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"Sahaya"- A Multirole IoT Based Bot for Geriatric Care

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***Abstract*— Due to the global shortage of trained labor and the aging population, the healthcare industry may consider utilizing robots to fill the void. The deployment of Artificial intelligence-equipped senior care robots has been beneficial for the healthcare sector; however, adoption rates of these robots are still lower than those of other service robot market sectors. In the event of a sharp rise in different pandemic situations, like COVID-19 cases, we are adopting a number of measures to prevent the spread of contact. Moreover, healthcare workers are often infected due to the physical contact. This rationale led us to come up with this work. "Sahaya", a multi-functional robot that offers not only food and drug delivery systems but also health monitoring, thermal screening, and UV disinfection in old age homes. It can be controlled either manually or automatically, and it can be used to carry food to patients as well as to give medicines and other emergency care. It offers real time monitoring, and it analyzes and displays the collected data through ThingSpeak (an IoT analytics platform).**

***Keywords*—IoT, Artificial intelligence, health monitoring, U.V disinfection, thermal screening, ThingSpeak.**

I. Introduction

Demand for caregivers and nursing homes is rising as a result of the world's aging population. Robotics in geriatric care is a vital way of addressing the mismatch between the number of senior citizens in need of medical care and the availability of caregivers. A UN analysis projects that the number of adults over 60 would increase from 962 million in 2017 to 21 billion in 2050 and 31 billion in 2100. Advances in technology have resulted in the development of robot caregivers and caretakers, who hold the potential to assist and monitor senior citizens.

A. *Scope of the system*

The deployment of robots in senior care is gaining more popularity and attention since it can enhance people's quality of life. Our "Sahaya" is designed to provide vital assistance, such as delivering food and medical items, monitoring medication compliance, and providing emergency alerts to protect senior citizens. These features help elderly people stay independent for a longer period of time and potentially reduce the need for advanced care. These smart devices are primarily intended to care for the elderly, the physically impaired, patients with infectious illnesses like COVID-19, and patients in locations where medical professionals are unable to reach them quickly.

Depending on the situation or environment, we can operate this robot either manually or automatically. The main aim is to avoid direct interactions and ensure a safe and healthy environment in geriatric care. In order to avoid direct contact and human effort, a bot that can serve food, medicines, and U.V disinfectant for disinfection along with temperature screening is being proposed. An IoT analytics platform that enables us to accumulate, visualize, and analyze real-time data streams in the cloud is used to display the measured health parameters, including temperature and heart rate. Moreover, it is applicable to people who have undergone quarantine or are bedridden. This concept is put forward as a multifunctional bot whose functions will change according to the requirements of each one. While operating in automatic mode, we adopt a line-follower method, whereas in manual mode, we control this robot with the help of a mobile application. Our goal is to implement this bot in order to reduce physical interaction and human effort.

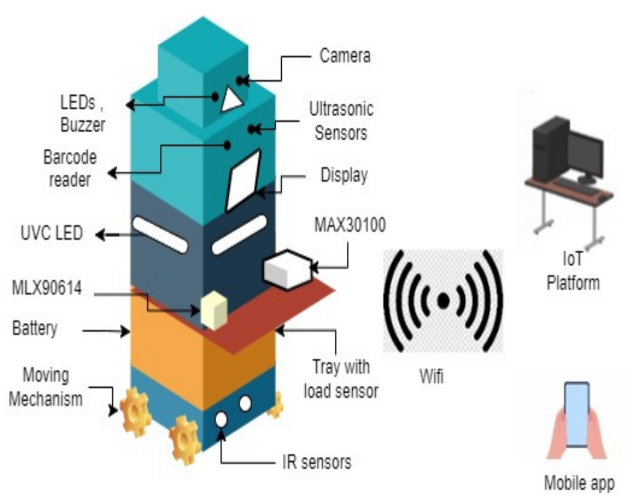

Fig. 1. Schematic diagram of of the working model

B. *Objective*

The primary objective of this paper is to implement an IoT-based multirole robot that can be made effective in places like geriatric care without compromising on treatment quality and standard. This concept is put forward as a multifunctional bot whose function will change according to the requirements of each one. Therefore, we can offer comprehensive health monitoring and prompt food and medication delivery with the help of modern technological innovations.

