Automated Robotic System for Medical Assistance

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Abstract - *The end of 2019 and the start of 2020 remained the time of the world's largest medical emergency due to the coronavirus disease known as COVID-19, which is spreading all over the world. It spreads the infection to anyone who is in close contact with the sick person. This is the primary cause of the viral pandemic. For doctors, dealing with patients is the hardest part. Sufficient medication is required for affected patients during care. Due to the repercussions of swallowing, it spreads to the person from the affected person. Therefore, an automatic robotic system was created for patients who were placed in quarantine in order to solve the issues. In order to simplify life, humans are adopting robots in a variety of fields, according to today's developing technologies. In the meantime, the healthcare system makes use of robots to care for patients. By maintaining social distance, doctors can remotely check on a patient's health in the system that has been presented. The patient will receive food and medicine via a robotic cart. The suggested system also includes a mobile application that may be used to call a doctor and other medical teams in an emergency. The arrangement will allow the medical personnel to care for the most patients in the shortest amount of time. Additionally, it will allow them to create social distance in order to focus more on patients who are seriously affected. This system can be used to sanitize the areas of the hospital with the help of UV LEDs connected to this model. Social transmission will be significantly decreased by the proposed method. Additionally, it minimizes the rate of severe cases as well as the localization of severe diseases.*

Key Words: Atmega328P, LCD panel, COVID-19, Sensors, Actuators.

1. INTRODUCTION

The coronavirus is one of the main diseases that is spread through indirect contact (COVID-19). It is necessary to keep these patients in an isolated place. Care for thousands of people at once in these circumstances is a challenging undertaking for paramedical workers. Also, direct contact with all these patients infected a large number of medical specialists, doctors, and medical staff. There is currently no antivirus available because the virus was created using animal cells. There is no specific COVID-19 vaccination or treatment. Persistently frequent trials in the lab are evaluating potential therapies. The WHO is monitoring it closely and will make an announcement when clinical findings are made public. Only medication is used as a therapy. Only to get a tiny bit of period relief, cough, fever, and kidney and to keep the sick away from external stimuli environment. The public must be adequately educated. On how to avoid social isolation, take good care of yourself, and prevent the spread of COVID-19. Self-care is another crucial element that includes washing your hands before repeatedly massaging with an alcohol-based sanitizer without touching your face. But the most crucial thing is quarantine.

This autonomous robot will be highly beneficial for organizing the medical field. The robot is obedient and highly accurate as it follows the doctor with the aid of ultrasonic sensors. As a result, the hospital only needs a minimal amount of staff to carry out treatment in peace. For the medical system, hygiene is crucial. Since the equipment is kept clean and secure in UV sterilization lockers, the units are also known as autonomous transportable UV sterilization chambers. By using this, doctors may treat patients without worrying about viruses because they are using clean equipment. Since robots are becoming increasingly intelligent, we have developed voice-activated lockers that open in response to their instructor's commands, making them touchless robots. With the aid of its voice recognition module, this was all accomplished.

1.1 Aim and Objectives

The main aim of the project is to create a robotic system that can help the doctors, nurses and also helping the patients when they are kept in quarantine due to pandemic diseases like covid-19.

The objectives of this project are:

- To avoid direct contact with patients who suffer from pandemic diseases.
- To enable the medical staff to deal with the maximum number of patients in less time.
- To serve medicine and food to patients on time.
- To provide immediate consultation on emergency situations.
- To provide an isolated environment with the best of comfortable services.
- To provide worldwide interaction between the doctor and patient.

1.2 Existing Systems

The final step on this path of innovation are intelligent robots, like SOFIA. These robots are controlled by computers that run programme instructions and send them to the manipulator so that it can make the required movements. They also send information to the control computer about the process's status, enabling intelligent decision-making and real-time process control. The Aizu Wakamatsu hospital has more than 100 of these robots now, and some or most of them have screens on their breasts to pay attention to youngsters in the hospital, cheer up the populace, and assist with medical care.

1.3 Limitations of Existing Systems

1. In the existing model, there is no robotic arm for collecting and delivering medicine or food items.
2. There is no automatic UV disinfection system.
3. There is no self-sanitizing option in the existing system. The robot needs an external sanitizing device to disinfect it.
4. Human body temperature cannot be measured by using the existing technology.

