DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

Project Report

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Automated Medicine Dispenser Robot

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Automated Medicine Dispenser Robot

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***Abstract*—The increasing demand for efficient, accurate, and timely delivery of medications in healthcare facilities has necessitated the development of innovative solutions. The Automated Medicine Dispenser Robot (AMDR) is a pioneering device designed to address this need by automating the process of medicine dispensing and delivery. This robot integrates advanced technologies such as robotics, artificial intelligence, and IoT to ensure precision and reliability. Equipped with sensors and actuators, the AMDR can identify, sort, and dispense the required medications based on pre-programmed prescriptions, reducing human error and enhancing patient safety.**

The robot is designed with a user-friendly interface that enables healthcare professionals to input prescription details, while its IoT capabilities allow for real-time monitoring and timely medicine delivery. Its mobility features enable autonomous navigation within healthcare facilities or senior living facilities, ensuring prompt delivery of medicines to patients or specific departments.

This innovation has the potential to revolutionize healthcare by improving efficiency, reducing workload for medical staff, and minimizing errors in medicine administration. The abstract outlines the design, functionality, and prospective benefits of the Automated Medicine Dispenser Robot, highlighting its significance in advancing healthcare technology.

***Index Terms*—assistive technology, IOT in healthcare, automated medication management, medication error reduction**

I. Introduction

The healthcare sector faces continuous challenges in ensuring the accurate, timely, and safe distribution of medications to patients. In times of pandemic, the situation gets worse. Errors in medication dispensing and administration can lead to severe health consequences, while the increasing workload on healthcare providers has amplified the need for automation in medical processes. Addressing these issues, the Automated Medicine Dispenser Robot (AMDR) emerges as an innovative and assistive solution designed to enhance efficiency, reduce human error, and improve patient outcomes.

The AMDR leverages cutting-edge technologies, including robotics, artificial intelligence (AI), and Internet of Things (IoT) integration, to automate the dispensing and delivery of medications in any size, in any amount and in any environment. By streamlining the process, the robot reduces the reliance on manual interventions, offering precision and reliability in medication management. Its user-friendly interface enables healthcare professionals to input prescriptions with ease, while the robot autonomously detects the patients by scanning RFID tags, dispenses, and delivers the appropriate medications to patients or designated locations.

Furthermore, the system incorporates real-time monitoring and real-time updating ensuring an uninterrupted supply of medications while minimizing wastage and need for resetting the whole system upon changing medication dosage. The mobility feature of the robot allows it to navigate hospital wards, clinics, or old-age homes independently, fostering convenience and accessibility.

This introduction explores the purpose and scope of the Automated Medicine Dispenser Robot, emphasizing its potential to revolutionize healthcare systems by addressing key challenges in medication management and delivery.

II. Literature Review

In recent times, automated medicine dispensers integrated into robotic systems have gained significant attention. Particularly in hospital settings where the need for contactless medicine delivery has become critical. These systems are designed to replace or assist nurses in delivering medications, especially during pandemics like COVID-19. Also, delivering through automated systems reduces the chances of human error. These systems also reduce the burdens from the nurses and gare-givers. By integrating advanced technologies such as robotics, IoT, and automation, these dispensers provide precise and timely medication as well as help maintain minimal human interaction, thus reducing the risk of disease transmission. Robotic systems for healthcare have evolved from its early days when it could only do one thing. It can now serve several purposes, including delivering medicines, food, and medical supplies. During the COVID-19 pandemic, when human interaction became the medium of disease transmission, these systems proved invaluable. These systems could work in quarantine and isolation wards, where direct contact between nurses, care-givers and patients posed significant health risks. These robots are equipped with features such as path-follower, obstacle avoiding navigation, and conveyor systems for accurate delivery. For example, robotic carts can autonomously navigate hospital corridors to deliver medications to patients. It also reduced the workload on medical staff and ensured social distancing protocols during pandemic. [1][2]. The functionality of these systems got enhanced by telemedicine and IoT integration. These enabled remote monitoring and control. Doctors can access a patient's medical history and prescribe medications via connected devices, which are directly linked to the automated dispensers. This approach not only ensures real-time delivery of medicines but also facilitates continuous monitoring of patient health metrics. So the overall quality of care is increased. [3][4]. Also critical situations are addressed through emergency features, which are very thoughtful design features of these systems. Patients can use bed-side interfaces or mobile applications to alert medical staff in emergencies. The robotic dispensers are equipped with obstacle avoidance sensors, so it can navigate crowded environments and deliver the required medicines or supplies very fast with good accuracy. Their ability to function autonomously without human intervention makes them ideal for handling viral outbreaks or situations requiring strict isolation. [2][5] One of the key advantages of robotic medicine dispensers in hospitals is their scalability. These systems can handle a large number of patients simultaneously. During the healthcare crisis these systems become very helpful. They also minimize the risk of errors in medication delivery by automating the process. It ensures that patients receive the correct medication at the right time. Additionally, the inclusion of contactless operations aligns perfectly with the need for infection control in hospital environments. [4][6] In conclusion, automated medicine dispenser robots are examples of a transforming healthcare system. It becomes more vital when scenarios requiring reduced human contact arise. Precise, efficient, and scalable operations are ensured by their integration with telemedicine and IoT. It can address both routine and emergency medical needs. As these systems continue to evolve, they are expected to play a very important role in reshaping hospital workflows and improving patient outcomes during pandemics and beyond.

