and nurse side. Also for real time data display in server, AJAX is added in our frontend part. To make incoming and outgoing call more smoothly transmit, REST API is used.

3.3 System Design

In this section, total block diagram of the system including all the subsystems shown in fig. 3.1. We have designed the system in such a way that makes it unique from all other systems available in the market. Fig. 3.1. explains in brief how the system was made in initial step.

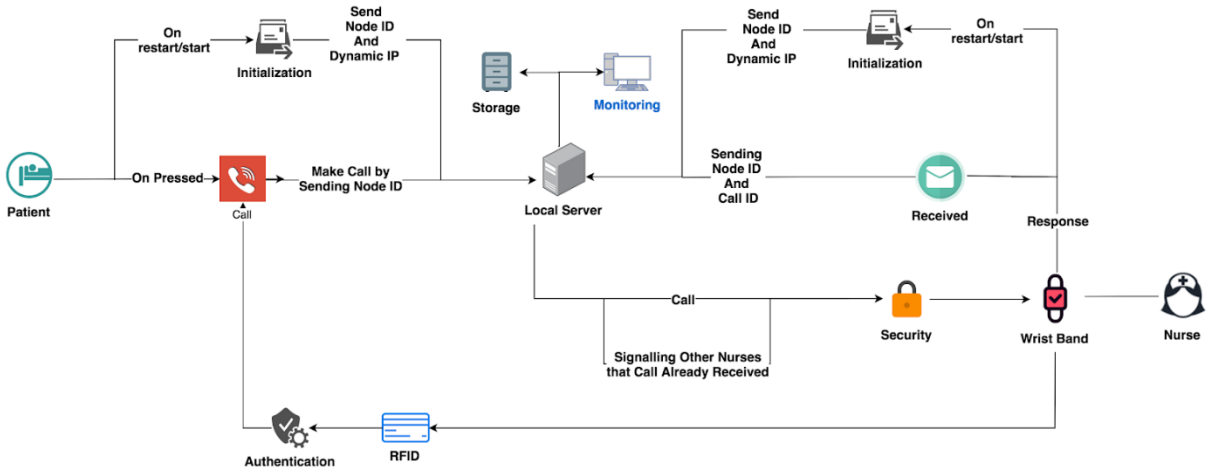

Fig. 3.1. Complete design of the system

3.3.1 Patient Side

This part of system is designed with one button and when pressed it will send an immediate call to the local server along with necessary information like Node ID or IP through the hospital WiFi system. This device has an RFID reader to authenticate nurses. After pressing the button three things will happen which are:

i) The buzzer make sound like alarm

ii) Lights will blink in Nodemcu Microcontroller

iii) Send a request to server

The lights in nodemcu will blink and the alarm immediately starts to buzz for five seconds with intervals to aware the surroundings. After the buzzer is triggered, a post request will send to the server of hospital management to notify immediately. Therefore, at the same time, in wrist band of all nurses will received a message that patient from particular bed is calling and need help for emergency. Design of the internal part is shown in the Fig. 3.2.

3.3.2 Nurse Side

Every nurse who is on duty will have a wristband to receive the calls and notifications from patient's call via the server. The wristband is also made of same wifi module, nodemcu D1 mini and has a button to receive calls. When the wrist band will power on, an initialization call will be sent to the server along with information to allocate the new IP to the server's database. This device also contains an OLED display that will show the call information and time along with that an RFID chip is embedded in the wristband for authentication and daily attendance.

3.3.3 Server Side

For processing all incoming, outgoing calls and re-routing them, a local server is installed in our system. It will receive the initialization call from both patients and nurses. The server has the facility to store calls as data and have all kind of information about patient, bed, nurse, ward etc. The server is intelligent enough to accumulate calls to the right peers.

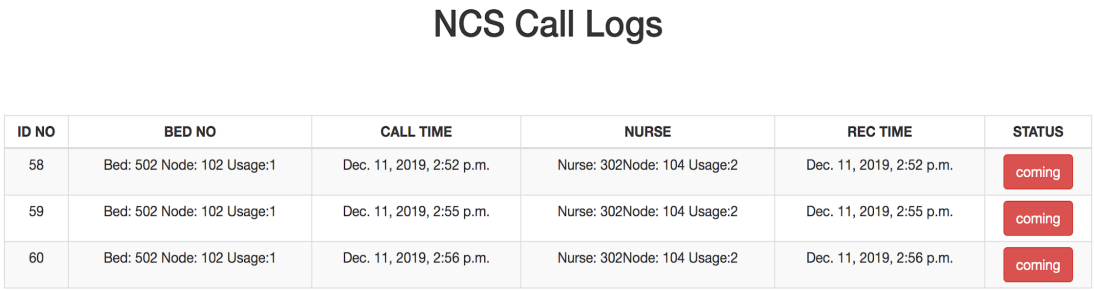

Fig. 3.2. Working procedure of Server Side

3.4 Summary

In this chapter, we have discussed how the main parts of the system works for a better understanding of the system. The system is designed into three main parts, patient side, nurse side and server side. We have discussed all the sides of the system in this chapter. The patient part of system is designed in such a way that it will ensure to reach the call nurses inside the hospital only. This nurse part consists of few features, which provides the nurse to ensure if she is agree to treat patient in that time and let them know instantly. The server system is designed in such a way that it will cover all incoming and outcoming call, track down nurses workflow and activity. It will

monitor 24*7 of the activities taking place inside the hospital and provides the service to patients. Our system lets hospital management to keep an eye on nurse scheduling and provides smart solution for maintain proper patient treatment service in simple and better way.

