RESEARCH PAPER

IoT Based Medicine Reminder & Dispersing Machine for Elder Care

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ABSTRACT

The current research presents a new solution to the common issue of pharmaceutical non-adherence, which is also recognized as a phenomenon in patients of all ages, yet in old age with cognitive disabilities, it is considered a serious problem. This sophisticated smart pill box is thoughtfully aimed to provide a small and cheap solution. With such an interface that is, rather intuitively designed, it enables an unlimited number of users or caregivers to implement rather specific medication schedules, which would activate exceptionally timely alarm bells. Whether some of the meds are required to treat specific conditions, beauty enhancements, or provide an added value, the technological product ensures a stable adherence to predetermined routines, despite a hectic everyday life. The whole system is developed through an ESP32 Micro Controller, precise servo motors, an LCD display, as well as many LEDs that serve as output indicators throughout such process.

Keywords: LCD, LED, servo motor, ESP32 micro controller, Medicine, elderly health, health system.

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1. Introduction

As the healthcare environment keeps being dynamic, the diagnosis and treatment of diseases are also increasing with surgeries and medicines becoming central to the treatment of the patients [1]. Postoperative prescriptions are in most cases necessary to aid in the immune response of the body and treat many health conditions ranging from vitamin deficiency, chronic conditions, genetic problems, and elderly-related issues. People of all ages rely on prescribed medications to manage such symptoms as pain, nausea, and headaches after visiting healthcare providers [2]. However, Patients might not remember to administer their drugs since day-to-day living is so fast, which worsens their conditions and reduces their overall health [3, 4]. As an illustration, young children, who are easily distracted, are prone to forgetting doses unless reminded to do so by their parents, who, themselves, can forget due to work stress and other commitments [5]. A rational solution to this problem can be the creation of a smart medicine box. This device can be programmed by the parents to remind their children to take their medicines when they are not around [6]. In the same way, adults and teenagers who have to work, attend school and do other activities can utilize the device to remind themselves of medication schedules [7]. There is a possibility of using phone alarms, but it is easy to forget them in the middle of a hectic life. The smart medicine box is mobile and this ensures that the users can carry it everywhere and an alarm reminds them to take medication immediately [8]. In case of the neglect of the reminder, it reminds the chosen caregiver or guardian of the necessary time of administration and with this innovation the strict adherence to the set time of administration becomes less challenging [9]. It is best suited to the elderly who may have memory lapse due to old age or have other related neurological disorders like the Alzheimer or Parkinson disease [10]. Any missed dose might cause distress or problems, most especially if alone or in instances of sparse support from caregivers [11]. The smart medicine box can reduce the burden on the patient and the caregiver by serving as a good reminder system, so they can take medication regularly and on time [12].

2. Literature Review

The article under review, Literature review of intelligent medicine boxes with the ESP32 Micro Controller Model, addresses the current developments in the field of the IoT-based healthcare technology, namely automated medication management systems. These are targeted using the Raspberry Pi GPIO pins [13]. Also, the system has the ability to alert via senWi-Fi-based notifications to a connected mobile application serving as a place to provide alerts on missed doses, and even directly alert caregivers or family members in case of noncompliance continues [14]. In the case of programming, the development software uses programming languages such as Python or C to apply functionality with the help of GPIO control, time-based scheduling, and network connectivity. The medication journals and adherence records can be placed on the Raspberry Pi locally or in cloud storage to be used in the future [15,16]. This real-time monitoring tool improves medication adherence, ensuring that patients are adherent to prescribed medications and reduce the chances of missing one or two doses, thereby increasing medication control in the home environment Preventing patient non-compliance and dosing omissions with real- time medication monitoring and alarm clocks [17,18]. Intellectual medicine boxes with IoT capabilities and microcontroller devices such as the ESP32 Micro Controller Model Bhave become popular because of their flexibility and processing power [19]. Most of these systems will have sensors e.g. RFID to track pills and load cells to track remaining doses. They are likely to be linked with mobile or cloud-based systems, which allow caregivers or medical practitioners to check intake remotely [20]. The integration of application and databases offers features like customized scheduling, patient focused notices and notifications [21]. One of the studies demonstrates the usefulness of these systems that help to reduce the risk of mistakes and increase the likelihood of taking medication by raising an alarm or creating smartphone notifications at the time of taking medication and keeping the data in the cloud to monitor the process safely [22]. It has been demonstrated that Python scripts are extensively used to run the GPIO pins of the Raspberry Pi to provide connections with actuators and sensors to support key functions such as light indicators, audible alarms and locking functions. These features help in facilitating an user-friendly and easy to use interface. The scalability of the smart medicine box to fit into the needs of multiple medicines and patients is also noted by research. Researches the implementation of machine learning algorithms to study patient history and predict dose changes, and the issue of data security and privacy remains of paramount importance. Overall, smart medicine boxes represent a practical example of the use of IoT in the real world to offer convenient, personalized, and reliable health services. Even though the potential of such systems is enormous in terms of improving medication adherence, studies are still in progress to solve the challenges regarding the further enhancement of accuracy and the development of user interfaces as well as providing more robust security measures to protect confidential health information.

