DESIGN AND CONSTRUCTION OF AN RFID DRUG PRESCRIPTION MANAGEMENT SYSTEM (HARDWARE)

BY

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(PHYSICS ELECTRONICS TECHNIQUES)

DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN,

BENIN CITY.

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY, FACULTY OF LIFE SCIENCE, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE (B.SC) IN SCIENCE LABORATORY TECHNOLOGY (PHYSICS/ELECTRONICS TECHNIQUES).

NOVEMBER, 2022.

CERTIFICATION

This is to certify that this project work was carried out by Izehise Lucky IGBINOMWANHIA with matriculation number, LSC1605958 of the Department of Science Laboratory Technology (Physics/Electronics Techniques), Faculty of Life Sciences, University of Benin, Benin City.

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DEDICATION

I dedicate this work to God Almighty, my father, Anthony Igbinomwanhia and the rest of my family for the inspiration and encouragement given towards the successful completion of this work.

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I would like to acknowledge the University of Benin and Management for the platform given to me. I would like to acknowledge the department of Science Laboratory Technology for this opportunity. I also would like to acknowledge the lecturer of Physics/Electronics Techniques.

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In all I say, 'TO GOD BE THE GLORY'

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LIST OF ABBREVIATIONS

RFID= Radio Frequency Identification

LCD= Liquid Crystal Display

IOT= Internet of things

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ABSTRACT

The device described in this study can be used in hospitals to verify prescriptions, maintain patient data, and protect patient privacy. In this study, patient databases are tracked using RFID tags and a web server. This method can prevent prescription drug abuse in addition to capturing precise and current information on patients' prescriptions. Real-time patient data can assist clinicians in reducing medication errors and provide the best care possible. In this paper, a medical mechanism that uses the modified grouping proof process is suggested in order to improve medication safety for inpatients.

The medical staff could verify the authenticity and integrity of a group of Radio-Frequency Identification (RFID) tags that are embedded on inpatient bracelets and drug containers by using the grouping proof protocol. RFID authentication is the ideal option for automated patient medication systems since it requires mutual authentication between the medication server and the tag.

CHAPTER ONE

INTRODUCTION

1.01 BACKGROUND OF STUDY.

Today, there is a big utilization of information technology in various business services. The healthcare industry is essentially tied to economic development (Balog *et al.,* 2020). It is evolving quickly, necessitating a critical need for efficient hospital management software (Husar and lakovets, 2019). Modernizing healthcare institutions has led to the development of numerous cutting-edge health management strategies. 56% of drug errors occur when ordering, 34% occur when administering, 6% occur when transcribing, and 4% occur when dispensing in hospitals.

The Institute of Medicine (IOM) reports that despite hospital statistics data demonstrating that the majority of healthcare institutions have computerized medical data, a patient may face many drug mistakes during the clinical process (Omotosho *et al.,* 2019). Additionally, there are approximately 1.5 million drug mistakes that could have been prevented each year in the US. Hospital management provides a technique to reduce mistakes, improve medicine safety, and quicken the flow of materials and information. A similar method may be used to record patient health cards.

Typically, medical facilities use warehouses to run their operations (Safae *et al.,* 2020).. For logistical reasons, a variety of procedures are employed in warehouses to allocate data to products. To give one example, medications and materials sold in the European Union are identifiable by a serial number, a batch number, a serial number (a 13-digit code), and a Global Trade Identification Number in compliance with the rules controlling pharmaceutical labeling. The GS1 code formatted information is printed on the product's packaging. The GS1 data matrix code is read to check and verify the distribution of medications. If the validity of the medication is established, the patient is given the medication (Safae *et al.,* 2020).

Healthcare services are intricate and life-critical; a single mistake in any procedure could have lifelong consequences (Ting *et al.,* 2011). Information and communication technology are therefore used by many studies to improve service standards and boost patient safety by reducing medical errors. Radio frequency identification, or RFID, is a newly developed tool that can help with the problems of the current scenario. Medical institutions have started using RFID in recent years to manage and track medical equipment, monitor and identify patients, ensure the right medication is given to the right patient, and stop the use of fraudulent medications (Ting *et al.,* 2011).

The majority of the literature that is currently accessible, however, focuses on outlining how RFID might benefit the healthcare industry, while giving less attention to the managerial difficulties involved in implementing an RFID project in medical organizations. In this paper, an exploratory case study in a medical organization is conducted in order to illustrate the development framework and significant challenges that should be considered during the planning, execution, and maintenance stages of developing such a project. People who want to start using RFID in medical organizations might get useful advice from the study's experiences and conclusions (Ting *et al.,* 2011).

In the not-too-distant future, the ability of RFID systems to offer precise and accurate data on tagged products will enhance efficiency and bring additional benefits to both the corporate community and consumers (Bardaki *et al.,* 2012).

RFID is not a new technology in the conventional sense because of its low present cost and advancements in other computing fields that broaden its potential applications. It only recently started receiving greater notice. Radio frequency identification (RFID) is a smart system that combines microchip and radio frequency technology that can be used to identify, monitor, secure, and classify items. RFID systems, at their most basic, use tiny chips called tags that broadcast identifying information to an RFID reader, a device that may then communicate with computers (Dawes, 2014).

Radio waves are employed in radio-frequency identification (RFID) technology to send data from an electronic tag, sometimes referred to as an RFID tag or label, attached to the object in order to identify and track it. Using radio frequency identification (RFID), a well-known method that makes use of electromagnetic or electrostatic coupling in the radio frequency area of the electromagnetic spectrum, a thing, an animal, or a person can be uniquely identified. A coded identification number is released when an RFID chip's radio transmitter is scanned by a reader device (Amirjan, 2011). Several meters away and outside of the reader's line of sight, some RFID tags can be read. Bulk reading is used to practically allow concurrent tag reading (Amirjan, 2011). Even animals are implanted with this little type to identify them when they receive consumer items.

The data on the tag is electronically saved. The RFID tag has a tiny RF transmitter that sends a radio signal that is encoded to the tag in order to ask it questions and a receiver that receives the message and returns the tag's identification information. Some RFID tags operate without batteries. The reader's radio energy is used by the tag as its energy source instead. The architecture of the RFID system include a technique for differentiating between several tags that might be in the RFID reader's field of view. RFID has a wide range of uses. Any object can have a tag attached to it, which can be used to manage inventory, assets, people, and other things. It can be attached to things like cars, computers, books, cell phones, etc. RFID has been employed by the healthcare sector to cut down on counting, looking for things, and auditing objects. RFID is widely used by financial organizations to automate compliance and track important assets. RFID is being utilized to connect the physical world with contemporary developments in social media. with the online environment. The first mention of RFID in social media occurred in 2010 at the Facebook annual conference (Amirjan, 2011).

Compared to manual systems and bar code systems, which have been in use since the 1970s, RFID is a better and more effective means to identify objects. Additionally, if passed close enough to an RFID scanner, passive RFID tags (those without a battery) can be read. As opposed to a bar code, the tag does not need to be "seen" to the reader device (Dawes, 2014). In contrast to barcodes, RFID tags may be read hundreds at a time and do not require line of sight to read. The tag can also be read within a case, carton, box, or other container. Only one bar code can be read at a time (Dawes, 2014).

Despite significant improvements in patient medical information sharing across healthcare providers, experts still need to address the problem of effective electronic medical records. Real-time information, then, continues to be a problem for the emergency response sector. Giving emergency doctors an accurate medical history of the patient could mean the difference between life and death in emergency situations, especially with unconscious, incoherent, and unsupervised patients. Due to its improved functionality, low cost, great dependability, and simplicity of use, RFID technology has permeated the healthcare industry. In order to effectively handle vital information for emergency care across hospital and national boundaries, as this article illustrates, our main goal was to build an RFID-based system architecture and data model. (Cristina *et al.,* 2009)

Millions of people suffer injuries or pass away as a result of poor medical care, according to recent research and surveys conducted by the World Health Organization (WHO). The misidentification of diseases and the patient's most recent medical history have been found to be contributing factors in the rising death rate. They are helped by RFID and IOT technology, which improves services in medical facilities. It lessens file work and mistakes. The introduction of RFID into the sphere of supply chain management has been a remarkable success. It has recently been used in the healthcare industry to increase effectiveness and safety. It works better and is more affordable in the healthcare industry. As the patient enters the hospital, an RFID device is utilized to follow and monitor them and get any database information about previous illnesses, allergies, etc (Shivani and Avinash, 2020).

1.02 AIMS AND OBJECTIVES

This paper is geared towards designing a circuit using an RFID reader and an RFID tag to prescribe or administer drugs to a patient and also record and keep the medical history of the patients. For better management of the patients data, the system using a software interacts with the users through their smartphones and computer that allows them to access the newly prescribed drugs and older medical history.

1.03 SIGNIFICANCE OF THE STUDY

The use of an RFID drug prescription management system offers the chance to improve patient care, integrate performance metrics into clinical procedures, and streamline clinical research. A number of issues have been brought up, including the difficulty of recruiting participants in trials, the laborious and intrusive nature of data gathering, and the generalizability of the findings. There is a lot of interest in using RFID medical records systems to buck these tendencies.

Initially, observational studies, embedded pragmatic or post-marketing registry-based randomized studies, or comparative efficacy studies are anticipated to use electronic health records as the primary data source. Electronic health records may be utilized to evaluate research viability, to ease patient recruitment, and to speed data collection at baseline and follow-up, advancing this strategy for randomized clinical trials. The hurdles of adopting electronic health records in clinical research include ensuring data confidentiality and privacy, overcoming the difficulties of connecting various systems, and sustaining infrastructure for repeated usage of high quality data. The increasing use of electronic health records in clinical research depends on collaboration between academics, industry, regulatory agencies, policy makers, patients, and electronic health record providers.

1.04 LIMITATIONS OF THE PROJECT

Though this project has a lot of benefits and relevance, it is challenged with limitations. These limitations include;

1. Users must have mobile data in order to make use of the software website on their mobile phones or computer for accessing the medical history of a patient and also administering drugs to the patient.
2. The circuit lacks the capability to inform the user when it is fully charged.

1.05 SCOPE OF THE WORK

The project entails the construction of an automatic embedded system used for keeping the medical history of the registered patients in an hospital or clinic as well as the prescription of drugs. The paper covers an RFID system working with an RFID tag and a software that enables collection of the patients medical data. The software allows easy interaction between the user and the circuit.

CHAPTER TWO

LITERATURE REVIEW

2.01 RFID TECHNOLOGY.

A radio frequency identification (RFID) system is an automatic technology that enables machines or computers to identify things, record metadata, or control certain targets using radio waves. By connecting to an Internet terminal, RFID scanners may locate, track, and keep a watch on the things with tags in order to identify them automatically and in real-time (Xiaolin *et al.,* 2012). RFID is a wireless communication technology that enables computers to read the identity of inexpensive electronic tags from a distance without the need for a battery inside the tags. As it advances, RFID technology will likely lead to a new wave of applications that profit from automatic identification that is both affordable and widely available (Badri *et al.,* 2006).

When RFID technology initially emerged, it was not widely used because of a lack of standards and high pricing. New technology has reduced costs, and standards are being developed. Today, the majority of operations that make use of RFID include supply chain management, tracking livestock, detecting fakes, access control in buildings, and automated checkout. The use of RFID is being constrained by standards challenges and security concerns. This essay examines RFID technology and its current uses (Sanjay and Pavan, 2010).

In applications that speed up the transportation of raw materials and manufactured goods, radio frequency identification technology has emerged from obscurity and gained widespread adoption. RFID technology allows identification from a distance and without a line of sight, in contrast to previous bar-code technology (Roy, 2006). RFID differs from past technologies like electronic data interchange (EDI), software agents, and the Internet because it offers "sensing" capabilities in a physical environment that is becoming more dynamic and mobile (John *et al.,* 2007).