Chapter 4
Technical Description

4.1 Introduction

In this chapter, we will discuss about the components used for technical functions of this project. The technical description of our project will be discussed in this section. As our project comes with different types of features, we will discuss them one by one along with their roles in this project.

4.2 System Description

The entire multi-level system consists of several components which supports the project to be useful in all aspects. The components are described below for the better understanding of the project:

4.2.1 Esp8266 Nodemcu D1 Mini

Wemos D1 mini is based around the ESP8266, has one analogue port and 11 digital ports. It can be programmed via micro-USB (or remote flash via wifi). We have used it with the Arduino IDE. It runs from 5V or 3.3V. Logic levels are 3.3V for all ports. We have integrated this microcontroller to RFID transmitter and OLED display. The Esp8266 D1 mini is shown in Fig. 4.1.

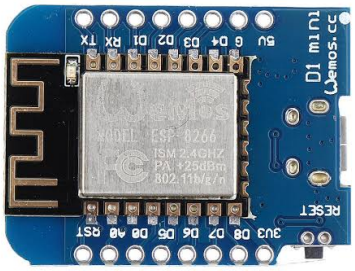

Fig. 4.1.Esp8266 Nodemcu D1 Mini

4.2.1 Esp8266 Nodemcu

ESP8266 Nodemcu is Wi-Fi module that we used in our system. It has a built in firmware that uses the Lua scripting language but also c++ is supported using Arduino IDE. It is featured with wifi capability, analog pin, digital pins and serial communication protocols. We have integrated this microcontroller to RFID display. All incoming and outgoing calls from nurse and patient's are possible because of this module. . The Esp8266 Nodemcu v3 is shown in Fig. 4.2.

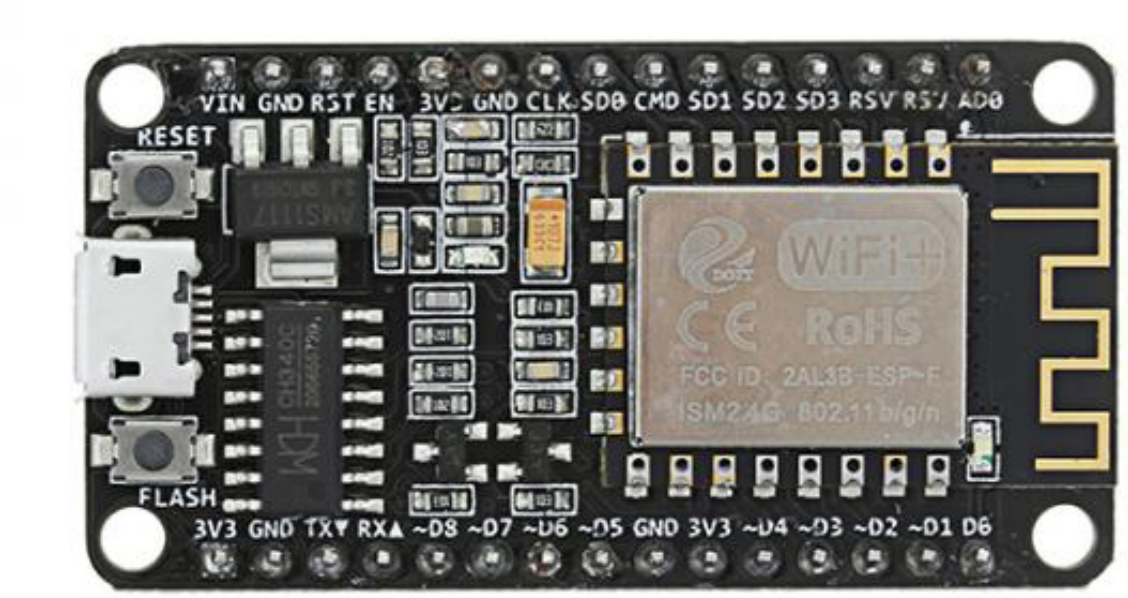

Fig. 4.2.Esp8266 Nodemcu V2

4.2.2 RFID RC522

The RC522 is a 13.56MHz RFID module that is based on the MFRC522 controller from NXP semiconductors. The module can support I2C, SPI and UART and normally is shipped with a RFID card and key fob. It is commonly used in attendance systems and other person/object identification applications. The RFID is shown in Fig. 4.3.