III. Methodology

The Automated Medicine Dispenser Robot employs a multifaceted approach combining robotics, electronics, and data integration:

A. Navigation System:

The system utilizes pre-mapped routes for moving within hospital environments or old-age homes. Ultrasonic sensors are employed for real-time obstacle detection and avoidance, ensuring smooth and safe navigation. Pre-mapping the route is sufficient for our purpose. Since the target objects,i.e., the patient beds are static objects and with zero mobility, we do not need dynamic mapping of the routes. So, we do not need very sophisticated and computationally expensive algorithms for our purpose. Moreover, as the patient ID detection is done by the RFID reader system, the requirement of uniquely identifying each bed becomes void.

B. Patient Identification:

RFID tags attached to patient beds are used for accurate identification. These tags store unique patient information linked to the local server, allowing precise delivery to the intended recipient.

C. Medicine Dispensing Mechanism:

A rotary and slide dispensing mechanism ensures the correct medicine and dose are delivered. The mechanism is programmed to align with the local server's instructions on dosage and timing.

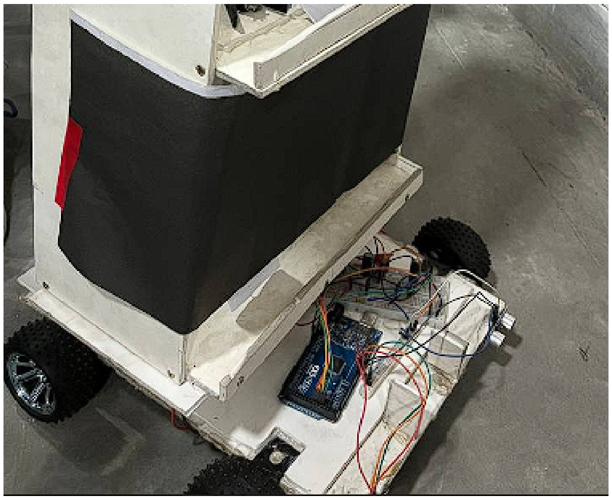

Fig. 1. Circuit for Navigation and Movement

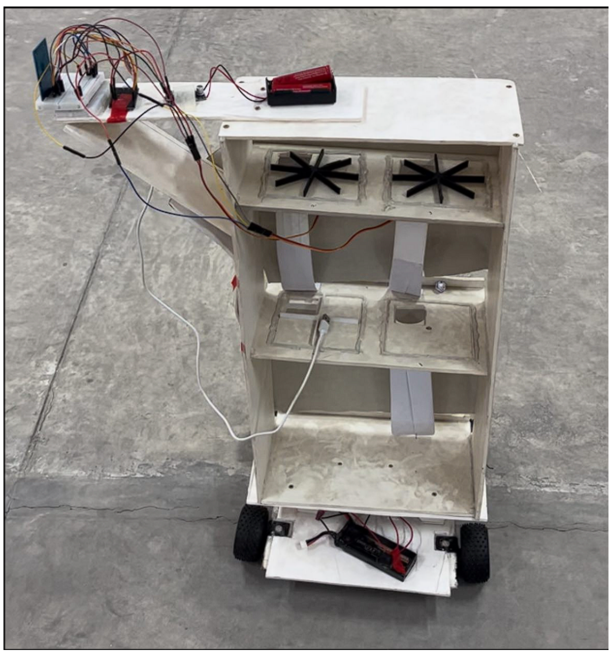

Fig. 2. The Whole Setup of Automated Medicine Dispenser Bot

D. Centralized Information Retrieval:

A local server stores and manages patient-specific data, including medicine type, dosage, and routine. The local server is basically a desktop computer connected to a local network which contains the patient-data. This computer also serves as a controlling station of the dispenser robot. The patient-data is stored in a spreadsheet file. This file is accessed by the micro-controller via the local network. That is, the micro-controller and the desktop computer must be connected to the same network. The dispenser retrieves this data dynamically during operation, ensuring up-to-date delivery.

E. Hardware Components:

Core hardware includes servo motors for movement, ESP32 for data retrieval from the local server, an Arduino Mega for central processing, RFID sensors for identification, and a 2200 mAh LiPo battery for power. These components are housed in a PVC structure for durability and portability.

