Autonomous Hospital Assistant Bot

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Abstract. In times of outbreaks, pandemics and otherwise there is no system in place to aid the doctors and nurses in their routine work such as monitoring, interacting, and providing necessities to the patient. These tasks tend to overburden the hospital staff and also bring them in proximity to the affected. Thus, The Autonomous Hospital Assistant Bot will act as a middleman through which the hospital staff can remotely monitor, interact and provide necessities like food, water, and medicine to the patient. Thus, reducing burden and proximity risks for the hospital staff. It can also establish communication between the patient and doctor through the bot enabling two-way communication. Bot also has a camera via which doctors can check the patient's health credentials as displayed on the devices connected to them. The addition of the system to the hospital ecosystem will revolutionize the stagnated hospital culture regarding hospital staff and their work & difficulties. The bot can help to cut down these interactions exponentially since it takes care of the three major reasons for the routine check-ups i.e. patient monitoring, interaction, and providing the necessities, thus reducing these physical, in-person interactions down to only the critical patients who need more attention.

1 Introduction

With the exponential rise in the human population, the people at the forefront tending to human health and wellbeing are doctors and nurses. As we know doctors and nurses are the lifelines of any nation. But, a major aspect usually under looked is the effect of overburden and proximity risks implicated in them. The reason for the same is the routine rounds to be made by the staff for patient monitoring and providing the necessary supplements.

To reduce these interactions the Autonomous Hospital Assistant Bot can be used by the hospital staff to remotely check on the patients. This can be done with the help of the website wherein the staff can select which patient they want the bot to go to. The bot will then autonomously reach its specified destination; without knocking over someone as it has an obstacle avoidance system. In this, the staff can also make use of the camera and the two-way communication system to monitor and interact with the patient in the safety and comfort of their remote location. The attached arms allow the staff to supply the patient with required necessities such as food, water, medicine, etc., and when the need arises, they can also measure the temperature of the patient remotely.

2 Literature Survey

A study on the autonomous hospital assistant bot was made. This helped us to learn about how we can build a bot and control the bot. The Literature survey is given in different ways that have been proposed over the years.

2.1 PSLB: Portable Sanitization and Locomotive Bot

In this paper, the portable sanitization bot moves on a track that needs to be placed by the user on the surrounding. On a clean surface like a floor, a black or non-reflective path of considerable width must be placed as shown in Fig. 1. PSLB would follow that path for its motion. The user will control the speed at which the bot will manoeuvre. The infrared sensor comes into play when the user would lay bends in the path, then the sensor would find a non-reflective surface on its path and it correspondingly generates no output signal for which the connected wheel momentarily stops rotating. At higher speed, it would be difficult for the robotic platform to confirm its laid path if the bend angle is considerably high [1].

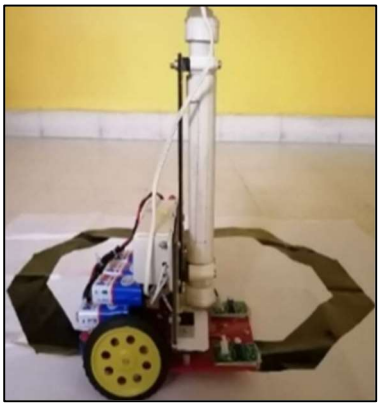

Fig. 1. Developed PSLB [1]

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2.2 Line Follower and Obstacle Avoider Robot

It gives the idea that a line follower is an intelligent robot that detects a visual line embedded on the floor and follows it. In this the path is pre-defined. It can be either visible like a black line or a white contrasting color as shown in Fig. 2. IR sensors are used to detect the line that the robot has to follow. The moment of the robot was automatic and could be used for long-distance applications [2].

Fig. 2. Line Following Robot Model [2]

2.3 Arduino Controlled War Field Spy Robot using Night Vision Wireless Camera and Android Application

In this paper, a robot is built using a night vision wireless camera run by an android application [3]. A Night vision wireless camera is used which sends videos of the war field to prevent damage to the human beings as shown in Fig. 3.

