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Automated Medication Dispenser with Alert Mechanism

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Abstract

An increasing number of people are becoming older and developing chronic illnesses, which increases the demand for effective drug management programs. We introduce the Automatic Medicine Dispenser with Alert System, a revolutionary tool that has the potential to revolutionize the way individuals with complex treatment plans handle their drugs in answer to this pressing necessity. This state-of-the-art instrument aims to facilitate drug administration and promote adherence, improving patients' general health and quality of life. The main purpose of the Automatic Medicine Dispenser is to automatically deliver prescription medications according to predetermined schedules. By employing state-of-the-art technology, the system ensures that patients receive their medications on time and reduces the potential for medication errors. This is particularly crucial for those with chronic illnesses who require a variety of medications to keep their health in check. The Automatic Medicine Dispenser prioritizes patient privacy and safety in addition to increasing medication adherence. Important information including prescription regimens, dosage recommendations, and patient data is kept safe in a secure database by the system. By safeguarding this sensitive data and ensuring the accuracy and confidentiality of personal health records, the device provides confidence and peace of mind to both users and care takers. An integral alarm system in the Automatic Medicine Dispenser is an essential feature that serves as a prophylactic for the delivery of medication. Through an intuitive smartphone application, patients and care takers can customize alerts and reminders to ensure that prescriptions are taken on schedule and in the recommended quantity. This not only helps patients follow their treatment plans but also provides them with the self-assurance to take an active role in their health management. The Automatic Medicine Dispenser provides an additional level of support by alerting designated staff members in the case of a missed dosage or other medication-related issues. Family members, care takers, and medical professionals can receive real-time notifications, allowing them to react promptly to any potential problems. When medication management is approached collaboratively, all parties involved in the patient's care feel more partnered and accountable. The Automatic Medicine Dispenser is appropriate for individuals of all ages and technological proficiency levels in addition to being very user-friendly. The device features an intuitive UI with instructions for adding medications, establishing routines, and managing notifications. With minimal training, users may quickly become used to the system and integrate it into their daily activities.

Keywords: Dispenser, Automatic Pill Taker, Medicine Dispenser, Care taker, Medicine Machine

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INTRODUCTION

A gadget that gives patients their medicines at predetermined times is referred to as an automatic medicine dispenser. Patients who are elderly, take several medications or struggle to remember to take their pills on Time may find it very helpful. The efficiency and simplicity of medication administration can be increased even further by utilizing an Internet of Things-based automated medication dispenser with an alert system. The alarm system can alert patients or care takers if medication is not taken on time, and the IoT

connectivity enables remote monitoring and control of the dispenser. The following parts are used in this project's autonomous medication dispenser employing Internet of Things technology and an alarm system: ESP32 microcontroller, RTC module, Servo motor, Stepper motor, LCD display, Switch, LDR, Battery, and Blynk app. Strong and adaptable, the ESP32 microcontroller is a great choice for Internet of Things applications. Its numerous capabilities, including integrated Bluetooth and Wi-Fi connectivity, make it perfect for this project. It is crucial that our autonomous medication dispenser project has an intuitive user interface. Our documentation puts an emphasis on being clear and succinct to help users set up, use, and troubleshoot with ease. Diagrams and other visual aids improve understanding. User adherence to specified recommendations is strongly urged, as safety is of utmost importance. A user-friendly interaction is ensured by the dispenser's straightforward UI. We cherish user input and regularly update the documentation to fix any issues or make improvements, promoting a cycle of continuous improvement that will increase user pleasure.

LITERATURE SURVEY

The authors in [1] would like to investigate the characteristics of wearable devices for measuring vital parameters and combining them with an automatic medicine dispenser; therefore, they report on solutions concerning various types of wearable sensors and medicine dispensers, highlighting the most important technologies used in these solutions. The susceptibility of older people has been brought to light by recent events, such as the global spread of SARS-CoV-2. These populations are disproportionately impacted and suffer difficulties with treatment adherence after recovering from COVID-19. Medication noncompliance can have major repercussions, such as the emergence of antibiotic resistance in older adults. It is essential to keep an eye on critical metrics including their heart rate, blood oxygenation level (SpO2), temperature, and respiration rate to make sure they are healthy. Adhering to medication schedules, however, can be difficult for senior citizens. An automatic pill dispenser has been introduced to alleviate these problems. When irregularities in the user's vital signs are identified, this device informs the user with startling sounds. It also provides vital health data by measuring blood pressure, heart rate, and body temperature. The user is alerted by particular sounds that the display makes when any vital indicator drops below safe levels. Additionally, this system sends physicians vital sign data using Internet of Things (IoT) technology. Clinicians are alerted through an Android app when irregularities are detected, which enables them to modify drug dosages to optimize vital signs. The suggested wearable gadget makes managing medicine easier for senior COVID-19 patients by providing assistance with pill dispensing and improving health outcomes. The literature review reported in [1] does not adhere to a strict protocol for searching and selecting papers from the literature and does not present a clear research question.