Compared to other systems now in use, our suggested system offers numerous enhanced functions. A robot in an existing system is built for a specific environment. Here, we integrate many functionalities into a single robot to meet the demands of various contexts. All types of conditions and circumstances, including houses, nursing homes, and hospitals, can employ our suggested approach. The working model's schematic diagram is displayed in Fig. 1. In our system, there are three main sections. A cloud-based IoT platform, a screening and health monitoring system, and a UV disinfection system are among the moving mechanisms that use line-followers. In the moving mechanism, An app-enabled system allows for manual operation of the robot from a distance, and a line follower is employed in automatic mode. We are using PIR sensors, UV LEDs, and infrared heartbeat and heat sensors in order to ensure the screening and disinfection process in an effective and adaptable manner. It has an RFID based patient identification system, also it can record temperature, pulse rate, and other data, and store it locally on a microSD card along with a cloud-based database. There is a camera module available in addition to these screening modules in case real-time monitoring is needed. This sensor data and the camera footage are processed and sent to an IoT platform called Thinkspeak, a cloud-based platform that allows us to do the required analysis and decision-making.

II. Related Works

Taking care of the sick and aged is one of a family's top concerns. All forms of assistance are appreciated by those who realize the responsibility and immense amount of effort involved in providing this care.

The objective of Nurse-Bot [1] is to highlight Nurse-Bot's role for providing medical assistance to sick people. It records vital signs and keeps track of information to enable better monitoring of the outcomes of a specialist's advised treatment prior to consultation.

Another remarkable effort is Nurse Bot for Elderly People [2], which created an automated tiny robot with a scheduling and monitoring system that gives elderly patients their medications on time.

Another noteworthy project is the implementation of an IoT-based nurse-BoT [3], which created a robot that can be directed toward a specific patient using Bluetooth or other wireless control devices. It could gather the patient's data, temperature, and pulse rate and save it on an SD card in a local database.

The robotic waiter technique [4][10] is also a significant idea, which suggests a mobile robot that can work effectively in a restaurant environment within a certain area, taking orders and serving food.

Another significant breakthrough in this sector is the robot that could take human body temperature and heart rate in non-invasive manner [5].

Autonomous UV robots [6] to limit human interaction in the disinfection mechanism and minimize health risks.

Line follower robot[7][8] for transporting goods that can automatically deliver the goods[9] by following a track and stopping.

A. *Limitations*

The primary drawback of the aforementioned strategies is that they are not reliable solutions in all circumstances and environments. In the IoT Nurse-BoT [3], bot movement is controlled by Bluetooth-based wireless technology, which has certain limitations in practical scenarios like range, obstacles, etc. In our proposed method, when the bot encounters any obstacle during its operation, it is not going to abort the duty. We have solved this problem by programming the robot in such a way that it allows us to switch bot movement from auto mode to manual mode with sensors and a mobile application. Another limitation of the existing nurse bot is that it is limited to hospital applications and is not suitable for geriatric care, where we need more functionalities like food delivery, real-time monitoring, disinfection, etc. Existing works have a lot of hardware limitations to adapt modern technologies like artificial intelligence and natural language processing to meet current requirements and future demands.

Thus, it goes without saying that an appropriate system is much more essential in this hour. Now that science and technology have advanced as much as humanity is going to touch Mars, it is imperative that we must resolve this problem appropriately.

III. Proposed System

The basic concept of our proposed robotic system "sahaya" is inspired by a nursebot [3], which records patient vitals and saves the data to facilitate doctor consultation. We made the system more functional by adding more features that are necessary for tailoring it to suit various environments and emerging demands.

