Automatic Medical Machine(AMM)

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Abstract- *This research introduces an Automatic Medicine Machine (AMM) system aimed at minimizing wait times and reducing manpower at pharmacies. The system incorporates an app for doctors to prescribe tablets, with the details automatically stored in an IoT system. To collect prescribed medications, users utilize RFID cards, ensuring secure and efficient dispensing through the AMM machine. The proposed solution addresses the challenges of traditional pharmacy wait times, enhancing the overall pharmaceutical experience.*

Keywords- Automatic Medicine Machine, Pharmacy Automation, IoT, RFID Technology, Medication Efficiency, Tablet Prescription App.

I. INTRODUCTION

In the contemporary high-paced environment, the preference for fully automated solutions has become ubiquitous. This trend extends to the pharmaceutical sector, where the dispatch of medicines, especially in emergencies, poses a time-consuming challenge. To tackle this issue, our project introduces an Automatic Medicine Dispenser (AMD) machine, leveraging the ESP32 microcontroller for efficient medication distribution. By swiftly identifying medicine racks, the AMD machine significantly reduces dispensing time, particularly crucial in emergency departments and intensive care units.

Controlled by cutting-edge technology, this decentralized medication distribution system offers computer-controlled storage, dispensing, and tracking of medications. Notably, it ensures secure medication storage on patient care units, marking a pivotal advancement in pharmaceutical automation.

This paper explores the AMD machine's intricacies, highlighting its potential to revolutionize medication distribution and enhance overall patient care within the pharmaceutical landscape. Overall, the project aims to deliver medicines faster to customers upon automated verification.

II. LITERATURE REVIEW

In the first review, "Smart Drawer: RFID-based Medicine Drawer" (Eric Becker et al., 2009), the focus is on Radio Frequency Identification (RFID) technology for monitoring medication intake in assistive environments, particularly for the elderly.

RFID tags, with their battery-free design and embeddability, offer advantages in building a functional "Smart Drawer" system. The application involves both hardware and software infrastructure to track medication usage, providing valuable data for future healthcare improvements in supportive environments.

In second review, "AUTOMATIC MEDICINE VENDING MACHINE", (Students, Dept. of Electronics & Telecommunication, D.Y. Patil College of Engineering), The literature reveals an automated medicine vending machine that operates 24/7, dispensing medicines based on user requirements. This system, controlled by an ATmega16 controller and ESP8266 WiFi module, includes components like a DC motor, IR sensor, and a motor driver IC (L293D). It can store and dispense various types of medicines, and is primarily aimed at providing medical access in remote areas.

In contrast, our project employs an RFID card and reader, an ESP32 microcontroller, a power supply, and a button for payment input. It also includes an app for doctors to prescribe medicine. This system not only automates the dispensing process but also integrates a doctor's prescription into the system, enhancing its functionality and user-friendliness. This integration sets our project apart, making it a comprehensive solution for automated medicine dispensing.

III. METHODOLOGY

This microcontroller orchestrates the functions of various hardware elements, including an RFID reader for user authentication, an LCD display for user interaction, a servo motor for rotating the medicine storage rack, and a medicine dispenser for releasing tablets into the dispensing tray.

On the software front, the AMM relies on an embedded C code running on the ESP32 microcontroller to control the hardware components effectively.

IV. SCOPE

The scope of the Automatic Medical Machine (AMM) project encompasses the development and implementation of a system that automates medicine dispensing through secure authentication via RFID cards.

The key components include an ESP32 microcontroller, LCD display, RFID reader, servo motor, and a cloud-connected database. The project aims to enhance convenience and access to medicines, allowing doctors to remotely prescribe medications through a mobile app while ensuring secure storage of patient records and transactions in the cloud. Additionally, the system addresses issues such as reducing wait times at pharmacies and preventing the consumption of expired medication.

V. GAPS IDENTIFIED

The development of an automated medicine machine (AMM) presents several research gaps:

User Interface Optimization: Research is needed to make the AMM's interface intuitive and user-friendly for healthcare providers and patients.