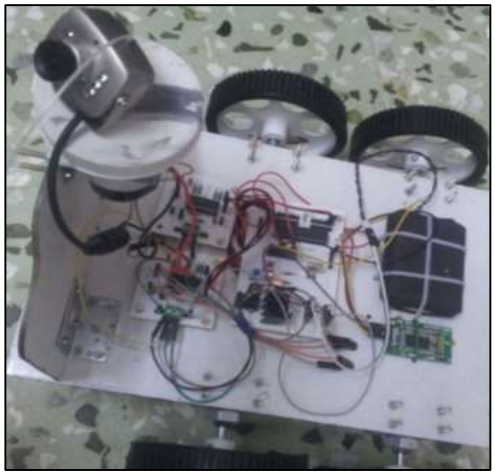

Fig. 3. War Field Robot With Wireless Night Vision Camera [3]

2.4 Smart Surveillance Robot for Real-Time Monitoring and Control System in Environment and Industrial Application

This paper presents the monitoring and controlling of the visuals of a real-time environment. IoT and IoR are the two fields that are growing rapidly and can offer many services for monitoring, manufacturing, security surveillance, etc. in various diverse fields. In this, we saw that the robot was fitted with sensors like DHT11, MQ-6, MQ-3, 3-axis accelerometer, and ESP 8266 module for providing real-time environmental monitoring. Figure 4 shows a smart surveillance bot with real-time monitoring. As shown in Fig. 4[4].

Fig. 4. Smart Surveillance Bot With Real-Time Monitoring [4]

3 System Block Diagram

Fig. 5 represents the block diagram of the Autonomous Hospital Assistant Bot. Herein, Commands can be sent to the RPI via a webpage, and the RPI, in turn, commands the Arduino modules to perform the necessary actions required for autonomous travel. Finally, when the travel is completed, the webpage can be utilized to access the other features of the bot which are aimed at patient-doctor monitoring and interaction.

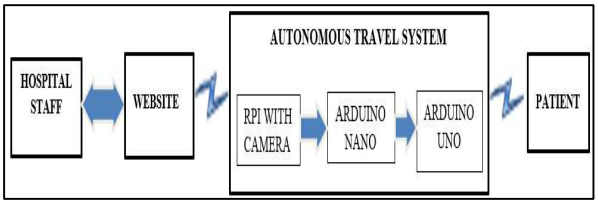

Fig. 5. Block Diagram of the System

3.1 Hospital Staff

The hospital staff are the main focus of this project as the bot aims at reducing their monotonous tasks of checking on the patient, their health credentials, interacting with them, and providing them the necessities may it be eatable, liquid, medicine, etc. The term hospital staff includes nurses, doctors, and any other hospital authority who has the official rights and requirements including but not limited to making rounds, checking on the patients, interacting with them, keeping track of their health progress, their current and past health status as and when the requirement for the same arises.

3.2 Website

The website will be the mode of control given to the hospital staff for enabling them the usage of the bot and its features. The major features of this website will be a camera, audio, and temperature check. For a

communication system, a microphone and speaker are available on the bot. With the help of this feature, the hospital staff and the patient will be able to converse with each other. Another major feature of the website is the camera; the hospital staff can select the access to the camera on the bot via the website to see what the camera of the bot is picking up, its mainly in place for viewing the health parameters as displayed on the various and respective devices connected to the patient along with being able to have a general view on the patient and the in-travel areas, if required. Temperature check is also made available on the website.

3.3 RPI with Camera

The RPI is the webpage-bot interface handler as all instructions from the webpage are sent to the RPI and the RPI then segregates these instructions and sends them to the respective devices and modules for their execution. These instructions include Camera access, Communication system access, Temperature Sensing, and Bot's destination selection i.e. the patient bed.

3.4 Arduino Nano

The Arduino Nano handles the Obstacle Detection and Avoidance System of the bot. Herein, if no obstacle is in front of it, it sends a HIGH; and if an obstacle is in front of it will send a LOW. Now these HIGH/LOW signals will be sent to the Arduino UNO and if the signal is HIGH the bot will continue its travel and if LOW it will halt its travel until the signal becomes HIGH again [9].