RFID tags offer more unique IDs than bar codes and can also contain further details about the product's producer, type, and even environmental measures like temperature (Mandeep *et al.,* 2011). Additionally, RFID technology can automatically identify many tags that are dispersed across the same geographic area. As an illustration, visualize a grocery store checkout counter where each bar-coded item must face the reader before being scanned. Why then did it take more than 50 years for this technology to become extensively used? Cost is the main defense. To compete with printed symbols' low prices, electronic identification solutions must either be as affordable or provide enough added value for an organization to recuperate the cost someplace else. Although more expensive than traditional labeling techniques, RFID adds value and has become affordable enough to be used widely for controlling consumer items in retail settings (Mandeep *et al*., 2011) As a result of its adoption in the industrial, retail, pharmaceutical, and logistics industries, RFID is now being evaluated for application in a range of fields, including ubiquitous computing, health care, agriculture, transit, and security (Abu and Zubair,2008). An RFID framework is made up of various components connected by a specific communication channel. To realize the benefits of an RFID solution, the component pieces are coordinated into a framework. The list of components is as follows:

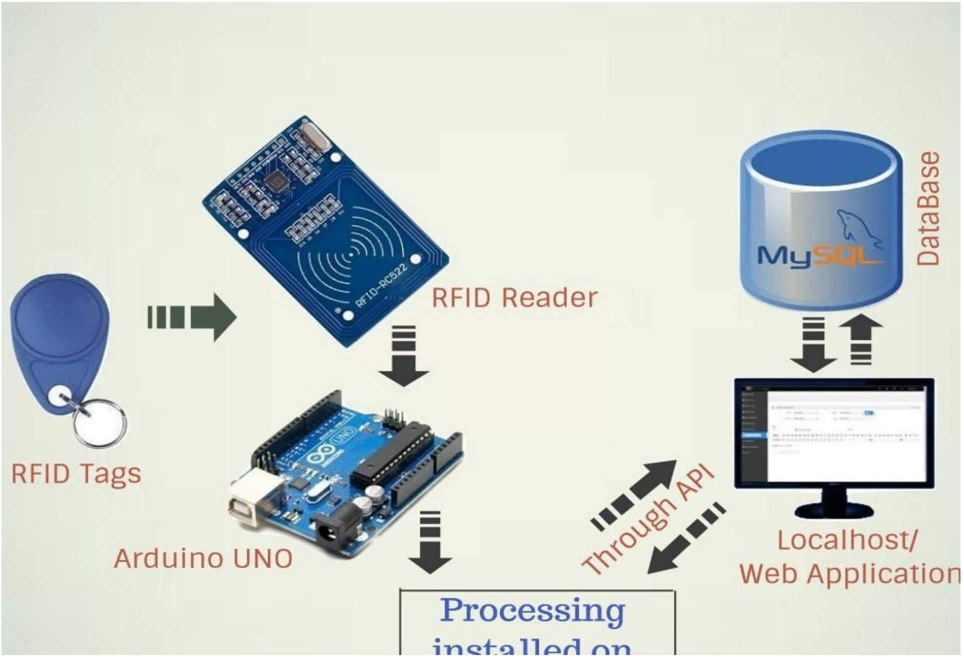


Fig 2.10 : Block diagram of an RFID system (Turcu, 2011)

A. Tags: Tags is sometimes referred to as the transponder, which is derived from the terms of the transmitter, and it consists of a chip and an antenna. (Mohammed and Kameswari, 2013)

B. Antenna: It is in charge of utilizing radio waves to transmit information between the reader and tag (Mohammed and Kameswari, 2013). The reception and transmission of a radio signal will be compromised if an antenna is not set to the same frequency range as the radio system to which it is attached (Lehpamer, 2012).

C. Reader: a scanning gadget that makes use of an antenna to identify nearby tags. It sends signals to the tag at a specific frequency and waits for the tag to respond. When this energy is detected, the tag responds with a response that includes its serial number and maybe other data as well. (Nainan *et al.,* 2013).

D. Middleware: The widely used RFID board demands the least amount of work from tags and readers, as well as an appropriate systems administration framework. This supporting RFID foundation typically includes a component frequently referred to as RFID middleware. It serves as a correspondence interface to process and translate the information that readers feed into the data. It takes into account each important point of contact and a product application to speak to this data. (Nainan *et al.,* 2013)

E. Backend Database: A vault of data, which is designed specifically for the application. The database stores records.

Radio frequency identification was developed at the same time as mobile phones, laptops, and wireless networks. It is employed in many contexts, including healthcare, to stop the selling of counterfeit medications (Safae *et al.,*2020). Without making physical touch, the identificationmethod (Fig 2.01) reads an RFID tag that is attached to a person or an asset.

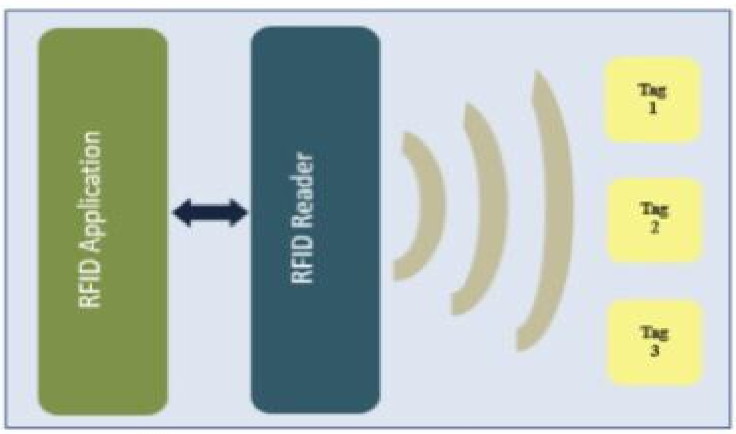


Fig 2.01. RFID identification process. Source: Safae *et al.,* 2020

If the tag uses the same energy source as the reader, it can be considered passive. If this tag uses a different energy source than the reader, it is then active. The third form of tag is called a semi-active tag, which uses the energy from the reader to send data while the energy from the tag fuels the chip (Safae *et al.,* 2020).

Fig. 2.02 RFID tags

Source: Safae *et al.,* 2020

RFID technology works under the following frequency bands:

• Low Frequency: 125 -134 KHz

• High Frequency: 13.6 MHz

• Ultra-High Frequency: 865-954 MHz

• Microwave: 2.4 -5.8 GHz

RFID technology offers large possibilities such as different shapes of tags and storing information in the tag memory but requires extensive research due to its particular complexity (Safae *et al.,* 2020)

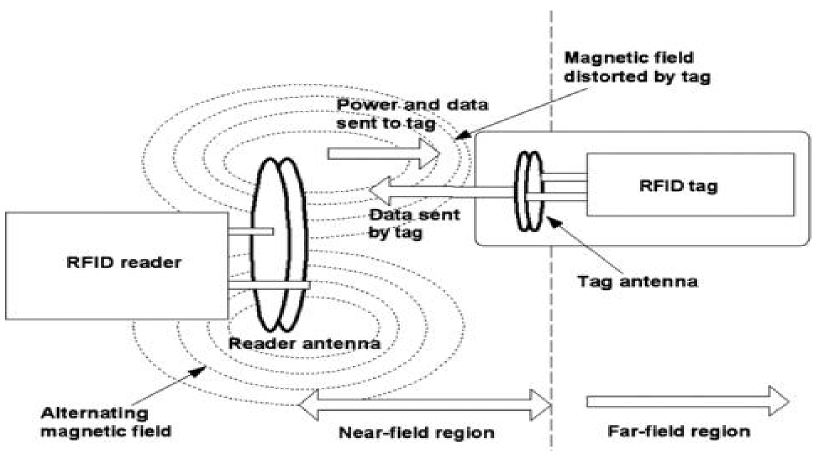


Fig 2.03 Working schematic diagram of an RFID system. Source: Kumar *et al.,* 2009

2.02 HISTORY OF RFID

Every day, we employ radio frequency identification (RFID). This term refers to any procedure that permits information to be sent by radio transmission between mobile units or between permanent units (Land J, 2005). World War II is where RFID first emerged. Sir Robert Alexander Watson-Watt, a Scottish physicist, devised radar in 1935. Radar was then employed to warn of approaching aircraft (Paulo and Tales, 2017). In order to change the reflecting radio signal as their aircraft approached the base, German pilots, for instance, used an unusual maneuver. Due to this simple procedure, the ground radar personnel was told of German planes returning and not friendly aircrafts. One of the earliest passive radio frequency signal detection techniques, perhaps. (Land J, 2005).

Under Watson-guidance, Watt's British scientists created a unique system with an extremely brilliant concept during World War II. All British planes had transmitters, and when they detected signals from ground-based radar systems, they began broadcasting a signal back identifying the plane as a friendly one. A signal must be sent to a transponder for RFID to function; once awake, the transponder must either reflect the signal back (if the system is passive) or broadcast the signal (active system). It was done using the "identify friend or foe (IFF)" method. Radar and RF communications made great strides in the 1950s and 1960s, mostly because to American and European research. The use of an energy in the RF band for remote object detection and identification is extensively covered in a number of academic works. In a remarkable article from 1948 titled Communications by Means of Reflected Power, Harry Stokman stated, "Evidently, considerable research and development work has to be done before the remaining fundamental problems in reflected-power communication are solved, and before the field of useful applications is explored" (Domdouzisa *et al.*, 2007). RFID systems were still considered to be "secret technology" throughout the 1960s and 1970s. As an example, the US Energy Department gave the Los Alamos National Laboratory permission to develop a system for monitoring and controlling sensitive materials. Innovators, developers, academic organizations, and government laboratories all put a lot of effort into researching RFID. One of the earliest RFID inventions is that of Mario W. Cardullo, who received a US patent on an active RFID tag with rewritable memory on January 23, 1973. Technology advancements in the 1980s and 1990s led to cheaper costs as well as the creation of more intricate and extensive RFID systems. It is a critical task to begin standardization for the interoperability of RFID devices or systems. Only in the USA do RFID systems reach the critical milestone of millions of tags, especially from the automotive industry, in the 1990s. The Massachusetts Institute of Technology (MIT) opened the Auto-ID center in 1999 with support from the Uniform Code Council, EAN International, Procter & Gamble, and Gillette. This facility conducts research on automatic identification, particularly UHF RFID. Between 1999 and 2003, the Auto-ID Center received assistance from the US Department of Defense, multiple key RFID suppliers, and more than 100 sizable end-user enterprises. (James, 2015). The MIT Auto-ID center established the global Electronic Product Code, an entity in charge of furthering the EPC standard. Some of the largest retailers in the world including the US Department of Defense have announced their plans to use EPC technology. The Auto-ID center's doors were closed in October 2003, and the research duties were transferred to Auto-ID Labs. In December 2004, EPC Global was adopted as the second-generation standard, which is now widely utilized. Several industries are using this technology. Thanks to cheaper equipment and tag prices, enhanced performance with 99.9% dependability, and a solid global standard, the adoption of RFID systems had a substantial uptick in the 2010s.

In March 2010, a Korean lab successfully created a printed gadget with a significantly lower cost thanks to the usage of carbon nanotubes. The International Standard Organization (ISO) took part in the creation of technical and practical standards that have a high level of interchangeability. Hundreds, if not thousands, of applications and industrial sectors use RFID technologies (aerospace, automotive, logistics, transport, health, life, etc.). Currently, there are different RFID frequency bands with sizes ranging from a few kilohertz to a microwave frequency band (2.4-2.5 GHz). One of the newest is the UHF Generation 2, which runs at 860-969 MHz (James, 2015).

System engineering, circuit technology, software development, integrated circuit design, network engineering, antenna theory, propagation theory, microelectronics technology, materials technology, receiver and transmitter design, encryption theory, mechanical design, and mechanical engineering are just a few of the professionals and knowledge areas that are combined in the wonderful technology known as RFID (Weinstein, 2005)

2.03 APPLICATIONS OF RFID

2010 saw a significant increase in the use of RFID due to three key factors: lower costs for tags and equipment, improved performance with 99.9% dependability, and a reliable worldwide standard for UHF passive tags. More than 60% of the top medical equipment manufacturers used passive UHF RFID in 2010. The main applications are financial services for IT asset tracking and healthcare. RFID is spreading as the cost of the technology falls (Turcu, 2011). As a result, some of the present-day usage are:

- **Electronic Vehicle Registration**: The government is employing RFID technology for vehicle registration because car security is a major issue in many countries. This helps with both the detection and recovery of stolen vehicles (O'Connor, 2014).

