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VIRTUAL HEALTH ASSISTANCE ROBOT FOR DOCTOR USING IoT

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Abstract - Doctors are usually needed to work at every hospital and emergency center every now and then. But it is not feasible for every doctor to be available at every place at desired time. The problem with video calling is that video calls need to be done from a PC or laptop on a desk. This limits the doctor's capacity to view patient or around operation theatre at will or even move through hospital rooms as needed. To help solve this issue, we here develop a VIRTUAL HEALTH ASSISTANCE ROBOT FOR DOCTOR USING IoT that allows a doctor to virtually move around at a remote location at will and even talk to people at remote location as desired. The system makes use of a robotic vehicle with 4-wheel drive for easy navigation. The robot also includes a controller box for circuitry. The doctor can use an IOT based panel to control the robot. The control commands sent online are received by the robot controller. The robot controller operates over Wi-Fi. The received commands are received in real time and the robot motors are operated to achieve the desired movement commands. In the covid-19 pandemic situation whole world is afraid about the future earth and recently covid-19 has come with the more powerful wave and again human life is facing a tough situation. Our society is spending life in between life and death. But in this current destroying situation we human being also have to survive through this condition and for this, each and every one has to maintain their lifestyle according to a proper schedule and also have to follow few rules to avoid the fatal attack of covid-19. And among these rules, there is a rule of social distancing where every human being has to maintain a distance of 6 feet. Now in this condition besides other needs, there is a necessity to go to doctors but due to social distancing there can be a risk to come to touch in each other but without touching patient doctors cannot properly diagnose patients and for this, we have proposed this idea which will help the doctors to diagnose patients properly without touching. This robot will help to measure body temperature, pulse rate, physical condition and will display it based on which doctors can recommend prescription and medicine. Thus, this will help to prevent the spreading of diseases. Also, this device can be carried easily to remote areas where doctors cannot reach easily and thus it can be used to treat patients when doctors are at the comfort of their own surroundings.

Index terms – IoT, Virtual Health Assistance Robot, Sensors, Control Commands, Health, Vital Parameters

1. INTRODUCTION

Technology in biomedical field is the blessing for human society. But we can see in our daily routine most of the people don't take care of their health seriously. Problems such as cancer and various diseases due to which death rate is increasing because of poor medical infrastructure. So, for better observation of health

at personal level medical kits are best option. In older days due to lack of technology and facilities doctors were not able to attend all the patient on time, so there were chances of patient death. But nowadays because of this technology doctors can connect with the patient virtually. The doctors can collect all the basic parameters which are required for their treatment so if there is an emergency the doctors can take preventive action instantly so chances of deaths are reducing. As we can see technology like IoT is completely dominating the future for development of health sector, IoT is nothing but a blessing for us which connects humans with the technology. It includes uses of various sensors and actuators which are very useful in our everyday life. It has changed people's lives by sending the health signals to the concerned family members and doctors, so the chances of danger decreases and we can live a healthy life style.

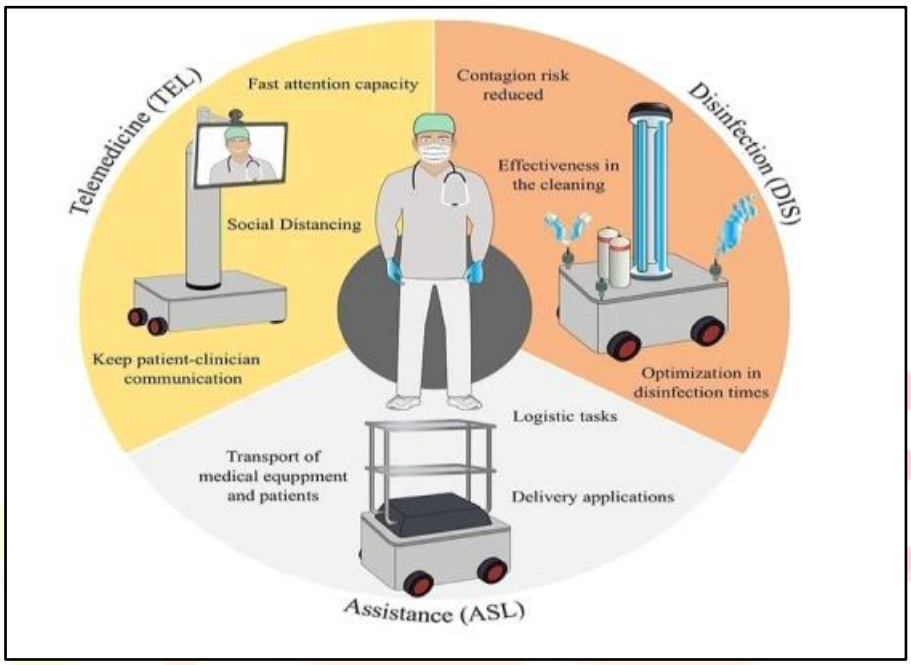

Figure 1 Method to lower contact between doctor and patient

1.1 OBJECTIVES

The main goal is to develop a fully automated system that can autonomously administer medication to patients using a robotic arm while diagnosing common illnesses. Pulse rate, physical condition and temperature monitoring are three examples of modern self-testing.

