



MediTrack: An Automated Medication Delivery Robot for Elderly and Visually Impaired Individuals

Thushara Hameed, Mohammed Zahir Sulaiman Al-Zakwani, Rashid Said Hamdan Al-Jabri, Muath Saud Saif Al-Qassabi, Moosa Said Sulaiyam Al-Kendi

Abstract: Medication non-adherence among elderly and visually impaired individuals often leads to missed doses, incorrect intake, and adverse health outcomes. Conventional solutions, such as pill organisers and alarm reminders, are limited in their ability to ensure accurate and timely medication administration. This paper introduces MediTrack, an automated medicine-delivery robot designed to improve adherence, enhance patient safety, and reduce caregiver dependence. MediTrack uses an Arduino microcontroller to coordinate navigation, scheduling, and dispensing. Infrared sensors enable line-following navigation along predefined paths, while ultrasonic sensors provide real-time obstacle detection and avoidance. A Real-Time Clock module schedules medication delivery at set intervals. Upon arrival at the designated location, a servo motor dispenses the correct dosage, and a buzzer provides an audible alert. An LCD module displays real-time system status for improved usability and monitoring. Experimental validation in a controlled indoor environment assessed navigation accuracy, obstacle avoidance, timing precision, and dispensing reliability. Results show consistent, timely medication delivery with minimal error and effective handling of obstacles. The automated dispensing mechanism reduces the risk of incorrect dosages and missed medications. MediTrack addresses the limitations of manual and semi-automated solutions by offering a cost-effective, reliable, and user-friendly assistive technology. This system demonstrates the potential of embedded and robotic solutions to improve medication management and quality of life for individuals with disabilities.

Keywords: Arduino UNO, Ultrasonic Sensor, Motor Driver, Servo Motor, Power Supply, LCD Module, RTC Module, Buzzer, NodeMCU.

Nomenclature:

AI: Artificial Intelligence

I. INTRODUCTION

Health and medical routines can be major challenges for

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older adults and those with visual impairment, leading to issues such as missed medications, doctor visits, or lost records—factors that can severely impact quality of life. The MediTrack automated medication delivery robot directly addresses these challenges by providing a comprehensive, user-friendly medication delivery system that leverages smart robotic technology. MediTrack automates medicine dispensing, allowing users and caregivers to reliably receive medications, and treatment support from anywhere at any time. This ensures medicines are always delivered on schedule and facilitates monitoring with authorised caregivers, improving communication and continuity of care. The robot empowers elderly and visually impaired individuals to manage their medication independently and safely, thereby enhancing their quality of life and providing them with peace of mind. Its integrated features ensure medicines and care schedules are handled systematically, reliably, and on schedule, specifically tailored to support the needs of these populations.

II. LITERATURE REVIEW

Efficient medication delivery in hospitals is vital for patient care, but high patient volumes, staff shortages, and diverse patient needs make it challenging. To solve these problems, Sriviveknath et al. (2025) introduced MediBot, a smart robot that follows lines on the floor using IR sensors and avoids obstacles with ultrasonic sensors. MediBot, controlled by an ESP8266 microcontroller and fitted with a rotating hexagonal box for medicines, delivers medicine correctly. It alerts caregivers in real time via phones and computers, making it easier to monitor and reduce human error. Similar works using IoT and Arduino/NodeMCU demonstrate how robots, IoT, and cloud systems can help hospitals operate more efficiently, improve patient safety, and reduce staff workload, indicating that these automated systems can address many new healthcare problems [1].

Selvaraj et al. developed a smart medicine-delivery robot using IoT, sensors, microcontrollers, and cloud systems to improve hospital operations. This robot moves autonomously, finds its path, and avoids obstacles using its sensors, while IoT means data is always sent to the cloud for real-time tracking. Health workers can assign tasks, track delivery progress, and receive real-time alerts, reducing the need for hands-on work and mistakes. It can store and study data to improve routes and schedules. Its design enables it to work with other smart hospital systems and adapt to varying patient volumes. Overall, using IoT makes medicine distribution more open, reliable, and accurate, while lowering staff loads and keeping patients safer [2].