3. Methodology

To be functional, the device requires an external power source, and the main part of it is an ESP32 Micro Controller Model B. The system has a SD card that is small to store simple data and programs of medications. To give the interactive input by means of the external output mediums such as speakers and an LCD display, four servo motors and LED are constructed within the medicine box. The device will alert the user to take the medications by opening the medication container automatically, raising an alarm, using LED lights, and offer the user voice feedback through speakers and showing the user relevant information on the LCD display. The users can choose the language that the device uses depending on their requirements. In addition, the system uses Real VNC software to enable Raspberry Pi to be controlled and serves as a Wi-Fi card to network. The smart medicine box includes the camera and panic button. When the patient presses the panic button, an alarm is forwarded to a designated guardian with a "DANGER" message and the picture of the patient captured by the camera. This feature will enable the caregiver to react fast through an inbuilt mobile application, and one can be in a position to offer real-time assistance. The design of this IoT-based smart medicine box based on ESP32 Micro Controller Model B involves the design of a system which will enable patients to effectively manage their drug schedule. Raspberry Pi is the central device and interconnects with various other units such as sensors, display unit, and warning systems to enhance medication adherence. To get the timely reminders, the Raspberry Pi is connected to a real-time clock module, which will make sure that the timings of the medications are right. The medicine box is compartmentalized and respective medicines have been designated compartments according to the treatment plan of the patient. There are sensors or weight-detection modules that monitor whether a pill has been administered when the person was supposed to take it, and as a result, the system monitors a missed dose and tells the patient about it. The system gives auditory and visual medication reminders on the LEDs and buzzers when medication time comes, controlled.

4. Existing And Proposed System

IoT and microcontroller-based systems, usually Raspberry Pi or Arduino based, are also the foundation of existing smart medicine box systems. Such devices are likely to help the user to control the time of taking medication by reminding them at the right time so that they can take them effectively. The majority of systems use sensors to verify the use of medicine compartments as scheduled. Moreover, notifications are usually required to be delivered to patients via mobile applications to alert about the lack of doses. However, the majority of the existing solutions are not adequate to support advanced real time monitoring of health and emergency warning functions which are of particular importance to the aged and chronically ill patients under home care.

4.1 Suggested System

The high-tech smart medicine box utilizes the ESP32 Micro Controller Model B to address the negative aspects of the existing designs to introduce new functionalities to increase the level of drug compliance and patient safety. The system is a blend of real-time health monitoring through sensors that track the vital indicators such as heart rate and temperature and transfers the data to a mobile app via Wi-Fi or Bluetooth. In instances of irregularity/ missed dose, the system alerts the care givers or medical practitioners in time. Its processing capabilities allow the Raspberry Pi to be used as an efficient user interface, and its extension possibilities allow add-ons such as emergency alarm and compliance monitoring. The extensions enable the system of healthcare management to be more efficient and safer.

4.2 Working

A smart medicine dispenser that utilizes the IoT is a better way to manage drugs because it offers accurate and timely medicine using networked devices and sensors. The patient can input their drug schedule, names, doses, and time of administration into a companion application or a web portal. The dispenser has sensors that monitor the level of medication and consumption, and record any changes in the amount of pills, fluid volume, or weight of the container. The system is networked through the internet using Wi- Fi or any other communication protocols to enable real-time alerting and monitoring of missed doses or low drug levels. Auto-refill reminders and sending to the user app or to the designated caregivers would supply the patient with a long-lasting supply of medicine. The device has an easy user interface whereby it has an LED display or buttons to provide interactive input whereby users can accept the reminders or dispense medication when necessary. Furthermore, the system stores information regarding compliance, usage history, and history of refills, which can be of practical use to healthcare providers or caregivers to help them in better health management.

4.3 Components

System on Chip (SoC) microcontroller or ESP32 has gained massive popularity over the past years. The popularity of ESP32 rose in 2018 due to the fact that it is debatable whether the introduction of ESP32 contributed to the development of the IoT or vice versa (see Figure 1). Among the ten individuals you know that have assisted in developing the firmware of any IoT device, seven or eight have most likely worked with ESP32 at some stage.