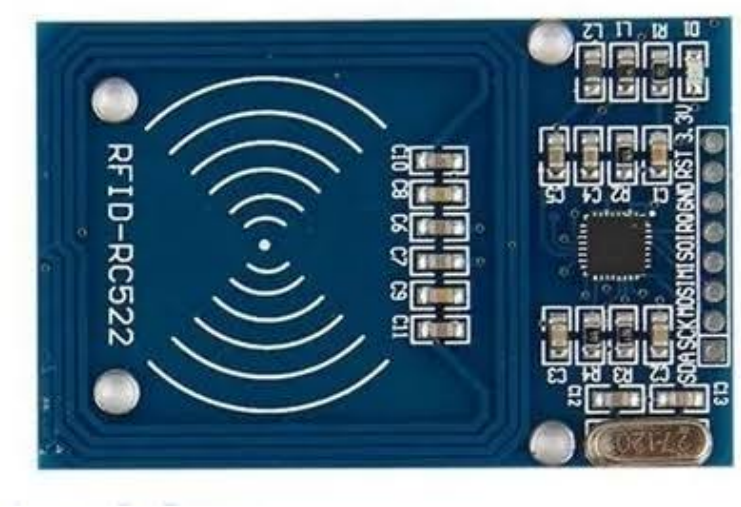

Fig. 4.3. RFID RC522

4.2.3 13.5hz RFID Tag

It is the transmitter part of RFID. It has 13.5hz frequency capacity. These tags are powered by electromagnetic induction from magnetic fields produced near the reader.

Fig. 4.4. 13.6 Hz RFID TAG

4.2.3 Buzzer

A buzzer works as an audio signaling device for alarm devices. In our project, we have previously used a 5-V buzzer, which was implemented to get an output. If any intruder enters in the home is detected by the PIR motion sensors. The normal buzzer alarms would not be heard from far clearly, which is required for the system. That is why we have used the 5-V speaker as alarm, which is compatible with the *Esp8266 Nodemcu and D1 mini*.

Fig. 4.5. 5-Volt Buzzer

4.2.3 Switch

For project purpose, we used two types telephone switch. One is press on / off , second one is toggle switch. Both are 6 pin DPDT switch. Normally known as Telephone Switch.

Fig. 4.6. Switch

4.2.4 OLED Display

This 1.3″ I2C OLED Display is an OLED monochrome 128×64 dot matrix display module with I2C Interface. It is perfect when you need an ultra-small display. Comparing to LCD, OLED screens are way more competitive, which has a number of advantages such as high brightness, self-emission, high contrast ratio, slim outline, wide viewing angle, wide temperature range, and low power consumption. It is compatible with any 3.3V-5V microcontroller, such as Arduino.

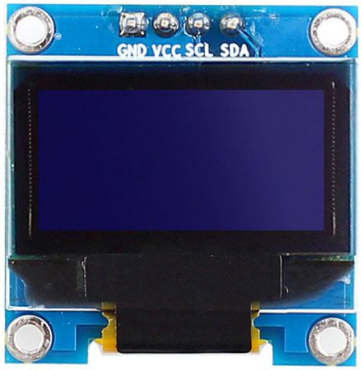

Fig. 4.7. 0.96″ I2C OLED Display

4.2.5 Battery

Lithium ion polymer (also known as 'lipo' or 'lipoly') batteries are thin, light and powerful. The output ranges from 4.2V when completely charged to 3.7V. This battery has a capacity of 500mAh for a total of about 1.9 Wh.

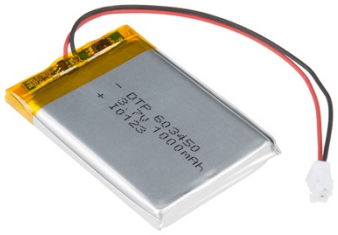

Fig. 4.8. 5-Lithium Battery 500mAh

4.2.6 Battery Controller

The battery controllers are monolithic integrated circuits designed for charging and end-of-charge control for lithium-ion rechargeable batteries. It is available in an 8.4-V version for one through four cell charger applications. Included in a very small package is an (internally compensated) op amp, a band gap reference, an NPN output transistor, and voltage setting resistors. The amplifier's inverting input is externally accessible for loop frequency compensation. The output is an open-emitter NPN transistor capable of driving up to 15 mA of output current into external circuitry.

4.2.7 Breadboard

A breadboard is a solder less device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate.

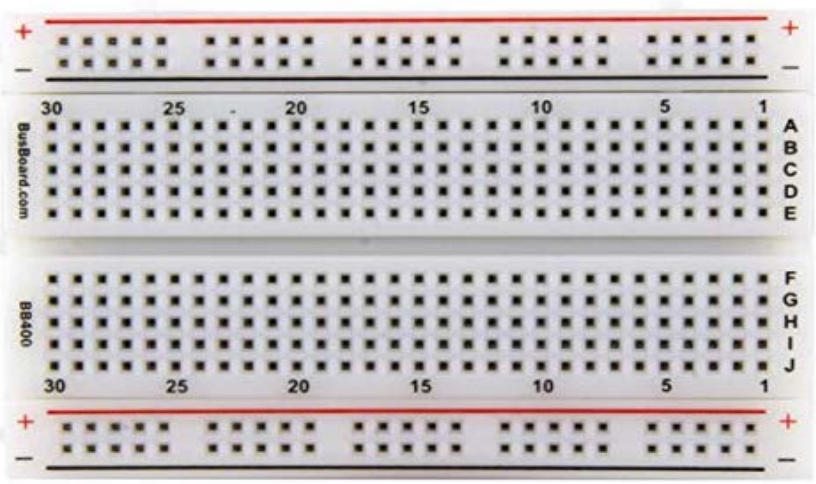

Fig. 4.9. Breadboard

4.3 Summary

In this chapter, we have discussed the components, their features and how they have played vital roles respectively to make the project a perfect one. We have discussed every single component. We have discussed about Nodemcu Esp8266, D1 mini Esp8266, RC522 RFID CHIP, OLED DISPLAY, Switch, BUZZER, Battery, Li-ion Battery Controller etc. We have used reasonable components and that is the most interesting part of the project.

