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Design and Implementation of Multipurpose Robot for Covid-19 Ward

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Abstract - A multipurpose robot is a system for the covid-19 ward to provide support for serving food, medication, perform temperature check etc., for the covid positive patients without making more efforts by the medical or frontline workers towards the care of patients. As everyone there is a high risk getting infected by the virus. So, to avoid visiting rooms by the staff, multipurpose robot can minimize the contacts of patients and frontline workers or medical staff.

The robot is controlled by the user using a transmitter section / remote. The main purpose of the robot is to move around, serve the food, check patient vital parameters like temperature, heart rate, SpO2 level wirelessly without making any contact with the patient and can transmit live video of patient using an IP web camera which will be placed on the robot. It will also help to navigate the directions in the hospital so that anyone can easily handle the robot. For the movement of robot from one place to other, authors have used 4 motors with dedicated wheels attached to them, which can be controlled by microcontroller using RF wireless communication module. The robot will be robust enough that it can sustain approximately 5 to 10 kg weight on it. Also, the patients can have a discussion with their families because everyone know family member are not allowed in the covid ward to visit the patient. The transmitter section plays a role of master and the robot plays the role of slave in this system. The multipurpose robot has many advantages with it as it is a low-cost system which requires low maintenance, easy to use, easy to deploy and can-do surveillance as well.

Keywords – Robot, Covid-19, dc motors, temperature sensor, joystick, Arduino UNO, lcd display, MAX30100 Heart rate, SpO2 sensor and nRF24L01 radio module.

I. INTRODUCTION

In the year of 2020, the world has been hit by the Covid-19 pandemic, by which people has gone through some strange and horrible situations. Millions of people have been tested positive for the deadly virus and has caused fatalities too. According to reports of government of India till now 1,22,714 active cases are present which are 0.36% and 4,65,662 number of deaths encountered which is 1.36% of India's total population. Moreover, these cases are still increasing daily. Due to this, the increasing number of infected patients has crowded the hospitals and it is really difficult to get the accommodations in private as well as government hospitals. Besides of this, it is also getting harder for the hospital staff to take care of the admitted patients efficiently as well as effectively. This is because of the fact that the number of staff members is relatively lower than that of the patients. Because of this, the staff members require some sort of support to properly cater and monitor the covid positive patients.

This is where the multipurpose robot for Covid19 ward comes into picture. For this purpose, there are several robots that have been developed and tested practically to confirm their credibility. These robots are specifically designed for serving purposes in order to help medical health workers to take care of the patients without any difficulties and a danger of getting infected by the virus, as these robots reduces direct contact of the doctors and nurses from the infected patients. Even after getting infected by the virus a greater number of patients are dying because of the fear of Covid-19 one reason behind this can be there is no communication between patient and their family members. To provide a moral support to the patient and the family members of the patient authors are suggesting to use the multipurpose robot camera mounted on it.

As Coronavirus (COVID-19) is an infectious disease, hence the virus can spread from an infected person's nose, mouth from the small particles when they sneeze, speak, cough or breath. So, to provide more protection and to minimize the contact of medical staff and frontline workers between patients, there authors are planning to use this system. Thus, implementation of these robots in hospitals are very helpful in providing convenience as well as safety to the medical department team.

The surveillance bot which is based on robotics and IoT, which also speaks about the low cost, low maintenance and easy to implement the robot. The main aim they kept is to provide a good and low-cost security system which can be deployed to perform surveillance for the defense team. They have used Raspberry Pie as a main controller of the system, wheels are connected to motor and the motor is then connected to motor driver module L293D for the movement of bot. They are using Bo-1 toy motors so for their robot movement. One webcam is placed at the top of the robot using a wooden stick for streaming videos and a 9v battery for the power supply. The chassis body used here is a small metal case which is not capable of holding more than half kg of weight. Even the motors which are used are not used to carry more than half kg of load. For providing commands to the raspberry pie the WIFI router is used so that the robot can be used from the remote place. To control the bot position from remote place, laptop is used with python software installed in it. Once forward, reverse, left and right buttons are pressed on the keyboard, raspberry pie will receive all one by one and then it will send signals to motor driver module and the module will control the motor direction with respect to commands. Here every time

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author has to open the python software and need to provide commands by pressing keyboard buttons. The webcam is used to capture the video and the same can be transmitted via raspberry pie so that the live video can be seen on the remote laptop using VNC software which helps them to shows the real time view of surrounding near the bot. The bot has several modes programmed in it. If SPACE key on keyboard is pressed then robot will stop its movement, if ESCAPE key is pressed on the keyboard, then bot will not do anything simply program will be halted [1].

