IoT Based Medical Equipment Supply System



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Declaration

It is declared hereby that this thesis paper or any part or it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled "**IoT Based Medical Equipment Supply System**" is done by the following students under my direct supervision. This project work has been carried out by then in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ABSTRACT

Healthcare monitoring systems in hospitals and many other health centers has experienced significant growth, and portable Healthcare monitoring systems with emerging technologies are becoming of great concern to many countries worldwide nowadays. The advent of Internet of Things (IoT) technologies facilitates the progress of healthcare from face-to-face consulting to telemedicine now. This project proposes a smart healthcare system in an IoT environment that can supply and monitor a patient's medicine through a car system. In this system, some sensors are used to capture the data to move and deliver medicines. The condition of the patients is conveyed via a portal to medical staff, where they can process and analyze the current situation of the patients. The developed prototype is well suited for healthcare monitoring that is proved by the effectiveness of the system.

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LIST OF ABBREVIATIONS

IoT	Internet of Things
Wi-Fi	Wireless Fidelity
MCU	Microcontroller
IC	Integrated Circuit
DC	Direct Current
Li-ion	Lithium Ion
HTTP	Hyper Text Transfer Protocol
MQTT	Message Queuing Telemetry Transfer

Chapter I

Introduction

Introduction

In early 2020, the world experienced a deadly infectious disease caused by the coronavirus pandemic. COVID-19 pandemic has overwhelmed the healthcare systems and medical staff in countries around the world. The systems that have faced real constraints in capacity and accessibility during normal times have worsened during the outbreak, thus leading to worse clinical outcomes. The peak demand for hospital facilities due to the COVID-19 pandemic is expected to surpass capacity considerably. Despite the introduction and execution of social distance initiatives, there is an immediate need to establish and adopt strategies to decrease non-COVID-19 pandemic demands and temporarily increase the capability of health facilities.
This is an integrated healthcare information system that provides a complete paperless healthcare environment based on information technology (IT) which serves to improve the data collection process, storage, and sharing of medical information between modules in the system using standard application interfaces (APIs). An Intensive Care Unit (ICU) is a special facility that is dedicated to treating patients who are critically ill. In the context of the COVID-19 pandemic, ICUs need to increase their capacity of operations due to growing population and other socioeconomic factors such as the increasing number of people moving between countries, which has influenced healthcare systems' capacity around the world. Medical Equipment Supply System refers to medical equipment's asset management where the system manages medical devices within a hospital supported by an automated system. The motivation behind discussing Medical equipment supply system of ICUs is that the healthcare departments that provide intensive care can access advanced medical equipment not routinely available elsewhere. Therefore, the type of data and its sources are entirely different from those available in normal departments. Some challenges that exist in the current MEMS need to be resolved. For example, the risk of outbreak and its relations with the shortage of medical equipment, poor coordination of intensive care teams, and lack of information required for efficient clinical and managerial decisions. In contrast, unwise decisions may have caused wastage of medical equipment in ICUs such as beds, ventilators, defibrillators, and other scarce medical equipment. It is necessary to review the reallocation process of scarce medical equipment to eliminate tasks that require substantial time but may be of limited value to the front-line medical teams or the patients during the pandemic. Researchers have pointed out that IoT has a greater capacity for vital data transfers in the healthcare of the new century. The integration of IoT with medical equipment would reduce smart healthcare systems' total expense and reaction time [24]. Today, in the medical field, IoT technology seems to provide extensive applications towards customizing different tools and devices to meet healthcare requirements to strengthen the response of hospital information systems during the pandemic. Utilizing this technology to control the outbreak has proved its efficiency in Wuhan, China, where drones were used for monitoring citizens to ensure impermanent quarantine in the Wuhan city and mask utilization [12]. Also, IoT aids in increased safety in ICUs and across hospitals, as well as improving the quality of ICU healthcare services which will impact efficiency on overall hospital capabilities at a lower cost. It can provide decision makers with more accurate information when formulating healthcare policies during a pandemic outbreak by developing the Medical Equipment Supply System in hospitals. IoT is an automated solution used for data transfer, analytics, and storage collected by sensors incorporated in