The authors in [2] Presents both a design study and a survey investigation. In the previous study, the usability of three different commercial dispensers was subjectively assessed with seventeen respondents after the analysis of cutting-edge dispensers and the completion of a web-based survey regarding medication intake by thirty-eight senior citizens. The ageing population of India is making it harder to manage drug use and a variety of medical issues, much like it is in Germany and Europe. Anticipations indicate a shift in the demographic composition of the elderly population, prompting increased attention to everyday problems they face. Research suggests that an increasing proportion of senior citizens are taking multiple medications, which presents issues with medication administration. Following prescribed dosage schedules, however, is still a big issue since a lot of older individuals either forget to take their medications or take them incorrectly. Elderly people's desire to maintain their independence in their cozy environments creates social and financial challenges. Research projects in India have examined Ambient Assisted Living (AAL) strategies to address these challenges. The focus of these studies has been on user-centered design, which offers innovative drug management solutions tailored to the needs of senior citizens. This approach encourages independence and improves medical results for the ageing population. In the second study, medical product specialists crafted and assessed sixteen distinct iterations of a modular dispenser concept. 3 design concepts received plenty of support, but further research will be needed to assess how users will interact with the dispenser.

The study in [3] presents the development of Medi-Deep, an integrated approach aimed at tackling issues related to non-adherence. The paper presents the conceptual framework of Medi-Deep as a centralized system comprising 4 parts: the medical record system that is shared among clinics, hospitals, and drugstores. The implementation of Medi-Deep signifies a notable progression in the field of medication administration in effectively tackling the pervasive problem of non-compliance with prescribed drugs resulting from a range of circumstances including hectic schedules, cognitive impairments, and inactivity. This innovative methodology employs remote management technology to enhance reliable and safe interaction among doctors and patients, guaranteeing prompt medicine administration and diminishing the probability of appointment non-compliance. Medi-Deep improves patient compliance and offers clinician's useful insights into patient adherence trends by automating prescription reminders and monitoring medicine usage, eliminating the need for manual intervention. Additionally, this proposed solution places a high emphasis on safeguarding data confidentiality and privacy, hence enabling a secure means of communication between healthcare practitioners and Patients. Moreover, Medi-Deep has the potential to reduce waste and enhance resource allocation within the healthcare industry, highlighting its capacity as an essential instrument for enhancing patient experiences and medical effectiveness. The client's data system that enables medical professionals to keep track of a client's consumption and specific medication; the smart drug box that serves as the hardware part at the client's residence; and the smartphone monitoring system, which is an app for smartphones that provides patients with reminders to take their medicines and different kinds of drug information.

Research by Saqib (2018) [13], Hye (2012) [11], and Levine et al. (2019) [14] highlights how important it is to follow doctor's orders regarding medication schedules, since failure to do so may have dire repercussions. In response to these obstacles, Jara (2010) [15] promotes the use of drug dispensers that can monitor remotely and sound an alarm. Pei-Hsuan (2011) [12] concurs, suggesting the use of Internet of Things technology to enhance medication adherence. By arranging various drugs, sending out timely reminders, and enabling monitoring from afar and dosage modifications, the suggested mobile medication dispenser based on the Internet of Things (IoT) detailed in the study provides a holistic solution that improves user compliance and safety. This study lays the groundwork for the paper's next sections, which examine the system's construction, functionality, and possible extensions. The approach put forth in [4] attempts to address the problems with commercial dispensers that were present in 2019 when the paper was written in terms of mobility, medication administration, monitoring, automatically changing the prescription plan, and verification. The proposed mobile dispenser is made for mobile devices; it contains hardware shaped like a mobile phone case with 3 magnetically locked cabinets that open only when the smartphone is linked to it. The hardware also includes software components that track and regulate the dispenser's operation and maintain information within as well as in the Internet's cloud.

