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ADVANCED HOSPITAL ROBOT

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Abstract : In this paper, we are developing an automatic guided robot for hospital applications, called Advanced Hospital Robot, which can be controlled remotely. The Hospital Robot is both a line following and manually controlled robot, powered by a battery. It has infrared sensors at the bottom for path identification. The main purpose of this Hospital robot is to deliver the medicine to the patient either automatically or manually using Android application. Medicine is delivered using a vending machine associated with it. The robot automatically identifies the path using line following technique. A sanitizing machine, garbage collection box and patient monitoring system is attached to this robot. When the hand is placed near to the sanitizing machine it will automatically sanitizes the patient's hands. When the patient wants to dispose the garbage, he/she have to come closer to the garbage bin attached with hospital robot and as it detects the presence of the patient, it automatically opens the lid of the garbage bin and closes after the disposal. Patient monitoring system monitors the vital body parameters of the patient such as Temperature, Heart rate, Oxygen saturation level, and if any of this parameter exceeds the threshold value, a message is sent to doctor's mobile phone via SMS.

***IndexTerms* - Advanced Hospital Robot, Line Following, Medicine vending machine, Sanitizing Machine, Garbage Collection, Patient Monitoring System, SMS.**

CHAPTER 1
INTRODUCTION

Engineering and computer science are combined in the discipline of robotics to build machines that can move and respond to sensory input. The area of artificial intelligence known as robotics. Robotics is the application of engineering and computer science to the usage of robots in performing a variety of activities. Robots have primarily mechanical construction and can be controlled remotely or autonomously. Robotics are increasingly being used in a variety of fields because they can handle more work than humans can and lower workloads. Although the widespread usage of robotics technology would eliminate many human jobs and lead to unemployment in the community. Robotic job performance will result in a decline of human employment, so the transition should be handled methodically. It advances and will reduce the need for many high-end, precise occupations and benefits a number of industries, including agriculture, the military, healthcare, and others. As a result, there will be some balance between the actual need and demand for robot assistance in the job. The advancement of robotic technology should be encouraged by society, since it will benefit both individuals and numerous economic sectors. It can aid with a variety of activities that are beyond the capacity of humans, and their use in warfare would be very beneficial. Robotics technology has advanced so much, and they are now practically present in every industry and sector, from transportation to healthcare to recreation.

An IoT of robots are used in healthcare applications for surgery, caregiving, motion robots, and pharmaceutical robots. Robotic systems have significantly increased our ability to sense, interact with, manipulate, and change the environment around us. The surroundings and functions that medical robotic systems are built for in relation to the diagnosis, treatment, and prevention of diseases are completely different. Hospitals were overloaded as a result of a rise in the number of patients under the severe pandemic caused by the covid-19. Therefore, technical support for the hospital staffs was crucial. So, in considering such conditions or outbreaks in the future, the Advanced Hospital Robot we developed will thus finds the finest way to support them by giving them their excellent work and assisting them in avoiding direct contact with the patients who are under treatment. The primary responsibility of a nurse is to care for the patients who are assigned to them by administering the medications at the appropriate intervals and keeping track of the patient's physiological data. The key benefit of deploying this robot is that it can automate parameter monitoring and medicine dispensing, reducing the workload of medical professionals. This served as the impetus for creating this project.

CHAPTER 2
SYSTEM DESIGN

2.1 PROPOSED SYSTEM

Technology breakthroughs continue to revolutionise how we deliver medical services in the ever changing healthcare industry. The proposed system of an Advanced Hospital Robot is one such ground breaking invention. This robot, which was created using an Arduino Mega 2560 and a NodeMCU ESP32, performs the role of a multifaceted robotic nurse, providing both patients and medical professionals with a wide range of services. A new benchmark for healthcare institutions has been established by the Advanced Hospital Robot, which has a wide range of cutting-edge capabilities. Explore its impressive capabilities and the potential effects it could have on the sector.

RFID Tag Initiation: The sophisticated hospital robot makes use of RFID tag technology to improve patient safety and streamline operations. It can start customised tasks catered to a person's needs by reading RFID tags on medical goods and patients. This function ensures individualised treatment and makes it easier to administer medications, perform sanitization operations, and control waste.