ICUs'medical equipment. The information generated will be shared across diverse platforms and applications which can be used for analytics and decision making through a central server of a hospital. Radio Frequency Identification (RFID) is one of IoT's automated data collection technologies. An RFID reader is installed in medical equipment (bedside device) by adopting appropriate communication standards such as Message Queuing Telemetry Transport (MQTT) to connect with other devices such as web servers in the healthcare institution and by using proper communication protocols such as TCP/IP via Internet terminal. The RFID readers are placed in the bedside devices in ICUs to identify, track, and monitor the medical equipment that is tagged automatically and in real-time. RFID can also assist in inventory management and patient location identification. In this paper, we propose an IoT-based paradigm to empower the Medical Equipment Supply System of ICUs in light of the COVID-19 pandemic. This proposed paradigm guarantees the highest level of transparency and fairness during the outbreak in the redistribution of medical equipment in ICUs. This is different from existing works that have mostly focused on adopting IoT technology in patients' health monitoring. IoT MEMS consists of a theoretical framework for main dimensions of ICUs that are correlated with the COVID-19 pandemic and their interrelationships. It is a practical model that presents how the theoretical framework aspects can be integrated with the current situation. The outcome of this study will assist healthcare decision-makers to restructure ICU information systems to improve the information quality efficiency of Medical Equipment Supply System. Hence, achieving the highest level of transparency and fairness in ICU medical equipment reallocation during the outbreak. The study therefore will answer the following question ''how to design an IoT-based theoretical and practical paradigm for managing ICU resources efficiently during covid-19 pandemic outbreak?''.

Background

Resource limitation, infection control, and protection of ICU medical staff at the front-line are the most known challenges throughout the outbreak of the COVID-19 pandemic. The study concluded that it is important to ensure adequate supplies in ICUs during the outbreak to maintain continuous healthcare services. IoT is an innovative technology used from the fourth industrial revolution (IR 4.0) which connects biosensors and other medical devices via healthcare applications to collect, record, transfer, and share data to enhance communication between stakeholders. It also supports decision-makers to take proper decisions within a shorter time frame during the outbreak of the COVID-19 pandemic.IoT has added a new value to ICUs by offering novel methods, architectures, and solutions for enhancing their capabilities and capacity in fighting the novel coronavirus outbreak. IoT combined with other technologies such as cloud computing, artificial intelligence, and machine learning is one of the best-utilized innovations in combating the COVID-19 pandemic in healthcare institutions in general and ICU departments in particular. IoT provides the ICUs with proper services to control COVID-19 by using remote health monitoring systems (telemedicine services) and biosensors to provide useful information to patients and doctors. Dziak et al. in an article entitled ''IoT-Based Information System for healthcare application'' released in 2017 stated that one of the most significant issues in IoT healthcare applications is the localization of patients or equipment. Another study by Omran et al. released in which proposed an IoT-based intensive care secure paradigm for patient monitoring and tracking mentioned that IoT can provide smart health systems to enhance working efficiency while considering service quality in ICUs. Another study by Khan et al. which was published in 2020 proposed a smart helmet integrated with IoT technology for monitoring infected COVID-19 patients using facial-recognition and thermal camera technology to get real time data [28]. Kumar et al. in a study entitled ''Role of IoT to avoid spreading of COVID-19 pandemic'' pointed out that