The goal is to reduce the time and effort required to measure and diagnose vital signs, and to develop and implement a reliable, low cost, low power, non-intrusive and accurate system.

The major objectives include:

- Make your daily work more efficient.
- Make sure that procedures are more uniform.
- Lessen the amount of labour needed to care for patients.
- Enhance patient compliance tracking and healthcare services.
- Perform a variety of jobs with more independence and autonomy than people.
- Virtually, doctors are accessible at any time or location.
- Doctors can virtually and in real time go from one room to another.
- Medical reports can be checked by doctors remotely.
- Physicians can also move independently around the patient in the OT or in the virtual environment.

1.2 PAPER ORGANISATION

The various stages involved in the development of this device have been properly put into five sections to enhance comprehensive and concise reading. The work is organised sequentially as follows:

- Chapter one of this work is on the introduction to this work. In this chapter, the introduction, aim and objectives are discussed.
- Chapter two is on literature review of this work. In this chapter, all the literature pertaining to this work was reviewed.

- Chapter three is on implementation, design methodology. In this chapter all the method involved during the design and construction were discussed.
- Chapter four is on results and testing analysis. All testing that results accurate functionality was analysed and the pictures of the photos are given.
- Chapter five is the conclusion.

2. LITERATURE SURVEY

Person-to-person contact during the epidemic was very dangerous for the specialist, medical staff, and patient. According to Ayeesha Mahveen et al. [1], specialists are often expected to be present in medical clinics and crisis centers. Therefore, it is impossible for me to attend every single one and to be available at every location at the desired time. A Virtual Doctor system that enables an expert to essentially roam about any clinic space and have spoken conversation with patients helps with this problem. Such robots are used in healthcare settings to ensure assistance and to reduce individual-to-individual interaction. This may be accomplished by reducing the danger that the pandemic poses to clinical staff members and many other individuals who hold operational positions within the company. For professionals, this method has a number of benefits, including:

- In activity theatres, doctors will walk around.
- Through video chats, specialists will remotely see clinical records.
- Various rooms will be visited by specialists.

The survey by Mrs.A.Usha et al. [2] proposes a smart health monitoring robot system to provide a secure emergency solution to elder people that is living alone at their home. An intelligent smart real-time connected video communication between patient and doctor and there is a wireless Bluetooth connectivity or Wi-Fi connected robot system which can be controlled by the remote. The smart robot system will detect the health, alarm in emergency situations. It is very important to provide health-care service for elder's who live alone at their home especially people who have chronic diseases and heart problem they need 24/7 healthcare where it can't be provided by others or by a medical staff of hospital. So, to overcome these emergency situations making the health-care service available for everyone mostly for elders, and to avoid the public transportation problems while reaching the particular destination too late. To prevent this kind of emergency problem cloud storage service to store the data information of elders' daily health activities like blood pressure, pulse rate, temperature, mems is used and data can be monitored by their relatives and doctors.

'DOCTOR ROBOT' was developed by Anuradha .M .Sandi et al. [3]. The doctor can use an IoT based panel to control the robot. The control commands sent online are received by the robot controller. The robot controller operates over Wi-Fi internet. The received commands are received in real time and the robot motors are operated to achieve the desired movement commands. The major component of the Robot is Arduino UNO controller which runs on battery power supply, that as to be charged, whenever it gets discharge. It consists of Esp32 Camera which is used to see the real time situation. The robot having four wheels is controlled using commands by which it can move around the patients, robot is controlled by doctor by monitoring on the screen using Esp32 camera. It consists of ARP voice module through which speaker is connected to the robot, it consists of three voice commands. It consists of SPO_2 (heartbeat & Oxygen) sensor ad temperature sensor when touched the values are sensed ad displayed on LCD. The four wheels are controlled using motors which are connected.

According to Sahil Soni et al. [4], healthcare monitoring real time data transferring system in hospitals and other health sectors has tremendous growth, and this healthcare monitoring system having advanced technologies becoming one of the best approaches across globe nowadays. The system using smart technology in IoT sector for monitoring the patient's basic health parameters which are required for the doctors for further treatment. In this system sensors are used to capture the real time data of basic parameters such as temperature, O_2 level and heart rate of the patient from hospital environment. In older days the traditional method in order to measure all the basic parameters the doctor needs to visit the patient's ward. So, there are major problems that the doctors have to face while checking the patient is that the doctor needs to be present physically at the patient's location and second major problem is that if the patient is having contagious disease so it is harmful for the doctor's health also.

The preliminary health tests of patients in the hospital are carried out by doctors. This requires them to be in contact with the patient which may unknowingly expose them to contagious diseases and it wastes their invaluable time for tests which are primitive in nature according to Supreet Thale et al. [5]. This also increases the waiting time of other patients in the hospital and these lead times can stack up to delay urgent

medical treatment of the patients with severe illness. The present guidelines of the World Health Organization amidst the ongoing pandemic of covid-19 strongly suggest social distancing among humans to curtail the spread of the novel coronavirus. The objective of this project is to minimize the contact and the time of interaction between doctors and patients for preliminary tests which can be conducted autonomously by developing an Autonomous Smart Medical Assistant Robot for contactless preliminary testing of patients. This project uses Autodesk Fusion 360 software for the design and testing of the robot and Arduino IDE for control and programming. The robot can also be used as a companion for patients and to transport other medical supplies to both the doctor and the patients. Real time environment recognition technologies like LIDAR and SLAM can be implemented along with Artificial Intelligence and Machine learning to make the robot adaptive to changing environment and being more approachable to the patients.

