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RISK MINIMIZATION DUE TO COVID-19 USING CSR-BOT IN EDUCATIONAL INSTITUTIONS

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***Abstract*— Service robots are semi-autonomous or fully autonomous robots that have some mobility and interact with people, usually in a retail, hospitality, healthcare, warehouse or fulfilment setting, while others are used in more demanding settings, such as in space and defense, agricultural applications, and police work. The current pandemic situation due to Covid-19 has made employers to install service robots in many field to avoid human contacts and maintain social distance among them. This project focuses on building a low cost Classroom Service Robot (CSR-BOT) which is specifically designed to provide service in various rooms located on a single floor of educational institutions and design ensures that the payload will always be delivered to the right rooms in due time and alerts any human beings who are in its path through voice feedback. There by ensuring the safety of teaching and non-teaching staffs of the educational institutions.**

Keywords*— Covid-19, Service Robot, Payload, RFID, CSR-BOT

I. INTRODUCTION

The coronavirus pandemic has quickly become the most dramatic and disruptive event experienced by this generation. The disease has spread very quickly around the world and the growing number of new infections and patients in need of intensive medical care has pushed clinical services care beyond their limits, revealing a shortage of trained personnel and lifesaving equipment, such as ventilators. In addition, frontline health professionals operate in highly infectious areas, exposing themselves to the risk of becoming infected. The most common political response to mitigate the spread of the disease has been to promote social distancing, and locking down entire countries. Although being effective, these measures impose heavy social and economic consequences [1].

Robotics and automation technologies are already playing a critical role in this crisis, using robots in applications never seen before, such as helping to protect people by disinfecting risky environments, detecting disease, monitoring social distancing, providing remote care, promoting social interaction of confined patients, supporting remote work, delivering medical supplies to hospitals and goods to persons at home or in hard to reach places, etc. These applications, which typically involve the deployment of robots in normal living environments, their operation by non-skilled personnel and the interaction with the common population, impose significant research challenges that need to be addressed and overcome.

The robot is basically an electro-mechanical machine or device that is controlled either by computer program or with electronic circuit to perform variety of physical tasks. With the gradual development in technology scientists come up with new ideas and inventions of robots. As evident with modern technology, robots are assisting man in several avenues of the service industry. Robot can provide up to an extent error free service, work around the clock and consume less time with requested/repeated tasks. There are many types of robots used for different applications. Some of them are: Industrial robots, Frontline Service Robots, Domestic robot, Scientific robots, Event Robots, Service Robots.

A service robot which assists human beings typically by performing a job that is dull, distant, dangerous or repetitive, including household chores. The International Organization for standardization defines a “service robot” as a robot “that performs useful tasks for humans or equipment excluding industrial automation applications”. The service sector seems to be at an inflection point with regard to productivity gains and service industrialization similar to the industrial revolution in manufacturing that started in the eighteenth century. Rapidly improving technology that becomes better, smarter, smaller, and cheaper will transform virtually all service sectors. They typically are autonomous and/or operated by a built-in control system, with manual override options. There are two main requirements that a robot must meet to be brought to the market i.e. it must offer a good service at an affordable price, and it must perform the tasks with a minimal, tolerable failure rate. Service robots are categorized according to personal or professional use. They have many forms and structures as well as application areas.

Service robot is used in different fields like hotel, military, hospital, agriculture, airport, industrial application so we focus on extending this application in the educational field [2]-[9].

Agriculture robots are service robots used to automate traditionally labour-intensive agriculture practices. In many ways, agriculture robots help address specific societal problems surrounding our growing human populations by improving crop yields. Defence robots contribute to military superiority by giving troops an advantage at the ground level. Militaries as a whole gain a tactical advantage through the use of defence robots [3],[9] .