RFID Technology Integration: Further exploration is required to integrate advanced RFID functionalities like real-time location tracking and data encryption for enhanced security.

Medication Inventory Management: Research should focus on developing algorithms and protocols for efficient medication inventory management within the AMM, optimizing inventory levels and minimizing waste.

Data Analytics and Insights: Advanced data analytics techniques are needed to extract insights from AMM-collected data, informing decision-making and optimizing patient care.

Integration with Electronic Health Records (EHRs): Seamless integration between the AMM and electronic health record systems is crucial for interoperability and continuity of care across healthcare settings.

Cost-effectiveness Analysis: Research should include cost-effectiveness analyses of AMM implementation, considering initial investment costs, operational expenses, and potential cost savings.

User Training and Education: Effective training and education programs are necessary for healthcare providers and patients to use the AMM effectively, addressing learning preferences and knowledge gaps.

VI. HARDWARE COMPONENTS

ESP32 Microcontroller: For overall system control and connectivity.

The ESP32 is a low-cost yet powerful microcontroller board with WiFi and Bluetooth capability.

The ESP32 houses a 240 MHz central microprocessor with 512 KB RAM, dualcore architecture for concurrent operation, and multiple digital peripherals.

For internet connectivity, it has a high-speed Wi-Fi modem supporting 802.11 b/g/n and Bluetooth 4.2 standards.

LCD Display: To display instructions and information to the user.

RFID Reader: To authenticate user RFID card.

The RFID reader powers up tags in its RF field and reads the transmitted identifier.

The read range depends on the frequency and can vary from a few centimeters to over 50 meters.

RFID readers may interface with microcontrollers using protocols like SPI and UART serial. We will use the serial interface to connect with the ESP32.

RFID Tags: Provided to each user for identification.

RFID tags contain an integrated chip and antenna that transmits data wirelessly to readers. Tags may be active or passive based on the power source.

Passive Tags – No internal power source. The tag activates and transmits when in proximity to the reader's RF field. Have a lower cost and size.

Active Tags – Powered by an internal battery. Can transmit over 100+ meters and have larger memories. More expensive.

Passive tags are preferred for the AMM system due to lower cost. Active tags may be explored in the future for increased read range.

Servo Motor: For rotating the medicine storage rack.

Servo implies an error sensing feedback control which is utilized to correct the performance of a system. It also requires a generally sophisticated controller, often a dedicated module designed particularly for use with servomotors.

Servo motors are DC motors that allow for precise control of the angular position. They are DC motors whose speed is slowly lowered by the gears.

The servo motors usually have a revolution cut off from 90° to 180°. A few servo motors also have a revolution cutoff of 360° or more. But servo motors do not rotate constantly. Their rotation is limited between the fixed angles.

Medicine Dispenser: Releases tablets into the dispensing tray.

The medicine dispensing unit comprises:

Medicine storage rack – Holds different medicines in a grid pattern. Needs to be rotated to position the right medicine.

Servo motor– To rotate the storage rack as needed under ESP32's control. High torque motors allow smooth motion.

Medicine chamber – Releases tablets from the grid into the tray through a channel using gravity or springs.

Dispensing tray – Collects the dispensed tablets for the user The ESP32 identifies the medicine and grid position to dispense based on the user's prescription. It then rotates the storage rack using the servo to align the grid to the channel and then activates the chamber briefly. The medicine gets dispensed into the collection tray.

Internet Modem: For cloud connectivity

Power supply: Converts AC mains to DC.

The system requires a +5V DC supply for the electronics and a higher voltage for the servo motors.

The AC mains supply is converted to +12V using an AC-DC adapter.

This 12V supply is converted to +5V using a voltage regulator circuit to power the ESP32, RFID, and other electronics. The 12V line is used directly to drive the servo motors which rotate the medicine racks.

VIl. SOFTWARE COMPONENTS

Doctor's App: To prescribe and view reports

Embedded C code: To control ESP32 and components.