IoT applications in healthcare are helpful to improve access to patient information using cloud computing (CC). Based on the data collected in real-time by the ICU devices, healthcare experts can do statistical analysis to make decisions during the pandemic. A research paper by Chaudhari et al. released in 2020 discussed the role of IoT during the pandemic and concluded that a better integration environment in hospitals can be implemented by using IoT applications. Another research by K. Kushwaha discussed IoT-based health care systems during a pandemic using cloud computing. They pointed out that hospital information systems can be designed based on IoT to improve communication channels. This serves to support front-line physicians in critical care to monitor COVID-19 patients' conditions using biosensor nodes to collect more precise information about the pandemic. Dudhanikar et al. in an article published in entitled ''IoT based ICU monitoring system'' concluded that by adopting IoT-based systems in ICUs, patients are well-monitored through continuous tracking of their health information using biosensors and medical devices. A study by Abuelkhail et al. entitled ''Internet of things for healthcare monitoring applications based on RFID clustering scheme'' discussed developing a paradigm for IoT based on a clustering scheme involving RFID integration with wireless sensor systems to collect information efficiently. The smart nodes in the proposed clustering are composed of RFID tags to collect data to be sent to the RFID reader. This leads to a proposed paradigm that can effectively monitor people's health at the time of the pandemic outbreak. In the context of Medical Equipment Supply System, a study by Chien et al. addressed medical equipment management systems and proposed a paradigm for in-house clinical engineering departments. The study concluded that a medical equipment management system can improve the quality of information which can advance the quality of operations. Also, it can reduce the cost of maintenance, as well as boosting medical devices' safety which is used by patients and medical staff in healthcare facilities. The study added that by using an efficient medical equipment management system, healthcare facilities will be able to face potential challenges. M. S. Kumar et al. [33] who conducted a research under the title ''Applications of industry 4.0 to overcome the COVID-19 pandemic operational challenges'' pointed out that due to COVID-19, the demand for medical equipment and accessories has significantly increased. Therefore, there is a need to enhance transparency and trust in managing medical equipment. Using information technology to handle the lack of necessary medical equipment during the COVID-19 pandemic in medical facilities is considered one promising area of research. Utilizing IoT-based ICUs during the time of COVID-19 is still in its preliminary stage. Cao Xiaowu et al. designed a technique to manage medical equipment based on intelligent IoT. Specifically, the process consists of the following steps: S1, inputting equipment information and producing an electronic tag; S2, setting up equipment borrowing procedures; S3, equipment tracking; S4, returning, informing, and viewing equipment. Dai Yueyue et al. proposed a medical equipment management system based on IoT. They focused on managing the maintenance time of each medical system and avoiding excessive errors caused by missing the optimum maintenance time. Chen Weiyu et al. proposed a management platform of medical testing equipment and testing data, and an IoT application method. The management platform comprises development, examination, and pathological testing equipment distributed through each medical section workplace, a testing data acquisition management system, a testing database AI cloud and a testing equipment management system. Most current studies have focused on using IoT technology either in patients' health tracking decision support systems or survey works that present its role in pandemic situations. Some work has been done in the Medical Equipment Management field using IoT technology. Studies on how to utilize IoT technology in ICUs' medical equipment management taking into consideration the current health information system architecture like THIS are limited in number. Also, the literature that discussed this issue from different aspects including technical and management views has not provided a clear view of the best paradigm that can be adopted in case of an epidemic outbreak. To take advantage of IoT, integration with existing information systems is needed to enhance the performance and efficiency of the healthcare tasks, as well as the cost and quality of services in

healthcare institutions. The hospital still uses the barcode method to track and monitor hospital tasks such as patient status, medical inventory, and medical assets. The current system does not consist of any module that manages and tracks medical equipment position, status, and maintenance in real-time. The Medical Equipment Supply System module can improve the performance of healthcare information systems (HIS) and medical services' quality in the ICUs. It can also improve the ability of ICUs to face potential risks such as epidemic outbreaks by providing the necessary information anywhere in real-time to the front-line medical staff and decision-makers in healthcare facilities. Accordingly, the main hypothesis in this paper is that the authors presumed that to promote ICU management and the quality of service in light of the COVID-19 pandemic outbreak, the healthcare providers have to improve information quality by adding a new MEMS component to monitor and reallocate scarce medical devices fairly and transparently.

Our Project

Our project is an IoT based Medical Equipment Supply System. In this project our main component is NodeMCU DevKit. It is a hybrid board of Internet connectivity and Microcontroller.

NodeMCU DevKit

The NodeMCU (**N**ode **M**icro**C**ontroller **U**nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

Chapter II
Internet of Things (IoT)

Definition

The Internet of Things (IoT) describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

Why is the Internet of Things (IoT) so important?

Over the past few years, IoT has become one of the most important technologies of the 21st century. Now that we can connect everyday objects—kitchen appliances, cars, thermostats, baby monitors—to the internet via embedded devices, seamless communication is possible between people, processes, and things.

By means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention. In this hyperconnected world, digital systems can record, monitor, and adjust each interaction between connected things. The physical world meets the digital world—and they cooperate.

What technologies have made IoT possible?

While the idea of IoT has been in existence for a long time, a collection of recent advances in a number of different technologies has made it practical.

- **Access to low-cost, low-power sensor technology.** Affordable and reliable sensors are making IoT technology possible for more manufacturers.
- **Connectivity.** A host of network protocols for the internet has made it easy to connect sensors to the cloud and to other "things" for efficient data transfer.
- **Cloud computing platforms.** The increase in the availability of cloud platforms enables both businesses and consumers to access the infrastructure they need to scale up without actually having to manage it all.
- **Machine learning and analytics.** With advances in machine learning and analytics, along with access to varied and vast amounts of data stored in the cloud, businesses can gather insights faster and more easily. The emergence of these allied technologies continues to push the boundaries of IoT and the data produced by IoT also feeds these technologies.

Conversational artificial intelligence (AI). Advances in neural networks have brought natural-language processing (NLP) to IoT devices (such as digital personal assistants Alexa, Cortana, and Siri) and made them appealing, affordable, and viable for home use.

Chapter III

Electronics Components

In our project, we are using different types of electronics components.