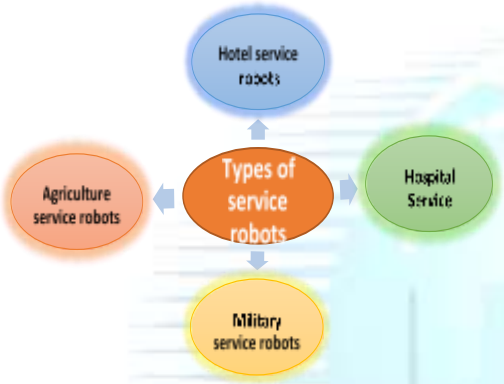

Fig. 1 Types of service robots

Construction robots are professional service robots currently used in the construction of new buildings. These robots automate dangerous and laborious tasks to keep workers out of harm's way. Medical robots are a type of service robot used in and out of hospital settings to improve the overall level of patient care. They ease the workload of medical staff, allowing them to spend more time caring directly for patients, while creating major operational efficiencies and cost reductions for Healthcare facilities [6].

There are service robots in different fields but in educational institutions especially in India there are no such service robots. Managing an educational institution, bringing together departments and campuses to achieve the mission is always a big challenge for management. Transforming an Educational system with high technology enabled automation tools to support the academic and administrative processes will make it easy to achieve their goals. As per the survey, there is no service robot in any of the educational field. To succeed in everyday tasks of an institution, there is an emerging demand to modernize public education system with cloud, mobile and digital technologies to improve operational efficiency and manage the institution effectively. Faculties are involved in doing both productive and unproductive works which is hectic.

Some of the Productive work and Unproductive works done by non-teaching faculties are shown in Table. I. These unproductive work done by the staff is time consuming for both management and teaching staff. The above mentioned problems can be solved by employing a Service robot into the Educational field. This paper, focuses on developing a service robot for Schools, Colleges and other Universities to reduce the amount of unproductive work as supplying stationaries, water bottles, records, booklets, circulars etc. The CSR-BOT can engage itself doing unproductive activities as mentioned above. While the staff can utilize their time to do other productive work and also helps to maintain distance among them during this pandemic situation due to Covid-19. The staff safety can be increased using this CSR-BOT during this situation. The robot does the required work with accuracy in optimum conditions. It's a boon not a bane for the management staff as it does not cause any threat to their employment.

Table.I List of work

Productive work	Unproductive work
Online Registration	Passing circulars to classes
Course Management	Distribution of stationaries
Admission & Enrolment	Distribution of files, records etc
Classroom Management Strategy and student monitoring	Distribution of question papers and other stationaries to invigilators

II. DESIGN OF CSR-BOT FOR EDUCATIONAL INSTITUTIONS

A. Block Diagram of Proposed CSR-BOT:

The proposed CSR-BOT which are very helpful in reducing the work burden of non-teaching staff is implemented using simple hardware components such as obstacle sensors, Arduino microcontroller and DC motors. The block diagram of the proposed CSR-BOT is shown in Fig.2. The CSR-BOT can receive commands from three different class rooms. It has the ability to deliver the load to correct destination from its base station. Also, it has the provision to carry payloads in its compartment and open the collection box lid using magnetic lock mechanism upon scanning an access card given to the person who has requested the item.