Automated and Manual Movement: To maximise its functionality, the sophisticated hospital robot integrates both automated and manual movement capabilities. It can autonomously move across the facility using line-following techniques, assuring the timely and accurate distribution of pharmaceuticals, carrying out sanitization duties, and gathering data. The Blynk IoT software also allows for manual control of the robot, giving medical staff flexibility and convenience.

Medicine Vending: A key component of this robot's operation is its mechanism for dispensing medications. It is capable of accurately storing and dispensing a range of drugs by utilising the Arduino Mega 2560 and NodeMCU ESP32 platforms. Patients may depend on the robot to provide their prescribed prescriptions at the right times, providing the best treatment compliance and lowering the possibility of mistakes.

Sanitization Unit: It is crucial to keep healthcare facilities clean and sterile at all times. This problem is addressed head-on by the sophisticated hospital robot by including a cutting-edge sanitization unit. It can effectively sanitise surfaces using UV-C lights and disinfectant sprayers, reducing the spread of dangerous microorganisms and enhancing general hygiene standards.

Garbage collection: It's essential to handle waste properly to stop toxins from spreading. The cutting-edge medical robot is built with an automated rubbish collection mechanism to solve this problem. It can move around the building, gathering and getting rid of medical waste effectively and safely. The robot frees up time-consuming and repetitive work for the medical staff by automating this process, allowing them to concentrate more on patient care.

Patient Parameter Monitoring: Real-time vital sign monitoring is crucial for a patient's health. As a result of the robot's integrated temperature sensors and SpO2 reading capabilities, patients' body temperatures and oxygen saturation levels may be measured quickly and precisely. For patients with respiratory disorders or those recovering from surgery in particular, this information is essential for the early detection and prevention of potential health concerns.

Power Source: The sophisticated healthcare robot is powered by 12V batteries to ensure continuous operation. This enables continued use without the need for regular recharging, allowing the robot to carry out its tasks effectively all day long.

The advanced hospital robot system that has been designed marks a substantial improvement in medical technology. This robot delivers a wide range of services, from pharmaceutical vending and sanitization to rubbish collection and vital sign monitoring, by utilising the power of the Arduino Mega 2560 and NodeMCU ESP32. It improves patient care and safety, lightens the load on medical staff, and streamlines procedures. The potential influence on healthcare institutions is enormous, even though the creation and application of such a system necessitate extensive testing and improvement. By embracing the potential of robotics, IoT, and RFID technologies, we open the door to a time when sophisticated hospital robots are essential to providing effective, dependable, and patient-centred care

2.2 SYSTEM ARCHITECTURE

2.2.1 Architecture of unit for the Motion.

NodeMCU ESP32: It serves as the communication module and creates connectivity between the robot and outside devices. It is in charge of establishing connections with the Blynk IoT server and app, allowing for remote management and information sharing.

Wheels and DC Motors: The robot has four wheels, each of which is powered by a DC motor. The NodeMCU ESP32 is connected to these motors, giving the robot's mobility precise control. The robot's ability to move forward, backward, and turn smoothly depends on the motors' ability to change their speed and direction.

The robot has two different operating modes: manual and automatic motion. By clicking on the correct keys on the Blynk IoT app, the user can manually control the robot's movement when it is in manual mode. These instructions are transmitted to the NodeMCU ESP32, which deciphers them and operates the motors as necessary. In automatic mode, the robot travels independently by employing a line-following approach to follow a predetermined course. The user can choose between these modes via the Blynk IoT app, providing flexibility and adaptability in various situations. Communication between the robot and outside components, like the Blynk IoT app and server, is made easier by the NodeMCU ESP32. In addition to providing regulated motion, the line-following and ultrasonic sensors also guarantee precise navigation and obstacle avoidance. An easy-to-use interface is provided for manually controlling the robot and switching to autonomous mode through the Blynk IoT app, which is connected to the Blynk server. This cutting-edge medical robot offers healthcare facilities improved mobility, precise movement, and the capacity to complete activities on its own, ultimately enhancing productivity and patient care.