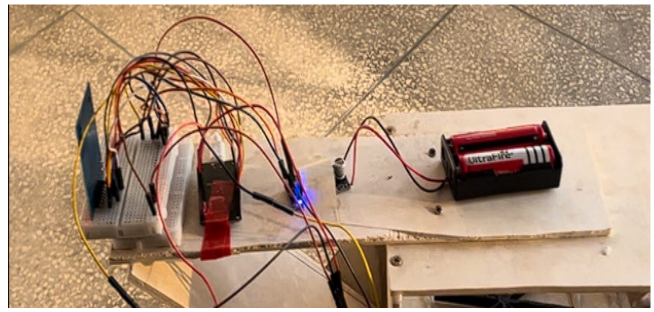

Fig. 3. RFID Card Detection Circuit

F. User Interface:

A simple and intuitive interface allows hospital staff to program and operate the system without extensive training. The interface includes options for updating medicine schedules and monitoring dispensing activities just like the figure 4.

Bed No	RFID No.	Medicine-1	Medicine-2	Medicine-3	Medicine-4
1	9C0B82E7	1	0	1	1
2	5C7E92A1	1	1	0	0
3	A4D2F9B7	0	1	1	1

Fig. 4. User Interface Storing Patient Information

This methodology ensures a comprehensive and efficient system for automating medicine delivery.

algorithm algorithmic

IV. Algorithm for Robot Movement

Robot Movement Sequence

Initialize:
Set motor pins for forward and backward directions.
Define motor control functions: `moveForward()`, `turnLeft()`, `stopMotors()`.
Set motor speed: `motorSpeed = 40`.

Setup:
Configure motor pins as output.
Start serial communication.

```
Main Steps in Loop:
Move forward for 10 seconds using moveForward().
Stop for 6 seconds using stopMotors().
Move forward for 10 seconds using moveForward().
Stop for 6 seconds using stopMotors().
Move forward for 6 seconds using moveForward().
Turn left for 10 seconds using turnLeft().
Move forward for 5 seconds using moveForward().
Stop motors using stopMotors() and halt execution indefinitely.

Execution:
The sequence runs as many times as it is programmed, stopping the robot permanently after completion.
```

V. Algorithm for RFID-Based Medicine Dispensing System

Medicine Dispensing System Using RFID and WiFi

```
START
Initialize serial communication at 115200 baud rate.
Initialize SPI and RFID modules.
Attach servos to pins 12, 14, 25, and 26 (set to 0 degrees).
Connect to WiFi (retry until connected).
PRINT "Connected to WiFi".
LOOP:
if new RFID card detected then
  Read and convert UID to HEX.
  PRINT "RFID UID: " + UID.
  if WiFi connected then
    Send GET request to server.
    if response received then
      Parse JSON response.
      if UID match found then
        PRINT "Match found!".
        for each medicine (1 to 4) do
          if medicine == 1 then
            Rotate servo to 45/90 degrees.
            PRINT "Dispensing".
            WAIT 1 second.
            Reset servo (if needed).
          else
            PRINT "No action".
          end if
          WAIT 2 seconds.
        end for
      else
        PRINT "No match found".
      end if
    else
      PRINT "Request failed or server offline".
    end if
  else
    PRINT "WiFi Disconnected. Reconnecting...".
  end if
else
  WAIT 1 second.
end if
END LOOP
```

VI. Cost Analysis

The cost analysis of the Automated Medicine Dispenser Robot is summarized in Table I. The device is designed using cost-effective components, ensuring affordability while maintaining functionality.

TABLE I
COST ANALYSIS OF THE AUTOMATED MEDICINE DISPENSER ROBOT

Component	**Quantity**	**Unit Cost (BDT)**	**Total Cost (BDT)**
Servo Motors	4	170	680
ESP32 (32 pins)	1	500	500
Arduino Mega	1	2000	2000
2200 mAh LiPo Battery	1	2500	2500
RFID Card	3	40	120
RFID Reader	1	200	200
Structure Material (PVC Sheet)	1	200	200
Total	–	–	**6040**

The use of modular components allows for cost-effective maintenance and upgrades, further enhancing the affordability of the system.

VII. Limitations and Future Works

A. Limitations

- Mechanical vulnerabilities, such as potential cable tears and wire disconnections, may interrupt operation.
- RFID sensors have a limited range, which may affect accurate patient identification in large facilities.
- Static pre-mapped navigation restricts adaptability to dynamic environments with frequent changes.
- The server for patient -medicine information and the microcontroller has to be under same network in order to function properly.

B. Future Works

- Designing a more compact and robust system to minimize mechanical failures.
- Enhancing RFID sensor technology to improve detection range and accuracy. Any other method can be used for patient detection such as- bar code scanning, patient face recognition using image processing, etc. to alleviate range related limitations.
- Implementing AI-driven dynamic mapping for better adaptability to changing surroundings.
- Introducing advanced security protocols for server communication to safeguard sensitive patient information.
- Exploring long-lasting battery solutions for uninterrupted operation.

VIII. Conclusion

The Automated Medicine Dispenser introduces a practical and innovative solution for automating medicine delivery in healthcare environments in both normal or pandemic situations . By reducing human interaction, it minimizes the risk of disease transmission and enhances operational efficiency. Its scalable and modular design makes it adaptable to diverse settings. While certain limitations, such as sensor range and static navigation, exist, proposed improvements aim to address these challenges. This project demonstrates the potential of robotics and automation in healthcare, paving the way for smarter and more efficient medical systems.

IX.

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