1. Node MCU DevKit

2. L298N Motor Driver

3. Four Wheeler Robotics Chassis

4. Li-ion Battery

5. Miscellaneous (PVC sheet, Switches, Connectors etc.)

NodeMCU Devkit

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But, what about Arduino? The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino

board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments.

There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi capabilities, and some even have a serial data port instead of a USB port.

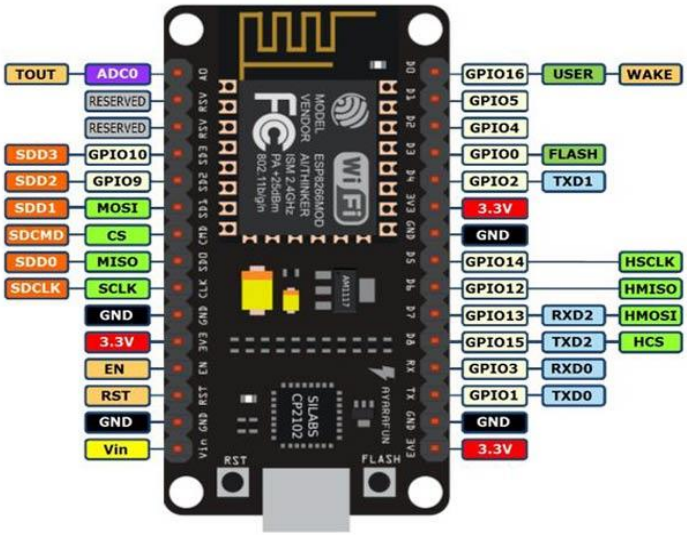


Figure 3.1.1: NodeMCU DevKit

L298N Motor Driver Module

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This consists of an L298 Motor driver IC and a 7805 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

A motor driver IC is an integrated circuit chip that controls motors in autonomous robots and embedded circuits. A motor driver is unquestionably something that causes the motor to move in accordance with the given instructions or inputs (high and low). It listens to the low voltage from the controller/processor and controls an actual motor that needs high input voltage A motor driver IC, in simple terms, controls the direction of the motor based on the commands or instructions received from the controller. Many motor drivers follow different topologies. L298N IC based on popular H-bridge topology.

H-bridge topology :

An H-bridge is a simple circuit that allows you to control the direction of a DC motor. It is typically used in conjunction with a microcontroller, such as an Arduino, to control motors. You can build a robot if you can control two motors to move forward or backward.

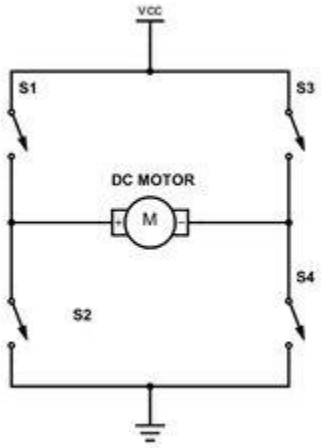


Figure 3.2.2 : Construction of H-Bridge Topology

A DC motor can spin either backward or forwards depending on how the plus and minus are connected. When switches 1 and 4 are closed, plus is connected to the left side of the motor, and minus is connected to the opposite side.

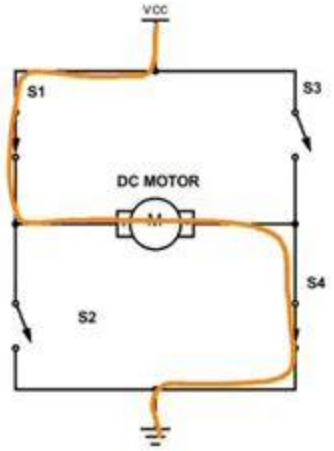


Figure 3.2.3 : Working Process of H-Bridge Topology

If you instead close switches 2 and 3, you will have plus connected to the right and minus connected to the left, and the motor spins in the opposite direction.

Pin Name	Description
IN1 & IN2	Motor A input pins. Used to control the spinning direction of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinning direction of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 & OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power source
5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

Features & Specifications of L298N Motor Driver

- Driver Model : L298N 2A
- Driver Chip : Double H Bridge L298N
- Motor Supply voltage(Maximum) : 46V
- Motor Supply Current (Maximum) : 2A
- Logic Voltage : 5V
- Driver Voltage : 5V - 35V
- Driver Current : 2A
- Logical Current : 0-36mA
- Maximum Power (Watt) : 25W
- Current Sense for each motor
- Heatsink for better Performance
- Power-On LED indicator