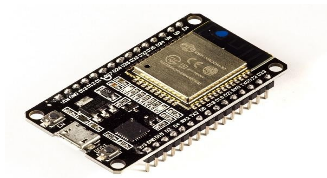

Fig. 1. ESP32 Microcontroller

Before getting down to the actual causes of popularity of ESP32, it is worth considering some of the main characteristics of the product. The subsequent specifications are those of ESP32 WROOM 32 version40 MHz Integrated Crystal UART, SPI, I2C, PWM, ADC, DAC, GPIO, pulse counter, and capacitive touch sensor are some of the module interfaces4 MB of integrated SPI flash ROM448 KB (to boot and core functionality)SRAM4520 KB Integrated Connectivity Protocols Wi- Average Operating Current: 80 mA Since the abovementioned specifications are provided, it is very easy to identify which factors lead to the prevalence of ESP32. Imagine what a microcontroller (u C) of an Internet of Things device would have to do. As you may have observed reading the previous chapter, the key functional elements of any Internet of Things device are its sensing, processing, storing, and sending aspects. It should be capable of communication to a variety of sensors to begin with the µC. It should be capable of supporting UART, I2C and SPI three popular communication protocols required by sensor interfaces. It should be capable of counting pulses and ADC. Before getting down to the actual causes of popularity of ESP32, it is worth considering some of the main characteristics of the product. The subsequent specifications are those of ESP32 WROOM 32 version40 MHz Integrated Crystal UART, SPI, I2C, PWM, ADC, DAC, GPIO, pulse counter, and capacitive touch sensor are some of the module interfaces4 MB of integrated SPI flash ROM448 KB (to boot and core functionality)SRAM4520 KB Integrated Connectivity Protocols Wi- Average Operating Current: 80 mA Since the abovementioned specifications are provided, it is very easy to identify which factors lead to the prevalence of ESP32. Imagine what a microcontroller (u C) of an Internet of Things device would have to do. As you may have observed reading the previous chapter, the key functional elements of any Internet of Things device are its sensing, processing, storing, and sending aspects. It should be capable of communication to a variety of sensors to begin with the µC. It should be capable of supporting UART, I2C and SPI three popular communication protocols required by sensor interfaces. It should be capable of counting pulses and ADC. LCD screen: The LCD display is one of the most common alphanumeric display modules used, and it has the capacity of displaying up to 16 characters in a single line, in two lines. They are also one of the most popular uses of such displays in electronic equipment and embedded systems to informational display, and have a backlight to make them brighter in dark places. A servo motor is one type of rotary actuator which provides a high degree of angular position control. This is a motor connected to a feedback mechanism which is normally a potentiometer that measures the position continuously. A regulated power supply is used to ensure that the output remains unchanged in case the power input changes. Another term used is a regulated DC power supply that is known as a linear power supply and the circuit is an embedded circuit that comprises of a number of blocks as indicated in the figure 2.

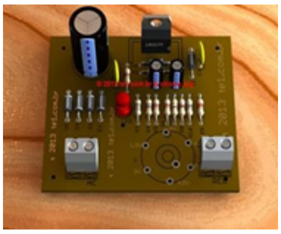

Fig. 2. Regulated power supply

A bridge full wave rectifier is used to convert an ac voltage into a dc voltage using both half cycles of the input ac voltage. The figure represents the bridge rectifier circuit. The circuit has four diodes which have been connected to form a bridge. The ac input voltage is placed in the diagonally opposite ends of the bridge. The other two ends of the bridge are attached to the load resistance.

(a) (b) (c)

Fig. 3. Bridge rectifier (b) Buzzer (c) RTC

Fundamentally, a piezoelectric diaphragm is the source of sound of a piezoelectric sound element. A piezoelectric diaphragm consists of a metal plate (e.g. stainless steel or brass) and a piezoelectric ceramic plate having electrodes on both sides glued together by adhesives. Piezoelectric effect produces a mechanical distortion when a D.C voltage is applied between the electrodes of a piezoelectric diaphragm. The DS1302 trickle-charge timekeeping chip also has a real-time clock/calendar in addition to 31 bytes of fixed RAM. It has a simple serial interface in communicating with a microprocessor. The real-time clock/calendar provides information concerning the number of seconds, minutes, hours, days, dates, months and years. There are only three wires, CE, I/O (data line) and SCLK (serial clock) that can be used to communicate with the clock/RAM. Data can be transferred to and from the clock/RAM in one byte at a time or bursts of up to 31 bytes. The DS1302 is designed to operate on very small power, less than 1 - of power is needed to store data and clock information. The DS1302 has 2 power pins, one of them being a primary and the other one being a backup. It is fundamentally the motor shaft. The use of servo motors in robotics, automation and control systems is due to the feedback system where the motor can be moved to the desired point and controlled to withstand the desired position with minimal errors. Speaker. A USB speaker is a sound output device, which can be inserted in the USB port of a computer or any other compatible device. The USB connection provides power and audio data to USB speakers unlike the traditional speakers which need an independent power supply and an audio input connection. This makes them easy to set up and the number of cords needed is less and hence they can be used in many applications. Buzzer: Buzzer is an electronic signalling device where when it is connected to power electricity the device produces a constant or repeated noise as in the figure 3. Sound vibrations are typically generated using an electromechanical transducer, e.g. a coil or piezoelectric material. Electronic devices with alerting, alarm and notification functions are the most frequent applications of buzzers.