3.5 Arduino UNO

The Arduino UNO handles the Autonomous Travel of the bot. It achieves this with the help of Rotary Encoder. The rotary encoder is placed in a way that a wheel attached to its dial moves with the bot's wheel. The number of turns made by this dial is sent to the Arduino UNO and for each patient, the point of interest i.e. where it needs to take a turn, is fed to the bot and it moves accordingly when the set rotary encoder value is reached. And thus, it successfully reaches the selected patient [5].

3.6 Patient

The autonomous hospital assistant bot not only aims at assisting the hospital staff in their daily routine responsibility but also provides the patient with a pleasing experience and saves the staff's time thus making it possible for more critical patients to get more attention.

4 CIRCUIT DESCRIPTION AND IMPLEMENTATION

Following are the system that is used for the implementation.

4.1 Obstacle Detection System

The bot to be implementable in a hospital environment must possess some means by which it will avoid collision with people and other objects that will come in the bot's path. The first part of solving this problem is the detection of the obstacle. For this, HCSR04 Ultrasonic Sensor has been utilized to detect obstacle that comes in front of the bot.

To simulate this, the HCSR04 sensor is connected to an Arduino UNO wherein, if the distance of an object in front of the bot is less than 50cm it will glow the LED, and if greater than 50cm the LED remains OFF. As observed in Fig. 6, the LED glows.

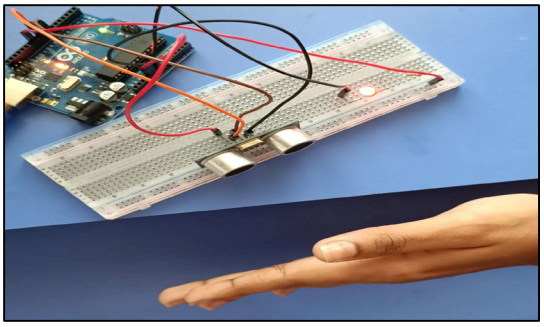

Fig. 6. Ultrasonic Sensor Reaction 1

Thus, with the object being at a distance greater than the set threshold the LED in its corresponding output i.e. Fig. 7 remains OFF[5][6].

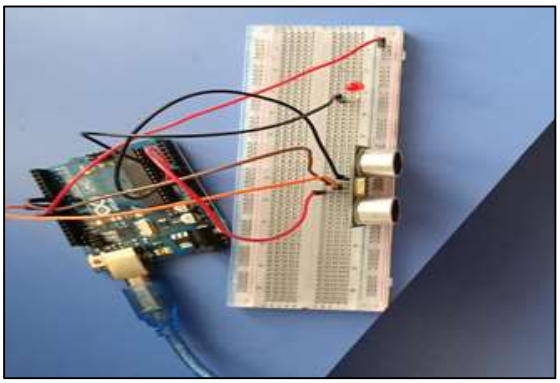

Fig. 7. Ultrasonic Sensor Reaction 2

4.2 Obstacle Avoidance System

In order to implement the Obstacle Avoidance System, simulations were conducted on Tinkercad. The devices and modules used in the implementation were Arduino UNO, IC L293D, Motors, HCSR04 Ultrasonic Sensor, and a 9V power supply.