The surveillance carried out for the outside surroundings which can detect the metal bomb using the metal detector sensor module. A PIR (Passive infrared) sensor is used to detect the humans present near to the robot. A video camera is used mounted on servo motor so that it can rotate 360 degrees to steam the live video and the video is then processed by the raspberry pie 3 and the same video will be transmitted to remote PC over internet. A RFID module is used to check the person present near the robot is authorized one or not. An IR sensor module is used to avoid the obstacles' present in the path of robot. Also, two DC motors and one PIR sensor is interfaced with the Raspberry pie 3. A GSM module is used to send the notification of any suspicious activity found like metal bomb detected near the robot and person verification failed via RFID [2].

They proposed a robot which is used to support hospital staff to provide medicine to their patients. Robot is operated based on the principle of line follower robot mechanism. Each patient has given a RFID card which contains the patient's information. For the movement of robot DC motors are used and it will follow the Black lines which are kept on the floor so that robot can navigate itself in the patient ward and can read the respective patient details using the RFID reader. Also, they have proposed to check the blood pressure, SPO2 and Temperature of the patient. NODEMCU is used to transmit their vital parameter checked values to the user who is operating the robot [3].

The surveillance robot which can be controlled over RF communication modules. An accelerometer module is used to provide the commands to the receiver side in terms of x and y axis values. These values are first processed in the transmitter side arduino and using RF module these values are sent to the receiver RF module. Then based on the inputs received from the RF values receiver arduino will control the DC motors using L298 Motor driver module [4].

The system is designed to provide the medicine to the covid patient with the help of a line follower using IR sensors. They have used ultrasonic sensor to detect the obstacle in between the path of robot which will stop the robot if any obstacle is found. The real time clock has been integrated on the robot which will provide the medicines to the respective patients on time which has been programmed for the individual patient. So, to identify the patient an RFID scanner is installed on the robot which will scans the RFID tags of the patients where all the required data of patients' medicine and other details will be present. The name and quantity of the medicine has been displayed on the LCD display of the robot. Authors have also integrated an SMS alert mechanism where once medicine is dispatched from the robot then it will intimate patients' relatives or caretaker that patient has taken the medicines on time. The only thing in this paper is that all the time if new patient is admitted to the hospital, then there is no centralize platform to add all the details of patient to system.[5]

II. SOFTWARE DESIGN FLOW

The multipurpose robot system is majorly divided into two section which are transmitter section and the receiver section. So, the both approaches are explained below.

Transmitter section: Initialize all the input and output pins, global variables used in system, then declare all the required user defined functions. Next step is to setup serial communication baud rate to 115200 bps, initialize LCD module and set the microcontroller pin modes as input or output depending on the sensor or module type.