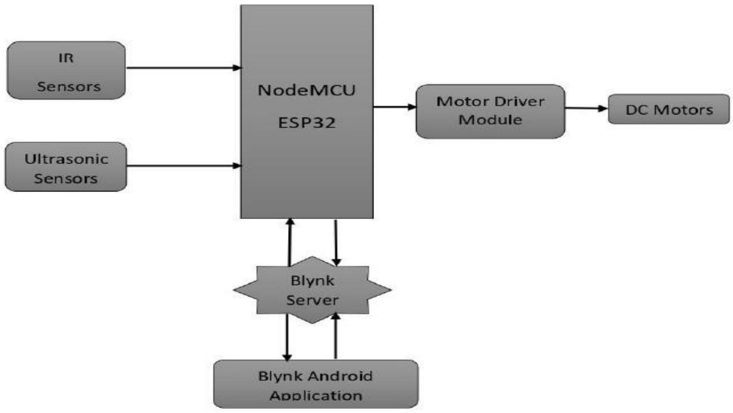

Fig 2.2.1.1: Architecture of unit for the Motion of the Advanced Hospital Robot

Ultrasonic sensor: The robot includes ultrasonic sensors to enable safe navigation and obstacle avoidance. These sensors produce ultrasonic waves, which they use to time how long it takes for a wave to return after colliding with an obstruction. Regardless of whether the robot is in manual or automatic mode, the NodeMCU ESP32 can detect the existence of obstacles by analyzing the returning signal and taking the necessary action.

Blynk IoT App and Server: In order to control the robot, the Blynk IoT app is essential. Through its user-friendly interface, the user can communicate with the robot. The app initiates contact with the NodeMCU ESP32 by connecting to the Blynk server, enabling the exchange of instructions and data.

Line Following Sensors: When the robot is in automated line following mode, infrared (IR) sensors start working. These sensors pick up the line on the floor and inform the NodeMCU ESP32 of their findings. By analyzing this data, the controller can modify the robot's motion to keep it on the intended course.

2.2.2 Architecture of units for the Medicine vending, sanitizing, Parameter sensing and Garbage collection.

Arduino Mega 2560: The Arduino Mega 2560, which is at the center of the architecture, is the primary microcontroller in charge of directing and coordinating the actions of the robot. It processes data from various sensors and modules and then takes the appropriate actions in accordance with the preprogrammed logic.

LCD Display: The LCD display is used as an interface for showing messages or information when it is linked to the Arduino Mega 2560. It enables simple communication between the robot and users by providing real-time feedback, such as instructions, alerts, or patient-specific information.

RFID reader: Reading the RFID tags connected to patients is done by the RFID reader, which is attached to the Arduino Mega 2560. The RFID reader recognises the distinctive tag when a patient approaches, enabling the robot to access the patient's medical history, any prescription medications, and other pertinent data.

5V water pump: An essential part of the sanitising unit is the 5V water pump. A chemical solution or sanitising agent, for example, is intended to be circulated onto the surfaces that need to be cleaned. The Arduino Mega 2560 supplies power and control signals to the water pump through the relay module, which is attached to the water pump.

Relay Module: The relay module controls the power supply to the 5V water pump by acting as a switch. It enables fine control over the sanitising process by enabling the Arduino Mega 2560 to turn the pump on and off. The Arduino Mega 2560, which provides control signals to turn on or off the water pump, has the relay module attached to the proper digital pins.

Pulse oximeter: The Arduino Mega 2560 is coupled with a pulse oximeter that measures SpO2 levels. It records the patient’s heart rate and oxygen saturation levels, giving important medical data. This data is processed by the Arduino Mega for analysis and, if necessary, further action.