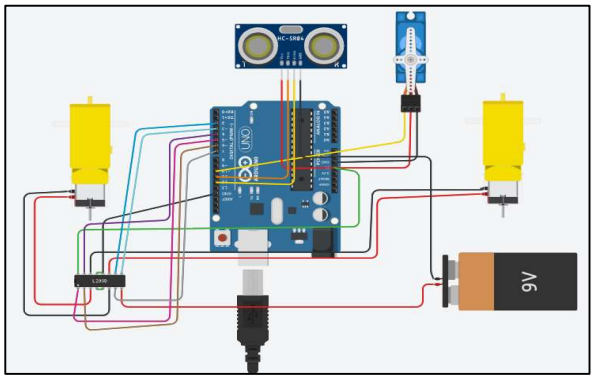

Fig. 8. Obstacle Avoidance System

The layout of the system is described in Fig. 8. Here, the HCSR04 Ultrasonic sensor sends its distance readings to the Arduino UNO. The Arduino UNO then processes the data and checks if the obstacle is at a distance greater than 50cm or not. If this threshold is broken then a signal is sent to the L293D to stop the motors via a LOW to its EN pin. If the obstacle is greater than 50cm then the bot movement is uninterrupted.

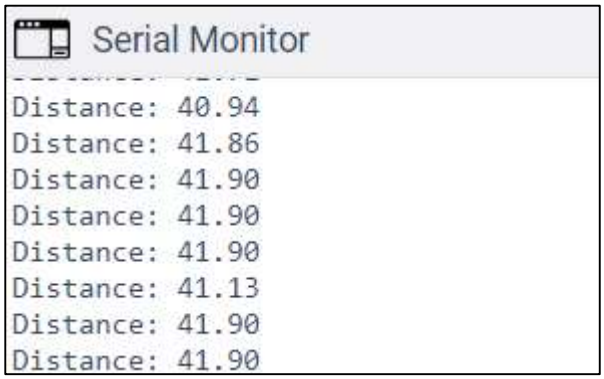

Fig. 9. Obstacle Avoidance System Reading 1

In the 1st test run the obstacle was situated at a distance of less than 50cm, as observed in Fig. 9.
Due to the threshold being broken, the bot movement is halted as observed by the denotation on the motors with 0 RPM.

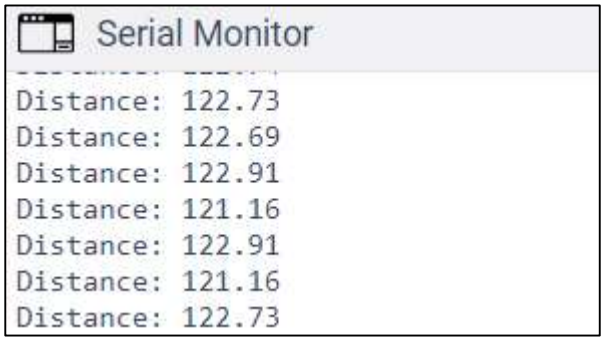

Fig. 10. Obstacle Avoidance System Reading 2

In the 2nd test run the obstacle was situated at a distance greater than 50cm, as observed in Fig. 10.
Due to the threshold not being broken the bot movement is not interrupted as observed by the presence of some RPM values of the motors.

4.3 Temperature Sensing and Display

For the patient's temperature to be checked MLX90614 IR Contactless Thermometer was utilized to measure the temperature without contact. This sensor works on Stefan-Boltzmann Law, according to which the IR energy radiated from a body is directly proportional to its temperature. The temperature thus calculated is displayed on the OLED 128x64 display.
In the test run, there is no body part in front of the sensor and thus the temperature of the room is measured. The room temperature measured was 29°C.

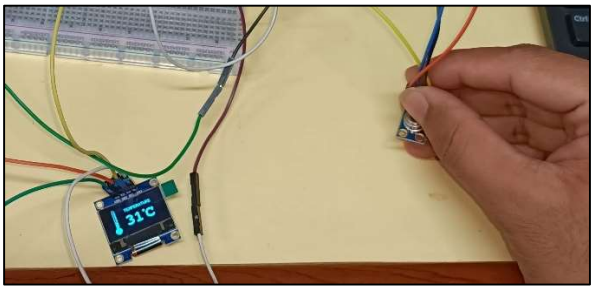

Fig. 11. Temperature Sensor Display

Here, a hand is in front of the sensor and thus the sensor measures the body temperature. As observed in Fig. 11, the reading changes from 29°C to 31°C[5][7].

4.4 Path Processing System

To enable autonomous travel a path is to be fixed. A fixed path is put in place primarily to minimize the obstruction in the hospital corridor by the bot during its movement[8].