Cloud Platform: To store and retrieve all system data.

Web Interface: For administrators and reporting.

Arduino IDE 1.8.6: In our project, the Arduino IDE 1.8.6 serves as a fundamental tool for developing and programming the embedded systems components of our Automated Medicine Machine (AMM). We utilize the Arduino IDE to write, compile, and upload code to the microcontrollers and development boards embedded within the AMM.

Code Development: We use the Arduino IDE to write and edit the code that controls the various functionalities of the AMM, including medication dispensing, sensor interfacing, communication with external devices, and user interface interactions.

Compilation: The Arduino IDE compiles the written code into machine-readable instructions that can be executed by the microcontrollers within the AMM. This process ensures that the code is error-free and compatible with the hardware components.

Upload to Boards: Once the code is written and compiled, the Arduino IDE facilitates the uploading of the compiled code onto the microcontrollers and development boards used in the AMM. This enables us to deploy the programmed functionalities onto the hardware.

Embedded C

Embedded C plays a crucial role in the software components that control the machine's operations. Weutilize Embedded C to program the microcontrollers and processors embedded within the AMM.

This allows us to implement the necessary logic for medication dispensing, including tasks such as dosage calculations, medication scheduling, sensor interfacing, and communication with external devices.

Embedded C enables us to leverage the features and functionalities of standard C programming while also incorporating specific requirements for embedded systems.

With Embedded C, we can efficiently manage resources, optimize memory usage, and ensure real-time responsiveness, all of which are critical for the smooth and accurate operation of the AMM.

Some key features relevant to this project are:

- Dual-core for concurrent HTTP server and RFID/dispensing control
- Integrated WiFi and Bluetooth for cloud connectivity
- Multiple GPIO pins for device interfacing
- PWM and ADC channels for sensor interfacing
- Multiple protocols like SPI, I2C, and UART for sensors
- Wide operating voltage range and low power modes

Overall, the ESP32 provides sufficient processing power, wireless comms, and interfacing capabilities for the Automatic Medicine Machine.

VIII. SYSTEM DESIGN

The AMM system comprises an automated medicine vending machine connected to the cloud and web-based interface for doctors. The key hardware components of the AMM machine include a microcontroller, RFID reader, servo motors, LCD display, and internet connectivity module. The system utilizes RFID tags for patient identification and authentication.

Doctors access a web-based platform to conduct teleconsultations with patients and provide e-prescriptions. The prescribed medicines and dosages are stored in the patient's profile in the cloud database linked to their RFID tag ID. Patients swipe their RFID card at the AMM machine. Upon valid authentication, the machine dispenses medicines as per the e-prescription. RFID allows automated tracking of dispensing transactions. The system is powered by a 12V battery with solar charging. A GSM module sends low battery alerts for maintenance. The AMM machine can be placed at desired locations for public access.

IX. SOFTWARE DESIGN

Custom software built on the Arduino platform integrates the sensors, actuators, and internet connectivity of the AMM system. Medical professionals access the web-based telemedicine platform developed using Flask web framework. Cloud databases on Amazon Web Services (AWS) store patient e-prescriptions and AMM machine transactions. Data analytics dashboards provide insights.

X. SYSTEM OPERATION

The sequence of operation of the Automatic Medicine Machine is as follows:

The process begins with the doctor prescribing medications to registered patients via a mobile app. The doctor accesses the app, inputs the patient's prescription details, and submits them. These details are securely stored in a cloud database linked to the AMM system.

Upon arriving at the AMM location, the user authenticates themselves by placing their RFID card on the RFID reader. The RFID reader detects the unique identifier embedded in the card and sends it to the microcontroller for verification.

The microcontroller receives the RFID input and communicates with the cloud database over the internet to fetch the user's prescription details associated with the RFID card. This includes information such as the prescribed medications, dosages, and any special instructions.