- **Payment by Mobile Phones**: Device Fidelity, based in Dallas, Texas, has collaborated with two credit card issuers since the summer of 2009 to create specific microSD cards. The microSD card can function as an RFID reader and a passive tag when it is put into a mobile device. After inserting the microSD, a user's phone can be used to make mobile payments and be connected to bank accounts. Diaryqueen and Vivotech have started embedding RFIDs on mobile phones as part of their new loyalty and rewards program, taking advantage of the benefits of RFID technology. The option exists for customers to purchase an RFID tag for their phone. Once activated, the phone can start receiving offers and coupons that the Vivotech hardware can scan. Both this and Nokia's 2008 6212 gadget support RFID. The device allows users to quickly access bank accounts and save credit card information. Users would need to input a passcode or PIN before a transaction is permitted if the phone served as the platform for mobile payments, enhancing the device's security (Turcu, 2011).
- **Transportation Payments**: Governments utilize RFID applications to regulate traffic, while automakers use a variety of RFID tracking systems to manage their product lines. (Emenike, 2007).
- **Car-Sharing**: The car-sharing service Zipcar uses RFID cards to identify users and lock and unlock vehicles (O'Connor, 2014).
- **Toll Roads**: Active tags, which are frequently utilized, are remotely scanned when cars pass through the booths, and the information from the tags is then used to debit the toll payment from a pre-paid account. Since the system keeps track of the date, time, and billing details for the RFID car badge, it aids in accelerating traffic through toll plazas. This has been implemented in a number of Nigerian cities (Emenike, 2007).

- **Public Transit** (bus, rail, subway): T-money cards can be used to pay for public transportation in South Korea. The majority of convenience stores and subway vending machines also accept it as payment. 90% of cabs in Seoul accept credit cards, including the T-money card and the majority of major credit cards. UPASS, which used MIFARE technology and had been used for transit payments since 1996, was replaced by T-money (O'Connor, 2014). In addition, the RFID payment system known as the "octopus card" is almost the only option to pay for public transportation in Hong Kong. Other nations, such as Canada, Russia, and others, have also used this (O'Connor, 2014).
- **Asset Management and Retail Sales**: Businesses may identify and manage their assets by using RFID, mobile computing, and online technologies. It was first introduced to large retail by Knoxville, Tennessee resident Craig Patterson. Thanks to integrated RFID readers, mobile computers may now provide a full range of capabilities that reduce paperwork and enable identity and attendance verification (Turcu, 2011). Businesses may manage their resources and make management decisions from any location in the world thanks to web-based management tools. As a result, the end user is always provided with accurate, up-to-date information. Web-based solutions now enable other parties, such as manufacturers and contractors, to update asset data online, such as inspection histories and transfer papers. Businesses already utilize RFID tags in conjunction with a mobile asset management solution to log and track asset locations, status updates, and maintenance information. At the item level, retail users are embracing RFID. Along with improvements in efficiency and product accessibility, the system offers customers a better self-checkout experience and a more effective method of electronic article surveillance (EAS). Other industries have adopted the technical standard for labeling IT assets developed by the financial services technology

consortium (FSTC). In order to passively RFID-tag IT assets, for instance, the US State Department is now implementing the ISO/IEC 18000-6 standard. In the Japanese city of Osaka, officials from the school are currently chipping student identification cards, backpacks, and apparel for kids (Tanpure, 2013). Whitcliffe Mount School in Chesterton, England uses RFID in a manner similar to this to track who enters and leaves the premises using a specially created card. At the moment, several Philippine schools have RFID ID scanners posted on their gates that may be used to sign students and teachers in and out, borrow books from the library, and make purchases at the school store and canteen (Tanpure, 2013).

- **Human Implants**: Humans now have RFID implants that were originally designed for animal tagging. As a test subject for RFID implants, British cybernetics scientist Kevin Warwick had a chip put in his arm in 1998. Conrad Chase gave his nightclubs in Barcelona and Rotterdam implanted chips in 2004 so that VIP patrons could be identified and charged for drinks. In order to manage access to a protected data room, the Mexican Attorney General's office implanted verichips in 18 of its staff in 2004 (O'Connor, 2014).

2.04 ADVANTAGES OF RFID

- Reader can read and write data to RFID tags without direct contact and no line of sight problem
- Data from the multiple RFID tags are accessed by the reader by radio waves
- No maintenance costs
- Fast read and write with the time taken for read/write being a few milliseconds

RFID tags can also be integrated with other technologies. E.g. Wireless sensor networks for better connectivity.

2.05 INTERNET OF THINGS (IoT)

A network of physical objects (things) that are outfitted with sensors, software, and other technologies in order to connect to other systems and devices and exchange data with them online is referred to as the "Internet of Things" (loT) (Magaret and Rouse, 2019; Brown and Eric, 2016; August et al., 2015; Drew and Hendricks, 2015). The Internet of Things (IoT) was brought about by the advancement of electrical technologies such as machine learning, real-time analytics, inexpensive sensors, and embedded systems (Magaret and Rouse, 2019). The most noticeable advancement in the Internet of Things over the past few years has been the exponential growth of internet-connected devices (Amy et al., 2016). IoT technology has so many different applications that the specs of each device might differ widely from one another, yet most devices share a few common characteristics. The Internet of Things (IoT) offers opportunities for a more seamless integration of computer systems and the real world, increasing productivity, having a favorable impact on the economy, and reducing the need for human labor (Friess *et al.,* 2013; Gerald and Santuceii, 2016; Mattern and Floerkemeier, 2016; Lidner *et al*., 2015). In 2017, there were 8.4 billion Internet of Things devices, and it is anticipated that there will be 30 billion by 2020, according to Köhn and Rüdiger (2009). (Amy *et al*., 2017).

2.06 HISTORY OF INTERNET OF THINGS (IoT)

When a modified Coca-Cola vending machine at Carnegie Mellon University became the first gadget to be connected to the internet and report whether freshly filled drinks were cold or not in 1982, the basic concept of a network of smart devices was first put forth (Bernard 2014). (Nordstark et al., 2014) Mark Weiser's 1991 cold paper on ubiquitous computing, "the computer of the 21st century," as well as academic forums like UbiCom and perCom, are credited with inventing the contemporary concept of the IoT. (Floerkemeier and Mattern, 2010; Weiser, 2011).

In a 1994 IEEE Spectrum article, Reza Raji described the concept as "(carrying) small packets of data to a wide collection of nodes, integrate and automate everything from home gadgets to entire SO as to factories." (Raji, 2014). Between 1993 and 1997, a lot of companies proposed solutions like Microsoft's NORVELL's NEST. The field gained off after Bill Joy imagined a device-to-device community while at work or while presenting his "Six Webs" architecture at the World Economic Forum in Davis in 1999 (O'Neill and Pontin, 2015).

The phrase "Internet of Things" was first used in 1999 by Kevin Ashton of Procter & Gamble, then by MIT's Auto-ID center (Ashton *et al.,* 2009). However, he preferred the abbreviation (Brendon 2016) At the time, he believed that radio-frequency identification (RFID) was essential because it would enable computers to manage the Internet of Things and personalize everything (Magrassi, 2002). (Alex and Wood, 2015; Carter, 2009; Berg and Magrassi, 2002). The main goal of the Internet of Things is to introduce new types of inter- and intra-thing communication by integrating short-range mobile transceivers into a variety of gadgets and ordinary objects (Stallings and William, 2016). IoT is "simply the moment when more things or items are connected to the internet than people," according to Cisco. Their systems claim that the Internet of Objects (IoT) was developed between 2008 and 2009, during a time when the ratio of things to people rose from 0.08 in 2003 to 1.84 in 2010. (Darwin *et al*., 2011).

2.07 APPLICATIONS OF INTERNET OF THINGS (IoT)

The infrastructure, business, and consumer lifestyle sectors can all benefit from the Internet of Things (loT) (Jayawardena *et al*., 2015; Mark *et al*., 2015). IoT is used in the consumer lifestyle to make everyday appliances smarter, including vehicles, watches, home automation, health, and other devices that can be monitored remotely (Elizabeth, 2016).

Processes can be carried out with more accuracy, more effective monitoring, better time management, and higher convenience thanks to IoT apps for business and industry. IoT can be used with sensors to control and monitor the performance of sustainable urban and rural infrastructures, such as bridges, railroad tracks, and on- and offshore wind farms, according to Buyya *et al.* (2013). Military missions including reconnaissance, surveillance, and other combat-related objectives can be made simpler with the use of loT. The IoT can be used in various disciplines, much like science and technology.

2.08 ELECTRONIC MEDICAL RECORD SYSTEM

An electronic medical record (EMR) database contains a patient's identity, previous medical histories, social security numbers, and other private data (Lei et al., 2021). Medical records are essential for medical treatment, instruction, prevention, research, and development. They are the core guidelines for managing hospitals. Traditional paper medical records are difficult to keep up with and difficult to search. Medical record management using information systems is now a possibility because to the development of information technology (Hao and Mengshu, 2018).

The practice efficiency of doctors who utilize electronic medical record (EMR) systems on mobile devices (such as smartphones and tablets) has increased. However, adequate measures of the quantitative effects of these systems have yet to be made (kwang *et al.,* 2018). Because there are still problems with the centralized application of the existing medical record technology, gaining patients' trust is still difficult (Riswahyuni et al., 2022).

As a result, in this case, the medical record system will store medical record databases independently using an RFID reader and tag.

2.09 RELATED WORKS

Different researches on medication management systems have been developed and achieved high performances by adopting the appropriate designation technology. Table below presents different existing management systems.

Despite the fact that barcode labeling is popular, affordable, and reliable, it is a time-consuming and labor-intensive process because of technological limitations including the requirement for line-of-sight and close reading distance (Rida *et al.,* 2010). The processes involved in receiving, storing, sorting, and shipping will be made more effective and efficient thanks to this wireless technology (Howard *et al*., 2013). The proposed system proposes to leverage Radio Frequency Identification (RFID) technology to manage and monitor pharmaceuticals in hospital environments, specifically in the case of public hospitals. The suggested approach uses UHF RFID tags to identify the tracked medication in an effort to be less expensive. An RFID network, a central database, and user/administration interfaces will all be present in the system. The proposed system will streamline stock keeping, prevent stock-outs by integrating re-ordering notifications on preset stock levels, reduce government spending by ensuring that resources are used effectively, eliminate manual work performed by pharmacy staff, prevent unexplained drug loss, improve health services, and prevent stock-outs. RFID technology was once thought to be used in the healthcare industry to identify patients in emergency situations, track patients' vital signs (for example, for patients with chronic diseases), record crucial medical information and transfer it to an electronic monitoring device, keep an eye on the elderly, even at home, monitor goods and equipment, and manage the administration of drugs and blood transfusions to reduce medical errors in hospitals (Turcu *et al*., 2009). The purpose of this study is to determine how well RFID can be used in the healthcare sector for medication control and monitoring.

RFID is a sort of wireless Automatic Identification and Data Capture (AIDC) technology that uses readers to read and write tags as well as electronic tags to store identification data and other specific information. The RFID network is made up of tags, readers, middleware, and databases as a result. The three fundamental types of RFID tags are semi-passive tags with a battery but reader signal activation, active tags with a battery, and passive tags that are activated by the reader's signal. Tags consist of small chips with an antenna. RFID tags, depending on the type of tag, can store additional data such as the product code, serial number, expiration date, and batch code, in contrast to barcodes and other comparable technologies that just save the product code. The RFID tag transmits the recorded data instantly and out of sight to a reader using radio frequency. The middleware receives this information from the reader and transfers it to the main database for processing and decision-making. The use of RFID technology in this study is intended to automatically recognize and track items with RFID tags, which, when put to use, can decrease medicine theft and loss and increase drug availability in hospital settings.

Medication errors are a major cause of patient morbidity, mortality, and rising costs, according to Merry *et al*. (2001), so developing a system to help with information is crucial for efficient health care delivery. The development of a system for managing drug information and communicating with pharmaceutical delivery systems (Howard *et al*., 2013). The system includes software for use in biomedical settings and hospital pharmacies (Howard *et al*., 2013). A prototype RFID-based piece of software that might be used to track and administer medication in a hospital environment was also designed and created by (Zhou 2012). The system has a flaw in that it only addresses drug error correction, not pharmaceutical monitoring and management. Over the past ten years, hospitals in wealthy countries have benefited from electronic drug management tools that help with the distribution and replenishment of medications and medical supplies (Lester *et al.,* 2010). The system controls drug inventory, distributes drug data, and packages medications. Additionally, each distribution point has technology that is electronically connected to the central pharmacy department and used to truck medications to patients at that particular healthcare facility. As a result, hospitals have made strides in the administration of pharmaceuticals to patients and the requirements for pharmacy departments' documentation. (Reardon *et al*., 2013) designed a drug distribution system which utilizes a central pharmacy and database to track all prescriptions for sensitive drugs. In order to verify that the correct doctor administers sensitive drugs/medications to the correct patients during drug distribution, information is retained in the database listing all physicians authorized to prescribe sensitive pharmaceuticals as well as beneficiaries of drugs/medications. The method, however, is more sophisticated and appropriate for hospitals with a solid information system network spanning all hospital departments, which is not the situation in rural hospitals. Another drawback of the drug management and replenishment system is that there are no electronic systems for patient data or prescriptions in public hospitals, making the deployment of such a system impractical.