3. METHODOLOGY

A detailed study has been carried out for the design of various components of the robot. The major systems of the robot include the mechanical aspect, electronic sensors and circuitry and the user interface and user experience of the robot with human beings. The robot is designed for the preliminary health check up and also as an assistant for the patients and doctors. The design of the robot was inspired from the viewpoint that it being an assistant to the patients of all ages, it should be appealing, approachable and also friendly towards them. To achieve this, a humanoid design concept was found to be the most suitable. The robot features a spherical head with a headphone featured on it to enhance the aesthetic look. Robotic arms are added on either side of its shoulder to complete the humanoid look. 2200 mah Li – Ion battery is used.

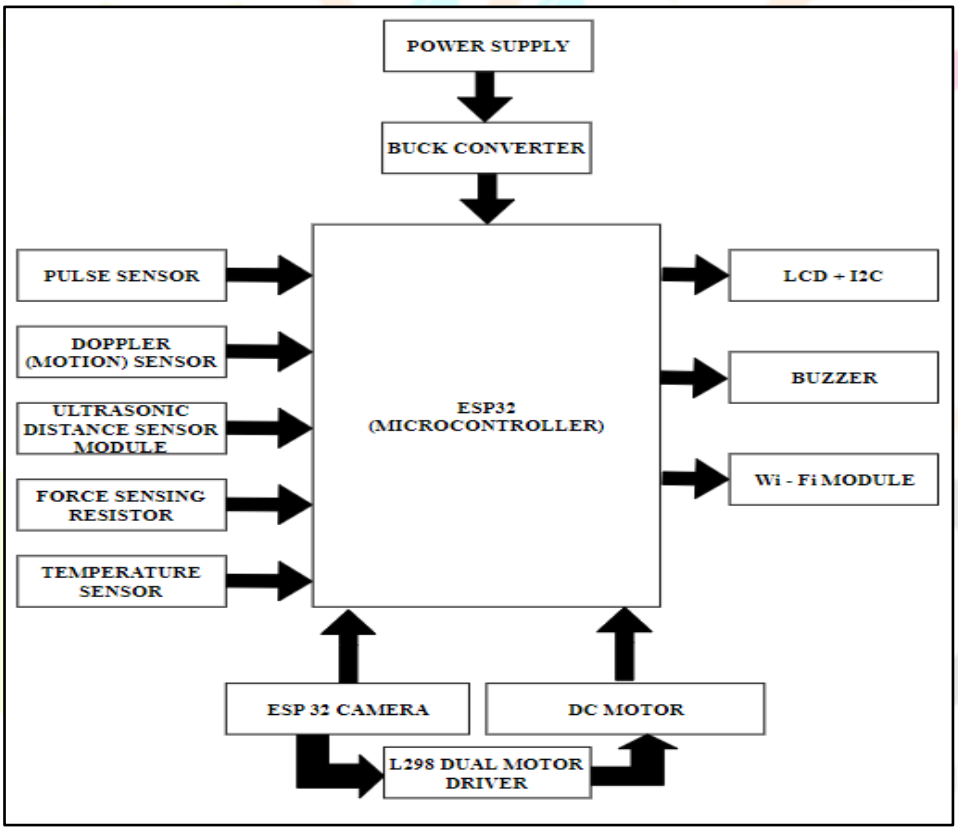

Figure 4.1 Block diagram

3.1 ALGORITHM

- Initially set all motors off.
- Set far and near parameter .
- Activate camera and other sensors.
- Check front distance, if equal to set threshold, then initiate forward, backward action and move method action.
- Check front distance, front right with far threshold and front left with near threshold, execute turn right action.
- Check front distance, front left with far threshold and front right with near threshold execute turn left.

- Check front distance, front right, front left with near threshold then execute backward.
- Only authenticated users can control our robot from anywhere.

3.2 HARDWARE COMPONENTS

3.2.1 ESP 32 MICROCONTROLLER

A feature-rich Micro Controller Unit (MCU) with integrated Wi-Fi and Bluetooth connectivity for a wide - range of applications. ESP32 is capable of functioning reliably in industrial environments, with an operating temperature ranging from –40°C to +125°C. Powered by advanced calibration circuitries, ESP32 can dynamically remove external circuit imperfections and adapt to changes in external conditions. ESP32 is highly-integrated with in-built antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. ESP32 adds priceless functionality and versatility to your applications with minimal Printed Circuit Board (PCB) requirements. Engineered for mobile devices, wearable electronics and IoT applications, ESP32 achieves ultra-low power consumption with a combination of several types of proprietary software.

ESP32 also includes state-of-the-art features, such as fine-grained clock gating, various power modes and dynamic power scaling. ESP32 can perform as a complete standalone system or as a slave device to a host MCU, reducing communication stack overhead on the main application processor. ESP32 can interface with other systems to provide Wi-Fi and Bluetooth functionality through its SPI / SDIO or I2C / UART interfaces.