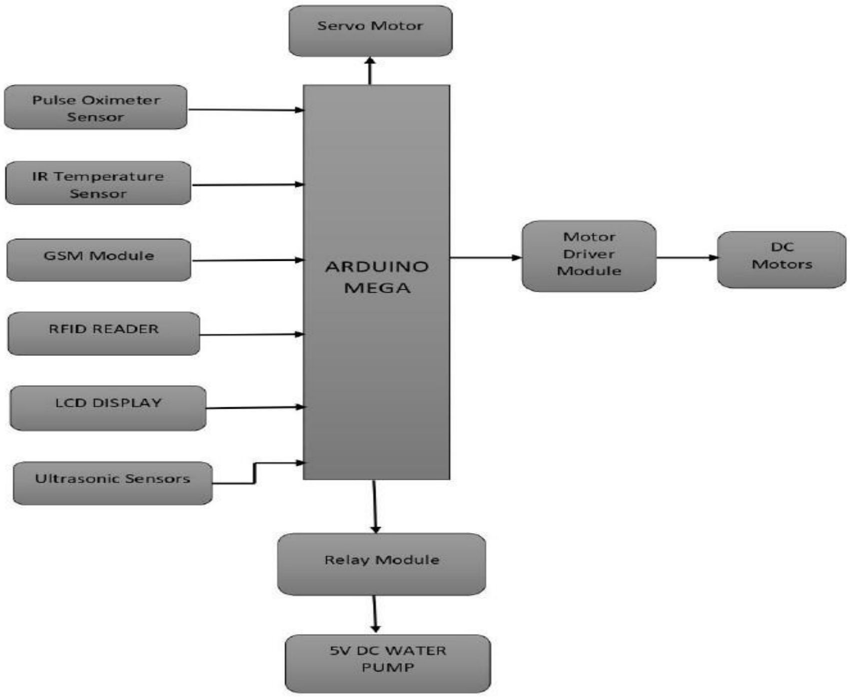

Fig 2.2.1.1: Architecture of unit for the Medicine vending, sanitizing, Parameter sensing and Garbage collection of the Advanced Hospital Robot

IR Temperature Sensor: An infrared (IR) temperature sensor is connected to the Arduino Mega 2560 to detect the patient's body temperature. It measures the infrared radiation emitted by the patient and provides accurate temperature readings. The Arduino Mega processes this information and triggers appropriate responses based on the predefined thresholds.

GSM Module: When the monitored parameters exceed the predetermined threshold values, the GSM module is used to relay messages. The robot may transmit messages or alerts to medical specialists or authorised personnel when it is connected to the Arduino Mega 2560, ensuring quick action and attention.

Servo Motor: The servo motor, controlled by the Arduino Mega 2560, is responsible for the medicine dispensing mechanism. Upon receiving instructions, the Arduino Mega triggers the servo motor to dispense the appropriate medication based on the patient's RFID tag or other identified parameters.

Motor Driver Module: The Arduino Mega 2560 is connected to the motor driver module, which regulates the DC motor in charge of opening the trash can. When instructed to collect the trash cans, the Arduino Mega turns on the motor driver module, assuring smooth and accurate operation.

Ultrasonic Sensors: Both the sanitization unit and the waste unit use ultrasonic sensors. These sensors, which are coupled to the Arduino Mega 2560, can recognise items in close vicinity or barriers. The robot uses the ultrasonic sensors in the sanitization unit to autonomously navigate and start the disinfection process. They aid in locating and recognising waste bins in the garbage unit, allowing the robot to collect them effectively.

CHAPTER 3

METHODOLOGY

3.1 WORK FLOW

Initialize all the sensors and board by powering the supply. The robotic movement mode is selected by using Blynk android application. We have two modes, first Automatic and manual mode. In manual mode the medical robot is controlled by the Blynk android application, and in automatic mode medical robot is moved along with the line following technique. In automatic mode, the medical robot detects an obstacle in front of the robot, it stops and waits for the path clearance. To start the rest of the process, instructions are displayed on the LCD display attached with the medical robot. To start the procedure the patient should show the RFID tag to the robot. The medicalrobot identifies the patient using RFID tag. The next instruction is to sanitization, patient need to show its hand to sanitizer unit is automatically detect the hand, if not then it waits until detection of hand and dispense the sanitizer. After sanitizer dispense the medicine start dispensing according to the predefined prescription allotted to the RFID tag. Then medical robot guide patient to show their hand to the temperature and pulse oximeter sensor to take readings, if parameters exceed the threshold, then alert message is sent to the doctor's mobile number. The medical robot waits for patient hand detection for garbage unit for opening and closing lid. If presence is not detected thenno action is performed.