CHAPTER THREE

MATERIALS AND METHODOLOGY

3.01. MATERIALS USED FOR CONSTRUCTION

In order to design an effective drug prescription management system, it is necessary to select the right components that will operate with the medicine process (ordering, administration, transcribing and dispensing). The main components of our proposed system are the following:

1. 16x2 LCD
2. Atmega328p microcontroller
3. 16mhz crystal
4. Rc522 RFID
5. Esp32-01s Esp8266 WiFi module
6. 1n4007 diode
7. 7805 voltage regulator
8. Lm1117 voltage regulator
9. Resistors
10. Variable resistor
11. Capacitors
12. 8V/2A battery

Other miscellaneous components

1. Packaging

2. Push button switch
3. Veroboard
4. Wires and Jumper wires

3.02 MICROCONTROLLER (ATMega328P)

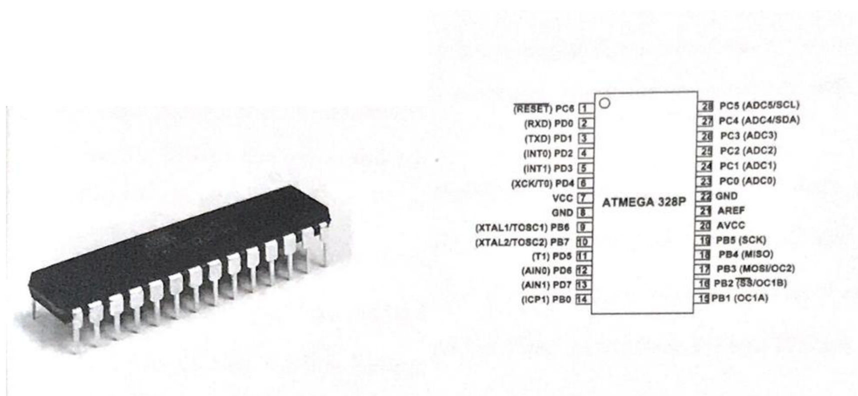


Figure 3.01 Microcontroller (ATMega328P)

Source: Compton and Jameson, 2018.

It has a high-performance and low-power controller and is an 8-bit Microchip microcontroller (Compton and Jameson, 2018). Engineers may use the ATmega328P IC for a range of tasks thanks to its inherent safeguards and a variety of programming methods (Jameson, 2018). Applications for the ATmega328p include embedded systems, motor control systems, display unit peripheral interface systems, SMPS and power regulation systems, industrial control systems, and ARDUINO UNO, ARDUINO NANO, and ARDUINO MICRO boards (Compton and Jameson, 2018).

The chip has 28 pins, some of which serve numerous functions. The ATmega328p flash memory, which contains a program memory of 32 kilobytes, is used for all programming operations. It has internal and external clock pulses, the values of which the Prescalar can receive at an external pin and divide. It is identified as CLKO-GPI 014. It contains three power pins (VCC-pin 7, GND-pin 8,22), one for voltage and the other two for common ground, as well as a reset pin (GPI01) that, in some cases, uses an external signal to restart the microcontroller (Compton and Jameson, 2018). Using the oscillator pins for input and output signals, the microcontroller can use an external oscillator with a frequency of up to 40MHz in addition to its internal oscillator, which has a variable frequency of 8Hz (XTAL1 and 2- GPI09 and 10). Additionally, it has three digital input/output ports and two interrupt pins (PORTS B, C, and D). It uses USART for communication, which entails sending and receiving data across two wires (RX and TX-GPI02 and 03). This can also be used to program. Additionally, it has pins for the ATmega328p and I(square) communication timer and comparator modules, as well as SPI communication, AREF, and capture/compare/PWP channels (Compton and Jameson, 2018).

3.03 LIQUID CRYSTAL DISPLAY (LCD)

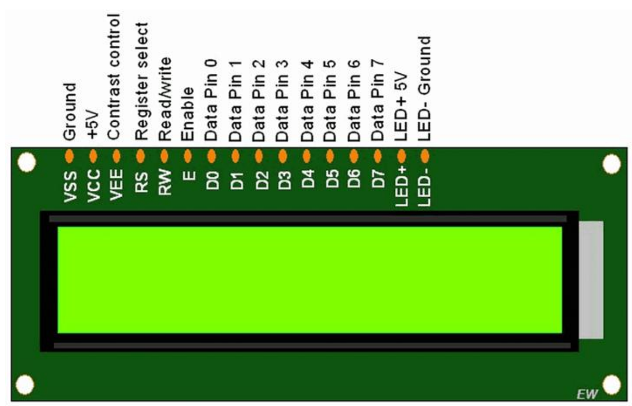


Fig 3.02 LCD (16x2).

Source: Mueler *et al*., 2010)

Table 3.1: LCD Display pin Description

Pin	Symbol	I/O	Description
1	V_{SS}	--	Ground
2	V_{CC}	--	+5 V power supply
3	V_{EE}	--	Power supply to control contrast
4	RS	I	RS = 0 to select command register, RS = 1 to select data register
5	R/W	I	R/W = 0 for write, R/W = 1 for read
6	E	I/O	Enable
7	DB0	I/O	The 8-bit data bus
8	DB1	I/O	The 8-bit data bus
9	DB2	I/O	The 8-bit data bus
10	DB3	I/O	The 8-bit data bus
11	DB4	I/O	The 8-bit data bus
12	DB5	I/O	The 8-bit data bus
13	DB6	I/O	The 8-bit data bus
14	DB7	I/O	The 8-bit data bus

Source: Müeler *et al.,* 2010

Electrical display modules called LCD (Liquid Crystal Display) displays have a variety of applications. A 16x2 LCD is a fairly basic module that is regularly used in a variety of devices and circuits. Compared to multi-segment LEDs with seven segments and more, these modules are preferable. According to Mueler *et al.* (2010), the reasons for this are that LCDs are less expensive, more easily programmed, and do not have any limitations on the display of unique and even original characters, animations, and other features. A 16 x 2 LCD has two such lines as seen in the above illustration and can display 16 characters per line. Each character in this LCD is presented in a 5x7 pixel matrix. The Command and Data registers on this LCD are its two registers. The command instructions sent to the LCD are stored in the command register. When you want an LCD to do something, like initialize it, clean its screen, move the pointer, control the display, etc., you send it a command. The data register stores the information that will be shown on the LCD. The data comprises the character's current, voltage, energy, and power numbers as well as the designer's name.

3.04 RFID Module (RC522)

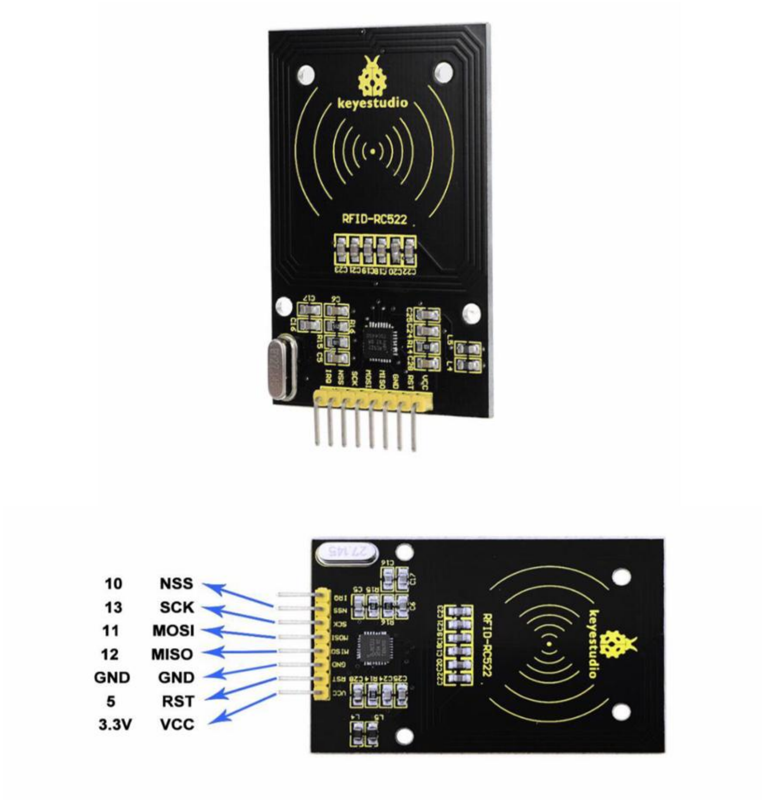


Figure 3.03: RFID Module (RC522)

Source:Wusheng and Weiwei, 2018

It functions as an input device and has an RFID reader and RFID tags with an antenna. Radio waves are utilized to read and gather the data on a tag when it is slid over an RFID reader. The MC522 RFID module, which is easy to use, affordable, suitable for equipment development, the creation of advanced applications, and necessary for the design and production of RF card terminals, uses the Philips MFRC522 original reader circuit chip design (Keyes, 2012).

This module allows for the direct loading of several reading molds. The reading distance will be constant and reliable as long as the module is powered by 3.3V and connected to any CPU board directly utilizing a few short lines on the SPI interface (Keyes, 2012).

NXP created the MFRC522 for the "Three Tables" application launch of a low-voltage, low-cost, small size, and non-contact card reader chip. It is applied to 13.56MHz contactless communication highly integrated chip card readers, improving the choice between smart instrumentation and portable handheld devices (Wusheng and weiwei, 2018).

The powerful modulation and demodulation technology of the MF RC522 is fully integrated with all 13.56MHz passive contactless communication methods and protocols. support 14443A certified transponder broadcasts. The digital component manages ISO14443A framing and error detection. Additionally supported are rapid CRYPTO1 encryption methods and MIFARE product terminology verification.

The MIFARE Series higher speed non-contact communication is made possible by the MFRC522, which supports two-way data transfer speeds of up to 424 kbit/s. Members of a new series of highly integrated 13.56MHz card reader chips are the MF RC522, MF RC500, and MF RC530. These chips have a lot in common with one another as well as many special skills. SPI-based host-to-host communication lowers the cost, PCB board space, and connection requirements (Wusheng and weiwei, 2018).

3.05 ESP8266 WIFI MODULE

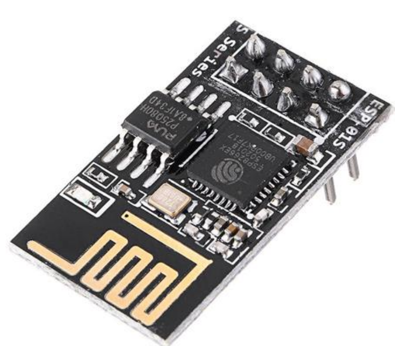


Fig 3.04: ESP8266 WiFi Module

Source: Harry *et al.,* 2018

IoT technology has spread more widely recently. The prevalence of wireless connectivity in everyday objects and devices has increased significantly. The ESP8266 WiFi modules are one of the technologies that have made wireless communication possible. There is a vast variety of ESP8266 development boards on the market right now. Sadly, it is unknown how much ground they have covered. The antenna is acknowledged as the key factor in determining the range of wireless transmissions. From among the popular development boards, four versions with various antenna types are chosen for comparison. Measurements are performed in front of the public (Harry *et al*., 2018). The model D dipole antenna, as expected, has the highest RSSI, followed by the model C ceramic antenna, the model A meandered PCB antenna, and the model B meandered inverted-F PCB antenna, in that order. At 40 meters, the RSSIs for Models D, C, A, and B are, respectively, -61.38 dB, -80.59 dB, -84.51 dB, and -90.94 dB. (Harry *et al*., 2018).
The factory-installed firmware on the ESP8266 allows for control of the device via standard "AT commands." Additionally, writing and submitting your own code is extremely easy, giving it a ton of power and versatility (Harry *et al.*, 2018).

The ESP8266, which debuted in 2014, is becoming more and more well-liked. There is only one ESP8266 processor, yet it is used by several breakout boards. The amount of flash memory and the number of accessible pins differ between each of these. There is a wealth of information available online about these breakout boards, which have developed quickly over the years. This is both a blessing and a curse because some of the advise is out-of-date or flat-out incorrect (Harry *et al*., 2018).

3.06 DIODE 1N4007

Fig 3.05: Diode 1N4007. Source: Larry *et al.,* 2010

The 1N4007 is a PN junction rectifier diode from the 1N400x series. The maximum repeated reverse voltage is the only difference between these diodes, which vary from 1N4001 to 1N4007. Since the 1N4007 is electrically compatible with other rectifier diodes, it can be used in place of any 1N400X series diode (Larry *et al.,* 2010).