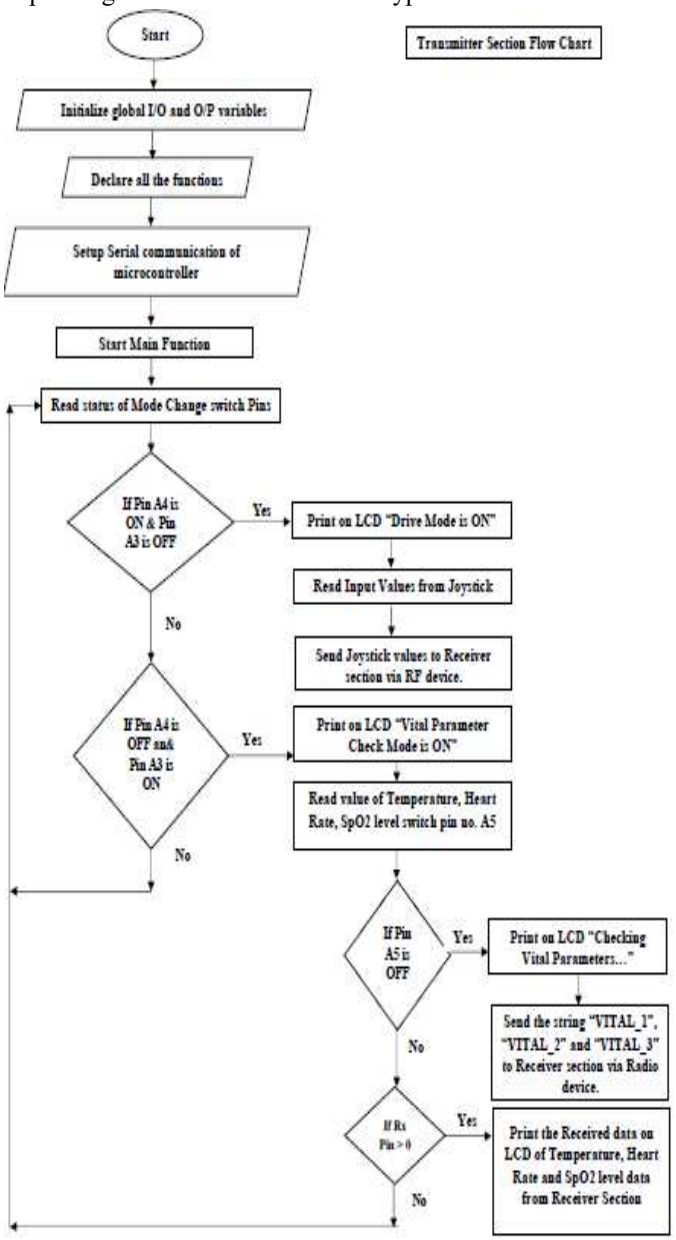

Figure 1: Transmitter section - flow chart approach of the multipurpose robot.

Finally, setup the required data rate of the RF module (nRF24L01) bidirectional communication. Once entered in main functions read the status of mode change toggle switch used for drive mode and vital parameter check mode. Based on respective pin status drive mode or vital parameter check mode will be running. If else conditional statement is used to check which mode the robot in. Based on the selected mode LCD display will print either "Drive Mode" or "vital parameter check mode" on it. Again, if else conditional statement is used

to recognize whether temperature switch pin is pressed or not. If pressed then send "VITAL_1" string to the receiver side via radio module and immediately check whether there is a data on serial (Rx) pin of microcontroller. If Rx pin data is greater than 0 then print the same on LCD display which is nothing but the temperature, similarly for "VITAL_2" and "VITAL_3" strings heart rate and SpO2 levels will be measured respectively. Once the power supply is off the transmitter section will be stopped.