Kavirayani et al. (2020) developed an advanced



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AI-based robotic system to automate the delivery of medicines to patients in healthcare settings. The system integrates artificial intelligence techniques with embedded hardware to enable intelligent navigation and autonomous operation. Using a combination of sensors and path-planning algorithms, the robot can move efficiently through hospital corridors, avoid obstacles, and identify the correct delivery locations without human intervention. The AI component supports decision-making by allowing the robot to adapt to dynamic environments, such as crowded wards or unexpected obstacles, thereby ensuring reliable performance. The robot is equipped with compartments for securely carrying medications and can deliver them directly to patients or designated locations. It also enhances accuracy in medication delivery, reducing the risk of human error and ensuring timely distribution. Overall, the study demonstrates that integrating artificial intelligence with robotic systems has significant potential to transform hospital operations, making them safer, more efficient, and more resilient to healthcare challenges [3].

Anuradha et al. (2024) designed and implemented an IoT-enabled medication delivery robot specifically for isolated patient care. The system utilises an Arduino-based control unit along with wireless communication modules to enable remote operation and monitoring. The robot is capable of delivering medicines and food to patients in isolation wards, reducing the risk of transmission of infections to healthcare workers. With a moderate load-carrying capacity and user-friendly interface, the system demonstrates how IoT and robotics can be effectively used to improve safety, efficiency, and resource management in hospitals [4].

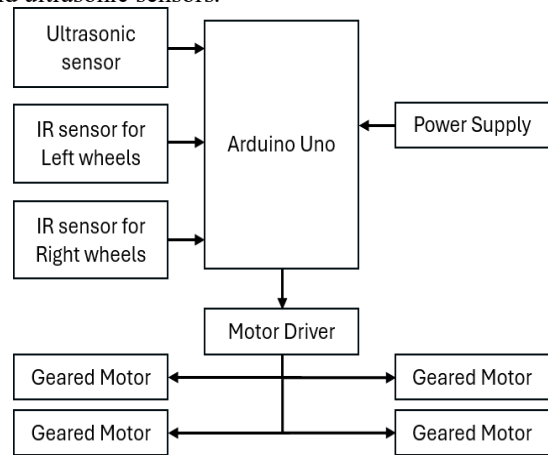
Ahmed et al. focus on Remote Health Monitoring Systems for older adults and demonstrate that remote monitoring improves quality of life and safety by enabling continuous monitoring and real-time data analysis. The authors list the following critical enabling technologies: wearable sensors, the Internet of Things, and cloud platforms, which help to monitor vital signs and provide a caregiver with an alert in case of an emergency. These issues are data privacy concerns, network reliability, and device energy consumption, all of which are discussed in the manuscript. In general, the paper clarifies current trends and limitations in the development of efficient remote health systems, which align with the MediTrack project's goals of providing continuous attention and faster notifications to older and visually impaired patients [5].

Miramirkhani et al. (2023) present a comprehensive review of recent innovations in remote health monitoring systems, emphasising the integration of IoT, artificial intelligence, and wearable technologies in modern healthcare. The study highlights how advanced sensor networks and cloud-based platforms enable continuous monitoring of patients' vital signs, allowing healthcare providers to respond quickly to emergencies. AI techniques are used for data analysis, anomaly detection, and predictive healthcare, improving decision-making and patient outcomes. The paper also discusses key challenges, including data security, interoperability, and energy efficiency, which are critical to the successful deployment of such systems. This work strongly supports the development of smart healthcare solutions by demonstrating how intelligent monitoring

systems can enhance patient safety, reduce hospital workload, and provide efficient, real-time healthcare services, aligning closely with the goals of automated medicine delivery and monitoring systems [6].