- Power: 3.3 V DC
- Memory: 320 KiB SRAM
- CPU: Tensilica Xtensa LX6 microprocessor @ 160 or 240 MHz

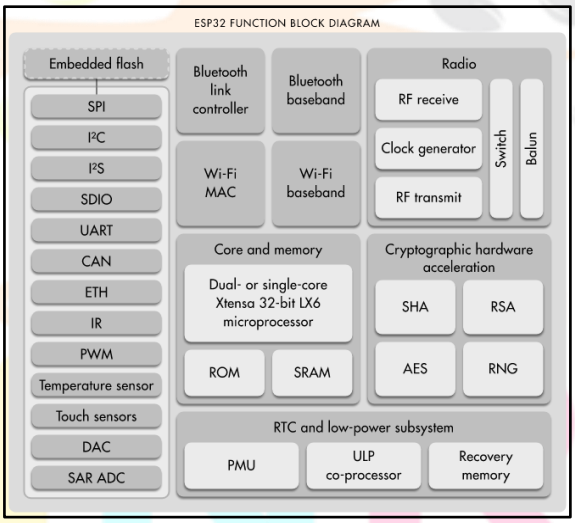

Figure 3.2.1 ESP32 Function block diagram

3.2.2 DC MOTOR

A DC motor is any of a class of rotary electrical machines that converts direct current electrical power into mechanical power. A DC motor with 60RPM 12V DC supply is used. It gives a massive torque of 25kgcm.

Figure 3.2.2 DC MOTOR

3.2.3 ESP 32 CAMERA

ESP32-CAM is a low-cost ESP32-based development board with onboard camera, small in size. The board integrates Wi-Fi, traditional Bluetooth and low power BLE , with 2 high- performance 32-bit LX6 CPUs. It adopts 7-stage pipeline architecture, on-chip sensor, Hall sensor, temperature sensor and so on, and its main frequency adjustment ranges from 80MHz to 240MHz.

- Flash LED off: 180mA @ 5V.
- Flash LED on to maximum brightness: 310mA @ 5V.
- Deep-sleep: 6mA @ 5V min.
- Modem-sleep: 20mA @ 5V min.
- Light-sleep: 6.7mA @ 5V min.

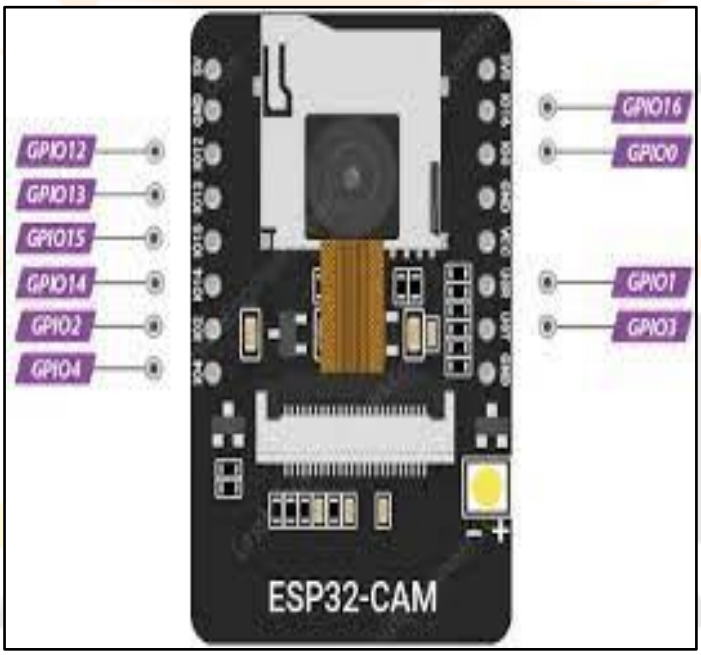

Figure 3.2.3 ESP 32 camera

3.2.4 L298 DUAL MOTOR DRIVER

The L298 is an integrated monolithic circuit in a 15-lead Multiwatt package. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals.

The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage.

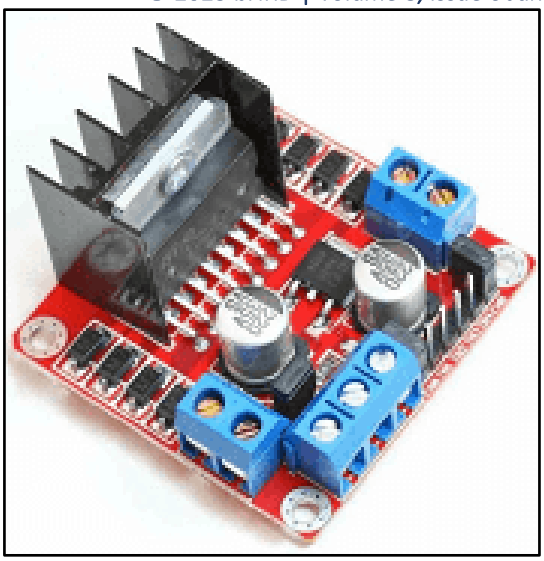

Figure 3.2.4 L298 dual motor driver

Features:

- Operating supply voltage up to 46v.
- Low saturation voltage.
- Total dc current up to 4a.
- Logical \"0\" input voltage up to 1.5 v (high noise immunity).
- Overtemperature protection.