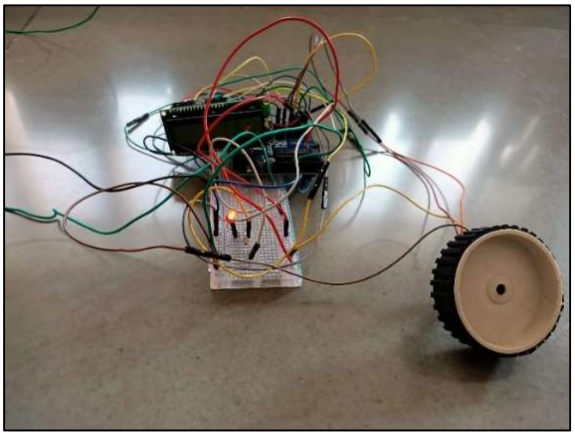

Fig. 12. Path Processing System

As observed in Fig. 12, the device made utilizes a Rotary encoder, LCD Display, LED, Wheel, and an Arduino UNO. The system is such, that when it's working the LED glows. From there on the wheel can be traced along the path the bot is planned to be moved. The LCD displays the number of rotations of the Rotary Encoder dial which is noted to plan the path.

Fig. 13. Path Processing System Reading

As observed in Fig. 13, the LCD is displaying the rotation of the rotary encoder dial, which in this case is 98. These readings are used to put in place points of interest from where changes are required in the bot's path to reach its destination.

4.5 Autonomous Travel Bot

All the systems mentioned above are utilized for enabling the autonomous travel of the bot. The devices and modules used are Arduino UNO, Arduino Nano, Rotary Encoder, HCSR04 Ultrasonic Sensor, and L298N Motor Driver Module.

The Arduino Nano controls the Object Detection System. The Arduino Nano works as a master and sends HIGH or LOW to the Arduino Uno which in turn is controlling the Locomotion system of the bot. If no obstacle is present in the set threshold, then the Arduino Nano sends a HIGH to the Arduino UNO which signals it to resume its travel and if an obstacle arrives it sends a LOW to halt the bot's travel. The Rotary Encoder is attached to a wheel and thus its dial moves along with the bot.

These readings are taken by the Arduino UNO and it compares them to the pre-fed rotary dial turns. When the stipulated Rotary encoder dial turn reading is matched it moves in the required direction. And thus the bot autonomously reaches its destination and stops.

4.6 Battery

The battery that is utilized in this model is a 12V 1.3Ah Lead Acid rechargeable battery. The battery sufficiently powers the bot in its travel and functionality. This battery can be easily recharged via its pins. As the charge in the battery reduces, the voltage output from it reduces too. This functioning of the battery is utilized to act as an indicator for depleted battery charge as before being completely drained out the output voltage will gradually reduce thus resulting in the bot moving slowly as compared to its usual speed. This reduced speed indicates that the charging is depleted and the battery needs to be charged.

4.7 Bot Specifications

The body of the bot was selected to have a wooden framework. The bot body is of the dimensions, 12"x3" of 18mm thickness on the wheel attached portion. 9"x3" of 18mm thickness on its perpendicular end. The pillar are made to be 10"x1.5" of 18mm thickness. The ideal power supply required for this system is 12V. In this, the Arduino UNO, Nano, L298N Motor driver modules are sufficiently powered for their functioning. Upon reduction in the voltage, the system will work at a reduced speed. The battery utilized in this system is a 12V 1.3Ah Lead Acid rechargeable battery. For the Rotary Encoder, 3.3V output of the Arduino UNO is used. And, for powering the HCSR04 Ultrasonic Sensor, 5V output of Arduino Nano is utilized. The L298N motor driver module powers the motors and thus, no external connections are required for the same.