Chapter 5
Design Implementation

5.1 Introduction

In this chapter, we will discuss about the design of the technical functions of the project. Implementation is the action that must follow any preliminary thinking in order for something to actually happen. Our project features required perfect design implementation in order to run in harmony with other features. We have discussed the entire design implementation in this part.

5.2 List of necessary hardware components

- NODEMCU ESP8266
- D1 Mini ESP8266
- RC522 RFID
- 13.6 Hz RFID CHIP
- OLED DISPLAY
- SWTICH
- BUZZER
- Velcro Tie
- 500mah Battery
- Li-ion Battery Controller
- Wires

5.3 Principle of operation

There are three parts of the whole system. Each part has some principles for working properly and they are described below:

5.3.1 Patient part

This part is an *Esp8266 Nodemcu v2* based which includes a button pressed option and RFID Receiver facility. When the microcontroller starts, it will send a node id and it's Wi-Fi module IP address to server and initialize its existence to server. After that if a patient presses the button that are setup in breadboard, it will make a beep noise in buzzer and the Nodemcu will blink a light. Then a post request will send to server. The server will process the call and try to figure out from which bed the call is made. Then the server will inform all the nurse are on duty that an emergency call is invoked. Nurse can response according to her wish. If a nurse received the call, all other nurse will get a notification message that the call is received. So, for all other nurses the call will be cancelled. Then the nurse who just received the call need to go near the patient's bed and punch her wrist band to RFID receiver. Then the server will finish the call. Some of this parts features:

- Call Button to Trigger Call
- Send information of caller
- Read RFID and Send Information

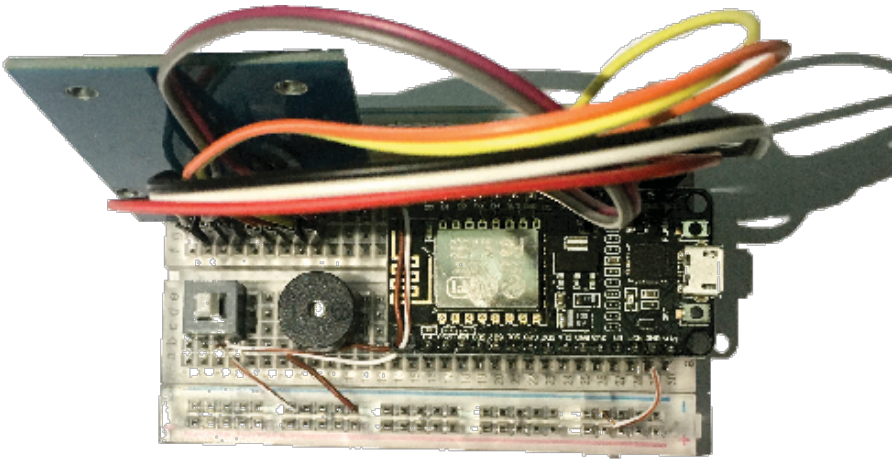

Fig. 5.1. Structure of Patient part

5.3.2 Nurse Part

When the patient will make a call via button press, all nurses on duty will get a notification message in her wrist band that a call is made from particular bed in particular ward. Any nurse call can receive the call but if she wants to refuse, she needs to don't response. If another nurse already received it, then automatically the call will be cancelled from her. In wrist band, the integrated OLED display will keep update all notifications messages. After receiving the patient's call, nurse need to punch her wrist band before RFID, then she will be identified as present and ensure that the treatment particular patient is served. Features that are covered here:

- Receive Call
- Send Call Received Information
- LCD Display
- RFID
- TIME and Battery Health Display

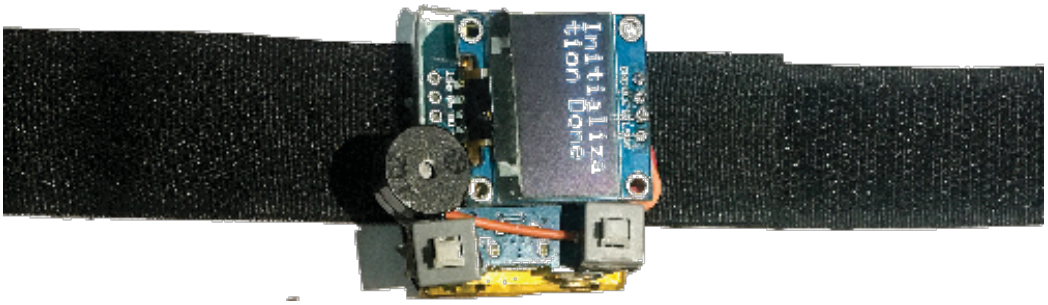

Fig. 5.2. Nurse Wrist Band

5.3.3 Server part

In this part, a web server is built for monitoring incoming and outgoing calls. Not only just monitoring but also re-routing and making track of nurse movement and activity the server is needed. Storing calling data in local database is also another reason why the server is installed.

The overall design of internal part is shown in Fig.5.2.