3.2.5 DS18B20 TEMPERATURE SENSOR

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points.

- Unique 1-Wire Interface Requires Only One Port Pin for Communication.
- Reduce Component Count with Integrated Temperature Sensor and EEPROM.
- Measures Temperatures from -55°C to +125°C (-67°F to +257°F).
- ±0.5°C Accuracy from -10°C to +85°C.
- Programmable Resolution from 9 Bits to 12 Bits.
- Required Parasitic Power Mode Requires Only 2 Pins for Operation (DQ and GND).
- Simplifies Distributed Temperature-Sensing Applications with Multidrop Capability.
- Each Device Has a Unique 64-Bit Serial Code Stored in On-Board ROM.
- Flexible User-Definable Non-Volatile (NV) Alarm Settings with Alarm Search Command.
- Identifies Devices with Temperatures Outside Programmed Limits.
- Available in 8-Pin SO (150 mils), 8-Pin µSOP, and 3-Pin TO-92 Packages.

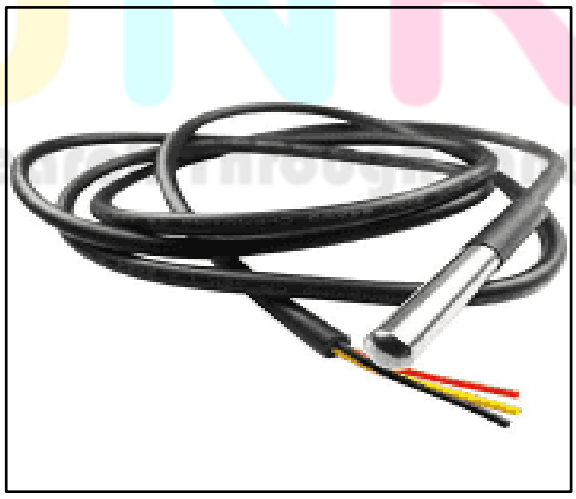

Figure 3.2.5 DS18B20 temperature sensor

3.2.6 PULSE SENSOR

An alternate name of this sensor is heartbeat sensor or heart rate sensor. The working of this sensor can be done by connecting it from the fingertip to microcontroller board, so that heart rate can be easily calculated. The pulse sensor includes a 24 inches color code cable, ear clip, Velcro Dots-2, transparent stickers-3, etc.

The main specifications of this sensor mainly include the following:

- This is a hear beat detecting and biometric pulse rate sensor.
- Its diameter is 0.625.
- Its thickness is 0.125.
- The operating voltage is ranges +5V otherwise +3.3V.
- This is a plug and play type sensor.
- The current utilization is 4mA.
- Includes the circuits like Amplification & Noise cancellation.
- This pulse sensor is not approved by the FDA or medical. So, it is used in student-level projects, not for the commercial purpose in health issues applications.

Figure 3.2.6 Pulse sensor

3.2.7 FORCE SENSING RESISTOR (FSR)

A sensor that is used to change an input mechanical load, tension, weight, pressure, or compression into an electrical output signal is called a force sensor or force transducer. This electrical signal can be changed, measured, and standardized. The specifications of the force sensor include the following:

- The actuation force is 0.2N.
- The range of Sensitivity is up to 20N.
- These are cost-effective.
- These are very thin.
- Operating temperature ranges from, -40ºC to +85ºC.
- Non-actuated resistance is 10M Ω.
- The rise time of the device is below 3 Microsecond.
- The range of bend resistance ranges from 100K to 1K Ohms based on force.

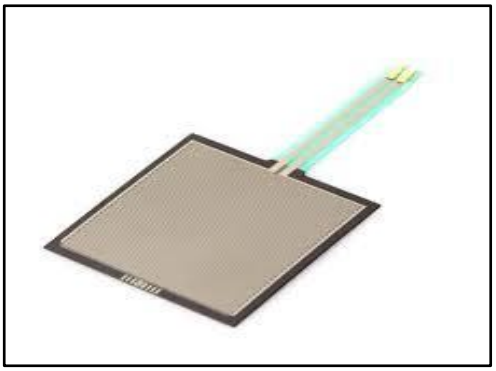

Figure 3.2.7 Force sensing resistor

3.2.8 HC SR – 04 ULTRASONIC DISTANCE SENSOR

This is the HC-SR04 ultrasonic distance sensor. This economical sensor provides 2cm to 400cm of non - contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit. There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground).

This sensor has additional control circuitry that can prevent inconsistent "bouncy" data depending on the application.