Work Flow Diagram of Line Following robot

Work Flow Diagram of Patient Monitoring system, Medicine Dispense, Sanitizing machine, garbage collection.

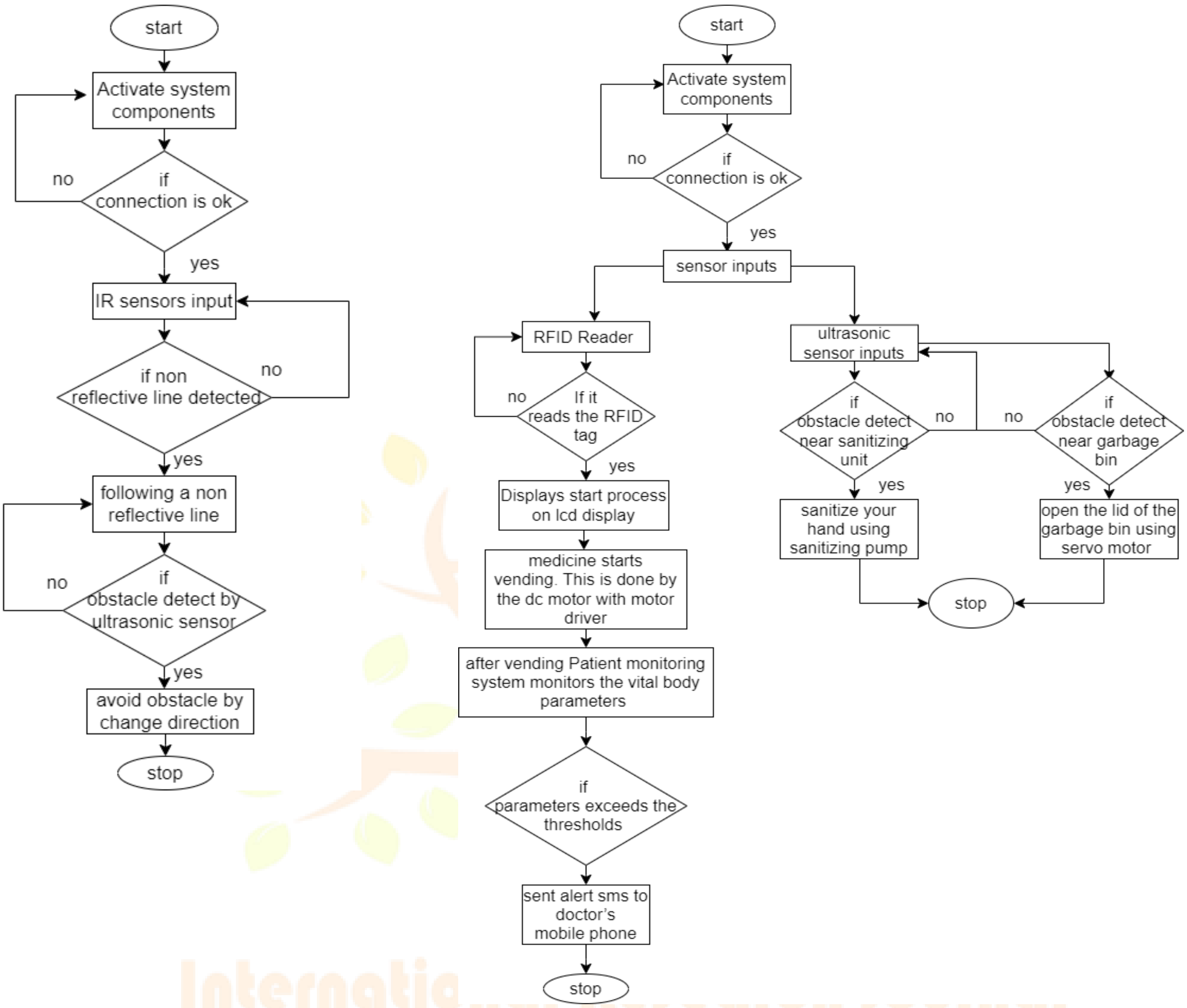

Fig 3.1.1: Work Flow diagrams of the Advances Hospital Robot

3.2 WORKING

The working of the line-following robot with various functionalities, such as detecting and following a black line, detecting RFID signals, vending medicine, and monitoring vital patient parameters are described.