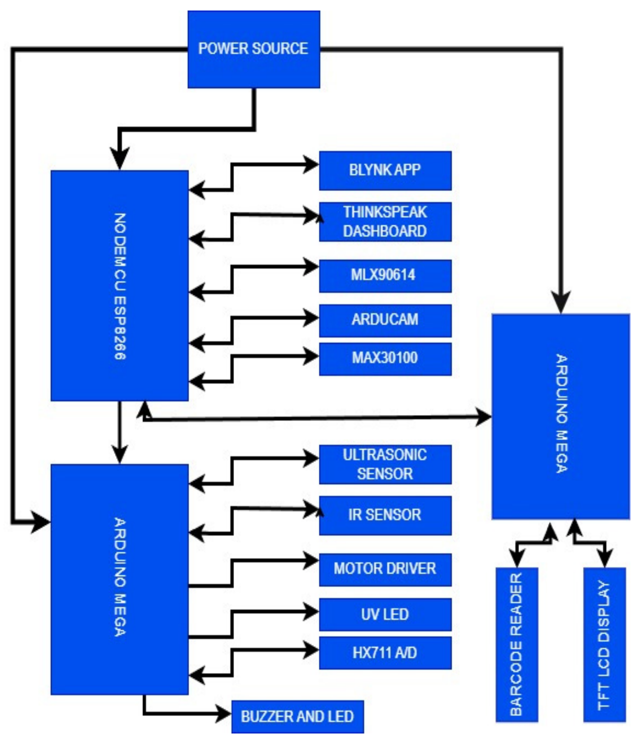

Fig. 2. Basic block diagram of the main system

To fulfill the diverse needs that arise in geriatric care, it is equipped with IoT-based health monitoring, thermal scanning, drug and food delivery facilities, a camera, and UV disinfection. To overcome terrain constraints and obstacles, we can maneuver the bot in either manual mode or auto mode. With the help of a line follower algorithm and obstacle sensors, the bot is programmed to follow a predefined path and stop wherever required. If the situation demands it, by enabling manual mode with the help of a mobile application connected over Wi-Fi, we can control the bot.

As illustrated in the basic block diagram, our proposed system comprises the Arduino Mega 2560, Nodemcu esp8266 for IoT applications, camera module, Wi-fi module, buzzer, LED, barcode scanner, sensors, U.V LED, motor and motor driver, display module, and power source.

A. Auto mode operation

The Arduino Mega controlled auto mode consists of infrared sensors, an ultrasonic sensor, buzzers, motors, and a motor driver. A line-follower robot can move through a designated line by identifying black and white colors. Two infrared proximity sensors, which serve as the eyes of the robot, are used for black-and-white detection and obstacle avoidance. Based on IR sensor data, the Arduino Mega controls the motors. IR sensors, including two infrared diodes, one for IR emission and the other for receiving IR rays. Two 150-rpm, 12-volt DC Johnson gear motors are employed for robotic movement. These motors offer a massive torque of 10 kg cm in practical applications. The motors are driven by the Arduino board through the L293D motor driver. The ultrasonic sensor helps with obstacle avoidance, and the buzzer gives necessary alerts to remove the obstacle or avoid collisions.

Infrared proximity sensors are placed at the front of the robot on either side. There are four possible sensor outcomes. We can depict the sensor outputs in four ways. The bot moves forward when the sensors don't detect the line. If the left sensor detects the line, the bot turns left by rotating the left motor in backward and the right motor forward. Similarly, the bot makes the right turn if its right sensor picks up the line. Finally, the bot stops whenever both sensors detect the line..

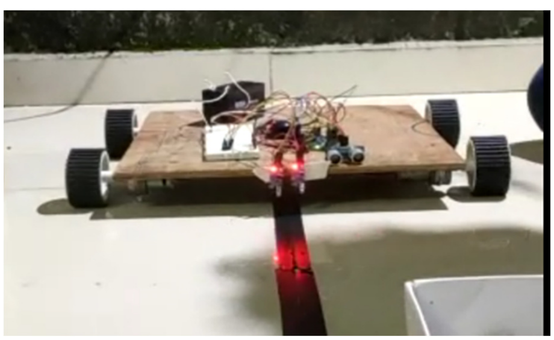

Fig. 3. Automode Operation

B. Remote Mode

In situations where we want direct involvement in bot movement, we can control the bot with the Nodemcu ESP8266 with the Blynk app, a mobile app for remote monitoring and control of connected devices over wifi. With the help of this app, Blynk, we can connect their devices and control them remotely from any location. We can also receive crucial information and do a lot more with it.

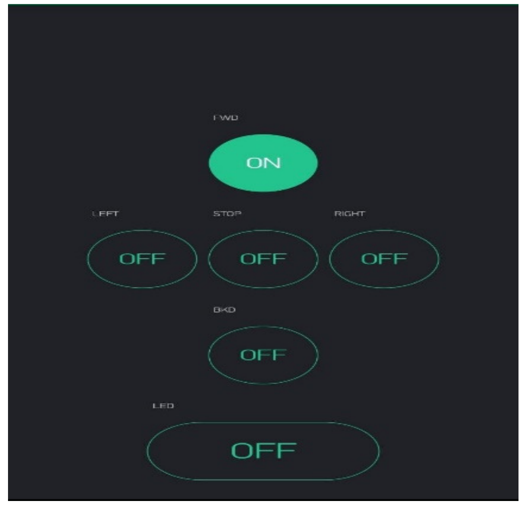

Fig. 4. Blynk widget for manual mode

The Nodemcu ESP8266 is a WiFi SoC compatible with the Arduino IDE. It has a flash memory of 4MB and SRAM of 128 kb. In manual mode, the Nodemcu ESP8266 and Arduino communicate serially to allow the Blynk app to control the motors driven by the Arduino Mega board over WiFi.