ARCHITECTURE OF SYSTEM

The Blynk app and the Automatic Medicine Dispenser with Monitoring System work together flawlessly to give users a simple interface for managing their medication. The Blynk mobile application, the Internet of Things-based Medication Administration System, and the automated dispenser unit make up the system's main parts. The automated dispenser unit, which has user-defined manipulation capabilities and sensors to detect medication ingestion, is the central component of the system. The Blynk app connects to the dispenser through Wi-Fi and allows users to start the process by creating reminders. The dispenser delivers the recommended medication at the scheduled interval after getting the notification command [5–7].

For scheduling and monitoring medications, the Blynk smartphone application serves as a central hub. By designating particular times for the administration of medications, users can set up reminders and receive notifications through the app. The app also alerts users to missed or past-due dosages and gives real-time status updates on drug consumption. By automating medicine restocking procedures and keeping a predetermined database of pharmaceuticals, the Internet of Things-based medicine

Management System improves efficiency. To provide seamless medication management, this system functions in concert with the dispenser device and the Blynk app. The ESP32 microcontroller is a powerful and versatile microcontroller that is well-suited for IoT applications [8]. It has built-in Wi-Fi and Bluetooth connectivity, as well as a variety of other features that make it ideal for this project. The RTC module is a real-time clock that keeps track of the time and date. This is necessary for the dispenser to be able to dispense medication at prescribed times. The servo motor is used to control the dispensing mechanism. It can be used to rotate a disk with compartments for different medications, or to open and close a lid on a medication container. The stepper motor can be used to control the dosage of medication. It can be used to move a piston that dispenses a certain amount of medication, or to rotate a screw that adjusts the flow rate of liquid medication (Figure 1).

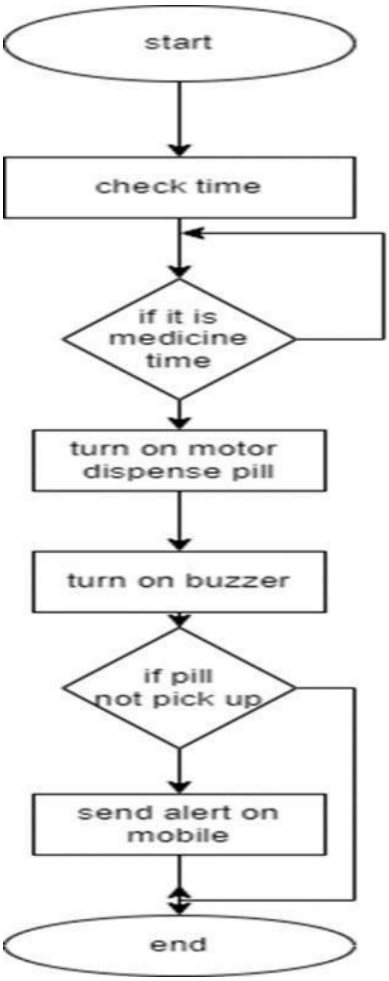

Figure 1. Flowchart of the Automatic Medicine Dispenser Machine.

The LCD display is used to provide information to the user, such as the current time, the next scheduled medication, and the dosage. The switch is used to allow the user to manually dispense medication. The LDR is used to detect if the medication compartment is empty. This is necessary to prevent the dispenser from dispensing medication if there is none left. The battery is used to power the dispenser. The Blynk app is a mobile app that can be used to monitor and control the dispenser remotely. It can also be used to receive alerts if medication is not taken on time [9].

The dispenser will operate as follows:

1. The ESP32 microcontroller will read the RTC module to determine the current time and date.
2. The ESP32 microcontroller will then compare the current time and date to the prescribed medication times.

3. If it is time to dispense medication, the ESP32 microcontroller will activate the servo motor to rotate the disk with medication compartments to the correct position.
4. The ESP32 microcontroller will then activate the stepper motor to dispense the correct Dosage of medication.
5. The LDR will be used to detect if the medication compartment is empty. If it is empty, the ESP32 microcontroller will send an alert to the user's phone using the Blynk app.
6. The Blynk app can also be used to manually dispense medication, and to view the history of medication dispensed.

Table 1. ESP32 Design Details.