2. LITERATURE SURVEY

Haider, K. B. Khan et al., [1] In order to help patients and hospital workers during the COVID-19 emergencies, the planned hospital assistance system will be implemented. The suggested system design has received approval from Bahawalpur's District Health Authority (DHA). Due to the straightforward D2D communication technology, there are no health hazards. Furthermore, there is no possibility of collision because the robotic system will follow the isolated, predetermined path. There is no medical reason why it might have a bad effect or contribute to air pollution. The system is able to offer patients effective and efficient services.

M. Y. Hossain et al., [2] The major objectives of this research is to design and implement an assistive robot that can support elderly and disabled people in their daily tasks. To create a robot that is easy to operate, economical, efficient, and controllable in order to assist the elderly and disabled who are in need. In this case, the robot must be able to locate, recognize, and pick up the object before returning to the person to dump it. Any task that is possible to command can be done with ease. They will become much more autonomous and their reliance on others will decrease. An assistive robot is a device that can be helpful for humans especially for older, disabled and blind people.

Dr. N. Dhanasekar et al., [3] Smart health monitoring device can determine the health parameters i.e. pulse rate, body temperature, ECG and SpO2 by using sensors. The Arduino collects the data using sensors. From this data, the device can decide whether the patient’s condition is normal or abnormal. The health parameters, such as heart rate, body temperature, ECG, and SpO2, are determined by smart health monitoring systems employing sensors. Through an Arduino-based microcontroller system, the sensors are connected and managed. The Arduino collects the data via sensors. With the aid of Node MCU, the gathered biological data is saved in ThingSpeak.

2.1 Conclusion Based on Literature Review

I've concluded that automation is necessary to improve the performance of the current model. I've seen a few problems that need to be solved by introducing advanced technologies into the design and structure. In the existing model, there is no robotic arm for collecting and delivering medicine or food items. There is no self-sanitizing option in the existing system. The robot needs an external sanitizing device to disinfect it. There is no self-sanitizing option in the existing system. The robot needs an external sanitizing device to disinfect itself. So in this model, we can add UV lights to kill bacteria and viruses.

3. MATERIALS AND COMPONENTS DESCRIPTION

3.1 Materials

3.1.1 Acrylic Sheet

This is the main material that is used as the platform of the project model. It's a special form of plastic called Polymethyl methacrylate (PMMA). The model consists of glossy rectangular designed Acrylic Sheet, Dimensions Thickness: 5 mm, Size: 13 X 8 inch.

3.1.2 PVC Forex Sheet

Forex sheet is a weather resistant solid sheet and Also resistant to corrosive conditions and chemicals. PVC sheet can easy to install and fabricate, so in this model Forex sheet is used as a body panel.

3.1.3 Centre Shaft Gear Motor L Clamp

This motor mounting bracket is made specifically for Center Shaft Gear Motors to facilitate and speed up the motor mounting process. Dimensions are Width: 40 mm, Length: 23 mm, Height: 40 mm.

3.1.4 Black Tape

For path creation, the robotic cart follows this line and delivers the medicines or food items at the right time.

3.1.5 Robot Car Wheel

The gear motor is connected with 70 mm wheel. In this project we use two gear motor wheels that connected with two gear motors. Width of the wheel is 20 mm.

Fig 1: Gear Motor Robot Wheel 7 X 2 cm.

3.1.6 Robot Caster Wheel

A caster is a type of undriven wheel that is intended to be fastened to the bottom of a bigger object to allow for the movement of that object. we use caster wheel as front wheel of the model. Diameter of the ball Caster wheel: 3.4 mm and the wheel height: 23mm.

Fig 2: Ball Caster Wheel.

3.1.7 PCB

It is a thin, stiff sheet with pre-drilled holes spaced uniformly apart over a grid, often a square pattern with 0.1 inches (2.54 mm) between each hole. Although bare boards are also an option, these holes are surrounded by round or square copper pads. Copper is applied to the layers of general-purpose circuit boards so that PCB components can be soldered properly.

