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Advancements in IoT-enabled Medicine Dispensers

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***Abstract*— This project presents a groundbreaking automated medication dispensing system seamlessly integrated with IoT technology, featuring a sophisticated alert system. The core architecture relies on cutting-edge components, notably the ESP32 microcontroller, RTC module, servo and stepper motors, LCD display, manual switch, LDR (Light Dependent Resistor), and the Blynk app. The ESP32 microcontroller serves as the central nervous system, orchestrating the entire dispensing process. Time accuracy is ensured through the RTC module, which plays a pivotal role in precise medication administration. The servo motor, responsible for opening and closing the medication compartment, harmonizes with the stepper motor, meticulously positioning the carousel to dispense the correct medication dosage. Real-time information, including scheduled medication details, is elegantly displayed on the LCD screen. A manual switch offers flexibility for on-demand medication retrieval, while the LDR provides an added layer of security by detecting medication presence. Notably, the Blynk app acts as a crucial communication bridge, sending timely notifications to caregivers in the event of missed doses, thereby establishing an intelligent and responsive medication management ecosystem. This innovative dispensing system holds significant promise in revolutionizing medication adherence and caregiver involvement, contributing to improved healthcare outcomes.**

***Keywords* --** IoT, environmental monitoring, Esp32 Module, RTC Module, IR Sensor, LCD Display, Blynk app, Embedded C, Cloud.

I. INTRODUCTION

The automatic medication dispenser, driven by the core principles of the Internet of Things (IoT), represents a significant advancement in healthcare technology. Its primary function is to autonomously administer prescribed medications to patients, adhering to predefined schedules and ensuring the accuracy of dosages. This innovative system introduces a level of flexibility that accommodates various types of medications, thereby catering to diverse medical needs. An intrinsic feature of this dispenser is its capability to alert caregivers in the event of patients deviating from their prescribed medication schedules, thereby enhancing patient care and safety. At the heart of this cutting-edge system lies the ESP32 microcontroller, renowned for its affordability and versatility, making it an ideal choice for applications in the IoT realm. The integration of an RTC (Real-Time Clock) module plays a crucial role in maintaining precise timekeeping, serving as the temporal backbone for coordinating the dispensing of medications. The servo motor, a pivotal component in this automated setup, ensures the seamless opening and closing of the medication storage compartment, contributing to the overall efficiency of the dispensing process. Further enhancing the precision of medication delivery is the incorporation of a stepper motor. This motor's role is to meticulously rotate a carousel, aligning the correct medication for dispensing. The LCD display interface adds a layer of real-time information, providing patients with details regarding their prescribed medications and dosages. A manual switch feature offers patients the autonomy to retrieve medication manually when necessary, thus catering to individual preferences and needs. The dispenser's intelligence extends to the use of a Light Dependent Resistor (LDR), designed to detect the presence of medication. This additional layer of security ensures that the system is not only efficient in medication dispensing but also vigilant in tracking whether the patient has retrieved the medication. In instances where adherence to medication schedules is compromised, the system leverages the Blynk app to generate alerts, promptly notifying caregivers. This interconnected approach promotes a comprehensive and responsive healthcare ecosystem, where caregivers can intervene when necessary, reinforcing patient compliance and overall well-being. The subsequent sections of this review will delve deeper into the technical intricacies, benefits, and potential challenges associated with this state-of-the-art automatic medication dispenser.

II. LITERATURE REVIEW

Automatic Hand Sanitizer Dispenser with Temperature Sensor and Heartbeat Measuring System (June 2021)

Authors - Dr.S. Prasad Jones Christydass, Dr.MLSNS .Lakshmi, Dr.V.Nishok

This study, authored by Dr.S. Prasad Jones Christydass, Dr. MLSNS. Lakshmi, Dr. V. Nishok, Dr. S. Suresh Kumar, and Mr. V. Jaikumar, focuses on the development of an affordable automatic hand sanitizer dispenser. Typically, infrared sensors are used in such devices to detect the presence of a hand. However, in this project, human intervention is not required. The infrared (IR) sensor identifies proximity and sends a signal to the microcontroller.

A Review on Dispenser Mechanisms of Medicine Dispenser (March 2021)

Authors - Asst. Prof. Sowmya Kini, Sagar S Acharya, Shreeraj Hegde, Ashwitha

In this research paper authored by Asst. Prof. Sowmya Kini, Sagar S Acharya, Shreeraj Hegde, and Ashwitha Sathish Kumar, the challenges of caring for the elderly, especially in nuclear families, are discussed. Medication adherence is a significant concern for seniors who often struggle to remember and manage their medications. Automatic medicine dispensers are explored as a promising solution, ensuring timely medication dispensing and caregiver notifications. These dispensers come in various designs and incorporate IoT functionalities, yet one crucial aspect is the dispenser's design, especially considering the diverse shapes and sizes of medicines. This paper offers a comprehensive review of the mechanisms and designs of automatic medicine dispensers.