- Local Server based on HOSPITAL BUS
- Decision making based on the call
- Segment call information
- Extendable to Attendance using RFID

5.4 Summary

In this chapter, we have discussed the design of our project and how we achieved it with proper implementation. This process helped us to achieve more than we expected. We have used Esp8266 Nodemcu to make the whole project handier. The whole project can work individually or can be attached together. We have merged both the systems for the betterment of the project and also to make it a low-cost system.

Chapter 6

Cost of Implementation

6.1 Introduction

Key factors in the project cycle are the materials used, their costs and the technologies used to make the system work. We originally listed the things we needed when we designed our program, and as time went by, we added more components to it. We initially made a costing list with the name of the components, but later we were able to cut costs from our initial costing compared to various shops where our components were available. We also had few components that didn't last long or that weren't ideal for the project.

6.2 Cost of Implementation

We have divided the costs into two parts since the server that we have used in our project is solely a computer that lay around in any hospitals thus the cost for server is not applicable. Our soul approach to this problem is to make much cheaper than the other options in the market thus we can cut down the cost of network simply using WiFi network of the facility. Here's our two-part pricing of the project. One is for the wrist band of nurses and another is for the calling device that will be attached to patients' bed.

Nurse Wrist Band for one unit:

Component	Unit	Price
OLED Display	1	450
Node MCU D1 Mini	1	350
Button	1	5
Buzzer	1	30
Battery Controller	1	58
Battery	1	245
Wires	1	50
Velcro Tape	1	10
RFID Chip	1	50
	Total:	1248

Patient Calling Device:

Component	Unit	Price
Node MCU	1	450
RFID MRC522	1	270
Button	1	5
Buzzer	1	30
Wires	1	50
	Total:	805

Table 6.1. Total Costing Breakdown

6.3 Summary

In this chapter we have discussed what was our costing regarding initial plan and the final plan, how we could reduce the costing after research in the local markets to keep a minimum costing for the system.

Chapter 7
Results& Analysis

7.1 Introduction

We would discuss the results we have obtained and their review in this portion. This illustrates how we received our results and the outcomes of the project. We will also discuss how our concept has been evaluated for its progress.

7.2 Results& Analysis

We saw the project working perfectly after our system was analyzed individually. In other words the prototype of the entire system that we originally planned was effectively implemented. There are two main parts in the entire system and they have been combined to enhance efficiency.

Since the only similarity between the both part of the project is dynamic IP allocation functionality, we have seen that it works fluidly whenever it gets reconnected to the network it sends its IP to the server to for updating the IP.

Fig.7.1. IP Initializations

We have also seen that in experiment doing 2 nurse and 2 beds it is really fast and responsive that it proves to be one of the fasters approaches to this domain.

When We used the RFID to authenticate it sends the data to the server to be authenticated and it is smooth with the flow of the date. However, we can much improve it by using threading to the server and make it parallel to each and individual tasks. Since the system is parallelable.

RFID PICTURE

7.3 Summary

The findings and interpretation of our program have been covered in this portion. The findings are described in this chapter and we can see that the entire system has been strengthened by our approach. We also discussed the correct workings of the internal and external parts and the perfect result.

Chapter 8
Compliance with Standards

8.1 Introduction

In this chapter we will discuss the various comparisons of standards with our system, such as IEEE standard, US standard and the European standard. In general, compliance means conforming to a rule, such as a specification, policy, standard or law. Regulatory compliance describes the goal that organizations aspire to achieve in their efforts to ensure that they are aware of and take steps to comply with relevant laws, polices, and regulations.

8.2 Compliance with IEEE standards

The establishment of electrical and hardware particular architect's guidelines companionship (IEEE-SA) is an association inside IEEE that develops worldwide principles for claiming industries, including: control systems, renewable energy, biomedical health care, data engineering. Furthermore robotics, telecommunication and also home automation, transportation, nanotechnology. Our project concerns wireless nurse calling system hence we look at standards that relate to the IEEE standards concerned with wireless communication system. Wireless Calling system is meant to be make a communication between patient and nurse without any wire. It involves the wireless communication between Server and Client. The IEEE standard IEEE802.11 that is relevant to our project applies to Standards for information exchange between systems which has made communications by sending client's text to the server using WIFI Module.

8.5 Summary

In this chapter, we examined the different standards of rules regulations for transportation, and how it compared to our own wireless nurse calling system. We have shown how our system follows all the standards, IEEE standards.

Chapter 9
Design Impact

9.1 Introduction

In this chapter we will discuss about the impact of our design on environment, politics, economic aspect and health issue that we could face. We will discuss the implications of our design on every aspect individually. We will discuss how it effects the economy and society and also the personal benefit. Our system does the followings: A unified network solution which is reused, fast and efficient and a lot cheaper to implement.

9.2 Economic Impact

Hospitals are one of important places on earth and it's an emergency call house. This system not only reuse an existing network but also improves the efficiency of nurse. By using a existing network we cutting down the cost of implementing the network structure of the project and by using a local web server hospitals don't have to deal with yearly payment of the server. And when it comes to wrist band and the calling device it's really easy to produce in bulk which cuts down a lot of costs brining it down under $10. And after implement an hospital can server people with much ease thus it will make the environment of the hospital a lot better which has economic impact of the society when the costs gets cheaper it gets easier for people to get service.

9.3 Social Impact

We saw the project working perfectly after our system was analyzed individually. In other words the prototype of the entire system that we originally planned was effectively implemented. There are two main parts in the entire system and they have been combined to enhance efficiency.