Line Following: The robot uses an IR transmitter and receiver pair as an IR proximity sensor. The transmitter emits infrared light, and the receiver detects the reflected light .By positioning the sensors on the robot's underside, it can detect the line underneath it. If the receiver doesn't receive the reflected light, it means the robot has deviated from the line. In this case, the robot stops its movement and performs a corrective action. The corrective action involves moving the motor two steps to the right or left to get back on the line. Once the receiver detects the reflected light again, the robot resumes following the line. Also, we can control the robot using a mobile app manually.

Sanitizing Machine: An ultrasonic sensor is connected to the Arduino Mega using GPIO pins. A water pump is connected to the Arduino Mega using a relay module. The ultrasonic sensor detects the presence of an object (presumably hands) and triggers the sanitizing process. The Arduino Mega controls the water pump to dispense the sanitizing solution.

RFID Detection: As the robot reaches in front of a patient, it uses an RFID reader to detect RFID signals. RFID (Radio Frequency Identification) is a technology that uses electromagnetic fields to identify and track tags attached to objects or people.

Medicine Vending: When the RFID reads, the robot initiates the medicine vending process. Medicine vending is accomplished using a DC motor and motor driver. The motor drives the vending mechanism to dispense the medicine into a box/container.

Vital Patient Monitoring: After the medicine vending process, the robot begins monitoring vital patient parameters. The specific parameters mentioned are temperature, heart rate, and oxygen saturation level. The robot likely uses appropriate sensors or devices to measure these parameters. If any of the monitored parameters exceed predefined thresholds, indicating a potential medical concern, the robot initiates an action. In this case, the action is sending an SMS to the doctor's mobile phone to alert them about the patient's condition.

Garbage Collection Box: An ultrasonic sensor is connected to the Arduino Mega to detect the presence of a patient. A servo motor is connected to the Arduino Mega to automatically open the lid of the garbage bin. When a patient approaches the garbage bin, the ultrasonic sensor detects their presence and triggers the servo motor to open the lid.