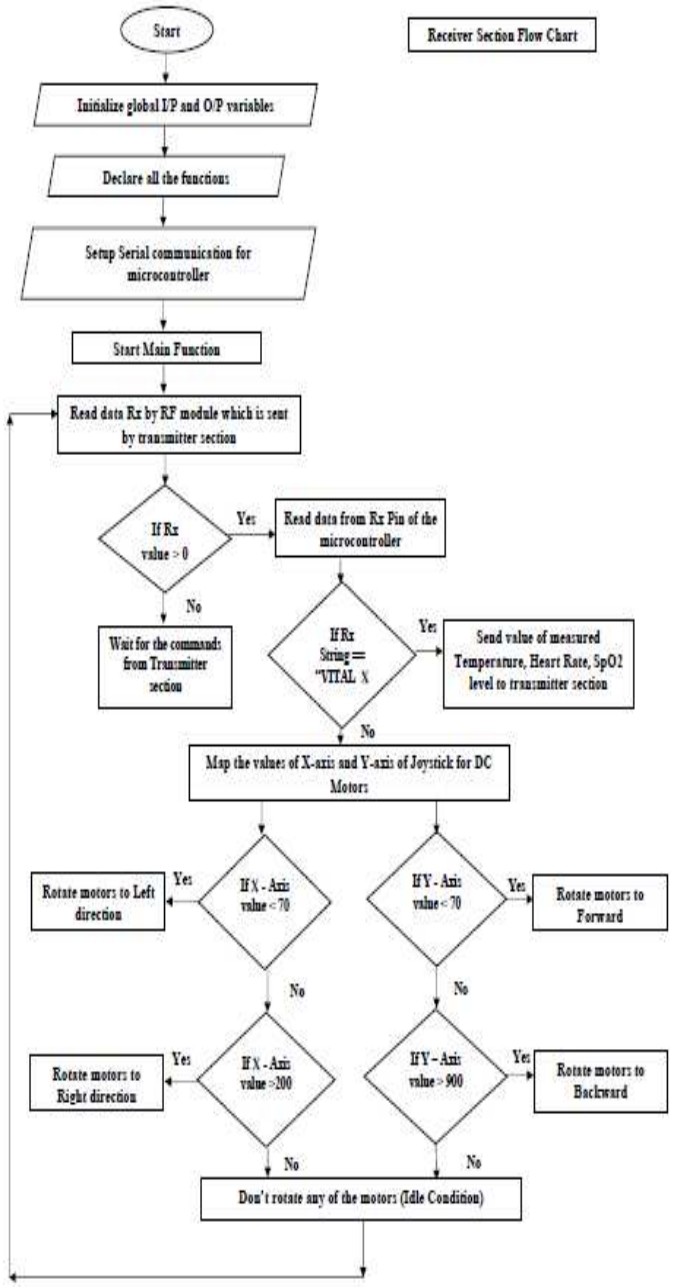

Figure 2: Receiver section - flow chart approach of the multipurpose robot.

Receiver section: The initial process needs to be the same as the transmitter section. So, initialize the required variables and declare the functions. Set the serial communication baud rate same as the transmitter section, initialize MLX90614 temperature sensor and DC motor pins which are connected to the microcontroller. Once entered in main function check the monitor the value of Rx pin of microcontroller using conditional statements. If the data recognized on the Rx pin is string "VITAL_1" then get the temperature from the MLX90624 sensor. Similarly, "VITAL_2" and "VITAL_3" will provide the readings of heart rate and SpO2 levels of patients respectively and send back to the transmitter section using radio module. If received data is interpreted as integer (0 - 255) then map the values of X and Y axis of the joystick to the DC geared motors for their movement using library function available in arduino IDE. Finally, after mapping the joystick values use the conditional statement to rotate the motors in forward, backward, left and right direction. If there are no values received from the transmitter section then motors will be in idle state and no movement will be performed by the robot. Similarly, if there is no power supply receiver section will be stop working.

III. PROPOSED MODEL

The system is divided into two parts: transmitter section and receiver section. The process begins at the transmitter section of the circuit, where the user can give the input through the toggle switch. In this case, the toggle switch operates in two modes: driver mode and temperature check mode. Now, the working can be explained for these two modes separately.

Drive mode: In this mode, components such as Atmega328p, radio device nRF24L01, motor driver L298N and motor (12V, 100 rpm) are used to execute the operation. Firstly, when user switches to the drive mode, the joystick gets activated. The joystick device has 4 ways of moments in different directions: forwards, backwards, left and right, which are coordinated by x-axis and y-axis respectively. The signal for any of these commands are recognized by the microcontroller via change in resistance range that can be from low (for backwards or forward) to high (for left or right). These input values of joystick are then transmitted using radio module nRF24L01. The RF module supports 2.4 GHz ISM band and baud rate of 115200 bps for the communication with receiver RF module.

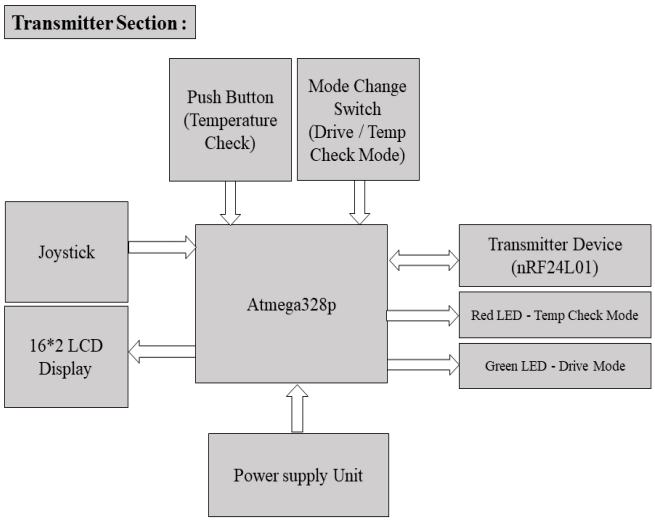

Figure 3: Block diagram of multipurpose robot transmitter section.