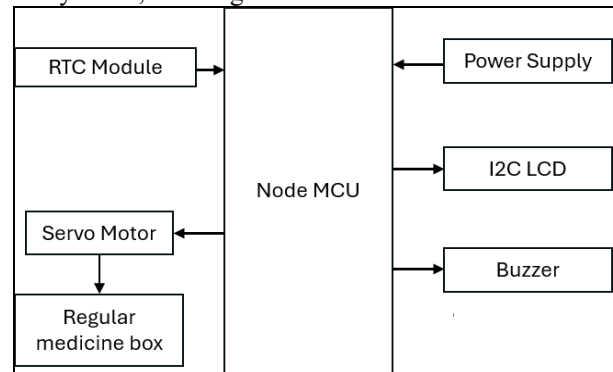
III. BLOCK DIAGRAM

Figure 1 shows the block diagram of the robot vehicle. The system is centred around an Arduino Uno, which functions as the central processing unit. The robot is equipped with two IR sensors, one for each wheel, to guide it along a designated path by detecting lines. Ultrasonic sensors are used to detect obstacles and measure their distance from the robot, allowing it to stop or avoid collisions. A motor driver controls the movement of four geared motors connected to the wheels, adjusting the robot's direction based on inputs from both the IR and ultrasonic sensors.



[Fig.1: Block Diagram of the Robot Vehicle]

Figure 2 illustrates the block diagram of the MediTrack system, where the NodeMCU serves as the central processing unit. The system includes an RTC (Real-Time Clock) module that schedules medication times for each patient, ensuring timely delivery. When the scheduled time arrives, the NodeMCU activates the robot, which follows the line using its IR sensors to reach the delivery point or patient. Upon arrival, the NodeMCU operates the servo motor to dispense the medicine, while the buzzer alerts the patient, particularly assisting visually impaired users. All data related to the delivery process is displayed on the I2C LCD. After dispensing the medication, the robot automatically returns to standby mode, awaiting the next scheduled task.



[Fig.2: Block Diagram of the Meditrack System]





IV. RESULTS & DISCUSSION

Test the project using the components in this project and other integration tests, then check the results in the Arduino IDE, which shows the same behaviour in the Serial Monitor.

A. Testing of Ultrasonic Sensor

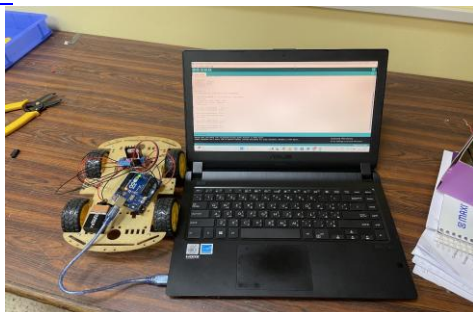
The Ultrasonic sensor has four pins: Echo, Trig, VCC, and GND. As the sensor's VCC is connected to 5V on the Arduino, GND is connected to Arduino ground, and the Echo and Trig pins are connected to Arduino output pins, such as D3 and D4. After that, open the Arduino program on your computer, write the ultrasonic sensor program, connect the Arduino to your computer using a USB cable, and then upload the program to your Arduino. Finally, press the run button in the Arduino program to see how far the obstacles go. It is shown in [Figure 3](#).



[Fig.3: Testing of Ultrasonic Sensor]

B. Testing of Motor Driver

To evaluate a motor driver using an Arduino Uno, we start by making the correct connections. The motor driver is connected to an external power supply to run the motor, while the Arduino provides control signals at 5V logic levels. We connect the motor driver's control pins IN1 and IN2 to digital pins 8 and 9 on the Arduino to control the motor's direction. For speed control, we connect the ENA pin to pin 10 on the Arduino, which sends a PWM signal. The motor is connected to the driver's output pins (OUT1 and OUT2). After uploading a simple program to the Arduino, we can change the motor's direction and speed by changing the signals sent to the driver. If the motor runs smoothly and responds correctly, the motor driver is working properly. It is shown in [Figure 4](#).