Features:

- Operating Voltage: 5V DC
- Operating Current: 15mA
- Measure Angle: 15°
- Ranging Distance: 2cm - 4m

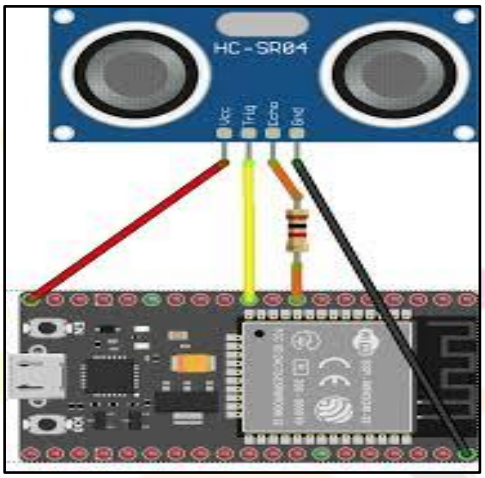

Figure 3.2.8 HC SR – 04 ULTRASONIC DISTANCE SENSOR

3.2.9 ESP8266 Wi – Fi MODULE

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

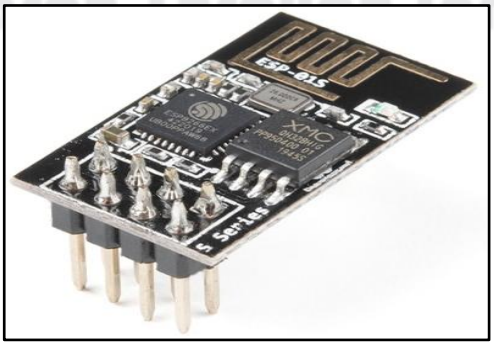

Figure 3.2.9 ESP8266 wi – fi module

3.2.10 16 X 2 LCD DISPLAY

This is I2C interface 16x2 LCD display module, a high-quality 2-line 16-character LCD module with on-board contrast control adjustment, backlight and I2C communication interface. For Arduino beginners, no more cumbersome and complex LCD driver circuit connection. The real significance advantages of this I2C Serial LCD module will simplify the circuit connection, save some I/O pins on Arduino board, simplified firmware development with widely available Arduino library.

Brief data:

- Compatible with Arduino Board or other controller board with I2C bus.
- Display Type: Negative white on blue backlight.
- I2C Address:0x38-0x3F (0x3F default)
- Supply voltage: 5V
- Interface: I2C to 4bits LCD data and control lines.
- Contrast Adjustment: built-in Potentiometer.
- Backlight Control: Firmware or jumper wire.
- Board Size: 80x36 mm.

Figure 3.2.10 16 x 2 LCD display

3.3 FLOW CHART

The figure 3.3 depicts the flow chart. The code for working of robot is written using embedded C language and compiled using ARDUINO IDE compiler.