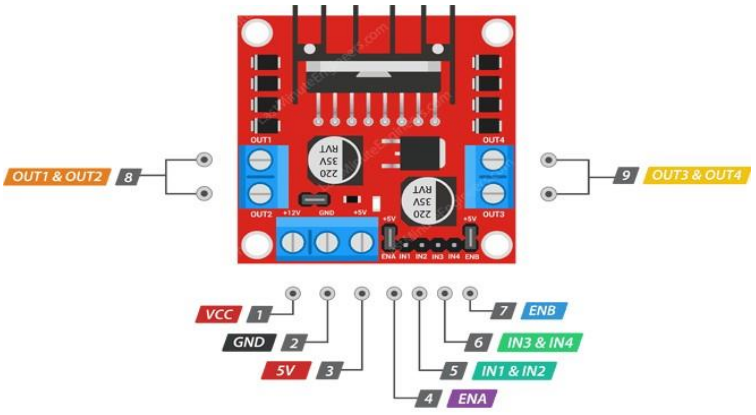


Figure 3.2.1 : L298N Motor driver and Pin definition

The L298N Motor Driver module consists of an L298 Motor Driver IC, 7805 Voltage regulator, resistors, capacitor, Power LED, 5V jumper is an integrated circuit.
The 7805 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through a 5V terminal to power the internal circuitry.
ENA & ENB pins are speed control pins for Motor A and Motor B while IN1 & IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

Four Wheeler Robotics Chassis

We are using Four Wheeler Robotic Chassis for our project. This chassis gives us more efficiency for carrying out the medicine to the patients. It consists of Two layered acrylic chassis, Four Gear Motor and Four compatible wheels and Screw with supportive parts set.

DC Motor Specification :

- Rated voltage : 3-12V DC.
- Unloaded Speed : 120RPM.
- Load Current : 190mA (250 mA MAX).
- Maximum torque : 800 gf. Cm min.

Wheel specification :

- Width : 30mm
- Diameter : 65mm



Figure 3.3.1 : Four Wheeler Chassis

Li-ion Battery Cell

A lithium-ion battery is a family of rechargeable battery types in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging. Chemistry, performance, cost and safety characteristics vary across lithium-ion battery types. Unlike lithium primary batteries (which are disposable), lithium-ion batteries use an intercalated lithium compound as the electrode material instead of metallic lithium.



Figure 3.4.1 : Lithium-ion Battery Cell

Miscellaneous

We use various components like PVC sheet, Switches Connectors, wires etc to build the proper model for our project.

Chapter IV
Circuit Diagram and Program

Block diagrams are given below.

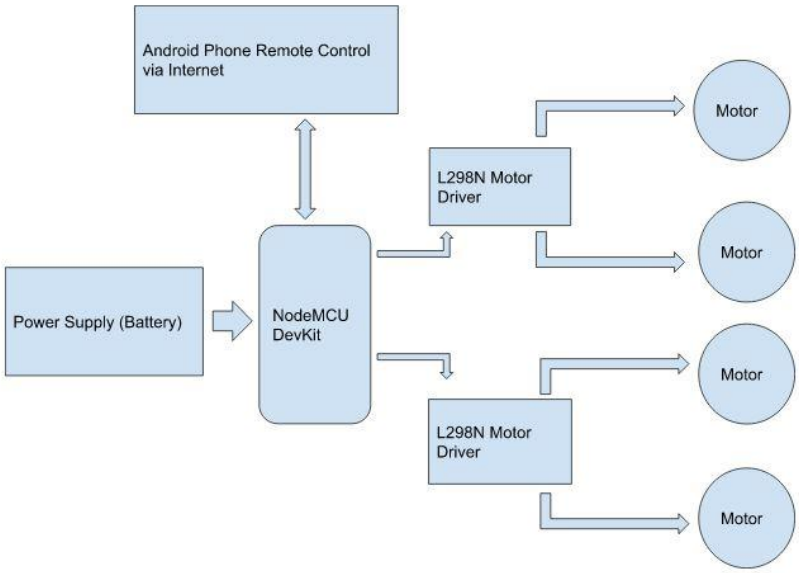


Figure 4.1.1 : Block diagram of Our Project

All the connections are done according to our circuit diagram given below.