Automatic Medicine Dispenser using IoT (August 2020)

Authors - Jyothis Philip, Feba Mary Abraham, Ken Kurian Giboy, B J Feslina

Authored by Jyothis Philip, Feba Mary Abraham, Ken Kurian Giboy, B J Feslina, and Teena Rajan, this paper addresses the challenges faced by the elderly in taking medications on time. The elderly often forget to take their medications and may struggle to recall whether they've taken them, potentially leading to overdoses and serious health complications. Despite the availability of expensive medicine dispensers in the market, many elderly individuals remain unaware of these products and continue to rely on traditional storage methods. This paper aims to address the limitations of existing dispensers and explores the use of IoT technology to provide a more accessible and effective solution for medication management.

Automated Medicine Dispenser in Pharmacy (August 2019)

Authors - Dr. Sivakumar Sabapathy Arumugam, Priyanka Dhanapal, Nandhini Shanmugam, Indumathi Balasubramaniam

In this paper authored by Dr. Sivakumar Sabapathy Arumugam, Priyanka Dhanapal, Nandhini Shanmugam, Indumathi Balasubramaniam, and Pavithra Vijayakumar, a project is presented that aims to reduce waiting times in traditional pharmacies. The project focuses on delivering medicines to customers efficiently and quickly, minimizing the need for manual assistance. Embedded systems and PROTEUS software are employed for the system's implementation, and the paper provides a detailed explanation of the dispenser machine's operation.

IoT-based Automated Medicine Dispenser for Online Health Community using Cloud (February 2019)

Authors - Suganya G, Premalatha M, Anushka Sharma, Muktak Pandya, Abhishek Joshi

In this study authored by Suganya G, Premalatha M, Anushka Sharma, Muktak Pandya, and Abhishek Joshi, an IoT-based automated medicine dispenser system is introduced. The system caters to the needs of online health communities by leveraging cloud technology to enhance medication management. It addresses the challenges faced by individuals in managing their medications, particularly in the context of online health communities. This innovative approach seeks to provide a more efficient and connected solution for medication adherence.

III. METHODOLOGY

This prototype's methodology include Esp32 Module, Blynk app, RTC Module, IR sensor, servo motors, Buzzer, LCD Display. The ESP32 microcontroller is used as the central processing unit, An IR sensor for cup detection, Servo motors for controlled medicine dispensing, Blynk app for user interface and remote control. The Buzzer can be utilised to make an alert system or to deliver an error warning in case there is any. The LCD Display helps to give informative output as well as provides a visual interface for the users.

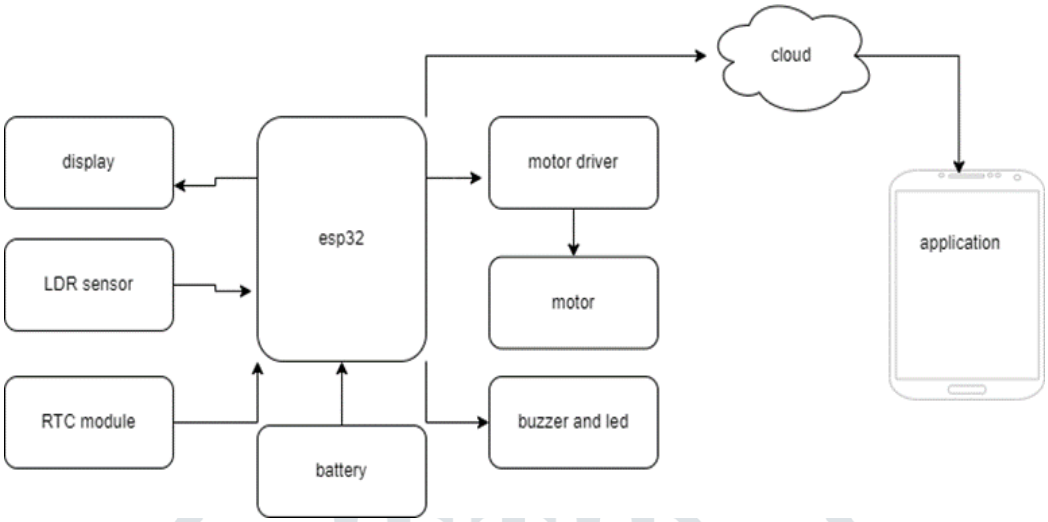

fig 1. component diagram

Esp32 Module: The ESP32 microcontroller which utilises the Arduino core, comes with integrated WiFi and Bluetooth modules, making it a preferred choice for interfacing with Firebase to retrieve data. Its WiFi capabilities, supported by dedicated libraries, simplify the connection to the cloud, especially when interfacing with an Android application via the Blynk app. For the specific task of tablet dispensing at user-specified intervals, the ESP32 integrates seamlessly with the Blynk app. Through this application, users can conveniently set the desired dispensing times, establishing a synchronized system between the ESP32 microcontroller and the NTC clock server for precise tablet dispensing.