The main idea of this project is to manage nurses so that the efficiency gets higher so that instead of waiting in the nurse room they can do other things. However, the main goal of this project is to reduce the cost of implementing this system especially in the government hospitals of Bangladesh. Since Bangladesh has vision 21 program it is high time to develop and digitalize all the government hospitals and in order to do that this project has a lot of potentials to have a huge impact on the hospitals.

The impact of this project is a lot significant. When the efficiency of nurses gets higher eventually the environment of the hospital gets better and if the management committee can have the data on how the nurses are operating, they can easily introduce some new regulations to the hospital. This system can bring back the ease of mind for patients as well since they are the main priority of the hospital and this will improve the patient hospital relation into some great extent. The service of the hospital will be better than the current standard and some of the issues that hospitals of Bangladesh has will be reduced.

9.4 Health and Safety Impact

Our system is designed in such a way that it has no negative impact on a person's health. Since we are talking about the hospitals there's no radiation or any kind of impact in the health of any user of the system. It is safe to use and easy to produce and one-time installation system.

9.5 Environmental Impact

To preserve the hospital standard environment, we have made the device low cost and low profile. We are talking about hospitals environments so it is really important to sustain that environment thus this device isn't loud or anything that could have any impact on the environment of the hospitals.

9.6 Manufacturability

In order to produce our system in larger scale thinking of marketing we can reduce cost per system if we get proper support from the government and buy components in bulk. Manufacturing the system can be a good deal for both the nation and for us.

9.7 Sustainability

Sustainability is one of the key aspects of our project. It is highly sustainable as it's portable and light weight for use case and since it has RFID with it can also be used for attendance purpose. It's a one-time install system that will keep providing service until the device breaks. So this project is highly sustainable.

9.8 Impact in Real Life

Our project is budget friendly and easy to use at the same time. The application in real life is much greater. If we all the hospitals of Bangladesh adopts this technology the condition will change and people will feel more reliable to the system. It's a move towards Digital Bangladesh in the health sector.

9.9 Summary

In this chapter we have discussed the impacts a Wireless Nurse Calling System will have on the economy, environment and also health. We discussed how this system does not do any pollution to the environment, provides security from every aspect and how the proper implementation with full support financially of this system can bring better days for the patients of a certain hospital. We have discussed that this is one of the cheapest alternatives in the market currently and very easy to implement.

Chapters 10
Conclusion

Our Wireless Nurse call system is designed with the new architecture and features compared to the current nurse call systems on the market. It does not only provide convenient, reliable and efficient management for direct user but also creates benefits for the deployment and installation as well as for hospitals. This system provides flexibility. It can provide customer specific requirements, the scale of each unit, from small- scale private clinics to large hospitals. When the scale and scope of the system increases, the possible installation is guaranteed to be easy, and the structure and operation of the system remains consistent. The system has integrated hardware and software, so it is easy to comply with the requirements of hospital. Hospital can reset the region, department, or rearrange the nurse rooms for relevant. The simplicity of system deployment is enhanced. The installation, setup, connection of wireless buttons in a network is easy, simple and can avoid the cables through walls and ceilings. It will save considerable cost, time of installation and maintenance. The system also is scalable in the future of the hospital.

Chapter 11
Future Work

11.1 Introduction

In this chapter, we will discuss about how we can reshape our system and use it in other fields like civil construction site, underground coal mining etc. Advancement in technology and emergence of our wireless calling system can led to the rise of integrated fast emergency help and wide range communication systems, which can be used in not only for calling but also surveillance by the monitoring of user's remote locations.

11.2 Future Planning

We have planned how we can successfully do the industrial marketing of our project. The presence of a nurse calling system provides a huge number of data of calling of patient's needs. Using and analyzing these data, any hospital can minimize their nurse assignment shift wise. Like how many nurses is sufficient and need to increase in night and day shift can be predicted. Not only that hospitals and data scientist can do analysis over disease wise patient's behavior and need using this calling system data. The features we are planning to add in future if properly nourished by our government and investors are:

- Add a camera system so that even if any patient unable to press button, the camera will auto detect the patient's condition and send a emergency call to server and let the nurse know what's happening.
- In patient side, a display will be integrated to make sure that patient can see if their call is sent and button press is working.
- Also, we will add a backup battery system in patient side so that even if there is a power cut of failure, it will be turned on always to provide the fast and instant communication.

11.3 Method of Productization & Marketing

The entire method of productization and marketing process on how we can implement the system in larger scale for marketing purpose is described below:

- **System Scalability**

The proposed system is highly scalable system and it can be deployed in many different use cases. It is a diverse system that can not only be used in emergency calling service but also it can be used for attendance can also be used as digital wearable.

- **Revenue Scope**

This project has several revenue sources: implementation, subscription and by selling generated data. If we take a look at the big picture of the proposed system, we can easily see that it can be used not just in hospitals but also multiple different fields such as construction and mass worker facilities. So, the key customers of this project are government hospitals in B2B market segment. The proposed system is one of the most economical approaches to its domain thus it could be easily installed in many different facilities and the main revenue would be though subscription and maintenance. The development cost of these products would be under $10 and can easily have around 50% revenue on implementations. Though subscription It could be about $100 per month including the servicing and maintenance generating $10,000 per month from just only 100 facilities and not to mention the generated data.