[Fig.4: Testing of Motor Driver]

C. Testing of ESP8266 (Blinking)

To make the ESP8266 blink, open the Arduino IDE, go to Tools, select the board as Generic ESP8266 module, then open File, Examples, Basics, and select blink. After that, connect the ESP8266 to the computer using a USB cable and then upload the program to your Arduino. Finally, press the

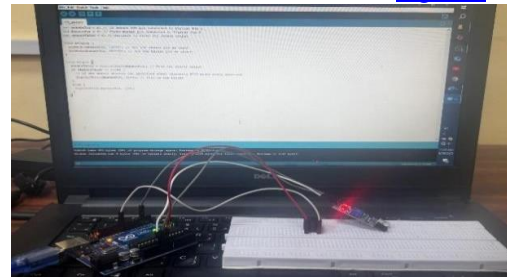
upload button in the Arduino program to see how far the obstacles are. It is shown in [Figure 5](#)



[Fig.5: Testing of ESP8266 (Blinking)]

D. Testing of the IR Sensor

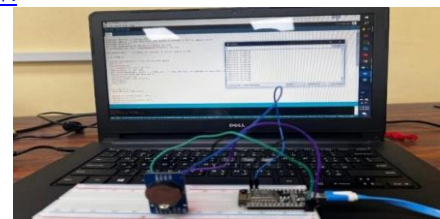
The IR sensor has three pins: OUT, VCC, and GND. As the sensor's VCC is connected to 5V on the Arduino, GND is connected to the Arduino's ground, and OUT is connected to an Arduino output pin, such as D2. After that, open the Arduino program on your computer, write the ultrasonic sensor program, connect the Arduino to the computer with a USB cable, and then upload the program to your Arduino. Finally, press the upload button in the Arduino program to see how far the obstacles are. It is shown in [Figure 6](#)



[Fig.6: Testing of the IR Sensor using Arduino Uno]

E. Testing of RTC

The RTC module includes four key pins: VCC, GND, SDA, and SCL. Here, the VCC pin of the RTC is connected to the ESP8266's 3.3V output, while the GND pin is connected to the ESP8266's ground. Also, the SDA and SCL pins should be connected to the I2C pins of the ESP8266, such as D2 and D1, respectively. After wiring is complete, the Arduino IDE is opened on the computer, and the RTC library and test code for reading the real-time clock values are written. Then the ESP8266 will be connected to the laptop using a USB cable, and the program will be uploaded onto the board. Finally, by clicking the upload button in Arduino IDE and opening the Serial Monitor, the current date and time readings from the RTC module can be observed. It is shown in [Figure 7](#).

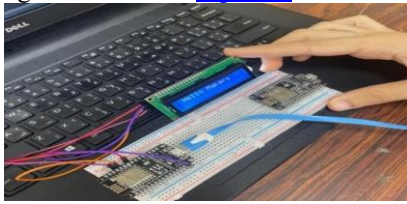


[Fig.7: Testing of RTC using ESP8266]



F. Testing of LCD

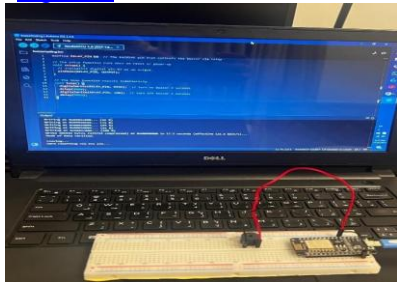
The LCD module (I2C) has four pins: VCC, GND, SDA, and SCL. The VCC pin on the LCD is connected to the 3.3V output on the ESP8266, and the GND pin is connected to the board's ground. The SDA and SCL pins are then connected to the I2C pins on the ESP8266, such as D2 (SDA) and D1 (SCL), to enable communication between the LCD and the microcontroller. Once all wiring is completed on the breadboard, the Arduino IDE is opened on the computer, and the correct LiquidCrystal_I2C library is installed. A simple test code for the LCD is written to put text across the screen. The ESP8266 is then plugged into the laptop using a USB cable, and the program is uploaded to the board. After the upload finishes, the LCD starts displaying the programmed message, indicating that it has successfully communicated and is working. It is shown in [Figure 8](#).



[Fig.8: Testing of LCD using ESP8266]

G. Testing of Buzzer

The buzzer module has two pins: VCC and GND. The VCC pin of the buzzer is connected to an I2C pin on the ESP8266, such as D2, while the GND pin is connected to the ESP8266's GND. This wiring allows the ESP8266 to send a HIGH or LOW signal to control the buzzer. Once the connections are made on the breadboard, the Arduino IDE is opened on the computer, and a simple test program is written to turn the buzzer on and off. After writing the test code, the ESP8266 is connected to the laptop with a USB cable, and the program is uploaded to the board. When the upload is complete, the buzzer begins to beep according to the programmed pattern. It is shown in [Figure 9](#).