Blynk App: The Blynk app is designed for remote control and monitoring of IoT devices, offering a user-friendly interface for creating customizable dashboards. Blynk app is all about easily managing your IoT gadgets from a distance. It gives you a friendly space to set up custom dashboards for monitoring and controlling your devices, like seeing live sensor data and getting notifications.

IR Sensor: The IR sensor, also known as an infrared sensor, is a gadget that detects infrared radiation. It's widely used in various applications, such as object detection an sensing proximity. These sensors can trigger a specific action or a set of actions by detecting the change in infrared radiations. IR Sensor is widely used in our daily life some of the applications include automatic doors, TV remotes, security systems, etc. They are also highly reliable and adaptable in detecting heat signatures making them a fundamental component in many electronic devices.

RTC Module: RTC or Real-time clock is a hardware component which helps keep track of current time and date in various electronic devices like computers, microcontrollers, Iot devices, etc. It can be utilised to accurately schedule tasks and log event in order to ensure synchronised operations.

LCD Display: An LCD (Liquid Crystal Display) is commonly used in electronic devices to provide a visual interface in order to provide information like text, number or graphics. It is a type of visual display technology that generates images by modulating light using liquid crystals.

fig 2. IR Sensor

fig 3. Esp32 Module

fig 4. RTC Module

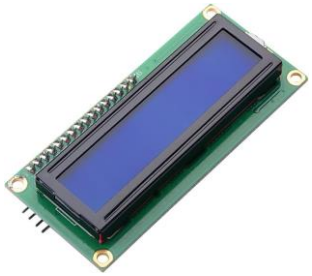

fig 5. LCD Display

The complete system is enclosed in a rigid cover that prevents any damage that might affect the performance of the system. The user has to install Blynk application on their devices. After installation the user is required to register first. For every user registration, a new database is created. The user can receive notifications about whether pill has been taken or not. Integration with the Blynk app allows to remotely control and schedule medicine dispensing.

To integrate all the hardware components in the medicine dispenser, the Arduino IDE provides ESP32 libraries and serves as an important platform for compiling the code to obtain the .hex file which can be used to test simulation cases in CAD apps like Proteus. The code is written in embedded C and facilitates the interaction between the various components of the system such as the Blynk app, IR sensor, LCD display, and servo motor. Arduino IDE also provides the Blynk library which is used to establish seamless communication with the Blynk app, allowing for remote control and scheduling. The code contains instructions for reading input data from the IR sensor and triggering the servo motor for accurate medicine dispensing, and combining with the LCD display to provide a real-time feedback and a visual interface for users.

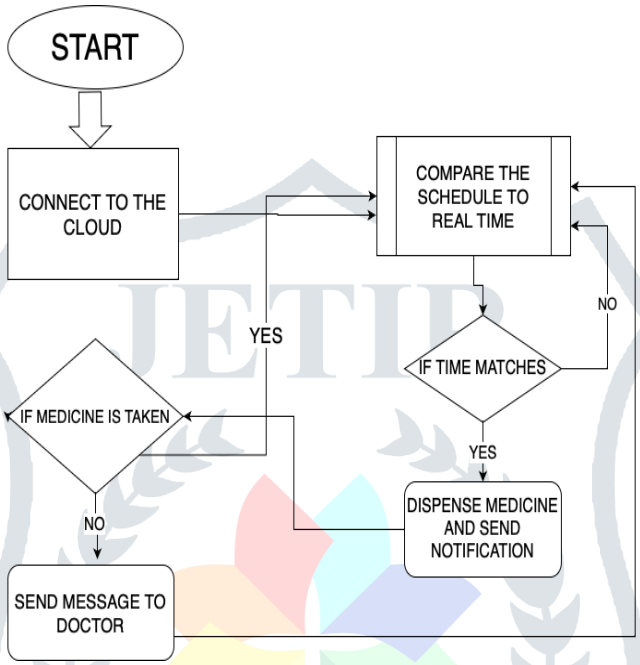

fig 6. Data flow diagram

When users interact with the Blynk app, it kickstarts the data flow. The Blynk server takes these inputs and communicates them to the ESP32 microcontroller, essentially the brain of the project. The Esp32 module is majorly used to compare the scheduled time with the time from the RTC module. If the times match the IR sensor detects the presence of a cup thus influencing the medicine dispensing, while the servo motor ensures that the medicine is accurately released. The LCD provides real-time feedback, providing system updates and alerts. The addition of buzzer has the facility to have audible alerts in the system, resulting in a comprehensive feedback loop. Details about system events are relayed back to the Blynk app to keep the caregivers or users informed about whether the medicine is being taken on time.