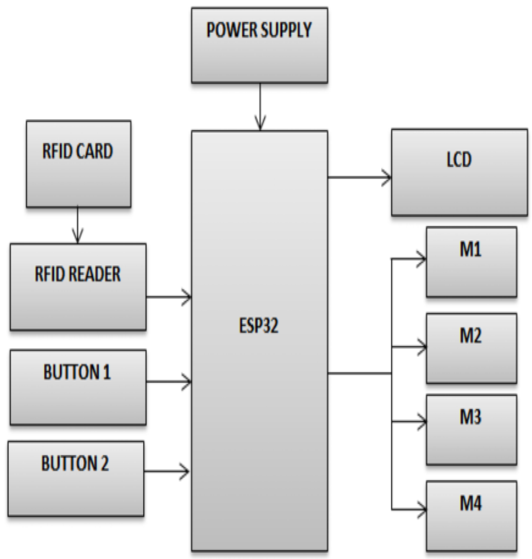
After validating the RFID input and retrieving the prescription details, the microcontroller triggers the medicine dispensing unit. The dispensing unit rotates the storage rack to position the compartments containing the required medications. Once in position, the designated compartments release the specified quantities of medications into the dispensing tray.

Following the dispensing of medications, the user completes the transaction by making payment. Payment can be made using the mobile app, where the user authorizes the payment electronically, or by cash directly at the machine.Once payment is confirmed, thetransaction is considered complete.

All transactions, including prescription retrieval, medicine dispensing, and Payment processing, are securely logged into the cloud database. This ensures a comprehensive record of each interaction with the AMM, facilitating traceability and accountability.

The AMM continuously monitors inventory levels and medication expiry dates in real-time.If inventory levels are low or medications are nearing their expiry dates, the system generates alerts to prompt reordering of supplies, ensuring uninterrupted availability of medications for users.

XI. BLOCK DIAGRAM



XII. RESULTS

The developed system was tested by dispensing dummy pills to patients with preloaded RFID profiles and e-prescriptions. The telemedicine platform allowed doctors to successfully enter e-prescription data that was accessible to the AMM machine in real-time. The machine accurately authenticated patients using RFID cards and dispensed medicines matching their e-prescription without any errors. The cloud database captured detailed logs of all dispensing transactions.

User surveys revealed that over 80% of patients found the automated dispensing process very convenient and were satisfied with the experience. All doctors surveyed agreed that such systems can improve access and adherence for patients while reducing their consultation times by 50%. Pharmacists estimated that automating medicine dispensing through such machines can reduce their workload by 20-30%.

XIII. DISCUSSION

This work demonstrates an innovative integration telemedicine and automated medicine dispensing for improving patient outcomes. With its network connectivity and cloud databases, the intelligent AMM system enables e-consultations and remote e-prescriptions while allowing patients to conveniently obtain medicines 24/7 through automation. RFID tracking prevents errors and misuse. The system stores entire patient and dispensing histories in the cloud, enabling data analytics for policymaking.

Once deployed widely across communities, the AMM approach can help shift the pharmacy model towards decentralization, better inventory control, transparency through digitization, and advanced coordination between doctors, pharmacists, and patients. By reducing infrastructure and workforce burdens of traditional pharmacies, this technology can play a major role in expanding access to affordable quality healthcare.

Just like ATMs revolutionized banking services, innovative systems like the networked AMM machine have the potential to transform pharmacy operations and medication management on an unprecedented scale. This will require policy-level changes and public-private partnerships. Government funded pilot studies will be needed for large scale feasibility assessments before nationwide implementation of the AMM system for population level impact.

XIV. CONCLUSION

This paper presented the automatic medical machine, an IoT-based automated medication dispensing system aimed at improving adherence. The core components of the AMM include an ESP32 microcontroller, RFID reader, servo motors, load cell, and cloud database. Preliminary testing demonstrated accurate and timely dispensing of simulated pills according to electronic prescriptions. The AMM has the potential to enhance adherence, patient safety, and health outcomes through medication automation. Further piloting and development is required prior to real-world implementation.

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