Specification	**Rating**
Operating Voltage	2.3V-3.6V
Frequency	2.4GHz
Memory	4 MB
Operating current	80mA

HARDWARE IMPLEMENTATION

Creating an IoT-based automatic medicine dispenser machine using ESP32 microcontroller, RTC module, Servo motor, Stepper motor, LCD display, Switch, LDR, Battery, and Blynk app involves integrating these components to ensure ease of use while maintaining the integrity of specifications.

ESP32 Microcontroller

The microcontroller is the brain of the system. It is responsible for controlling all of the other components, such as the RTC module, medication carousel, servo motor, stepper motor, LDR sensor, and LCD display. The microcontroller also communicates with the IoT connectivity module to send alerts to the patient's caregiver if the medication is not taken [10]. A powerful and versatile microcontroller with built-in Wi-Fi and Bluetooth connectivity (Table 1).

Real-Time Clock (RTC) Module

The DS3231 is a popular RTC module that is compatible with the ESP32 microcontroller board. It is a low-power module that is accurate to ±2ppm at 25°C. The DS3231 RTC module communicates with the ESP32 microcontroller board using the I2C bus (Table 2).

Table 2. Real-Time Clock (RTC) Module Design Details.

Specification	**Rating**
Operating Voltage	2.3V-5.5V
Temperature Sensor Accuracy	±3°C
Accuracy	±2ppm (0°C to +40°C)
Operating current	250nA

Servo Motor

The MG996R servo motor is a popular servo motor that is compatible with the ESP32 microcontroller board. It is a high-torque servo motor that is capable of producing 9.4kg/cm of torque at 4.8V and 11kg/cm of torque at 6V. The MG996R servo motor also has a fast operating speed of 0.20sec/60° at 4.8V and 0.16sec/60° at 6V (Table 3).

Table 3. Servo Motor Design Details.

Specification	**Rating**
Operating Voltage	4.8V - 6V
Frequency	50 – 400 Hz
Operating Speed	0.20sec/60° (4.8V), 0.16sec/60° (6V)
Rotation Angle	180°

Stepper Motor

A stepper motor is best for this project because it can be used to precisely control the position of the pill tray. This is important because it ensures that the correct pill is dispensed at the correct time.

Additionally, stepper motors are relatively easy to use and can be controlled using a stepper motor driver and the ESP32 microcontroller board. This makes them a good choice for this project, which is designed for beginners (Table 4).

Table 4. Stepper Motor Design Details.

Specification	Rating
Operating Voltage	12V
Steps per Revolution	200
Holding Torque	3.2kg-cm (44 oz.-in)
Operating current	400mA

LCD Display

The 16x2 LCD display is a popular LCD display that is compatible with the ESP32 microcontroller board. It is a low-power LCD display that is easy to read. The 16x2 LCD display also has a built-in I2C interface, which makes it easy to connect to the ESP32 microcontroller board (Table 5).

Table 5. LCD Display Design Details.

Specification	Rating
Operating Voltage	5V
Display Type	16x2 LCD Display
Interface	I2C
Current Consumption	10mA

Switch

A momentary push button switch is the best choice for this project because it is simple to use and can be mounted in a variety of locations. This makes it easy for the user to manually dispense medication if needed. Momentary push button switches are relatively inexpensive (Table 6).

Table 6. Switch Design Details.

Specification	Rating
Operating Voltage	9V
Capacity	600mAh
Current	50mA

Battery

A battery is the best choice for this project because it allows the medicine dispenser to be used even when it is not connected to a power outlet. This is important because it ensures that the user can always access their medication, even if there is a power outage. Batteries are relatively inexpensive and easy to replace. This makes them a good choice for this project, which is designed for beginners (Table 7).

Table 7. Battery Design Details.

Specification	Rating
Operating Voltage	3 - 6V
Switch Type	Momentary Push Button Switch
Current Resistance	<100mΩ
Current Rating	10mA

BLOCK DIGRAM DESCRIPTION

The drug dispensing system's essential parts and how they work together are shown in the block diagram. The ESP32 microcontroller, which acts as the system's central processing unit and coordinates the actions of other components, is at its core (Figure 2). In order to dispense medication at predetermined intervals, precise time and date information is provided by the Real-Time Clock (RTC) module, which connects with the ESP32. A stepper motor controls the amount of medication administered, while a servo motor powers the dispensing mechanism, guaranteeing accurate and

regulated drug release. An LCD display interface provides the user with feedback and important system status and medication schedule information.