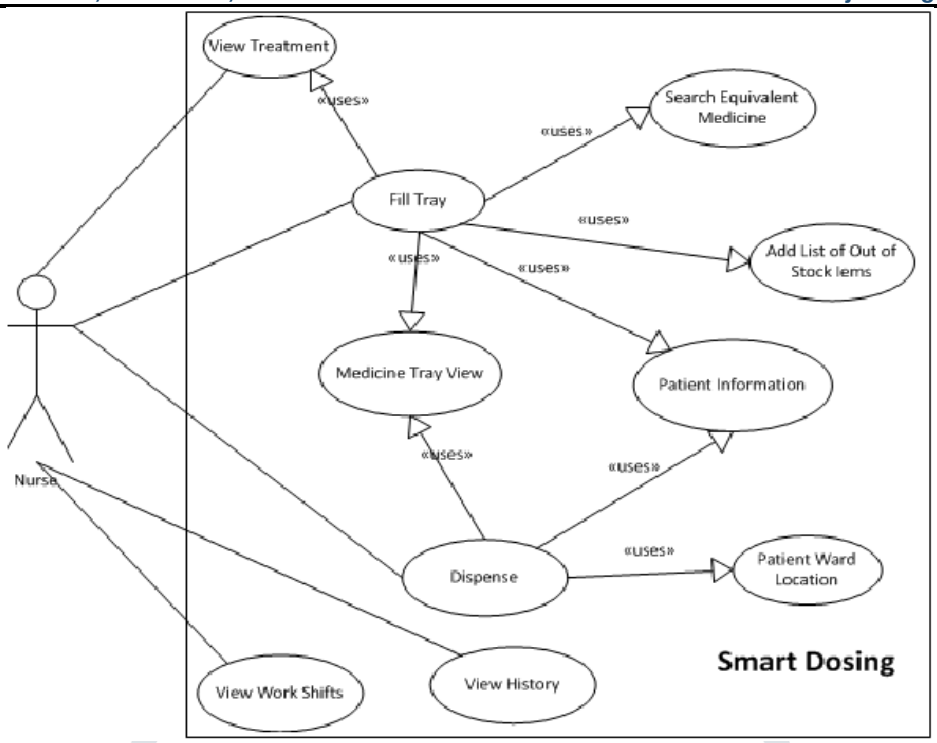

fig 7. Use Case Diagram

The proposed model aims to match or even surpass the performance of established brands in the field, all while keeping costs at a minimum. The main objective is to ensure top-notch quality while being cost-effective, with a specific focus on notifying patients and their caregivers about scheduled medication doses. We're keen on reaching out to patients via their phones, recognizing it as the most practical and dependable means of communication. This outreach can extend to family, friends, or healthcare professionals. Our straightforward goals involve storing pill schedules, delivering user alerts through the device or a mobile app, and, importantly, notifying the patient's family in the event of a missed dose.

IV. CONCLUSIONS

Medical adherence has to get serious attention by people. We try to overcome the improper medication and monitoring the patients with the help of IoT. The utilisation of IR sensor was a success as it introduced an additional layer of precision to the dispensing mechanism. The incorporation of RTC module facilitated accurate real-time dispensing of medication and the use of buzzer allowed useful alerts such that the medication dose will never be missed. The use of seemingly user-friendly Blynk app can allow users to have a interface which can facilitate the connection between the patients, caregivers and the medicine dispenser. This enhances not only user experience but also real-time monitoring and control. The use of Esp32 instead of using Aruidino or Raspberry-pi has successfully lowered down the cost of the proprosed prototype thus resulting in a really cost efficient alternative along with improving portability. Successful implementation of this prototype possess the potential to have an impact on medical adherence and healthcare management.

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I would like to express my gratitude towards my internal guide, Prof. A. M. Bagde, for their unwavering support and guidance throughout this project. Their expertise and valuable suggestions have played a pivotal role in shaping the course of our work, and I am truly thankful for their mentorship.

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