3.3 CIRCUIT DIAGRAMS

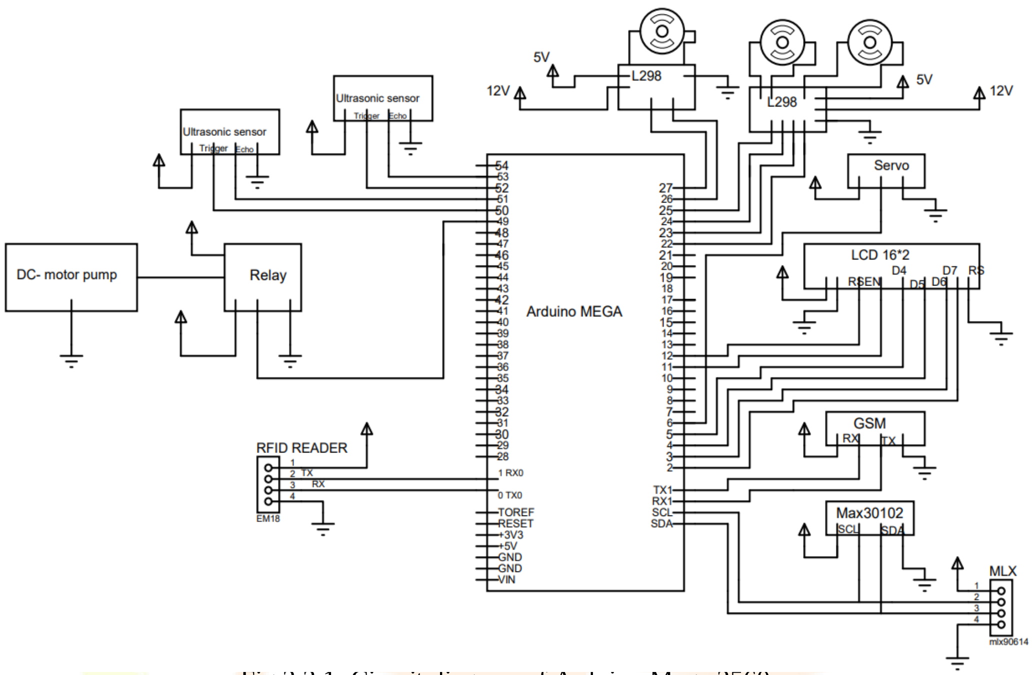

Fig 3.3.1: Circuit diagram of Arduino Mega 2560

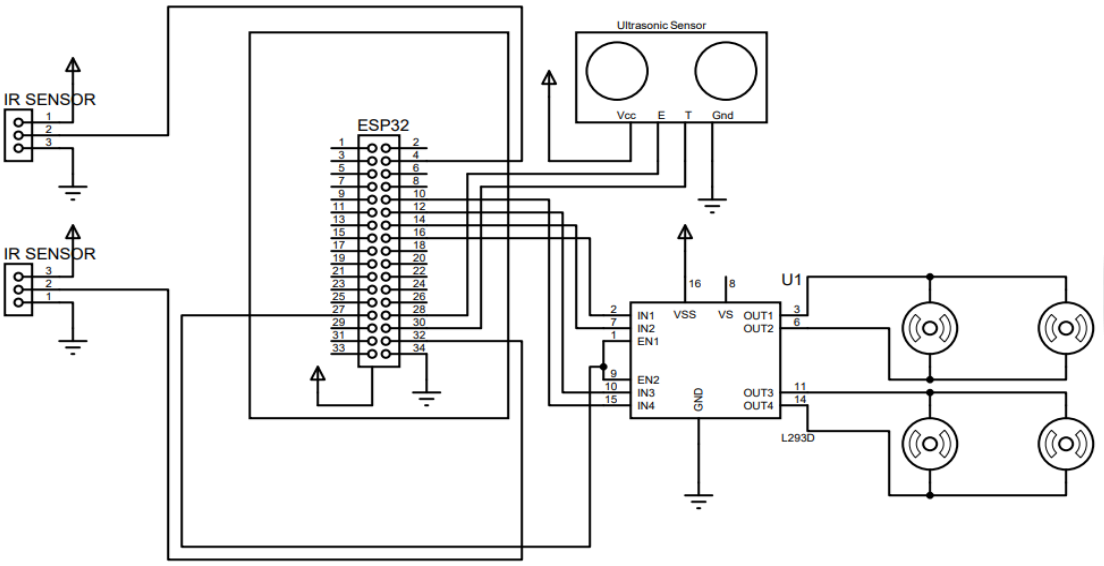

Fig 3.3.2: Circuit diagram of NodeMCU ESP32

CHAPTER 4

EXPERIMENT AND RESULT ANALYSIS

4.1 HARDWARE SETUP

Fig. 4.1.1: Front view of AHR, Fig. 4.1.2: Top view of AHR and Fig. 4.1.3: Back view of AHR

The Advanced Hospital Robot has all the components required for medicine vending, parameter monitoring, sanitizing and garbage collection. It includes sensors like ultrasonic sensors to detect hand for sanitization and garbage collection, IR sensors for detecting any objects in the robot's path, temperature sensor for measuring the temperature and pulse oximeter sensors for measuring SpO2 levels. A GSM module is used to relay messages if the monitored parameters exceed the threshold value. RFID reader is used to scan the RFID tags to identify the patient.

4.2 TEST CONDITIONS

Table 4.2.1 Test condition for Garbage Collection and Ultrasonic Sensor

Sl.No	Ultrasonic Sensor	Garbage Collection
1.	When the hand is shown in front of the sensor	Opens lid
2.	When no hand is shown	Lid remains closed

When the patient shows their hand in front of the ultrasonic sensor it detects the hand and opens the lid else the lid remains closed until no hand is detected.