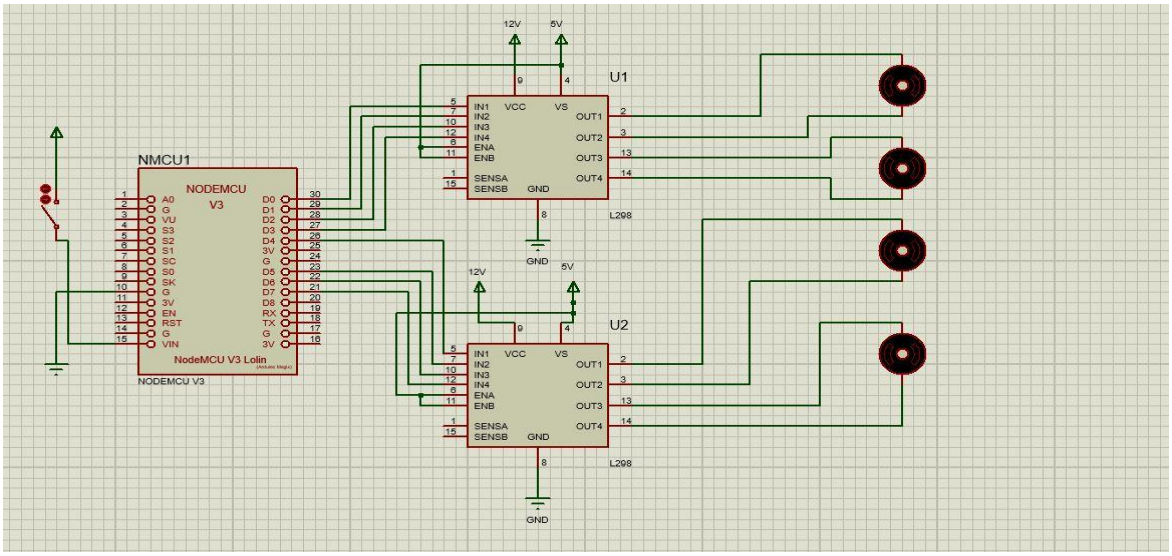


Figure 4.1.2 : Circuit Diagram in Proteus

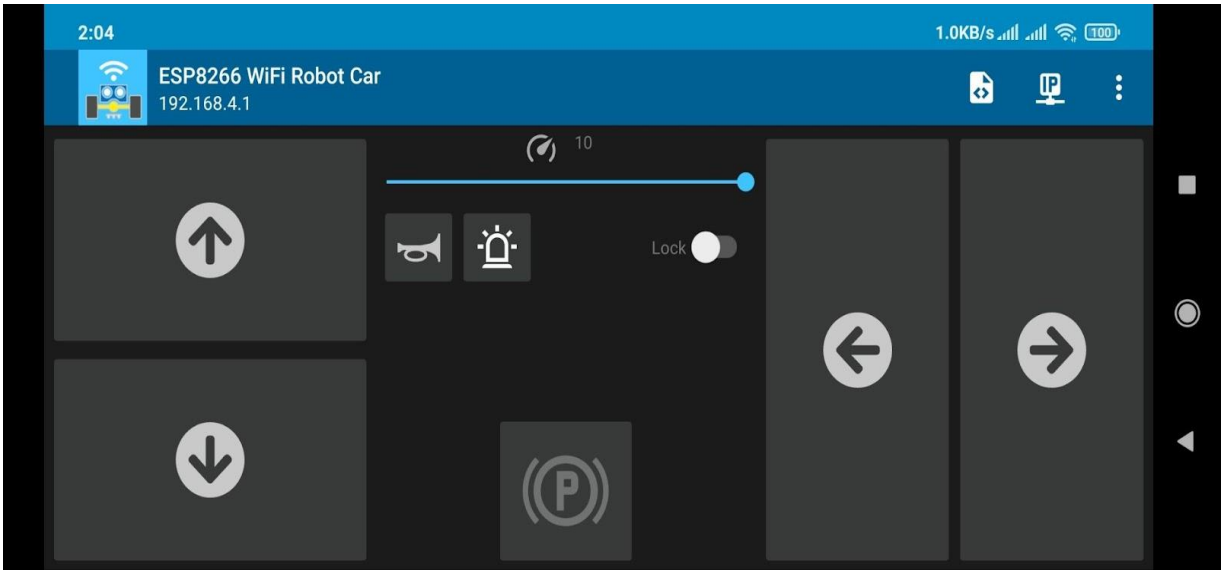


Figure 4.1.3 : Android Software for controlling the Vehicle



Figure 4.1.4 : Real Image of the Project

Program

```
#include <ESP8266WiFi.h>
#include <ESP8266WebServer.h>
#include <ArduinoOTA.h>

                                                    // connections for drive Motors
int forward1 = D1;
int forward2 = D2;
int forward3 = D3;
int forward4 = D4;

int backward1 = D5;
int backward2 = D6;
int backward3 = D7;
int backward4 = D8;

String command;

ESP8266WebServer server(80);

unsigned long previousMillis = 0;


                              //String sta_ssid = "$your_ssid_maximum_32_characters";

                                          // set Wifi networks you want to connect to
                                                //String sta_password =
                                          "$your_pswd_maximum_32_characters";
                                                // set password for Wifi networks
void setup(){
  Serial.begin(115200);                   // set up Serial library at 115200 bps
  Serial.println();
  Serial.println("*WiFi Robot Remote Control Mode*");
  Serial.println("-------------------------------------");
  pinMode(forward1, OUTPUT);
  pinMode(forward2, OUTPUT);
  pinMode(forward3, OUTPUT);
  pinMode(forward4, OUTPUT);

  pinMode(backward1, OUTPUT);
  pinMode(backward2, OUTPUT);
  pinMode(backward3, OUTPUT);
  pinMode(backward4, OUTPUT);
  String chip_id = String(ESP.getChipId(), HEX);
  int i = chip_id.length()-4;
  chip_id = chip_id.substring(i);
  chip_id = "wificar-" + chip_id;
  String hostname(chip_id);
```

```
  Serial.println();
  Serial.println("Hostname: "+hostname);

  // first, set NodeMCU as STA mode to connect with a Wifi network
  /*WiFi.mode(WIFI_STA);
  WiFi.begin(sta_ssid.c_str(), sta_password.c_str());
  Serial.println("");
  Serial.print("Connecting to: ");
  Serial.println(sta_ssid);
  Serial.print("Password: ");
  Serial.println(sta_password);

  // try to connect with Wifi network about 10 seconds
  unsigned long currentMillis = millis();
  previousMillis = currentMillis;
  while (WiFi.status() != WL_CONNECTED && currentMillis - previousMillis <= 10000) {
          delay(500);
          Serial.print(".");
          currentMillis = millis();
  }
*/
  // if failed to connect with Wifi network set NodeMCU as AP mode
 // if (WiFi.status() == WL_CONNECTED) {
  //  Serial.println("");
  //  Serial.println("*WiFi-STA-Mode*");
 //   Serial.print("IP: ");
  //  Serial.println(WiFi.localIP());
          //digitalWrite(wifiLedPin, LOW);                  // Wifi LED on when connected to Wifi as
STA mode
  //  delay(3000);
 // }
// if {
          WiFi.mode(WIFI_AP);
          WiFi.softAP(hostname.c_str());
          IPAddress myIP = WiFi.softAPIP();
          Serial.println("");
          //Serial.println("WiFi failed connected to " + sta_ssid);
          Serial.println("");
          Serial.println("*WiFi-AP-Mode*");
          Serial.print("AP IP address: ");
          Serial.println(myIP);
          delay(3000);