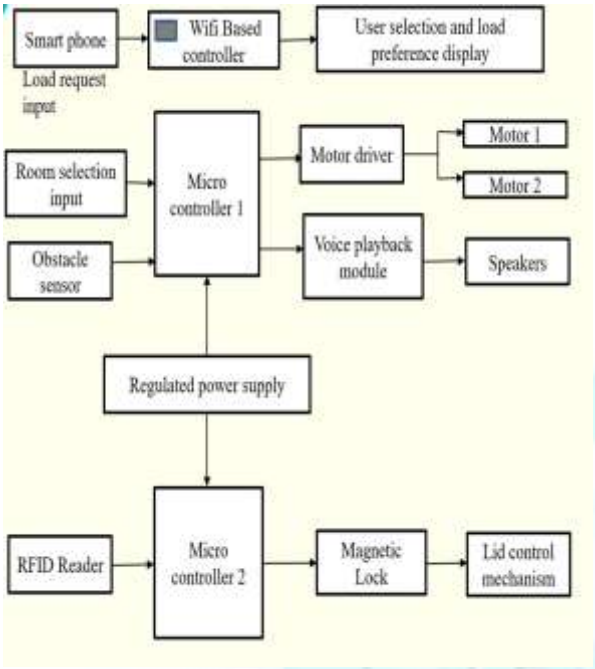

Fig. 2 Block diagram of proposed room service Robot

The CSR-BOT also uses voice feedback to interact with the customer and gives a specific duration of time to collect the loads an input to the Wi-Fi based controller, after which the robot will come back to its base station. The algorithm of the design ensures that the payload will always be delivered to the right customer in due time and alerts any human beings who are in its path through voice feedback.

The Robot initially stays at its base position from where the payloads will be loaded upon request from the specific rooms received over WiFi or can be requested over phone call as well. The concerned personnel will load these items and select the respective button corresponding to the room from which the request is received. When the command is received through the admins input, the robot sends a signal to the microcontroller-1as shown in the Fig.2 to initiate movement towards the designated room. The obstacle sensor input is given to the microcontroller-1 which will control the buzzer by giving warning to the obstacle if there is any blockage in the path of the robot. Once the robot reaches the designated room the voice feedback mechanism will instruct the user to scan their card and collect the load in stipulated time. The RFID reader input is given to the microcontroller 2.
Upon completion of the task, a final signal is sent to the microcontroller which drives the Robot back to the base. The movement of the robot for our system is based on time or delay. The time required for robot to move from its base to any room is calculated and that much delay is applied for the motors to be turned ON.

B. Algorithms for operation:

Fig. 3 represents the overall operational algorithm of CSR-BOT. The DC Motor and Arduino board are interfaced for the movement of CSR-BOT according to the required movements. Wi-Fi Module i.e. the Node MCU module is used to connect the developed app with the keypad present in the staff room. Once the staff sends the requirements, the LED glows indicating the room of requirement and the stationaries to be supplied. Node MCU module is programmed in a way where only staff can send the requests. The LED indicate the room number and the requirement sent by the staff through the developed smart phone application connected by wifi, according to which the input is fed to the robot by selecting the respective key on the keypad. The motor driver uses the fed input to drive the motor to the required destination.

The obstacle sensor (ultrasonic sensor) detects any obstacle on the way which is within the threshold distance and sends an alarm through voice playback module [5]. The flow chart shown below in the Fig.4. First the library files are downloaded for ultrasonic sensor. Following that trigger and echo pins of ultrasonic sensors are configured along with the buzzer pin. Then coding for triggering or generating the ultrasonic sound from the ultrasonic sensor. The most important step is to decide the optimum distance of obstacle measurement and calculate the distance in inches or centimetre. Then incorporate the calculated distance to the program. A condition is given such that if the obstacle is detected within the configured distance then the buzzer pin is made high otherwise it continues to remain low. The RFID cards are given to the in-charge staff of each classroom. Each RFID card has a predefined number which is pre-defined and stored in the microcontroller. On reaching the destination the in charge staff scans the card on the RFID scanner. If the card matches the number, the LED is turned OFF indicating the RFID number has matched and the magnetic lock unlocks allowing the faculty to access the requested payload. If the card does not match the number, then the magnetic lock

remains closed and after waiting for predefined time the robot returns without delivering the payload which makes the entire process secured.

The details of hardware components used to implement the CSR-BOT are tabulated in Table.II. The Node MCU after interfacing with APP Inventor and LED display board is fixed in the staff room. The geared DC motor is first interfaced with Arduino controller board for forward, backward and angular movements. Then obstacle sensors, voice playback module and magnetic lock are interfaced with Arduino board and fixed in CSR-BOT body. Since the robot works on time based delay, based on the trail-and-error method, the times for different destinations are set in the program.