In order to initiate this communication, we first add the required widgets, such as a joystick and slider, to the dashboard of the Blynk app. After installing the necessary packages and libraries in the IDE, we programmed the Nodemcu ESP8266 with the 'Auth Token' that it is getting from the Blynk app.

C. IoT enabled Health monitoring system

In geriatric care, it is essential to track and analyze the patient's vitals to ensure routine care and provide timely medication. Here, we propose an IoT-driven, non-invasive, real-time health monitoring system. With the help of sensor data and camera footage, we can perform cloud-based analysis using sensor data and camera footage to identify emergencies early and notify caregivers and medical professionals.

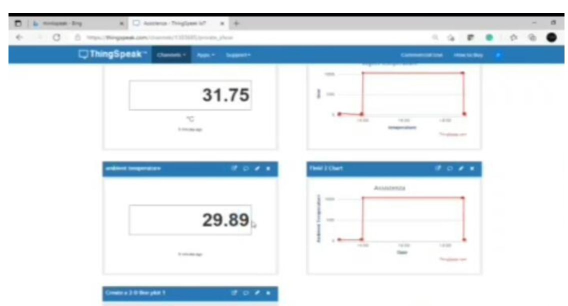

Fig. 5. Thinkspeak dashboard

Thermal screening is accomplished with the non-contact wireless temperature sensor MLX90614. The MAX30100 sensor is used to detect heart rate and blood oxygen levels non-invasively. The sensors are connected to Thinkspeak,a cloud-based IoT platform, through the NodeMCU ESP 8266 board. The collected data is uploaded to Thingspeak for visualization and analysis. An alert is generated when any of the collected data crosses the threshold. It also provides the facility to download the data in Excel format for future reference.

ArduCAM OV2640, an energy-efficient camera module, is connected to the NodeMCU ESP8266. Arducam GUI, the NodeMCU ESP8266 web interface, enables image or video capture. The web interface also allows us to access and display the captured data.

D. Disinfection and delivery system

Sanitization and disinfection are crucial parts of geriatric care, especially in nursing homes and senior care centers where elderly people have weakened immune systems and may have chronic illnesses. So, an autonomous sanitation system is integrated into our work to ensure hassle-free sanitization.

The UV disinfection system, composed of a UV-C LED SMD3535, 0.5W germicidal UV of wavelength 200–280 nm, and an HC-SR501 PIR sensor, can perform disinfection while ensuring inmate health. HC-SR501 is employed to detect human motion, and the UV-C LED will turn off when a human motion is detected. UV LEDs are mounted on the bot in such a way to get 360o all-round coverage. The food and drug delivery system has a food tray with a load cell weight sensor (HX711 A/D), a buzzer, and an IR sensor that can check if the tray is empty or not.

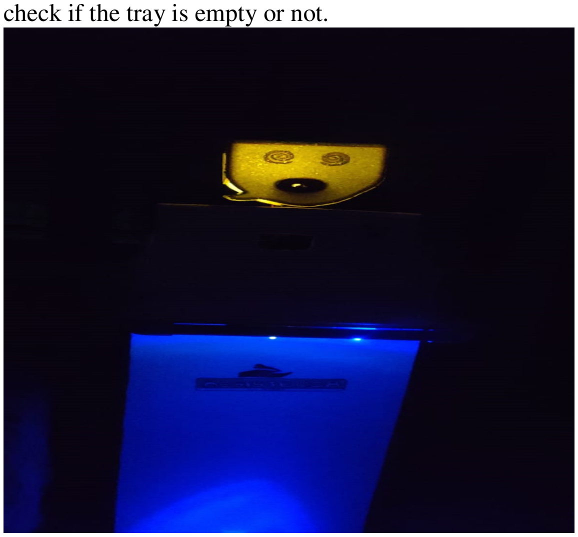

Fig. 6. UV Disinfection

E. Power supply

It is very important to select the right power supply for our robotics system. While selecting a battery for our robotic project, we took into account several criteria, including overall current consumption, the operating time on a single charge, physical dimensions, weight, and cost.