  //}


  server.on ( "/", HTTP_handleRoot );                     // call the 'handleRoot' function when a
client requests URI "/"
  server.onNotFound ( HTTP_handleRoot );              // when a client requests an unknown URI
(i.e. something other than "/"), call function "handleNotFound"
```

```
  server.begin();                                   // actually start the server

  ArduinoOTA.begin();                               // enable to receive update/upload firmware
via Wifi OTA
}


void loop() {
        ArduinoOTA.handle();                        // listen for update OTA request from clients
        server.handleClient();                      // listen for HTTP requests from clients

        command = server.arg("State");              // check HTTP request, if has arguments
"State" then saved the value
        if (command == "F") Forward();              // check string then call a function or set a
value
        else if (command == "B") Backward();
        else if (command == "R") TurnRight();
        else if (command == "L") TurnLeft();
        else if (command == "S") Stop();            // Added

}


                                                    // function prototypes for HTTP handlers
void HTTP_handleRoot(void){
  server.send ( 200, "text/html", "" );                     // Send HTTP status 200 (Ok) and
send some text to the browser/client

  if( server.hasArg("State") ){
        Serial.println(server.arg("State"));
  }
}

void handleNotFound(){
  server.send(404, "text/plain", "404: Not found");   // Send HTTP status 404 (Not Found) when
there's no handler for the URL in the request
}

// function to move forward
void Forward(){
  digitalWrite(forward1, HIGH);
  digitalWrite(forward2, LOW);
  digitalWrite(forward3, HIGH);
  digitalWrite(forward4, LOW);
  digitalWrite(backward1, HIGH);
  digitalWrite(backward2, LOW);
  digitalWrite(backward3, HIGH);
  digitalWrite(backward4, LOW);
}

// function to move backward
```

```
void Backward(){
  digitalWrite(forward1, LOW);
  digitalWrite(forward2, HIGH);
  digitalWrite(forward3, LOW);
  digitalWrite(forward4, HIGH);
  digitalWrite(backward1, LOW);
  digitalWrite(backward2, HIGH);
  digitalWrite(backward3, LOW);
  digitalWrite(backward4, HIGH);
}

// function to turn right
void TurnRight(){
  digitalWrite(forward1, LOW);
  digitalWrite(forward2, HIGH);
  digitalWrite(forward3, HIGH);
  digitalWrite(forward4, LOW);
  digitalWrite(backward1, LOW);
  digitalWrite(backward2, HIGH);
  digitalWrite(backward3, HIGH);
  digitalWrite(backward4, LOW);
}

// function to turn left
void TurnLeft(){
  digitalWrite(forward1, HIGH);
  digitalWrite(forward2, LOW);
  digitalWrite(forward3, LOW);
  digitalWrite(forward4, HIGH);
  digitalWrite(backward1, HIGH);
  digitalWrite(backward2, LOW);
  digitalWrite(backward3, LOW);
  digitalWrite(backward4, HIGH);
}
// function to stop motors
void Stop(){
  digitalWrite(forward1, LOW);
  digitalWrite(forward2, LOW);
  digitalWrite(forward3, LOW);
  digitalWrite(forward4, LOW);
  digitalWrite(backward1, LOW);
  digitalWrite(backward2, LOW);
  digitalWrite(backward3, LOW);
  digitalWrite(backward4, LOW);
}
```