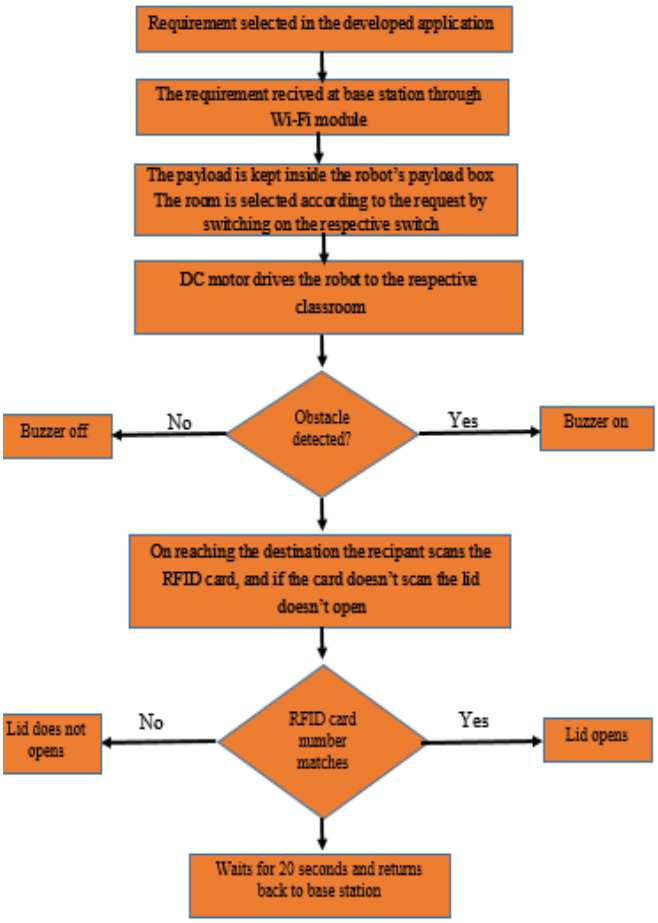

Fig. 3 Flowchart showing the working of CSR-BOT

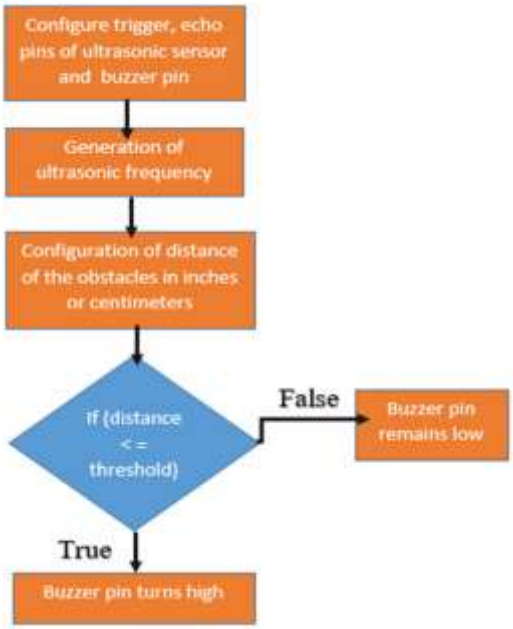

Fig. 4 Flowchart for Obstacle sensor interface

Table.II Hardware Component Details

Hardware component	Specification
Microcontroller	ATmega328 Node MCU [ESP8266]
Sensors	Obstacle sensor [HC- SR054]
RFID scanner & cards	RC 522 , 13.56MHz RFID module
Motor Driver	L293D
Geared DC Motor	Motor type: DC with metal gear Maximum torque: 1.5kgs at 12V RPM: 150 RPM at 12 V
Voice playback Module	Main chip: ISD1820 [AMR]

C. Developed Application:

App Inventor lets develop applications for Android phones using a web browser and either a connected phone or an on-screen phone emulator. The MIT App Inventor servers store your work and help you keep track of your projects. The Application RAVIGO is developed using MIT app inventor to place the orders/request the items as shown in Fig. 5. In this application there are three options that represent three different rooms i.e..Room1, Room2, Room3 and another three options that has water bottle, stationaries and bluebooks as

shown in Fig. 6. More options in the app can be added according the rooms need to be served and the based on the stationaries to be sent.