3.2 Hardware Components

3.2.1 TowerPro SG 90 Servo motor

Fig 3: SG90 Servo Motor.

The SG90 is a small, light, and powerful servo motor. Servo rotates around 180 degrees (90 in each direction) and functions similarly to larger types of servo. By using any servo code, we can control these servos. The angular or linear position, velocity, and acceleration can be precisely controlled with a servomotor, which is a rotary actuator or linear actuator. It comprises of an appropriate motor connected to a position feedback sensor to precisely control the motor's rotating position. The end effector moves by using the servo motor. It can produce 1.8 kg-cm torque at 4.8 V.

3.2.2 MG996R Servo Motor

Fig 4: MG996R Servo Motor.

This is a metal gear servo motor with a maximum stall torque of 11 kg/cm. They are small, powerful, easily programmable, and accurate. Most importantly, though, they allow for near perfect repeatability of motion. This servo motors are mounted in every joint of the robotic arm, actuating movement and adding dexterity. A robotic controller rotates the motors that are attached to each joint.

3.2.3 Robotic Arm with 5 Degree of Freedom

A robotic arm with five degrees of freedom is used in this project for pickup and placement. High quality 3D printed parts are used to manufacture these arms. The dimensions of the arm are 10 x 10 x 20 cm (L x W x H).

Fig 5: Robotic Arm

3.2.4 Buck Converter

Fig 6: DC-DC Buck Converter.

A buck converter (step-down converter) is a DC-to-DC power converter that reduces voltage from its input (supply) to its output while increasing current (load). With these few components, they can step-up or step-down voltages, and they also provide a shorter working duty cycle and improved efficiency over a wide range of input and output voltages.

3.2.5 ATmega 328P Microcontroller

Arduino Uno is the open source microcontroller board. The board has sets of I/O (input/output) pins for both digital and analogue signals. There are 6 analogue I/O pins and 14 digital I/O pins. Additionally, it is simple to programme in C++, a universal programming language.

3.2.6 ESP32 CAM and Wi-Fi Module

The ESP32-CAM is an ESP32-based, compact camera module with low power requirements. It can be widely used in various IoT applications such as wireless video monitoring, Wi-Fi image upload, QR identification, and so on. ESP32 can function as a full standalone system or as a slave device to a host MCU, which lessens the burden on the primary application CPU caused by communication stack overhead. It is a very competitive camera module. The AF2569 camera module consists of 2 MP resolution and provides a Wi-Fi consists of 802.11b/g/n/e/i and Bluetooth 4.2 standards.

Fig 7: ESP32 CAM and Wi-Fi Module

3.2.7 LCD (Liquid Crystal Display)

The LCD (Liquid Crystal Display) is a type of display that uses the liquid crystals for its operation. Here, we'll take the computer's serial input and upload the Arduino sketch. On the LCD, the characters will be shown.

3.2.8 IR Sensor

Fig 8: IR Sensor.

An electrical component known as an IR sensor emits light in order to detect nearby objects. An IR sensor can monitor an object's heat while also spotting movement. Typically, all items emit some kind of thermal radiation in the infrared range. Although these kinds of radiations are invisible to the human eye, infrared sensors can pick them up. By using these IR sensors, the model can follow the black line and deliver the medicine.

3.2.9 DC Geared Motor

12V DC geared motors with 10 RPM are frequently used in robotics applications. A DC motor is a type of rotary electrical motors that converts DC electrical energy into mechanical energy. DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor connected to a gearbox or transmission is referred to as a gear motor. A gear motor modifies the motor's speed and torque to suit the application by adding mechanical gears. Typically, such an addition decreases speed and increases torque. Two DC motors are connected to the robotic cart wheel that drives the wheels.

3.2.10 LM35 Temperature Sensor

The AM1011A is a basic, ultralow-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data.

3.2.11 I2C Converter

I2C LCD Adapter is a device with a PCF8574 microchip. Inter-Integrated Circuit (I2C) communication is the name given to the process of establishing communication between two or more ICs (Integrated Circuits). There are 20 male pins in all. 4 pins are facing the front while 16 pins are towards the back.

Fig 9: I2C Converter.