- **Innovative**

No other services in the hospitals of Bangladesh don’t use wrist band receivers for calling purpose. This project is highly effective in any kind of hospital since it is extremely cheap to make and when it is done in mass production the cost will go even down.

11.4 Market Share of current Nurse Call System around the world

Nurse calling system has become a significant part of hospital management system, and we can expect it to become even more present and discrete both inside and outside our buildings. The pie charts below will show the current share market of nurse calling system around the world from a recent study.

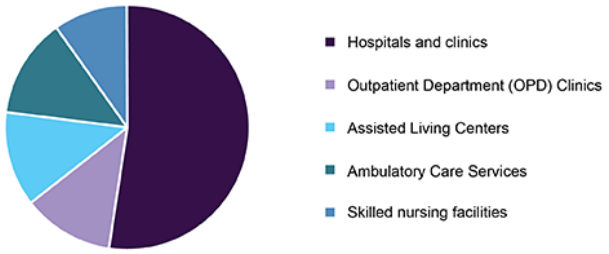

Fig.11.1. The global market Share of Nurse Calling System

11.5 Summary

In this chapter, we have discussed how we can make our system more efficient by implementing few more ideas in the future if we get the proper support and investments. Our system can add a great value to the society if properly nourished and implemented. We have also discussed how we can launch our project with proper support. Our nurse calling gives relatives and hospital authority a belief that patients will be not neglected. Every patient will be under monitoring every time. Designed to be technically advanced, simple to use and supported by unparalleled service, our nurse calling system is one of the significant systems ever.

Bibliography

[1] S. D. Peavey, J. E. Ogden, W. J. Hoyt, I. Dunn, P. E. Zmuda, D. A. Jamroga, and J. W. Jorgensen, “Calling system and method,” July 2 1996. US Patent 5,533,103.

[2] B. MEI, Z. XIONG, and Z. WU, “Design of hospital sickroom wireless calling system based on nrf401 [j],” Modern Electronics Technique, vol. 14, 2007.

[3] C. Sharma and D. K. Gautam, “Design development and implementation of wired nurse calling system,” in 2015 International Conference on Green Computing and Internet of Things (ICGCIoT), pp. 1258–1262, IEEE, 2015.

[4] N. Khera, S. Tiwari, R. Singh, T. Ghosh, and P. Kumar, “Development of android based smart home and nurse calling system for differently abled,” in 2016 5th International Conference on Wireless Networks and Embedded Systems (WECON), pp. 1–4, IEEE, 2016.

[5] J. Kuruzovich, C. M. Angst, S. Faraj, and R. Agarwal, “Wireless communication role in patient response time: a study of vocera integration with a nurse call system,” CIN: Computers, Informatics, Nursing, vol. 26, no. 3, pp. 159–166, 2008.

[6] J. H. M. Klemets, T. E. Evjemo, and L. Kristiansen, “Designing for redundancy: nurses experiences with the wireless nurse call system,” None, 2013.

[7] W. L. H. H. C. Yiwen, “Design of wireless calling system based on the zigbee technology [j],” Electronic Measurement Technology, vol. 10, 2008.

Appendices

Appendix A

Esp8266 Nodemcu v3 code

(Patient Side: Emergency Call)

The *Esp8266 Nodemcu v3* based code is given below:

```
#include <EasyButton.h>
#include <SPI.h>
#include <MFRC522.h>
#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include <ESP8266WebServer.h>
#include <ESP8266HTTPClient.h>

#define SS_PIN D4
#define RST_PIN D3

const char* ssid     = "*******";
const char* password = "*******";
String host="http://ip_address:port";
MFRC522 mfrc522(SS_PIN, RST_PIN);
EasyButton button(D1);
String node_id =[Node ID];
String rfid_code ="";
String call_id = "";

// Callback function to be called when the button is pressed.
void onPressed() {
  Serial.println("button pressed");
  patient_call();
}

void setup() {
  Serial.begin(115200);
  //connection();
  con();

  button.begin();
  button.onPressed(onPressed);
  pinMode(D2, OUTPUT);

  SPI.begin();        // Init SPI bus
  mfrc522.PCD_Init(); // Init MFRC522
}

void loop() {
  button.read();
  //connection();
  read_card();
```

```
}


void post_request(String route, String postData){

  HTTPClient http;

  route = host+route;
  char route_path[40];
  route.toCharArray(route_path, 40);

  http.begin(route_path);
  http.addHeader("Content-Type", "application/x-www-form-urlencoded");

  int httpCode = http.POST(postData);
  String payload = http.getString();

  Serial.println(httpCode);
  Serial.println(payload);

  if(route="/api/bed/"){
    call_id = "call_id="+payload;
  }
  http.end();
}

void init_server(){
  String ip_address = WiFi.localIP().toString();
  String concat_msg = "ip=" +ip_address+ "&" +node_id ;
  post_request("/api/init/", concat_msg);
}

void patient_call(){
  buzzer_sound();
  post_request("/api/bed/",node_id);
  Serial.println("/api/bed/ -> done");
}

void rfid_send(){
  buzzer_sound();
  String msg = call_id +"&rfid="+rfid_code;
  post_request("/api/rfid/",msg);
  Serial.println(msg);
  call_id="";
}
```

```
void read_card(){

  String UID_string ="";

  if ( mfrc522.PICC_IsNewCardPresent()){

    Serial.println("Trying to Read RFID");

    if ( mfrc522.PICC_ReadCardSerial() && call_id.length()>0){

        Serial.print("Tag UID:");
        unsigned long UID_unsigned;
        UID_unsigned = mfrc522.uid.uidByte[0] << 24;
        UID_unsigned += mfrc522.uid.uidByte[1] << 16;
        UID_unsigned += mfrc522.uid.uidByte[2] << 8;
        UID_unsigned += mfrc522.uid.uidByte[3];

        UID_string = (String)UID_unsigned;
        Serial.println(UID_string);
        Serial.println();
        mfrc522.PICC_HaltA();

        rfid_code = UID_string;
        rfid_send();
    }
  }
}

void buzzer_sound(){
    bool toggle = true;
    digitalWrite(D2, toggle);
    delay(200);
    toggle=!toggle;
    digitalWrite(D2, toggle);
}

void connection(){

  WiFi.begin(ssid, password);

  if(WiFi.status() != WL_CONNECTED){
    connection();
  }
  else if(WiFi.status() == WL_CONNECTED){
    init_server();
```

```
    Serial.println("Initialization Done");
  }
}

void con(){
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.print("Connected to ");
  Serial.println(ssid);
  Serial.print("IP address: ");
  Serial.println(WiFi.localIP());

  init_server();
}
```