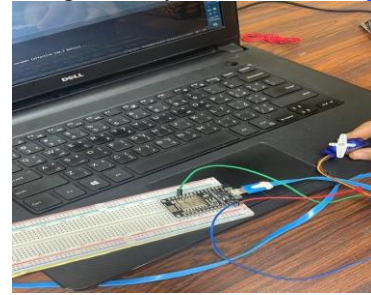


[Fig.9: Testing of Buzzer using ESP8266]

H. Testing of Servomotor

The servo motor has three wires: Brown, Red, and Orange. The Red wire connects to the ESP8266's 3V3 pin. The Brown wire connects to the GND pin of the ESP8266. The Orange wire connects to a digital pin on the ESP8266, such as D4, which allows the microcontroller to send control pulses to position the servo shaft. Once the wiring is complete, open the Arduino IDE on the computer and install the ESP8266Servo or Servo library. A simple test program is written to sweep the servo from 0° to 180° and back again. This code generates the required PWM control signals that tell the servo motor to rotate to specific angles. After the code

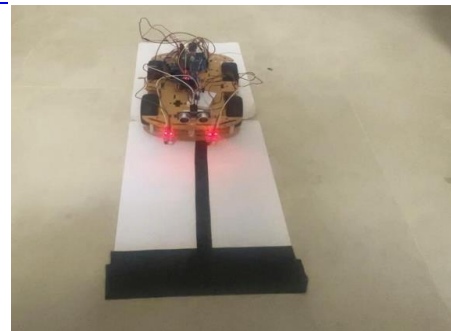
is prepared, the ESP8266 board is connected to the laptop using a USB cable, and the program is uploaded. When the upload finishes, the servo starts moving according to the programmed sequence, rotating smoothly between the set positions. This movement confirms that the ESP8266 is successfully communicating with the servo and that the servo motor is functioning correctly. It is shown in [Figure 10](#).



[Fig.10: Testing of Servomotor using ESP8266]

I. Testing of Robot Mechanism using Arduino Uno

In this testing we are connecting IR sensor left and right, Ultrasonic sensor, and motor driver to Arduino as is shown in circuit diagram the connection its same, now when the is white color Beneath both IR sensor the robot move forward, if left IR sensor sense black the robot move left to correct its path and if the right IR sensor sense black then the robot move right to correct its path and when both IR sensors sense black it stops. An ultrasonic sensor detects any obstacle in the path; if one is detected, the robot stops. The IR sensor and Ultrasonic sensor function as inputs to the Arduino, and the Motor Driver acts as an output; the robot's movement depends on both the IR and ultrasonic sensors. It is shown in [Figure 11](#).



[Fig.11: Testing of Robot Mechanism using Arduino Uno]

J. Testing of Medical Dispenser Mechanism using ESP8266

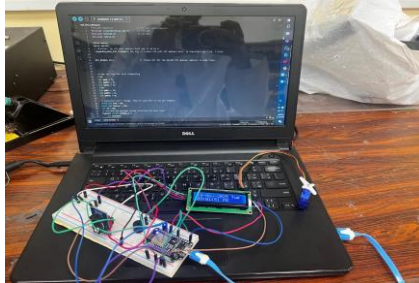
To test the RTC, LCD, buzzer, and servomotor together using the ESP8266, the components were first connected according to the circuit design. The RTC module was connected through the I2C pins (SDA and SCL) for real-time clock communication, while the LCD screen was also connected through I2C to display the current time and system messages. The servomotor was connected to a PWM pin on the ESP8266 to control its rotation angle, and the buzzer was connected to a digital pin to generate alerts during operation.