Table 4.2.2 Test Condition for RFID Reader and RFID Tags

Sl.No	RFID Tags	RFID Reader
1.	Valid Tag	Identify the patient
2.	Invalid Tag	Doesn't identify the patient

Each patient has its own RFID tags and without RFID tags robot doesn't identify the patient. Hence it doesn't vend the medicines. RFID tags are scanned using RFID readers.

Table 4.2.3 Test Condition for IR Sensor and Movement

Sl.No	IR Sensor	Movement
1.	If sensor detects the path	Robot moves with line following technique
2	If sensor doesn't detect the path	Robot stops

The robot starts to move by the line following technique wherein we use the IR sensors. If any object comes in front of the robot, it stops and wait for path clearance.

4.3 SOFTWAREE SETUP

Blynk IoT platform can be utilized to enable both manual and automatic mode movement in robots. In manual mode Blynk provides a user-friendly interface that can be customized with buttons, sliders, or joysticks. Through the Blynk app, users can interact with the robot and control its movement manually. They can use buttons to move the robot forward, backward, turn left or right, or stop.

In automatic mode, AHR is equipped with sensors such as IR sensors and ultrasonic sensors. Blynk app receives sensor data from these sensors, and based on the programmed logic, initiates the automatic movement actions. If an IR sensor detects an obstacle, the robot automatically change its path or stop. By integrating Blynk IoT with the robot's control system, users can switch between manual and automatic modes, providing flexibility and versatility in controlling the robot's movement.

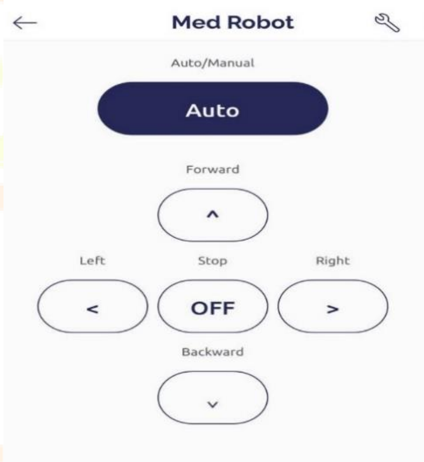

Fig 4.3.1: Blynk app user interface

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

AHR offers numerous benefits, including improved efficiency, accuracy, and patient safety. They can navigate hospital environments, deliver medications to patients, and provide automated reminders for medication adherence. We suggest AHR to administer medications to patients and monitor their vital signs in place of nurse care. With the aid of an RFID tag and a queue follower, the robot locates the patient's location. Since there is less direct contact between patients and staff members in hospitals, there is a lower risk of infectious diseases spreading among the medical professionals. Both patients and medical professionals save time. The future of these hospital robots is promising as continued research, development, and collaboration between robotics engineers, healthcare providers, and regulatory bodies will drive advancements in this field.

The future of these hospital robots is promising as continued research, development, and collaboration between robotics engineers, healthcare providers, and regulatory bodies will drive advancements in this field. The advanced hospital robot holds several potential avenues for further development and improvement. Enhanced Navigation and Obstacle Avoidance can be achieved by incorporating ultrasonic sensors for obstacle detection and further future iterations could incorporate advanced sensors, such as LiDAR or 3D cameras, for more accurate mapping and obstacle avoidance. This would allow the robot to navigate complex hospital environments with greater precision and safety. The inclusion of artificial intelligence (AI) and machine learning algorithms could enable the robot to learn and adapt its behavior based on the hospital's specific needs. This could involve optimizing the line following technique, improving object recognition capabilities, or dynamically adjusting its motion based on real-time feedback. Integrating the robot with the hospital's electronic medical records system would enable it to access and retrieve patient data, track medication administration, and assist healthcare providers in delivering personalized care. This integration could enhance the overall efficiency and effectiveness of the robot in supporting healthcare workflows.

CHAPTER 6

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