As our project consists of motors, Arduino boards, sensors, UVC LEDs, and buzzers, in order to meet the requirements, we selected the battery in the following way: First, we estimated the total current consumption of the circuit by totaling the current requirements listed on the datasheet for each component. Next, we estimated the battery capacity in Ah by multiplying the total current consumption by the planned runtime in hours. The voltage range was then chosen by making sure the chosen voltage could satisfy the highest voltage requirement.

After considering all these factors, we finally selected a 12V, 2.5Ah rechargeable sealed lead acid battery for our work.

IV. BASIC ARCHITECTURE

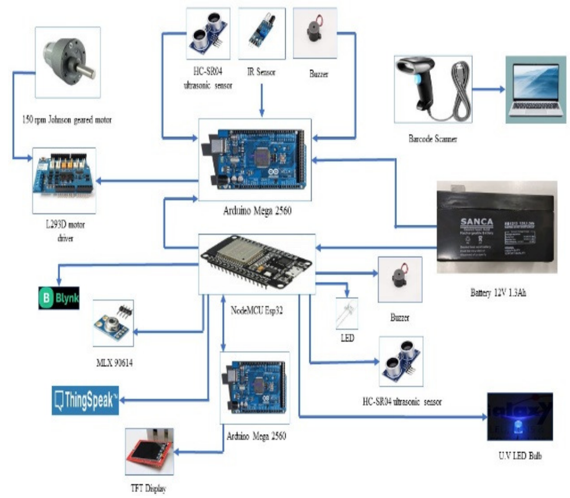

Fig. 7. Final architecture

V. RESULT

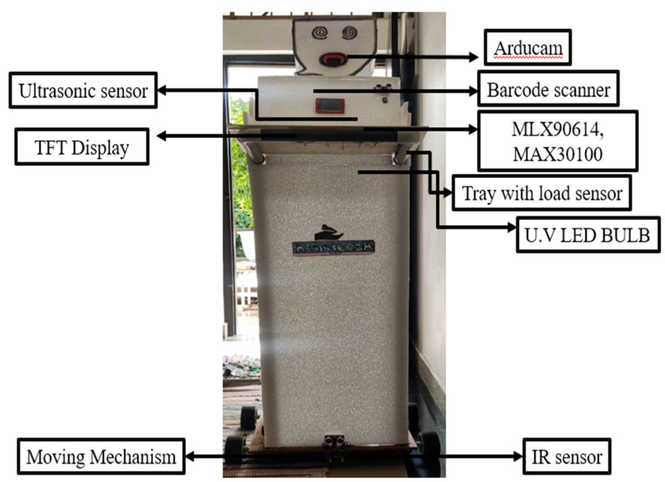

Fig. 8. Sahaya – working model

After the development, we tested our robot in an environment similar to our targeted areas. As we designed, in auto mode, the robot has line-following and obstacle-avoiding capabilities, is able to follow the predefined path, and recognizes the halt points. Similarly, when operating in manual mode, it was able to receive instructions from the mobile app and move as per our instructions in all directions. DC motors performance was also satisfactory.

We could successfully access the patient vitals that were collected through noninvasive sensors and uploaded to the Thinkspeak IoT platform. Arducam performed as per our expectations and was able to share the captured images through the camera GUI. The UV disinfection and delivery system was also able to meet our expectations.

Following the testing, which was successful, we learned that the system is operating as intended.

VI. Conclusion

In the process of testing, we not only checked the performance but also tried to identify what type of features we still needed to add. In this current scenario, we are considering the possibility of introducing an AI-enabled version of this model that will help to keep in touch with the elderly in a more interactive manner. Moreover, we are planning to implement a voice recognition system, which will help us keep in touch with the patient if any help is required. Additionally, we have plans to strengthen the health monitoring system with more non-invasive sensors, which will empower routine checkups and streamline the process of seeking medical consultation. We are working on developing an all-terrain robotic platform with a dedicated mobile app that can manage staircases, slopes, and other obstacles, since there are numerous such constraints with the existing robot movement mechanism. Likewise, we can accomplish further capabilities with this bot if we can incorporate an animatronic robotic hand [11] into it.

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