After completing the wiring, a combined test program was uploaded using the Arduino IDE. The goal of this test was to verify that the ESP8266 could read the correct time from the





RTC, display it properly on the LCD, activate the buzzer during the medicine time, and rotate the servo for medication dispensing. When the test was run, the LCD successfully displayed the time and status, the RTC kept accurate time, the buzzer produced an alert at the set schedule, and the servomotor rotated to release medication as intended. This confirmed that all four components worked together smoothly and responded correctly based on the programmed time settings. It is shown in [Figure 12](#).



[Fig.12: Testing of Medical Dispenser Mechanism using ESP8266]

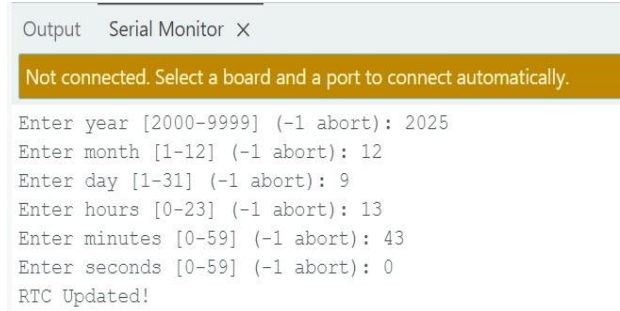
K. Testing of the Full Model

As shown in the circuit diagram, the connections of the two IR sensors, Ultrasonic Sensor, as well as Motor Driver L298N to Arduino UNO and RTC Module, LCD, Buzzer and Servomotor to ESP8266 boards, before the time of medicine the Line following robot is at rest and while the LCD show the time and date as the same time in our world and as the time and date can be change as per our requirement as well the time of medicine, Now when the time of medicine approaches the line following robot will move before the time of medicine to go to patient and stop when both IR sensors sense black the same time and as the robot move left and right also with the help of IR sensors, as the time is reached the robot is already at position near patient this if robot didn't encounter an obstacle while going to the patient, the servomotor rotates to drop the medicine as the buzzer make sound to alert the patient that the its time to take medicine as the LCD show in screen that AM/PM pills ready in short time. The Final Model is shown in [Figure 13](#).



[Fig.13: Testing of the Full Model]

As these steps are involved in setting the time and date using the Arduino IDE to display them on the LCD, go to the Serial Monitor, make sure the baud rate is 9600, then type u. It will ask to enter the year, then the month, then the day, then the minute, and lastly the second, as shown in [Figure 14](#).



[Fig.14: Typing Time and Date in the Serial Monitor]

While typing the time and date, the LCD Display (Edit Mode...) is shown in [Figure 15](#).

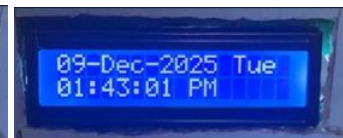


[Fig.15: Edit Mode in LCD]

After typing the time and date, the LCD (RTC Updated) shows the time, as in [Figure 16](#) and [Figure 17](#).

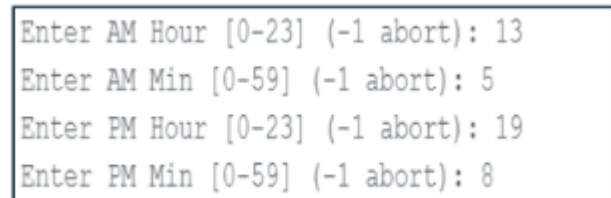


[Fig.16: RTC Updated]



[Fig.17: Updated Time and Time]

And to change the medicine's time, type p in the Serial Monitor. First enter the AM hour, then the minute, then the PM hour, and lastly the minute, as shown in [Figure 18](#).

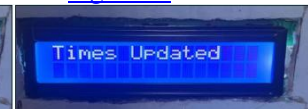


[Fig.18: Adjusting Medicine Time in Serial Monitor]

While entering the medicine times, the LCD (Set Pill Times) is shown in [Figure 19](#); then, after entering them, the LCD (Times Updated) is shown in [Figure 20](#)



[Fig.19: Adjusting Medicine Time in LCD]



[Fig. 20: Updated Medicine Time in LCD]

Now, as all programs are updated in ESP8266 and Arduino, at the time of medicine, it takes nearly 1 minute; the ESP8266 sends a signal to the line-following robot to start moving toward the patient, as shown in [Figure 21](#), and it displays its movement forward in the Serial Monitor, as shown in [Figure 22](#).