Appendix B

Nodemcu D1 mini code

(Nurse Side: Response Part)

The *Nodemcu* D1 mini based code is given below:

```
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h> //OLED

#include <RestClient.h>
#include <EasyButton.h>
#include <ESP8266WebServer.h>

#define OLED_RESET LED_BUILTIN  //4 SDA > D2 , SCL D1 OLED STUFF
Adafruit_SSD1306 display(OLED_RESET);

#if (SSD1306_LCDHEIGHT != 64)
#error("Height incorrect, please fix Adafruit_SSD1306.h!");
#endif

const int port = 8080;
const char* host = [IP Adresss];

const char* ssid = "********";
const char* password = "********";

String node_id = [Node ID];
String response = "";
String call_id = "";
bool call_status = false;

RestClient client = RestClient(host,port);
ESP8266WebServer server(80);

#define BUTTON_PIN D6                 // DD6
#define BUZZER_PIN D7                // D7

EasyButton button(BUTTON_PIN);
bool toggle = true;

void onPressed() {
```

```
  if(call_status)
  {
    onpress_side();
    call_status = false;
  }
  else
  {
    clear_screen();
  }


  Serial.println("Button has been pressed!");
}


void setup() {
  Serial.begin(115200);
  display.begin(SSD1306_SWITCHCAPVCC, 0x3C);
  button.begin();
  button.onPressed(onPressed);
  pinMode(BUZZER_PIN, OUTPUT);

  connection();
  route_server();
}

void loop() {
  server.handleClient();
  connection();
  button.read();
}


void init_server(){
  String ip_address = WiFi.localIP().toString();
  String concat_info = "ip=" +ip_address+ "&" +node_id ;
  char msg[30];
  concat_info.toCharArray(msg, 30);
  int statusCode = client.post("/api/init/", msg, &response);
}

void onpress_side(){
  Serial.println("Button has been pressed!");
  print_screen("Updating the server!");

  //NEED TO ADD CALL ID ALONG WITH NURSE ID
```

```
  String str = node_id+"&"+call_id;
  char msg[30];
  str.toCharArray(msg, 30);
  int statusCode = client.post("/api/nurse/", msg, &response);
  Serial.println(response);

  buzz();
  print_screen("Update done!");
}

void print_screen(String str){
 display.clearDisplay();
  display.display();

  display.setTextSize(2);
  display.setTextColor(WHITE);
  display.setCursor(0,0);
  display.println(str);
  display.display();
}

void clear_screen(){
 display.clearDisplay();
 display.display();
}


void route_server(){
    server.on("/",HTTP_POST, incoming);
    server.on("/alert",HTTP_POST, alert);
    server.begin();
}

void incoming() {
  Serial.println("Got One Incoming");

  String security_code = "123456789";
  if (security_code == server.arg("sc"))
  {
    Serial.println("CALLING...");
    print_screen("CALLING...");
    buzz();
    String bed_id = server.arg("bed_id");
    call_id =  "call_id=" + server.arg("call_id");
    Serial.println("Bed: "+bed_id);
    server.send(200, "text/plain", "success");
```

```
    call_status = true;
    return;
   }
  server.send(200, "text/plain", "404");
}


void alert() {
  Serial.println("Got One Alert!");

  String security_code = "123456789";
  if (security_code == server.arg("sc"))
  {
    buzz();
    String msg = server.arg("msg");
    print_screen(msg);
    server.send(200, "text/plain", "success");
    return;
  }
  server.send(200, "text/plain", "404");
}


void connection(){
  if(WiFi.status() != WL_CONNECTED){
    print_screen("Connecting...");
    int a = client.begin(ssid,password);


    if(WiFi.status() == WL_CONNECTED){
      init_server();
      Serial.println("Initialization Done");
      print_screen("Initialization Done");
    }
  }
}

void buzz(){
  digitalWrite(BUZZER_PIN, true);
  delay(300);
  digitalWrite(BUZZER_PIN, false);
}
```