Once these signal (digital values from 0 - 255) are received to the antenna of receiver radio module nRF24L01, which then gets forwarded to the microcontroller (receiver side), where it gets processed in order to provide the input of joystick signals

in terms of voltage values to the motor driver L298N module and then the 100 RPM DC geared motors will rotate according to the input driven by the microcontroller. Since, the microcontroller uses maximum of 5V supply, while the motor uses 12V supply to operate, there is a need of motor driver that acts as an interface between the motor and the microcontroller circuit in order to turn the low-power signal into a high-power signal that can drive the motor.

Figure 4: Multipurpose Robot (Receiver Section).

Motor driver L298N uses the h-bridge circuit that switches the polarity of the voltage applied to the load to allow the motor to run forwards or backwards, left – right or vice-versa directions.

Vital parameter check mode: In this mode, components such as microcontroller Atmega328p, radio antenna NRF24L01, IR temperature sensor MLX90614, MAX30100 Heart rate and SpO2 level sensor and LCD screen (16×2) are used to execute the operation. The process is initiated when the toggle switch is activated for vital parameter check mode. When the temperature check push button is pressed < 5 seconds then "VITAL_1" string in the form of radio signal is processed via microcontroller, which gets transmitted to receiver section using transmitter RF module, which will be received by receiver RF module antenna, the received "VITAL_1" string is compared in the microcontroller and IR temperature sensor is activated. The IR temperature sensor detects the temperature with the help of heat radiation generated from the human body. This detected temperature is then re-directed to the transmitter side antenna in reverse order where (transmitter) microcontroller will process the temperature, convert it into Degree Celsius and Degree Fahrenheit and the same readings of temperature will be displayed on the LCD screen.

Here, the transmitter section can send as well as receives the signal and hence, can be termed as a transceiver. Similarly, if transmitter section wants the heart rate and SpO2 level then push button needs to be pressed for more than 5 seconds and then "VITAL_2" and "VITAL_3" strings will be sent to the receiver section and then microcontroller will read the values from MAX30100 sensor and will transmit the sane to receiver side. Finally, temperature in degree Celsius and Fahrenheit, heart rate in BPM and SpO2 in % will be printed on 16*2 LCD display.

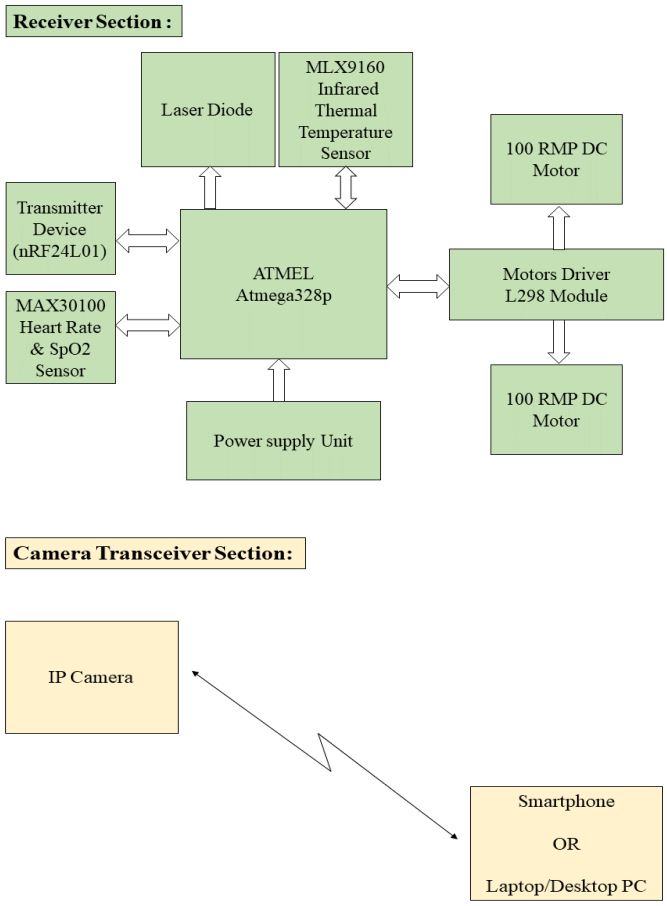

Figure 5: Block diagram of multipurpose robot receiver section.

The laser diode is used to just make an aim where the temperature needs to be checked. There are two LEDs used in the transmitter section which has significance too. Red LED indicates that vital parameter check mode is enabled and Green LED indicates that the drive mode is enabled. The modes are operated in such a manner that in vital parameter check mode robot will not make any moment and in drive mode system cannot measure the vital parameters of the patient.