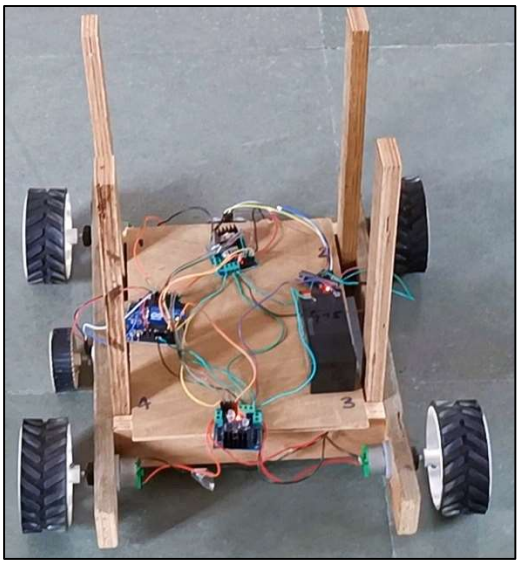

Fig. 14. Bot Body

5 Result

The implementation of the bot initially was conducted with it only possessing the Obstacle Avoidance system along with locomotion capabilities.

The 1st stage of the bot is attached to a stationary power supply which will be replaced by a portable battery. The devices used are Arduino UNO, L298N Motor Driver module, and Ultrasonic Sensor.

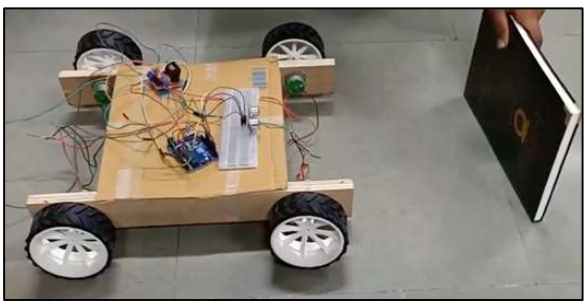

Fig. 15. Obstacle Avoidance Bot Test Run 1 with Obstacle (Book)

In the 1st test run, the bot is allowed to move and a book is brought in front of it at random intervals. As observed in Fig. 15, the bot successfully detects the obstacle and halts its movement up until the obstacle is moved out of its path.

Fig. 16. Obstacle Avoiding Bot Test Run 2 with Obstacle (Human)

Fig. 16 depicts the 2nd test run wherein a human walks in front of the bot. The bot successfully halts its movement up until the person moves out of its path.

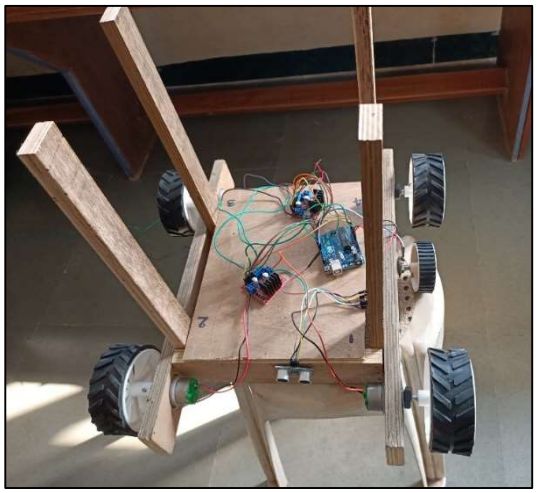

Fig. 17. Autonomous Travel Bot

Fig. 17 depicts the near-completed bot. Here, the bot can autonomously move to the patient as stipulated by the user. The bot performs obstacle detection and avoids the obstacle along with autonomously traveling to its destination.

6 Conclusion

The objective of this project is to make an autonomous movement and provide communication between the hospital staff and patient along with providing the essentials resources to the patient. The bot contains all the gadgets on the top part. These include a Camera, Ultrasonic sensor, temperature sensor, and microphone. The autonomous travel is brought about by the Rotary encoder and Ultrasonic sensor; the interaction is brought about by the camera, microphone, and speaker. The bot will also carry a tray which will be utilized for carrying necessities like food, water, and medicines for the patient. The actual movement of the bot is done with the help of wheels, servo motors, L298N motor driver, and a power supply.

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