The 1N4007 has a lot of real-world applications as well. Take freewheeling diodes, general rectification of power supply, inverters, converters, etc. as examples (Larry *et al.,* 2010).

The 1N407 is a general-purpose rectifier diode. It is often designed as a rectifier to work with other filter capacitors in the power supply section of electronic devices to convert AC voltage to DC voltage (Larry *et al*., 2010).

It can also be used in any broad application that calls for a general diode. Despite being designed to operate at high voltages, the 1N4007 diode can readily withstand values below 1000V. Due to its average direct current of 1000mA or 1A, 3W power dissipation, small size, and low price, it is the ideal diode for a variety of applications (Larry *et al*., 2010).

3.07 VOLTAGE REGULATOR (L7805)

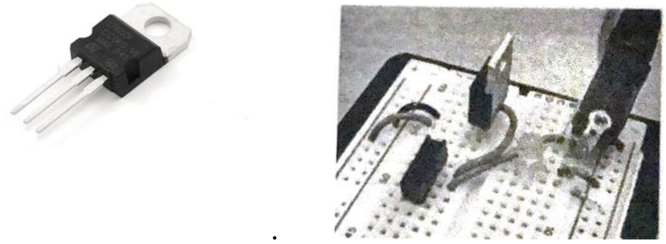
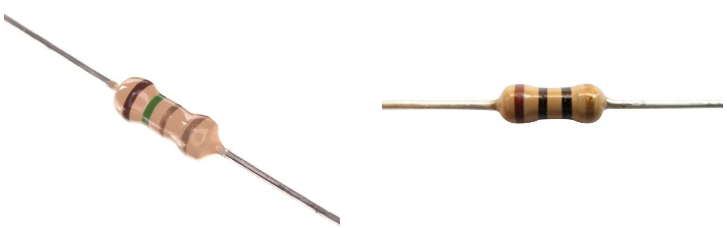


Figure 3.06: Voltage Regulator (L7805).

Source: Larry *et al*., 2010.

The set output value of the L7805 voltage regulator is 5 volts, and it has three positive terminals. This fixed regulator delivers local regulation, safe area protection, internal current limiting, and control over thermal shut-down for your project. The maximum output current for each of these voltage regulators is 1.5A at 5V. It is safeguarded from output transition SO, short circuits, and thermal overload (Larry *et al.,* 2010).

3.08 RESISTORS



Source: Larry *et al*., 2010.

Figure 3.07 Resistors

A resistor is the most typical electrical component. Resistors are electronic parts with a fixed, continuous electrical resistance. The resistor's resistance limits the passage of electrons via a circuit (Larry *et al*., 2010). They only use power since they are passive (and cannot generate it). Resistors are frequently used in circuits to counteract active components like op-amps, microcontrollers, and other integrated circuits. Resistors are widely used to divide voltages, limit current, and pull up I/O lines. The electrical resistance of a resistor, measured in ohms, is symbolized by the number 12.

The definition of 12 is the resistance between two points at which P volt (1 V) of applied potential energy will cause 1 ampere (1 A) of current. Greater or lower values of ohms can be matched with a prefix like kilo, mega, or giga to make large numbers easier to read when using SI units. Two 10 ohms and five 1 ohms were required for the circuit (Larry *et al*., 2010).

3.09 CAPACITORS

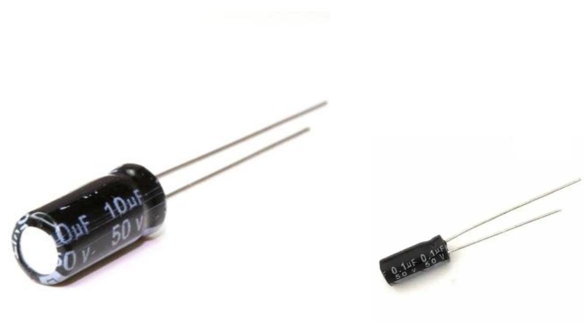


Figure 3.08: Capacitors (10uf (left) and 0.1uf (right)). Source: Larry *et al*., 2010.

A two-terminal electrical component is a capacitor. They are one of the most essential passive components we employ, along with resistors and inductors. Two 0.01uF and 10uF capacitors were needed (Larry *et al*., 2010).

Capacitors store electrical energy. Common applications include local energy storage, preventing voltage spikes, and complex signal filtering (Larry *et al*., 2010).

Every capacitor is constructed with a specific capacitance in mind. The capacitance of a capacitor determines how much charge it can store; higher capacitance means greater charge-storage capability. The usual unit of capacitance is the farad, also spelled as F. (Larry *et al*., 2010).

3.10 VOLTAGE REGULATOR (LM1117)

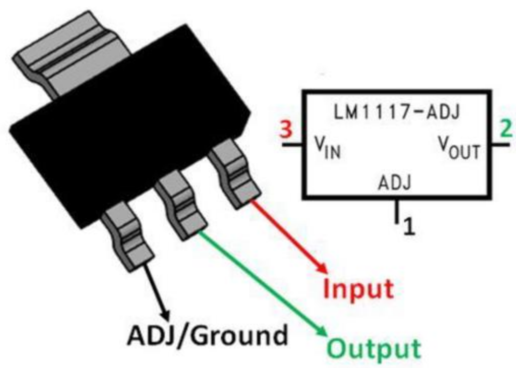


Fig 3.09 Voltage Regulator (LM1117) source: Jyothi *et al*., 2017

It changes the voltage applied to the logic, or the level of logic. If the controller transmits bits to the ESP8266 at 5V, the ESP8266's inputs will be affected. The converter lowers the voltage to the required 3.3V. It has to be powered by the lower voltage. The LM1117 has three major pins: an output pin that outputs 3.3 volts, a ground pin, and an input pin (Pimpalkar *et al*., 2020). The output voltage of the adjustable LM1117 can be changed from 1.25V to 13.8V using only two external resistors. Additionally, it is available at five fixed voltages: 1.8, 2.5, 2.85, 3.3, and 5V. (Amusa *et al*., 2012)

The LM1117 provides thermal shutdown and current limiting. To ensure output voltage accuracy to within 1%, its circuit contains a Zener trimmed band gap reference. The LM1117 provides thermal shutdown and current limiting. To ensure output voltage accuracy to within 1%, its circuit contains a Zener trimmed band gap reference. The operating temperature range of the LM1117 will be -55 °C to +150 °C. To increase transient response and stability, a tantalum capacitor at the output must be at least 10 F. (Jyothi et al., 2017)

Other unconnected components were also necessary for the concept to be realized. The veroboard served as the foundation for any connections that were made. The IC socket on the Vero board was used to connect the microcontroller there. The settings were controlled by three push button switches: one for increment, one for decrement, and one for saving parameters. The components were connected by cables, jumper wires, and connectors. The packaging contained both the circuit and its accessories.

3.11 METHODOLOGY

The circuit was designed on the software, Microsoft word 2010. It shows the interconnection on the components in the design.

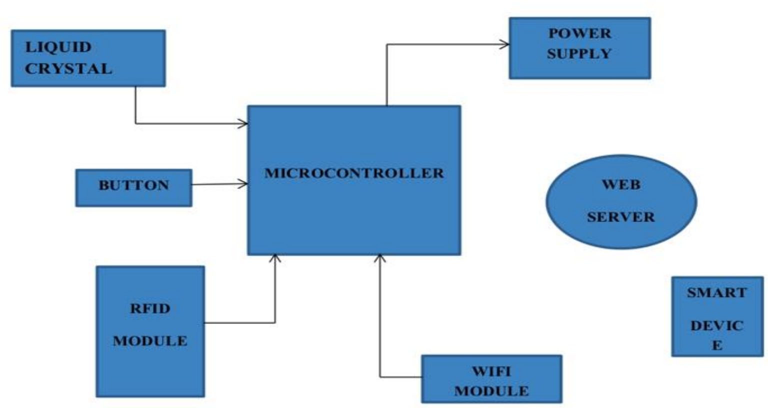


Fig 3.10. Block Diagram of the RFID drug prescription management system

Source: Microsoft word, 2010

From the block diagram, several units can be detected in the design. These include

1. Power Supply Unit
2. Processing Unit
3. Sensing Unit
4. Switching Unit
5. Display Unit

3.12 POWER SUPPLY UNIT

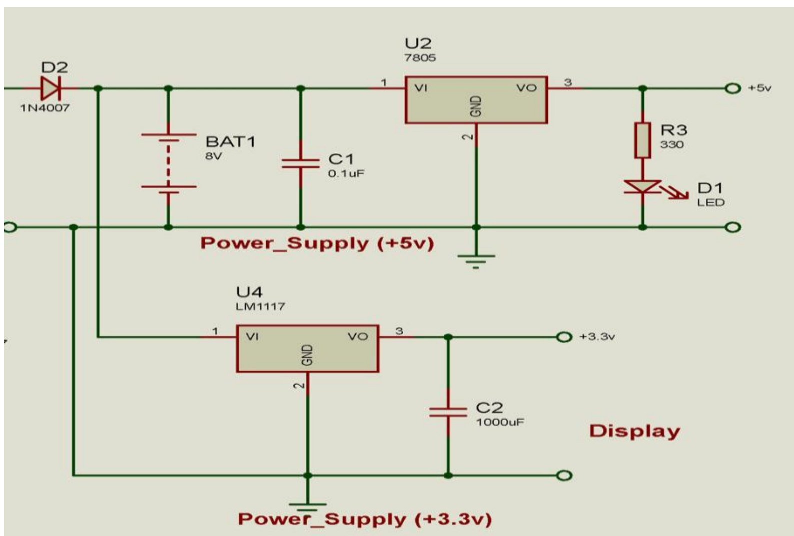


Figure 3.11 Power Supply Unit

Source: Proteus Professional v 8.1 SPI, 2014.

For this project, a power supply with a 5V and 3.3V output was employed. This is because the WiFi module (ESP32-01s) only needs 3.3 volts to operate, whereas the microcontroller (ATMega328P) and the RFID module (RC522) both need a 5 volt power source to operate. A diode, a filtering capacitor, and a voltage regulator make up the power supply. The voltage regulator produces a consistent output, the filtering capacitor eliminates ripples, and the diode transforms the incoming AC voltage to the DC voltage needed by the circuit. The power supply also includes an LED that illuminates to show that there is power in the circuit and a resistor with a resistance of 330 Ω.

To further breakdown the power supply as earlier explained, it shows various stages in which AC voltage must undergo beginning with the diode.

D1-D4(Diode). The diodes chosen must have a peak inverse voltage (PIV) that must be able to withstand twice the peak voltage (V_p) of the battery and a forward current ($D_{c)}$ of 1.5 times the output current of the transformer.

$V_p = \sqrt{2}$ Vrms…………………………………………………….… (3.1)

Where V_p is the peak voltage of the transformer output.

V_{rms} is the actual output voltage from the Battery = 8Vdc

$V_p = \sqrt{2}x8$

$V_p = 1.414x8$

$V_p = 9.128Vac$

$D_{(piv) =}$ 2 x Vp ……………………………………………………… (3.2)

Where $D_{(piv)}$ is the PIV of the rectifier diode

Therefore, $D_{(piv)} = 2x9.128$

$D_{(piv)} = 18.2255$

And $Dc = 1.5 \times 300 \times 10^{-3}$

$Dc = 0.45A$

Therefore the required diode must have a:

$PIV \geq 33.94V$

$Dc \geq 0.45A$

From diode catalogue, the IN4007 has the following characteristics:

$PIV = 50V$

$D_C = 1A$

Consequently, the diode chosen is the IN4007

D_1-D_4 = IN4007

C_1: This is the filters capacitor. Electrolytic capacitors come with a capacitance and a voltage rating.

3.3.1 Voltage Rating

The voltage of the capacitor (V_c) must be able to withstand 150% of the output voltage from the diode.