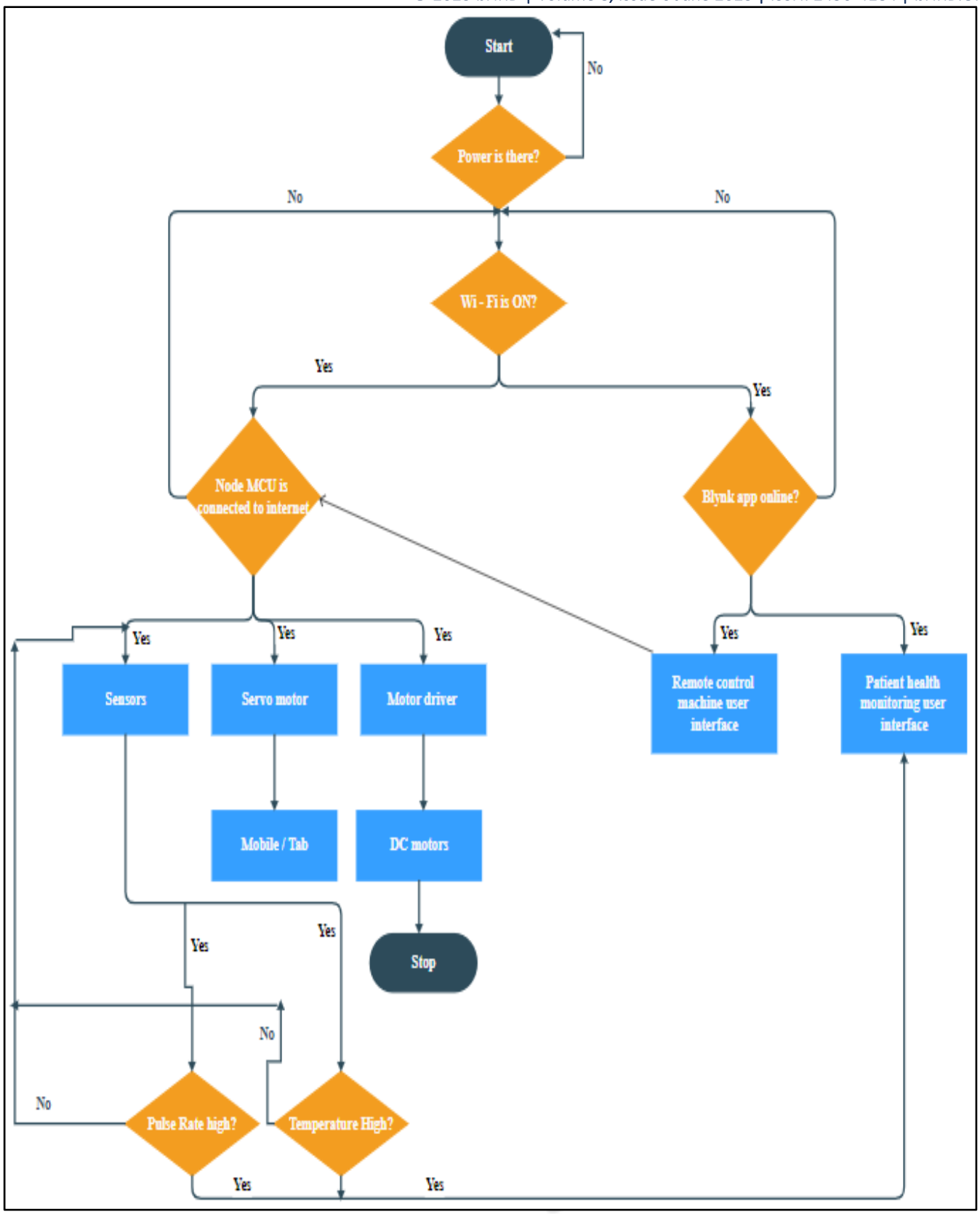

Figure 3.3 FLOW CHART

4. RESULTS

Some of the recognising features in the results are:

- Live interaction of doctor with parameters.
- Contactless communication.
- Live parameters monitoring.
- Easy care of patient and continuous monitoring.
- Graph of all parameters which can be stored for an hour, a day, a week, a month or how much ever time required and the data is stored permanently and does not get deleted automatically.