The IP web camera has built in speaker and mic installed in it. Which will help the user to navigate the directions in hospital and also, robot operator can see the real time condition of patients in terms of video as well as one can talk with him from remote place rather than visiting patient personally using the IP web camera. Authors has decided to install V380Pro software from the android play store. The camera can be connected to available WIFI device or can connect to the mobile hotspot. Once connected with mobile hotspot / Router then just need configure the camera device in V380Pro app.

IV. RESULTS

The transmitter section is completely implemented and the receiver section is partially implemented. In transmitter section authors have interfaced the joystick module with

arduino. The analog values of X and Y axis of the joystick are now mapped with the digital range ex. 0 – 1023 (analog range) values are mapped with 0 – 255 (digital range) values which will rotate the motors accordingly. The mapping of value is nothing but the mapping of Analog and digital voltage ranges which are required for ADC conversion. 16*2 LCD display is interfaced with the arduino using 4-bit mode of operation where VCC, GND, RS, RW, EN and DATA0 to DATA3 pins are connected to arduino. The toggle switch is interfaced with the arduino for changing the mode from drive to temperature check mode or vice-versa. The toggle switch is connected to arduino pin number A4 and A5. Where if A4 is activated then Drive mode will be enabled and Green LED will be turned on and if pin A5 is activated then Temperature check mode will be enabled and Red LED will be turned on.

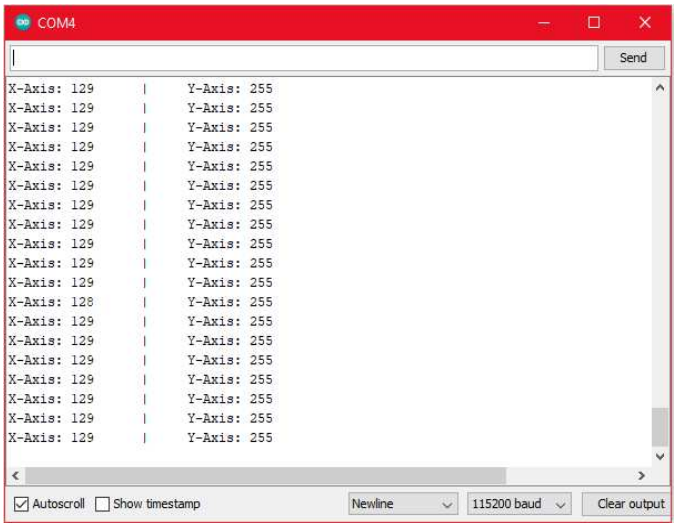

Figure 6: Serial values Joystick received at receiver section in arduino serial window.

The main component of wireless communication module nRF24L01 Radio device is interfaced with the arduino with 115200 bps baud rate. As of now the push button is interfaced with the arduino on pin number A5 for checking the temperature of patient. So, once the push button is pressed < 5 seconds then 16*2 LCD will show the temperature values in Degree Celsius and Degree Fahrenheit received from the receiver section (from robot) which can be seen in the fig. 7.


Figure 7: IR Temperature Sensor at receiver section

Figure 8: Transmitter Section of System with Temperature reading.

The traditional system does not support this feature where a user can check the temperature of a patient using a wireless robot from the approximate distance of 800 meters which makes it a unique solution which authors have implemented and tested in accordance with the traditional systems like surveillance robots.

V. CONCLUSIONS

The Multipurpose robot is really a best way to avoid direct contact of covid positive patients with the health workers and the doctors. The hospitals will definitely get more benefits with this low cost, low maintenance robot to perform n number of tasks in daily routines of hospitals. The robot not only can check the temperature, heart rate and SpO2 levels of patients wirelessly but also can help to cater the medicines and food to the covid patients and can reduce the manpower.

Till date authors have completed interfacing of 16*2 LCD display module, toggle switch, LEDs', push button, Joystick module, L298N motor driver, DC motors and IR temperature sensor (MLX90614) and radio device nRF24L01 for wireless communication with arduino. In upcoming months authors are planning to publish one more iteration of the same paper where heart rate and SpO2 levels of patients can be checked wirelessly using MAX30100 sensor as same as the patient temperature. Also, an IP web camera will be mounted on receiver section for audio and video transmission for communication between patient and their family members.

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