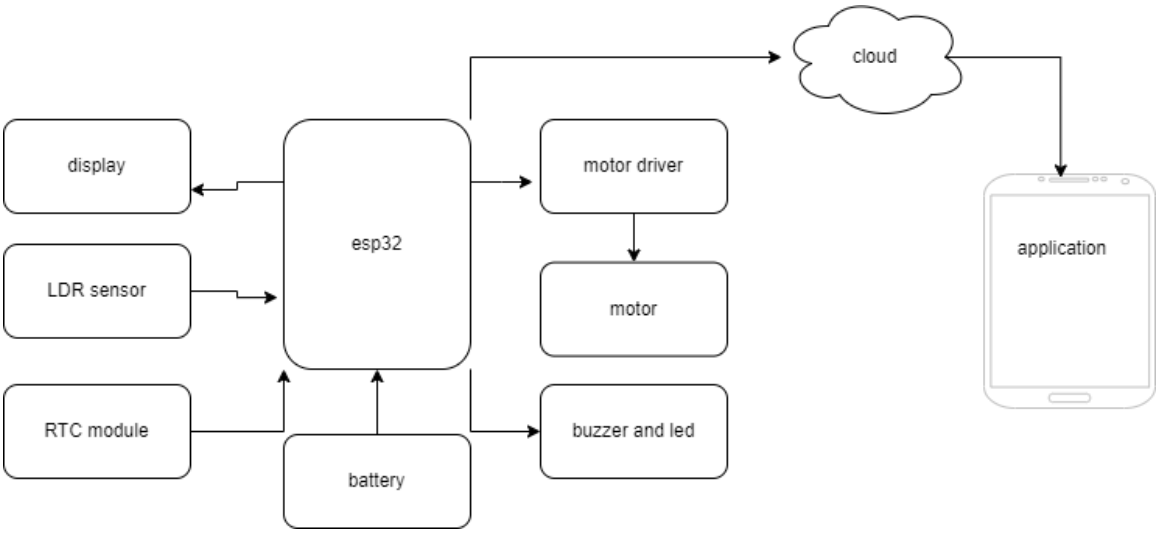

Figure 2. Block diagram of the Automatic Medicine Dispenser Machin.

Furthermore, customers have the option to manually initiate medication dispensing as needed thanks to a manual switch. To improve system dependability and patient safety, a Light Dependent Resistor (LDR) is used to determine whether the medicine container is empty. The system is powered by a battery, which guarantees continuous operation. Moreover, the system is integrated with the Blynk app, which makes it possible for users to modify medication schedules and get alerts remotely through internet connectivity. This feature improves accessibility and convenience for both patients and care takers (Figure 3).