$V_{C =}$ 150% of V_{DP} ………………………………………... (3.3)

Where V_{DP} is the peak output voltage from the diodes

But V_{DP} is given as

$V_{DP} = V_p - V_D$…………………………………………… (3.4)

Where V_p is the peak voltage of the transformer

$V_D$is the voltage drop of the diodes (0.7 2)

$V_{DP} = 16.97 – 1.4$

$V_{DP} = 15.57V$

$Vc=1.5xV_{DP}$ …………………………………………….(3.5)

Vc is the voltage rating of the capacitor

$Vc = 1.5 x 15.57$

$Vc = 23.6V$

3.3.2 Capacitance Rating:

The capacitance of the capacitor must be such that it could reduce the ripple voltage (V_R)

to about 30% of the output peak voltage from the diodes.

$$V_R = 30\% \text{ of } V_{DP} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ (3.6)}$$

From eqn. 3.3, V_{DP} is given as 15.57

$$V_R = \text{ x } 15.57$$

$$V_R = 4.67V \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ (3.6.1)}$$

From the ripple voltage equation, we could get the capacitance

$$V_R = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ (3.7)}$$

Where V_R is the ripple voltage

I_{max} is the maximum current from the diodes/ transformers (300mA)

f is the frequency of supply (50Hz)

C is the capacitance of the capacitor in Farads.

$V_R = 4.67V$ (from eqn 3.6.1)

$V_R (2FC) = I_{max}$

$C_1 = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ (3.8)}$

Substituting,

$C_1 =$

$C_1 =$

$C_1 = 6.42 \times 10^{-4}$ F

Converting to µF

$C_1 =$

$C_1 = 642.4$ µF

= 642.4µF

This value cannot be obtained in the market and due to the high ripple rejection factor of the voltage regulator, a lower capacitance could be chosen. Therefore the capacitance chosen is:

C_1 = 470μF @35V

U1: This is the voltage regulator.

Regulator specifications:

- Maximum input voltage = 30V
- Maximum output voltage = 5.5V
- Operating temperature = 0%- 150%

For effective Voltage regulation, the minimum input voltage should be:

$$V_{min} = V_{out} + V_{ref} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.9)$$

V_{min} – Minimum input voltage

V_{out} – required output voltage: 5V

V_{ref} – Datasheet Stipulated reference voltage; 3V

$V_{min} = 5 + 3$

$V_{min} = 8V$

The output voltage after the capacitor is 15.57 volts. This is enough to supply the minimum input voltage (8 volts) Therefore, the voltage regulator could be comfortably used. The regulator chosen is

U_1 = 7805

C_2 is a transient capacitor. The rating is stipulated in the 7805 voltage regulator's data sheet as 0.1uF

Hence,

C_2=0.1uF

This capacitor helps for smoothening of the output from the voltage regulator. It is also to prevent spikes in the DC output voltage waveform in the event of transient disturbances. It is known as a buffer capacitor whose value is gotten from the data sheet of the regulator.

Current limiting resistor calculation:

$R_1 = (Vs-V_d)/ Id$ …………………………………………………… (3.10)

$R_1 = (5-2)/10\times10^{-3}$

$R_1 = 300\Omega$

This value of resistor is not in the market, so the appropriate value to use is:

$R_1 = 330\Omega$

Light emitting diode characteristics:

Forward current of…..10×10^{-3}A to 10×10^{-3}A

Voltage drop of…….2V

3.13 PROCESSING UNIT

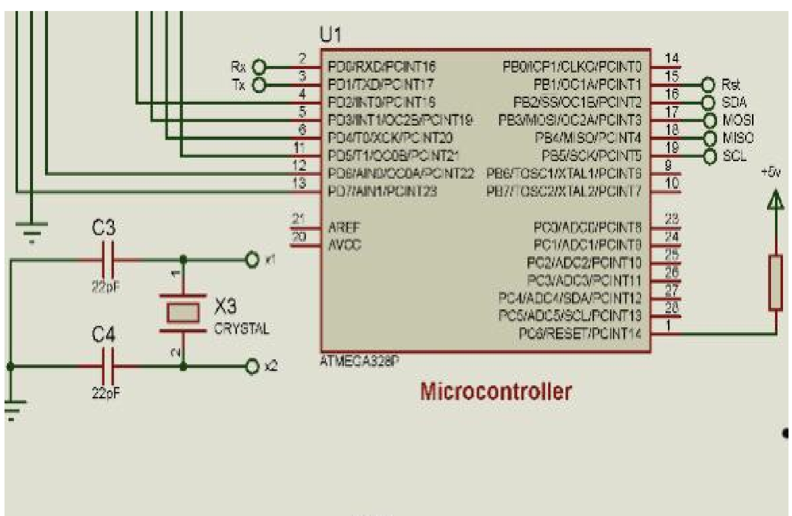
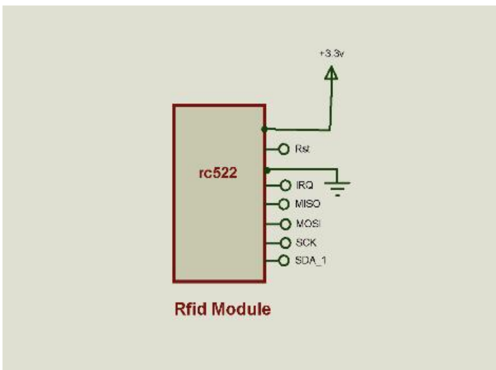


Fig 3.12 Processing Unit

Source: Proteus Professional v 8.1 SPI, 2014.

The processing Unit comprises of the microcontroller. The microcontroller used for this project is the ATMega328P. The microcontroller is the brain of the circuit transmitting signals responsible for the functioning of the system. The microcontroller is embedded with ‘C’ programming language using the Universal programmer. The microcontroller is programmed to transmit signals to the RFID module once it comes in contact with n RFID tag. ATMega328P microcontroller used for this project was also programmed to send signals to the Wifi module to automatically connect with an Hotspot named (hot) and password (2020hott). All these functions were made possible through programming. The microcontroller carries out instructions, under the guidance of a program. The working of the microcontroller is carried out through its input-output ports.

3.14 SENSING UNIT



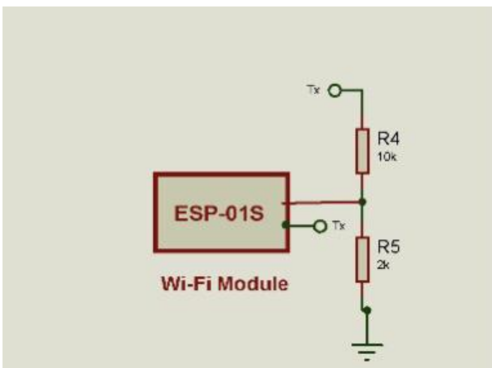


Fig 3.13 Sensing Unit

Source: Proteus Professional v 8.1 SPI, 2014

This unit comprises of the RFID module, RC522 and the Wifi module, ESP32-01s. It identifies the passive RFID tag when it comes in close range with it. The RFID module is designed to create a 13.56MHz electromagnetic field that is used to communicate with the ATMega328P microcontroller over a 4-pin Serial Peripheral Interface (SPI).

3.15 DISPLAY UNIT

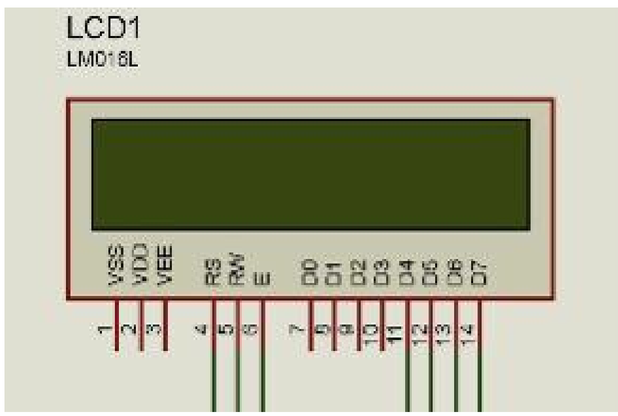
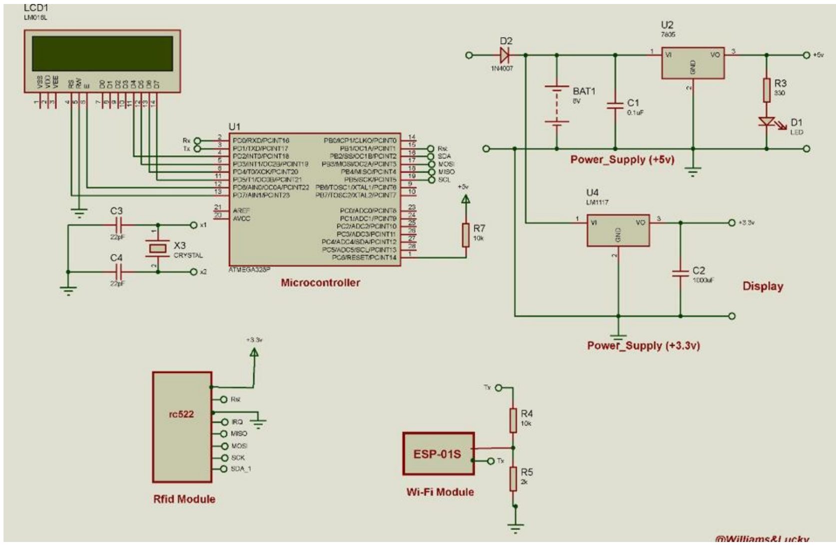


Fig 3.14 Display Unit.

Source: Proteus Professional v 8.1 SPI, 2014

This display unit comprises of the LCD. It displays the name of the device and the tag number of the patient when it comes in close range with the RFID module.

3.16 WORKING PRINCIPLE OF THE COMPLETE CIRCUIT



3.17 FLOW CHART

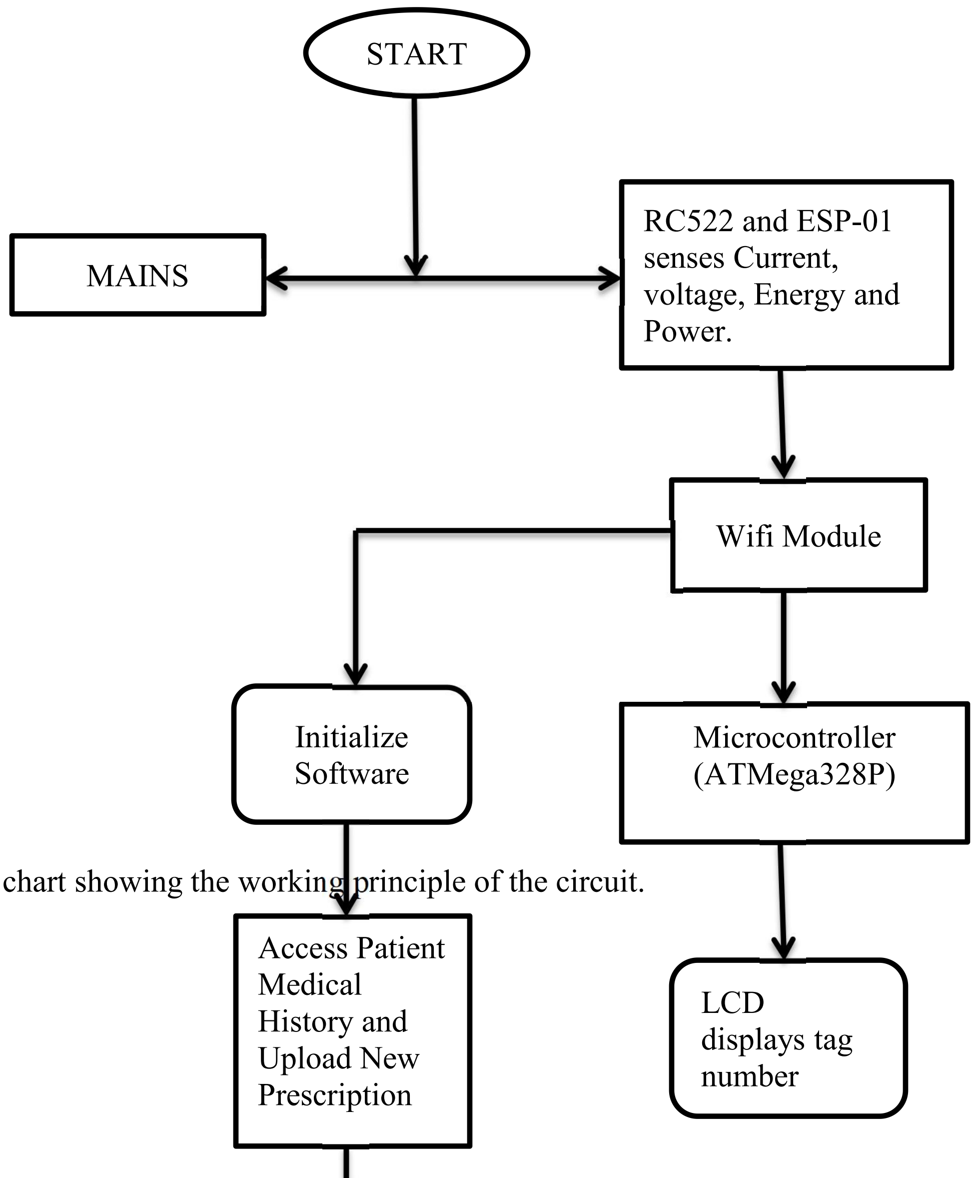


Fig. 3.15 Flow chart showing the working principle of the circuit.