Figure 4 (a) Front view of the robot

Figure 4 (b) Side view of the robot

Figure 4 (c) rear view of the robot

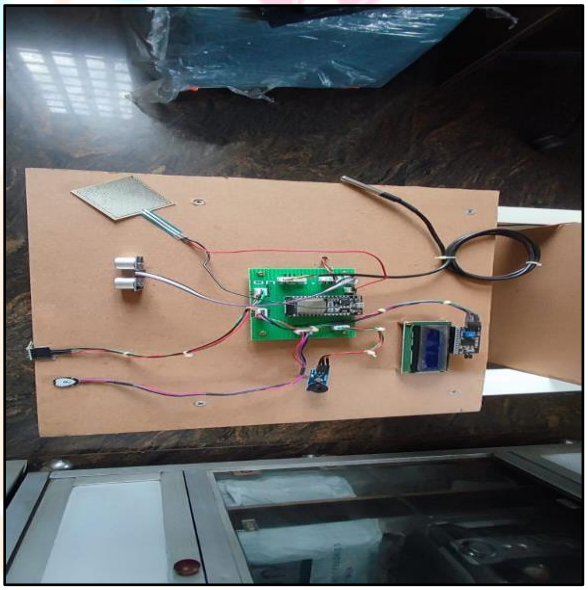

Figure 4 (d) all connections on board

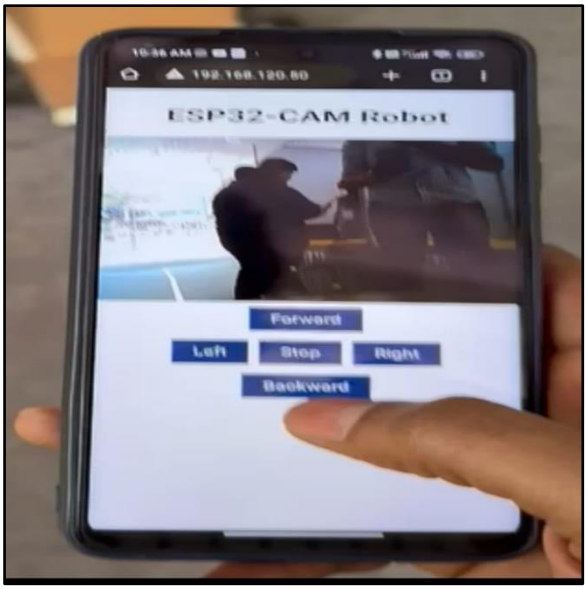

Figure 6 (e) Control panel on mobile along with subject face

figure 6 (f) Human motion detection status

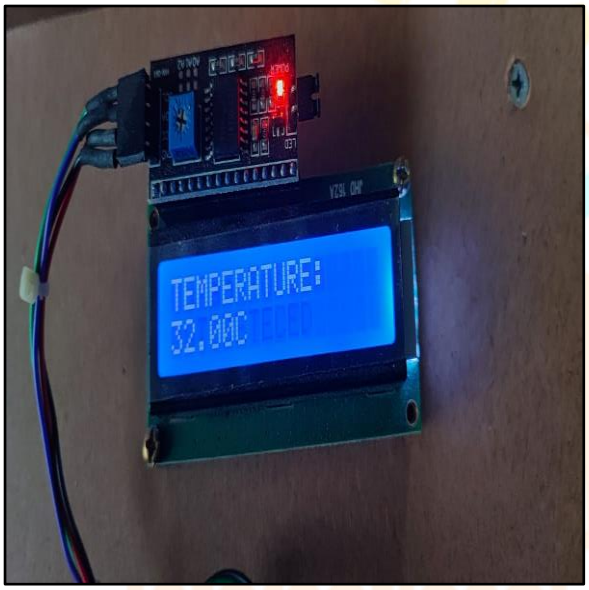

Figure 4 (g) Temperature reading

Figure 4 (h) Distance reading

Figure 4 (i) Force applied reading

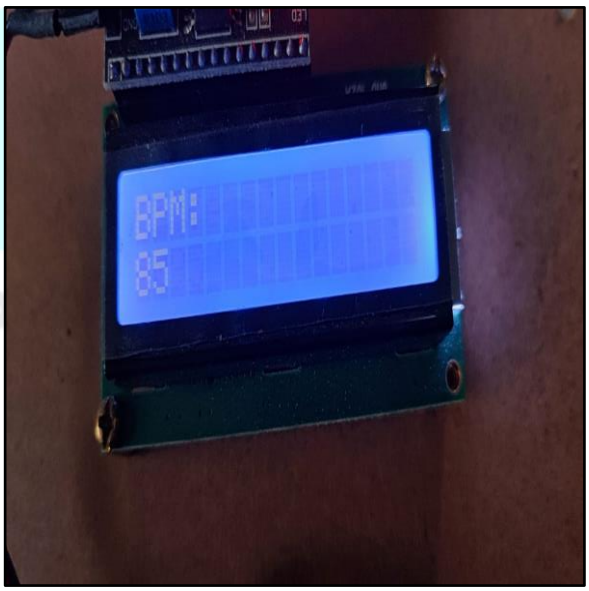

Figure 4 (j) Pulse rate reading

Figure 4 (k) Parameters reading seen on website through laptop

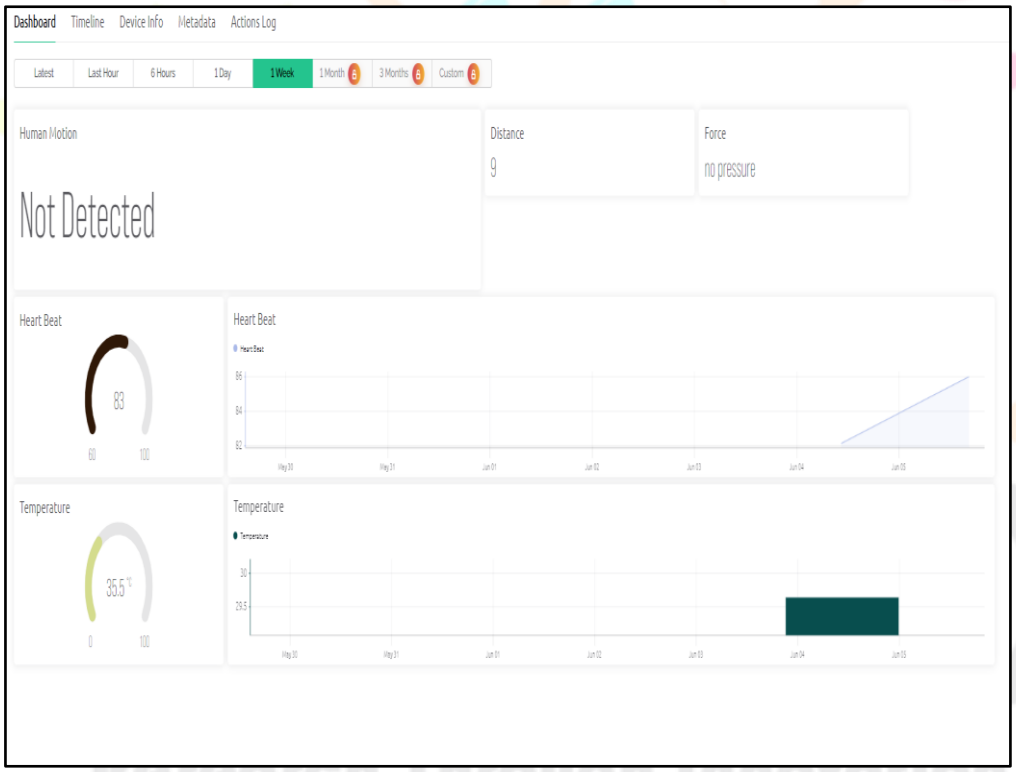

Figure 4 (l) Parameters reading seen on website through laptop

5. CONCLUSION

The mechanism technology used in this device helps to ensure peoples' safety and security. This efficient process is crucial in providing older citizens with emergency assistance, not only for patients and physicians. It has a positive effect on society; thus, the bio-medical and natural philosophy may have a big influence on the health industry.

The lives of people are dynamic every day, and they depend on technical advancements to help them solve their difficulties. Artificial intelligence in healthcare enables high-quality, cost-effective patient care. Each patient, patient, and doctor are in a clinical atmosphere that is secure.

The workload for a doctor during this pandemic can be lessened by utilizing an IoT based virtual doctor robot. Patients' wait times can be shortened. It is feasible to provide compassionate support with daily duties as well as primary patient monitoring. We created the "VIRTUAL HEALTH ASSISTANCE ROBOT FOR DOCTOR USING IoT" with a control mechanism to make it more user-friendly. Thanks to the Internet of Things, doctors from all over the world will be able to video chat with patients and see all of their data. We believe that our robot will make a substantial impact on the healthcare industry's effort to overcome the global physician shortage.

Our device is useful in ways in healthcare such as :

- Covid – 19 Management
- Rehabilitation and Prosthetics
- Assistive Surgery
- Elderly Care

Some of the advantages are:

- The ability to be anywhere, at any time.
- The ability to easily move among patients and operating rooms.
- The capacity to see medical reports remotely through video chats.
- The ability to walk about in many rooms at once.

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