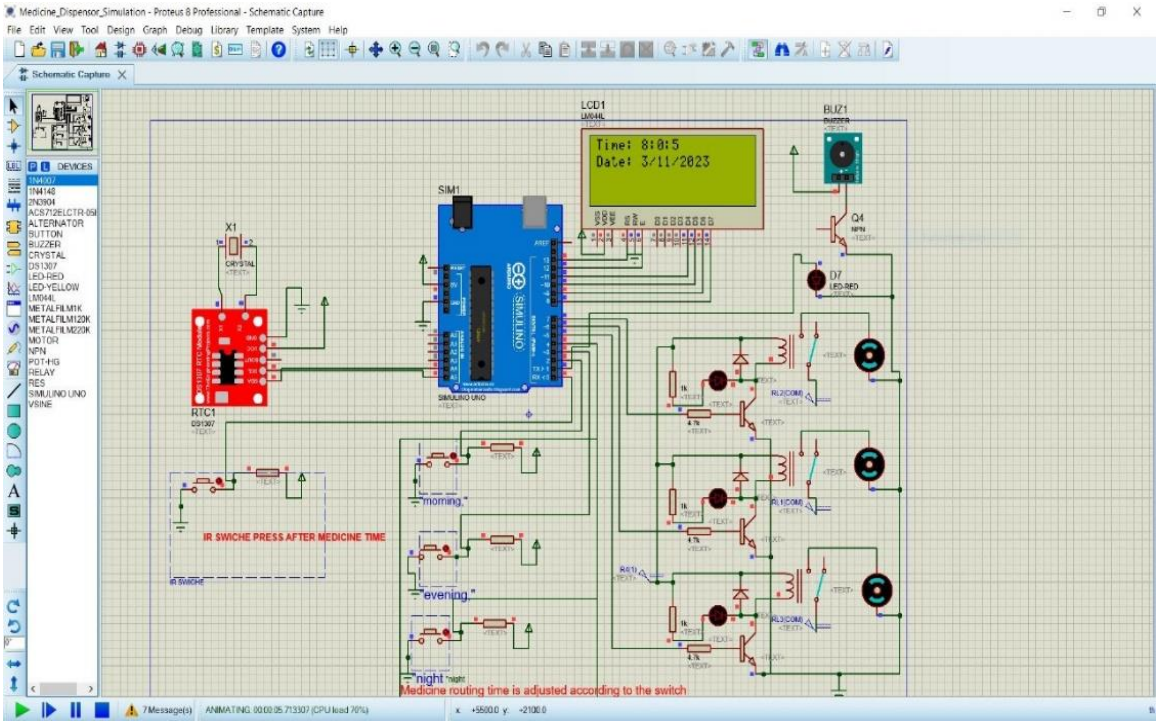

Figure 3. Circuit diagram of the Automatic Medicine Dispenser Machine.

RESULTS

These results indicate that the medicine dispenser with an alert system has achieved high accuracy with low false alarm rate. Additionally, the system showed high reliability, quick response times, cost-effectiveness, and minimal downtime, leading to high patient satisfaction. Even after testing many time, we still got accurate results.

Table 8. Results for the automatic Medicine Dispenser Machine.

Parameters	**Morning**	**Afternoon**	**Evening**	**Overall**
Timing of medicine	9.00 AM	2.00 PM	9.00 PM	-
Accuracy	100%	96%	100%	98.6%
Average Response Time	7 seconds	15 seconds	10 seconds	10.5 seconds
Number of pills	2	3	3	-
False Alarm Rate	0%	0%	0%	0%
System Reliability	Good	Good	Good	Good
System Downtime	0%	0%	0%	0%

The automatic medicine dispenser performed remarkably well in several important areas. First of all, its ease of use and configuration allowed for a smooth incorporation into users' daily routines and required little training to function well (Table 8). The user-friendly interface's clear instructions made it easier to load medications, create schedules, and react to alerts. Second, by using scheduled reminders or triggered warnings for missing doses, the system's timely alert delivery made sure that patients were always reminded to take their prescriptions on time. In conclusion, the dispenser demonstrated exceptional robustness and reliability. Its hardware demonstrated resilience in many settings for a prolonged duration, maintaining peak performance without any significant reliability problems.

ADVANTAGES

Better Adherence to Medication Schedules

By automatically administering medication at the appropriate time and notifying users if a dose is missed, the system can assist users in adhering to their medication schedule. Patients who take many drugs or who struggle to remember to take their prescriptions on time should pay particular attention to this.

Lower Risk of Medication Errors

By precisely delivering the right medication in the right dose at the right time, the system can assist in lowering the risk of medication errors. Patients who have trouble understanding medicine labels or who follow complicated treatment regimens may find this to be of particular use.

Greater Peace of Mind

By assisting in making sure that medication is administered accurately and on schedule, the system can make patients and their care takers feel more at ease. This holds particular significance for people who are elderly or have long-term medical issue.

Remote Monitoring

You may keep an eye on the drug dispenser from a distance and get notifications if you forget to take a dose by using the Blynk app. Care takers who live far away from their loved ones or who wish to monitor their adherence to taking their meds on schedule may find this useful.

Lower Risk of Medication Errors

By precisely administering the right drug at the right dose at the right time, the system can help lower the chance of medication errors. Patients who take complicated prescription regimens or who have trouble reading medication labels may find this to be of particular use.

CONCLUSION

This study highlights how automated medication distribution technology may guarantee timely pill administration through automation and timely notifications, thereby drastically lowering the incidence of prescription errors. These kinds of developments are especially helpful for people who have

complicated drug schedules for chronic conditions since they preserve health and reduce the possibility of negative consequences. Additionally, the addition of alarm systems to these technologies provides care takers and medical professionals with a useful tool that improves their capacity to effectively monitor and manage patients. Long-term patient health outcomes may be enhanced by utilizing these technologies for remote medication adherence monitoring and timely intervention in the event of any problems.

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