Chapter V
Result and Discussion

Introduction

After successfully doing our project, we accomplished our goal. There are some advantages and disadvantages which are given below.

Advantages

- Supply necessary medicine to the contagious patients remotely.
- Integrated many features easily.
- Increase area of service using Wifi router.
- More efficient using MQTT protocol.

Disadvantages

- Lack of technology only medicine can supply to the patients.
- Need custom android app for adding more features.
- Limited service of area without router.
- Infrastructure of the MQTT protocol is costly.

Conclusion

This project is very useful for medical industries that will help medical staff to carry more equipment at once. Also it brings more portability to supply medical equipment to hospitals and clinics.
An Iot based medical equipment supply system allowing devices to communicate between medical personnel and patients to manage demand and reduce human effort.

Chapter VI
Conclusion

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Limitations

The main problem starts with the HTTP protocol. What happens is when we try to send commands over wifi for controlling a robot the whole network lags for a moment. This lag is caused by the protocol itself. Because the MCU acts as a server we have to set up the command processor in MCU as HTTP handler.

When there is a HTTP protocol involved there is a question of handshake. This handshake requires about 10 steps each time we send a command. And it works both ways(receiver and sender). In between this handshake the command still goes on. And for this even if the button is released it is not stopped instantly. Hence it will continue running around for a while after the button release. On the other hand when BT is paired it can send data one way with very fast speed

There are other ways to handle these situations over wifi. But those are not cost effective at this parameter. In that case we have to maintain a server with extensive security protocol and use many third party applications as well.

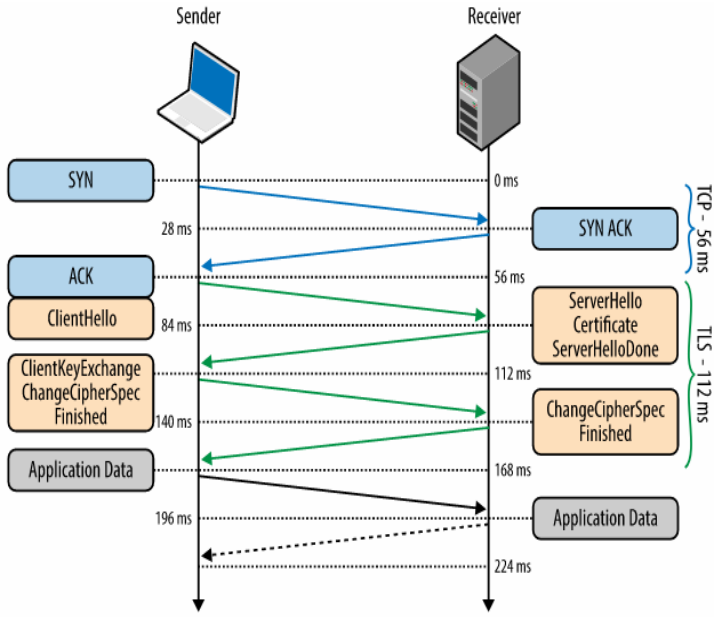


Figure 6.1.1 : Working Process of HTTP protocol

Future Scope

Building a MQTT infrastructure brings more efficiency on this project. A dedicated software enhancing this hardware with more features like in-built notification system, monitoring and observation system can be developed later.

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Appendix