With the help of the diagram, it is easy to understand the actual working principle of the system. In this system, the power supply unit of 5v and 3.3v respectively is connected to the switch. By pressing the switch button, DC current flows through the entire circuit.

The hardware is initialized when the system is turned ON, starting with the 16X2 LCD which is utilized to show or display different message or data and moving towards the Wifi Module (ESP-01s). After initialization, the ESP-01s connects to an hotspot/router for internet connectivity.

The Microcontroller (ATMega328P) is programmed using 'C' programming language to perform several task. The microcontroller will first show the message (swipe the card) on the LCD display when the circuit is switched ON.

When this connection is done successfully, the system using the RFID module (RC522) which is a scanning device that uses antenna to realize or decode the tags around its vicinity continuously scan the presence of an RFID tag. This RFID tag is an IC chip that has unique hexadecimal or electronic product code (EPC) contained in it. The tag acts as a key that is capable of opening a particular lock. So it is named the RFID key.

Immediately the RFID tag is detected , the ATMega328P microcontroller processes the data and the microcontroller continue the interfacing with the LCD and GPRS. With the help of GPRS the RFID tag number display on the web platform for further processing.

Once the user connects to the internet on the smart phone or personal computer (PC), the web platform (health-care-manager.herokuapp.com) connects to the circuit through the server and displays the card number and patient's medical record for the viewing of the user (Doctor and Pharmacist). The user can also recommend new drugs for the patient and it is then stored to the database.

CHAPTER FOUR

RESULTS

4.01 ACTIVATING THE WEBSITE

The steps to connect the website to the circuit are as follows;

1. The user must first connect the wifi to an hotspot named (hot) and a password (2020hott)
2. The user must open the website named (https://health-care-manager.herokuapp.com) on their smart devices (smart phones or laptop). The website works over the internet.

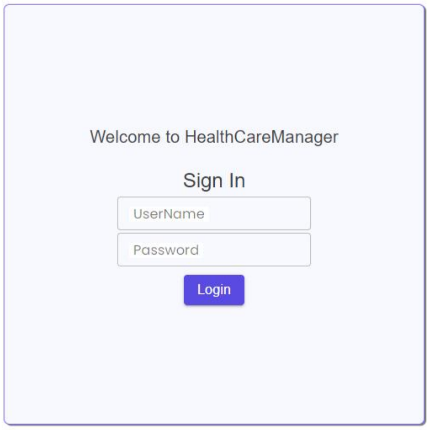


Fig 4.01: 'Sign in Account' page on HealthCareManager website

Source: Lucky and Williams

3 The first user which is the admin is to then create an account of the website. This enables the admin to create an account for the doctor and the pharmacist and the patient also.

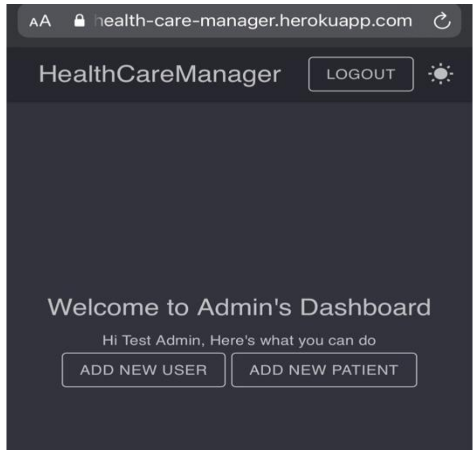
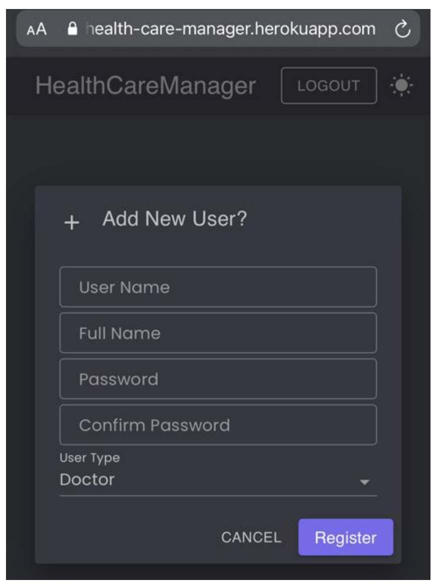


Fig 4.02 Admin Dashboard

Source: Lucky and Williams

4 To create an account for the doctor and the pharmacist, the full name, username and password is required.



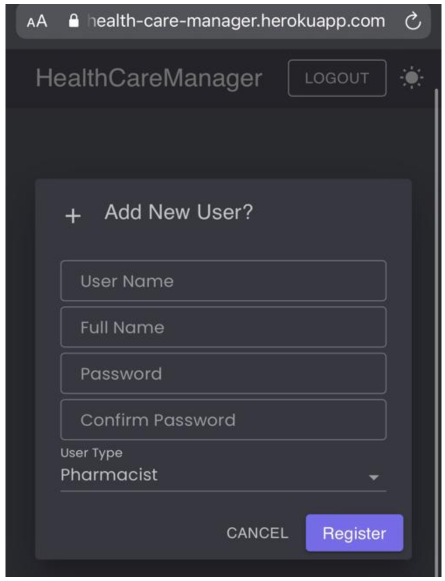


Fig 4.03 'Create new user'

Source: Lucky and Williams

5 After creating an account for the user, the admin creates an account for the patient by swiping the RFID tag issued to the patient on the device.

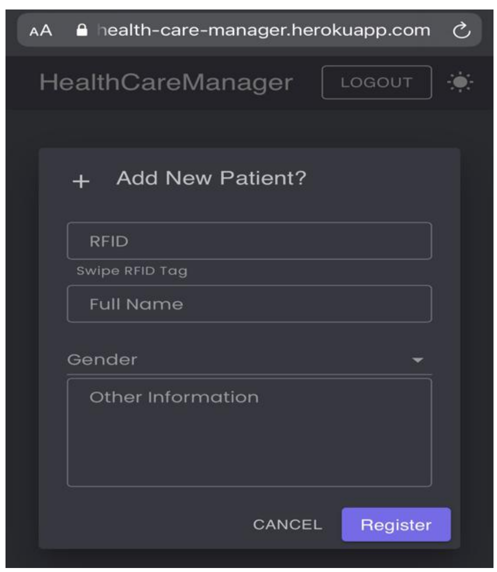
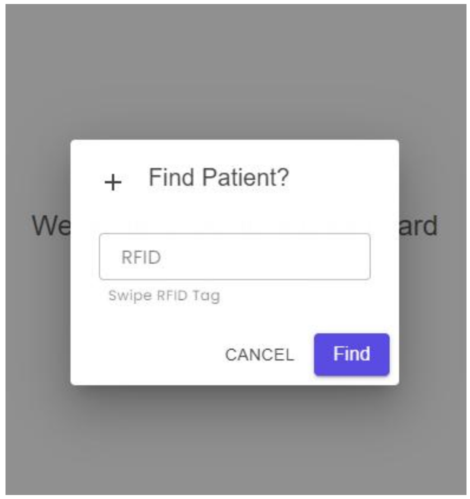


Fig 4.04 'Add New Patient Dashboard'

Source: Lucky and Williams

.

6 Next, after all these process is complete, Registered Doctor and Pharmacist can access patient's medical history through their respective dashboard.



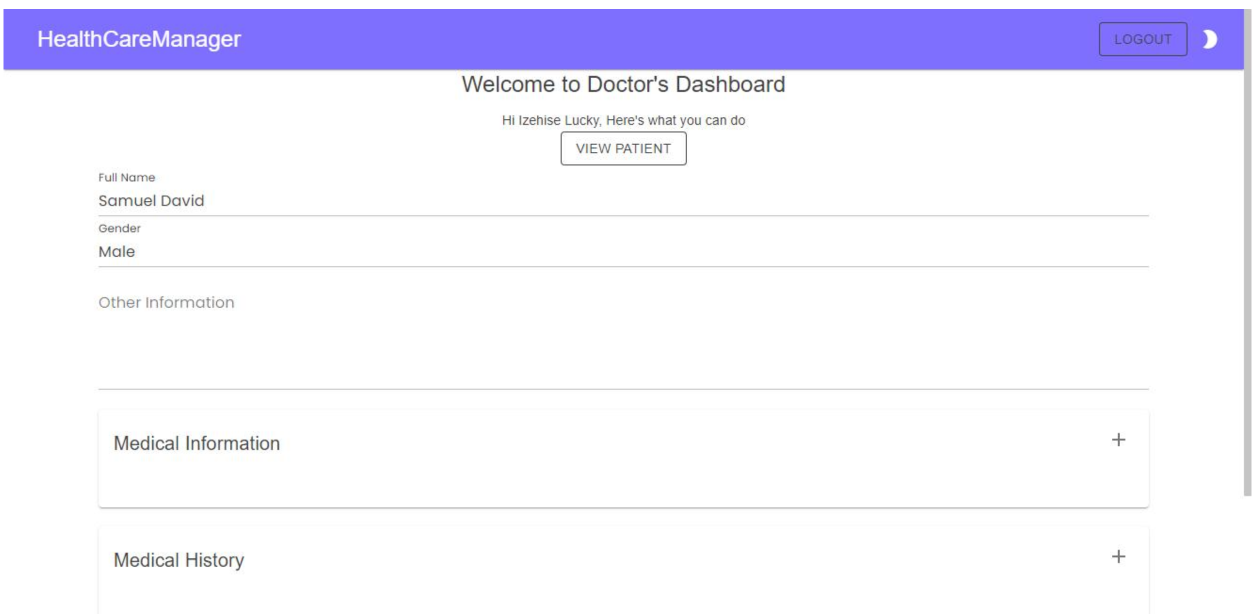


Fig 4.05 Doctor's dashboard.

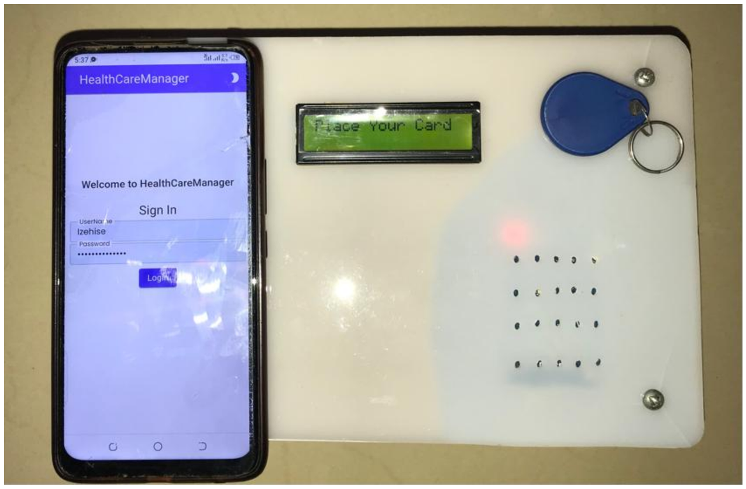
Source: Lucky and Williams

4.02 HARDWARE ASSEMBLANCE

The following procedures were followed in the construction of the hardware circuit.

1. The design of the circuit was made. This involved the block diagram, it was essential as it served as a guide for the construction of the circuit.
2. The schematic diagram was drawn on the Proteus software and run to ensure the viability of the project.
3. All components were procured.
4. The Vero board was filed on its bottom with sandpaper in preparation for the connections.
5. The IC socked was soldered to the board.
6. The power supply unit, 5V, was connected to the voltage regulator using a wire soldered to its input pin and the output pin of the voltage regulator, L7805 was connected to the microcontroller (ATMega328P) through pin 01 (+VCC) to power the microcontroller was 5V coming from the voltage regulator. The power supply used for this project were 5V and 3.3V respectively. This was possible by connecting the two grounds of the power supply i.e the negative terminals together, while the positive terminals were connected to various components it powered.
7. A DC-DC converter was used to power the Wifi module. This is because the ESP32-01s requires a maximum of 3.3V and voltage regulator coming through other components was 5V. So using the divider rule, two resistors (2kohms and 10kohm) are used as the DC-DC converter to step down the voltage going to the ESP32-01s. The resistors are connected end to end to form a junction.
8. The RFID module, RC522 positive terminal was connected to the ATMega328P on pin
9. The LCD was connected to the ATMega328P on pin 05-13.