Fig. 5 RAVIGO app icon

Fig. 6 App overview

III. WORKING MODEL OF A SERVICE ROBOT:

The app developed for this proposed work is named as "RAVIGO" through which the staff can place the order for required material. The base station will receive the request through the app. A staff near the base station loads the service robot with those requested items as shown in Fig. 7 and gives the input to the service robot. The Fig. 8 shows the CSR-BOT, the body of which made light weighted and also container for the stationary, due to lockdown situation while developing the BOT. Input denotes the classroom number. That staff needs to press the classroom number, once the switch is pressed the robot will reach the destined class room through time based approach [where the time taken to robot to reach different classrooms from the base station is pre measured and it is given as instruction to the robot] and delivers the requested item to the staff. After delivering the requested items to the staff the robot will reach the base station.

To start the movement of the CSR-BOT the below steps are followed: Turn on the Master switch, Obstacle detection system and RFID switch . Once the room is selected CSR-BOT moves towards the programmed destination. The RFID cards are given to the faculty of each classroom. On reaching the destination the faculty scans the card on the RFID scanner as shown in Fig. 9. If the card number matches, the LED will be turned OFF indicating the RFID number has matched and

Fig. 7 Wi-Fi module interface with the LED keypad

Room No.	Forward move time in secs	Wait in secs	Backward move time in Secs	Total time in secs
Room 1	11.5	15	7	33.5
Room 2	12.5	15	10	37.5
Room 3	14.5	15	12	41.5

Fig. 8 The CSR-BOT front view

magnetic lock will be opened. Once the Magnetic lock opens, the faculty can take out the requested material from the payload as shown in the Fig. 10. The payload is closed after programmed time. The CSR-BOT moves to back to the base station after the delivering the payload .

Fig. 9 Staff scanning the RFID card

Fig. 10 Staff receiving the required stationary through CSR-BOT

Table. III Time taken for CSR-BOT

Table III shows the time taken for the CSR-BOT to reach from office to destination class room for delivering the required stationary. The time take by the robot depends on the distance between the office room and class room and also on the payload. For testing purpose, in this paper rooms with shorter distance from the office were selected with Hand Sanitizer as load. If the load is heavy (maximum of 2kgs in this case) the time taken by the CSR-BOT to reach the same destination will increase by few seconds. If this prototype CSR_BOT is developed for the required ratings in all educational institutions, then the teaching and non-teaching staff can utilize this time spent on unproductive work to do some productive work. The non-teaching staff can utilize the saved time in pursuing their higher education or for some skill enhancement programs. Also, the interaction between humans can be reduced to a greater extension resulting in increased safety of staff members. Hence, the proposed CSR-BOT can make a great impact in increasing the safety of employees in the educational institutions and in other similar working environment offices during this pandemic situation such as Covid-19. It helps in maintain the social distancing in the working environment.

IV. CONCLUSION

In this paper, the service robot for educational institution is addressed. The developed CSR-BOT will deliver the requested materials as per the staff requirement to respective class rooms within the specified time. Items can be requested using an app that have specially designed for it named as "RAVIGO". This service robot will successively reduce the time taken to do unproductive work by teaching and non-teaching staff. Hence, improving their productivity and enhancing their performance. The Service robot provides good service by reducing the risk of staff in coming contact directly with other staff and which is very essential during this pandemic situation due to Covid-19.

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