3.2.12 UV LED

In this model, UV LED is used for sanitizing. It uses short-wave length ultraviolet light to inactivate or kill microorganisms and pathogens. UV radiation with short wavelengths disinfects water, air, and surfaces. When we use this UV LED in this medical assistance robot, we can clear the bacterial particles in the hospital area. UV can only work in its path and can be blocked by things.

3.2.13 Buzzer Module

A buzzer module is also called a piezo buzzer. It mainly functions as a little speaker that can connect directly to an Arduino. You can set a frequency and make it emit a tone. Based on the reverse of the piezoelectric action, the buzzer emits sound. In this project model, a 5V passive buzzer is used to notify the patient while the robotic cart delivers the medicine.

3.2.14 Ultrasonic Sensor

Fig 10: Ultrasonic Sensor

An ultrasonic sensor is fixed in the robotic cart for obstacle detection. Ultrasonic sensors use ultrasonic sound waves to measure distance. An ultrasonic wave is sent by the sensor head, which then picks up the wave that the target reflects back to it. The time gap between the emission and reception is measured by ultrasonic sensors to determine the target's distance. Active ultrasonic sensors produce ultrasonic sound waves at frequencies that are higher than those that are audible to humans.

3.2.15 Lithium-Ion Battery

This project uses a 12V rechargeable li-ion battery. It has a charging capacity of 2200 mAh. This battery gets fully charged in 40 to 90 minutes and includes a low self-discharge feature. It comprises an inbuilt charge protection circuit. Therefore, overcharging will not affect this battery circuit. The battery can operate between 7.2 and 11.1 volts.

3.3 Software Requirements

The application is coded using the Arduino Integrated Development Environment (IDE), which runs on Windows. C is the programming language used for coding. Blynk is a new platform that allows you to quickly build interfaces for controlling and monitoring your hardware projects from your iOS and Android device.

4. WORKING

This block diagram shows how the input sensor and output sensor are connected to the Arduino. The Arduino is used to control all the input and output components in this system. It will give proper timing and duties to the corresponding components on the basis of the program which is uploaded to it. The two IR sensors are connected as input modules on the Arduino. It helps to detect the black line and move the robotic cart through that line to reach the destination. One ultrasound sensor is provided for detecting the obstacle. A robotic arm is connected to the Arduino. It consists of a few servo motors and will work by using the Arduino program.

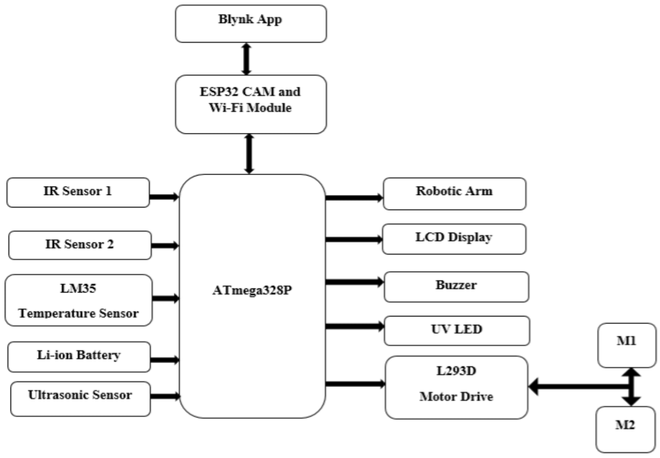

Fig 11: Block Diagram

Three UV LEDs are connected for sanitizing the hospital areas as well as the robotic cart itself. a buzzer is used to notify the patient while the robotic cart delivers the medicine and also while the UV LEDs are on. The ESP32 cam is used to monitor the patient through the Blynk app. It can be easily installed and controlled through a mobile phone. The ESP 32 Wi-Fi module is always connected to a Wi-Fi network, which helps to access data and send information to the doctors and staff. By using this app, hospital staff can give commands to the robotic cart. There is an LCD display provided on the robotic cart. If staff and doctors send a message through the Blynk app, it will be displayed on this LCD display. A temperature sensor is used to measure the body temperature of the patient. This measured temperature will be shown on the mobile phone by using the Blynk app. Two motors are connected to the wheel that gives power to the wheels. A L293D motor driver is connected to the Arduino for controlling these 2 motors, so we can drive the motors forward and backward. This motor driver also helps the robotic cart take a turn. The Li-ion battery is the source of energy for the model. It's used to power up the whole system and take its actions. A buck converter is used to distribute the different voltages to different components because some of the components need 12 V to work, especially DC motors. Some components need less voltage to work. A buck converter will reduce the voltage to the required voltage.