10. All the negative terminals are connected together and grounded.



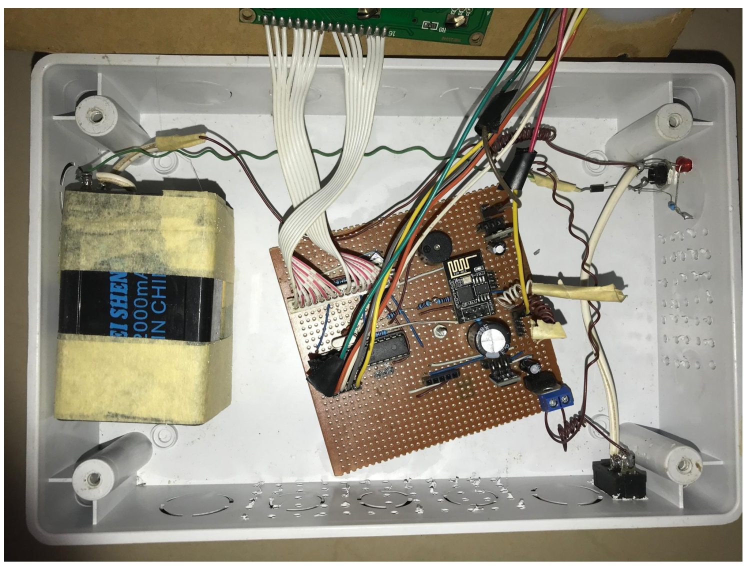


Plate 4.01: Images of Construction of the Hardware Circuit

Photo Credit: Lucky and Williams

4.03 PACKAGING

A plastic case of suitable insulation for electrical protection and simple use is utilized as seen below.

Plate 4.02: Packaging of the Hardware Circuit

Photo credit: Lucky and Williams

4.04 BILLS OR ENGINEERING MEASUREMENT AND EVALUATION

Table 4.1 shows the materials used in construction of the RFID based drug prescription management system alongside the unit price and the total amount per item, in order to create an estimate of the total cost utilized.

Table 4.1: Bill of Engineering Measurement and Evaluation (BEME)

S/N	ITEM	UNIT PRICE (N)	QUANTITY	AMOUNT (N)
1	ATMega328P	6200	1	6200
2	RC522	13000	1	13000
3	ESP32-01s	4400	1	4400
4	Crystal oscillator	800	1	800
5	Transistors	500	1	500
6	LCD (16x2)	2400	1	2400
7	Buttons	500	1	500
8	Vero board	1200	1	1200
9	Soldering lead	1000	1	1000
10	Jumper wires	800	50 pieces	800
11	Wires	1500	100 yards	1500
12	L7805	500	1	500
13	LM117	500	1	500
14	Resistors	50	10	500
15	Capacitors	70	10	700
16	Packaging	8000	1e	8000

17	Transportation	12000	-	12000
18	Total cost of materials			54150

CHAPTER FIVE

5.01 DISCUSSION

Hospitals in affluent nations have been helped by electronic drug management systems to construct a drug distribution system that uses a central pharmacy and database to track all prescriptions for sensitive medications over the past ten years. In order to verify that the correct doctor administers sensitive drugs/medications to the correct patients during drug distribution, information is retained in the database listing all physicians authorized to prescribe sensitive pharmaceuticals as well as beneficiaries of drugs/medications. Another drawback of the drug management and replenishment system is that there are no computerized systems for patient data or prescriptions in Nigeria's public hospitals, making the deployment of such a system impractical. Electronic drug delivery systems have helped hospitals in affluent nations over the past ten years. However, this solution overcomes this drawback by using an RFID module to decode the tag that holds the registered patient's information. This system can be utilized at any time because it has an 8V rechargeable battery. Additionally, a software website is used, which enables a special identifying password.

Despite the fact that barcode labeling is popular, affordable, and reliable, it is a time-consuming and labor-intensive process because of technological limitations including the requirement for line-of-sight and close reading distance. The processes involved in receiving, storing, sorting, and shipping will be made more effective and efficient thanks to wireless technology. The proposed system proposes to leverage Radio Frequency Identification (RFID) technology to manage and monitor pharmaceuticals in hospital environments, specifically in the case of public hospitals. The suggested approach uses UHF RFID tags to identify the tracked medication in an effort to be less expensive. An RFID network, a central database, and user/administration interfaces will all be present in the system. The absence of computerized systems for patient data or prescriptions in Nigeria's public hospitals makes the adoption of such a system impossible, which is yet another flaw of the drug management and replenishment system. By using an RFID module to decode the tag that contains the registered patient's information, this approach, however, gets around this problem. The 8V rechargeable battery in this system allows for use at any time. Additionally, a software website that allows a unique password for identification is used.

5.02 CHALLENGES ENCOUNTERED DURING THE EXECUTION OF THE PROJECT

While executing the project, some challenges were encountered sourcing for information on herokuapp was relatively new. This added more difficulty to the overall research. Major issues were encountered in the coding as it was difficult to program the RFID module to microcontroller communication. The microcontroller communicates serially with other modules and two modules are required for this project. After several trials, it was discovered that the microcontroller can only communicate with one module at a time and not concurrently. So, the microcontroller communicate with the RFID module and the Wifi module through the coding, one at a time. This implies that the RFID module and the Wifi module cannot transmit signals to the microcontroller simultaneously, only one at a time. So, each one was programmed to transmit singly.

Other challenges included trouble shooting, testing, hardware component assemblance, packaging assemblance and documentation.

5.03 CONCLUSION

Through experimental testing, the effectiveness of our suggested RFID medication management system for enhancing patient safety and the medication process was established. Due to its scalability and ease of use, this system can be linked into a variety of drug planning and management systems. By scanning a large number of medications at once, our proposal can also improve medication-patient safety, speed up information flow, and eliminate human mistake in healthcare organizations. Our RFID medication management system was created to meet the needs of current medical trends.

The improvement of medical treatment through lowering medication-related adverse events and boosting patient safety is one of the World Health Organization's top priorities. These problems mostly concern hospitals' management of pricey and dangerous medications. By reducing the likelihood of pharmaceutical errors from the prescription validation to the preparation, we improved medication management in this project. For this reason, we used Radio Frequency Identification technology to incorporate digital signatures into the architecture of a hospital and pharmacy services management system. The ESP8266 modules, RFID readers, and tags in our suggested system enable the automatic management of drugs while also allowing the detection of medication use.

5.04 RECOMMENDATION

It is common knowledge that there is always room for improvement. Many more features exist that could be added to the circuit for even more added benefits. For further research on future projects, the following are recommendation;

1. Easy means of contacting the hospitals from any geographical location in time of emergency.
2. The circuit should be modified to allow patient communicate with the doctors and pharmacist frequently.

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APPENDIX

SOFTWARE PROGRAMMING

```
/*Begining of Auto generated code by Atmel studio */
#include <Arduino.h>
#include <String.h>


#include <LiquidCrystal.h>
#include <EEPROM.h>


#include <SPI.h>
#include <MFRC522.h>


#include <SoftwareSerial.h>


SoftwareSerial esp(2,3);


//Connections and constants
LiquidCrystal lcd(A3, 4, 8, 5, 6, 7); //LCD


//Rfid
#define RST_PIN 9
#define SS_PIN 10
```

```
byte readCard[4];
String tagID = "";

char data[15];
unsigned int m = 0;

MFRC522 mfrc522(SS_PIN, RST_PIN);

#define DEBUG true
#define server "health-care-manager.herokuapp.com" //"class-attend.herokuapp.com"//
thingspeak.com ip

boolean getID();
String send_command();
String send_command1();

void setup() {

pinMode(0, OUTPUT);
  //Rfid card
  SPI.begin();
  mfrc522.PCD_Init();
  lcd.begin(16,2);
```

```
  lcd.print("DrugPrescription");
 lcd.setCursor(4,1);
 lcd.print("Manager");
 delay(5000);
 lcd.clear();
  lcd.setCursor(3,0);
 lcd.print("Starting");
 lcd.setCursor(2,1);
 lcd.print(".");
 delay(500);
lcd.setCursor(2,1);
 lcd.print("..");
 delay(500);
lcd.setCursor(2,1);
 lcd.print("...");
 lcd.setCursor(2,1);
 lcd.print("....");
 delay(500);
lcd.setCursor(2,1);
 lcd.print(".....");
 delay(500);
lcd.setCursor(2,1);
```

```
  lcd.print("......");
   delay(500);
 lcd.setCursor(2,1);
  lcd.print(".......");
  lcd.setCursor(2,1);
  lcd.print("........");
  delay(500);
 lcd.setCursor(2,1);
  lcd.print(".........");
  delay(500);
 lcd.setCursor(2,1);
  lcd.print("..........");
  delay(3000);


  esp.begin(9600);
  send_command("AT+RST\r\n", 2000, DEBUG); //reset module
  send_command("AT+CWMODE=1\r\n", 1000, DEBUG); //set station mode
  send_command("AT+CWJAP=\"hot\",\"2020hott\"\r\n", 2000, DEBUG);
  lcd.clear();


}


void loop() {
```

```
  lcd.setCursor(0, 0);
  lcd.print("Place Your Card");

   //Search for Tag
 if (getID()){
  lcd.clear();
  digitalWrite(0, HIGH);
  delay(300);
  digitalWrite(0, LOW);
  lcd.setCursor(2, 0);
 lcd.print("Please wait");
   lcd.setCursor(0, 1);
  lcd.print("Card no:");
  lcd.print(tagID);
  delay(10);
    updatedata();
    lcd.clear();
  }
 else{

 }
}
```

```
void updatedata(){

  String command = "AT+CIPSTART=\"TCP\",\"";
  command += server;
  command += "\",80";
  //Serial.println(command);
  esp.println(command);
  delay(2000);
  if(esp.find("Error")){
    return;
  }

        command = "GET /api/patient/" + String(tagID)+ "?token=access_token_12345" +" HTTP/1.1\r\n";
        command += "Host: health-care-manager.herokuapp.com";
        command += "\r\n\r\n\r\n";

  //Serial.print("AT+CIPSEND=");
  esp.print("AT+CIPSEND=");
  //Serial.println(command.length());
  esp.println(command.length());
  if(esp.find(">")){
```

```
  // Serial.print(command);
   esp.print(command);
   //Serial.println("AT+CIPCLOSE");
  send_command1("AT+CIPCLOSE=0",10000L,DEBUG);
 }
  }


String send_command(String command, const int timeout, boolean debug){
 String response = "";
 esp.print(command);
 long int time = millis();
 while ( (time + timeout) > millis())
 {
   while (esp.available())
   {
     char c = esp.read();
     response += c;
   }
 }
 if (debug)
 {
  // Serial.print(response);
 }
```

```
  return response;
}


String send_command1(String command, const int timeout, boolean debug)
{
  String response = "";
  esp.print(command);
  long int time = millis();
  while ( (time + timeout) > millis())
  {
    while (esp.available())
    {
     // char c = client.read();
      //Serial.print(c);
        if(esp.find("#")){
   while(esp.available()){


    char c = esp.read();
      data[m++] = c;
    if (c == '*'){


      }
          }
```

```
      }
    }

  //Serial.println("Closing connection");
    }
if(!(strncmp(data, "Success", 7))){

        lcd.clear();
      lcd.setCursor(3, 0);
    lcd.print("Welcome");
    lcd.setCursor(6, 1);
    lcd.print("ID: ");
    lcd.print("0");
    lcd.print(data[13]);
delay(4000);

    }
    else{

 lcd.clear();
lcd.setCursor(0, 0);
    lcd.print(data);
```

```
    }

m =   0;
memset(data, 0, 15);

  if (debug)
  {
   // Serial.print(response);
  }
  return response;
}

boolean getID(){

    //Getting ready for Reading PICCs
  if(!mfrc522.PICC_IsNewCardPresent()){ //If new PICC placed to RFID reader continue

    return false;
    }

  if(!mfrc522.PICC_ReadCardSerial()){ //Since a PICC placed get serial and continue

    return false;
```

```
 }

 tagID = "";
 for (uint8_t i = 0; i < 4; i++){

   tagID.concat(String(mfrc522.uid.uidByte[i], HEX));
   }
   tagID.toUpperCase();
   mfrc522.PICC_HaltA();
   return true;
}
```