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```
Output Serial Monitor X
Message (Enter to send message to 'NodeMCU 1.0 (ESP-12E Mod
0
Enter AM Hour [0-23] (-1 abort): 13
Enter AM Min [0-59] (-1 abort): 36
Enter PM Hour [0-23] (-1 abort): 13
Enter PM Min [0-59] (-1 abort): 39
AM: 1 minute before - robot
AM Pills Ready
PM: 1 minute before - robot
PM Pills Ready
```

[Fig.21: Sending Signal to Arduino]

```
Output Serial Monitor X
Message (Enter to send message to 'Arduino Uno' on 'COM6')
ESP signal HIGH -> Robot starts moving continuously
Moving forward
Moving forward
Moving forward
Moving forward
Moving forward
Moving forward
Moving forward
Moving forward
Moving forward
Moving forward
Moving forward
```

[Fig.22: Arduino Received a Signal and Started Moving]

While turning left in [Figure 23](#) and while turning right in [Figure 24](#).

```
Output Serial Monitor X
Message (Enter to send message to 'Arduino Uno' on 'COM6')
Turning left
Turning left
Turning left
Turning left
Turning left
Turning left
Turning left
Turning left
Turning left
Turning left
```

[Fig.23: Robot Moving Left]

```
Output Serial Monitor X
Message (Enter to send message to 'Arduino Uno' on 'COM6')
Turning right
Turning right
Turning right
Turning right
Turning right
Turning right
Turning right
Turning right
Turning right
Turning right
Turning right
```

[Fig.24: Robot Moving Right]

The robot stops upon arriving at the patient and waits for the ESP signal to be removed (see [Figure 25](#)). Then the servomotor dispenses the medicine and alerts the patient with a buzzer.

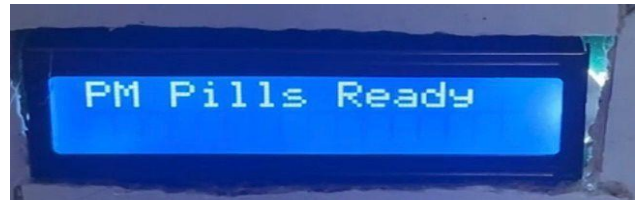
```
End of line -> Stop motors
End of line -> Stop motors
End of line -> Stop motors
End of line -> Stop motors
End of line -> Stop motors
End of line -> Stop motors
End of line -> Stop motors
End of line -> Stop motors
ESP signal LOW -> Robot stops
```

[Fig.25: Robot Stops and Signal Removed]

Then, the LCDs display (AM Pills Ready) for AM time to take medicine; otherwise, they display (PM Pill Ready) for PM time, as shown in [Figure 26](#) and [Figure 27](#).



[Fig.26: AM Pills Ready in LCD]



[Fig.27: PM Pills Ready in LCD]

V. CONCLUSION

The MediTrack system successfully achieves its goal of providing a reliable and automated solution for medication delivery and health management for elderly and visually impaired individuals. By integrating Arduino, NodeMCU, sensors, and cloud connectivity, the system ensures accurate navigation, timely medication dispensing, and continuous monitoring of essential health routines. The line-following robot demonstrated stable movement, effective obstacle detection, and successful pill delivery at scheduled times, while the cloud-enabled interface improved accessibility for both users and caregivers. Through extensive testing of components such as the IR sensors, ultrasonic sensors, RTC module, LCD, buzzer, servo motor, and motor driver, the final prototype proved to operate smoothly as a complete system. This project highlights how combining IoT and automation technologies can enhance independence, safety, and quality of life for vulnerable populations. Overall, MediTrack represents a practical and impactful step toward smart healthcare solutions that support both patients and caregivers.

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DECLARATION STATEMENT

As the article's author, I must verify the accuracy of the following information after aggregating input from all authors.





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- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author’s Contributions:** The authorship of this article is contributed equally to all participating individuals.

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