5. RESULT AND DISCUSSION

5.1 ESP 32 CAM

By using the system, the staff and doctors can monitor the patient's condition. The ESP32 CAM is used to send the video through the Wi-Fi module. We can see the video in the mobile app by connecting to the IP address 192.168.56.18 in our web browser or the Blynk app.

5.2 Blynk App

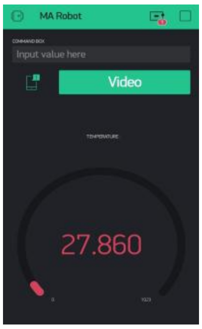

Fig 12: Blynk app

The patient temperature, and live video monitoring are displayed on mobile by using this app. There is an emergency switch is attached in the cart when the button press there is a notification send to the Blynk app. There is a command box given in this app for typing messages and commands. If the doctor or nurse wants to send a text to the patient, that text can be typed and sent to the cart by using Blynk. If we type any data between X and # and click the send button, that message will be displayed on the LCD screen fixed on the model.

5.3 Movement Evaluation

5.3.1 STAGE 1: Y1#

Fig 13: Room 1

If we give a command to the robotic cart through the Blynk app, the robotic cart will automatically detect the path and deliver the items. For delivering medicine to each room, there are different commands for different rooms. These commands are programmed and already saved into the Arduino. The command Y1# is for room 1, So If we write Y1# in the command box and click the send button, then the robot will pick up the items for delivery from the base camp and automatically detect the path and start move by using the line following method. If it reaches near to room 1, it will produce an alarm sound from the buzzer to inform the patient. Then the cart picks up the medicine item and places it near the room. After completing the task, the robotic cart will come back to the base camp by itself. The robotic cart waits in the base camp until it gets another task.

5.3.2 STAGE 2: Y2#

Fig 14: Room 2

If we write command Y2# to deliver medicine to the second room, then the robot will pick up the items for delivery from the base camp and automatically detect the path and start moving by using the line following method.

5.3.3 STAGE 3: Y3#

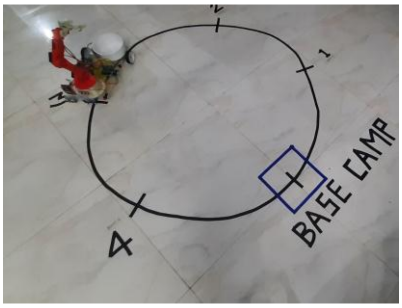

Fig 15: Room 3

If we write command Y3# to deliver medicine to the third room, then the robot will pick up the items for delivery from the base camp and automatically detect the path and start moving by using the line-following method.

5.3.4 STAGE 4: Y4#

Fig 16: Room 4

If we write command Y4# to deliver medicine to the third room, then the robot will pick up the items for delivery from the base camp and automatically detect the path and start moving by using the line-following method. If it reaches near to room 4, it will produce an alarm sound from the buzzer to inform the patient.

5.3.5 STAGE 5: Y5#

The command Y5# is entirely different than the other commands. This command is used for UV sanitization. While we give this command to the cart, the UV lights will be on at that time and will cover all areas of the hospital and sanitize everything.

Fig 17: Room 5

6. CONCLUSION

The technology has the ability to assist hospital staff members. To give and transmit data from the patient side to the doctor side, it is based on a device to device interaction established IOT system. With the use of an automated cart, it is able to give medicine and food to patients, allow the medical personnel to care for thousands of patients at once. Therefore, allow social distance for the most medical staff possible. We can also add an automatic charging system in the base camp so the cart will be charged while it is waiting for the next task. So that the robotic cart will always have a full charge and be available for service at all times. We can implement this proposed method in other domains, such as home healthcare, supermarkets, etc. after making some changes to it.

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