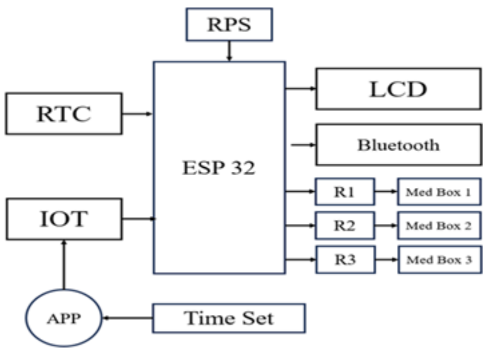

Fig. 4. Block Diagram

The application interface offers a time-setting feature that is intuitive and easy to use so that the user can set the start time and stop time to dispense medicine as it is shown in the figure 4. This makes every dose to be released at the appropriate time without either missed or delayed medication. The interface is created to accommodate three distinct compartments, and each of them can be configured separately. This is convenient to the users who have to use several medicines on different schedules. Upon reaching the set time, the box will automatically open the lid, so that at the correct time, the user will take the necessary dose. The automatic program removes the possibility of having to manually intervene and minimizes the risk of forgetting a medication.

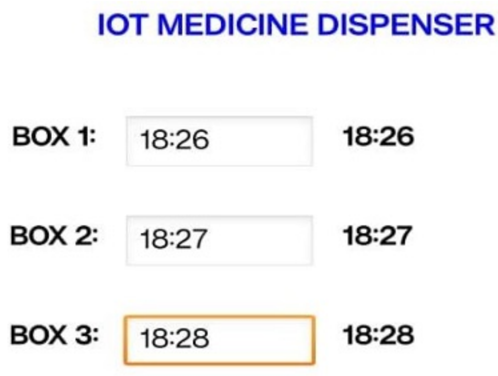

Fig. 5. IOT Medicine Dispenser

The interface is made easy to use with a clean and simple layout and easy to use controls. The user is easily able to choose at what time they want the boxes to run and on-screen markers indicate what boxes are on or off as illustrated in figure 5. The app also has safety measures like notifications and reminders to improve reliability. When a box is opened one gets an alert and in case of missed medication, a reminder is created by the system. This will make sure that the users stick to their medication timetables and this aspect will enhance health management and minimize chances of missing dosage as illustrated in the figure 6.

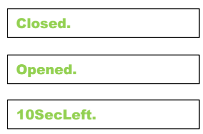

Fig.6. Dispenser's Status

The app interface offers clear and intuitive display of the status of the dispenser so that it is easy to monitor the medication schedule. All three compartments have real-time displays as to whether it is active or inactive or has already dispensed the medicine. A color-coded system is more visible- green means that a box has a scheduled dose and is active, red is a missed dose and gray is an inactive or idle box. Also, the animated lid icons will physically open and close in line with the predetermined schedules to provide users with an animated illustration of how the dispenser works. There is also the interface status summary which indicates the next scheduled time of opening each box so that the user is never left without knowing his medication schedule as in the figure 7,8,9.

Fig.7. Opening of the dispenser

Fig. 8. Alert on the LCD Display.

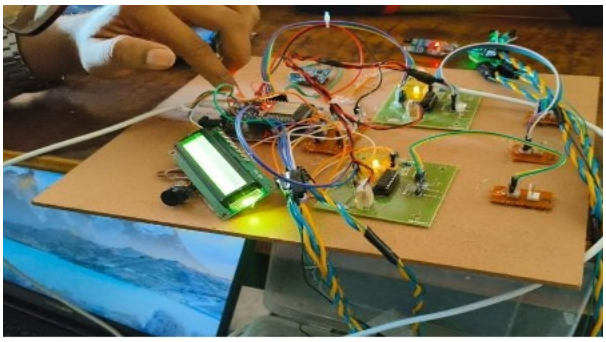

Fig. 9. Circuit Connections

5. Challenges And Future Scope

The challenges associated with smart medicine boxes are also data privacy and data security as it involves sensitive patient information and requires a high level of encryption and any security protocols to avoid unauthorized access to the information. The usability and adoption is also a problem particularly among the elderly who will need intuitive interfaces and may need training. It is important to have reliability and accuracy in sensors and therefore any discrepancies may result in wrong reminders but the ongoing calibration also makes the device complex and expensive. Connection with healthcare systems is a difficult task because of the different data standards whereas affordability is a hindrance and it is important to develop cost efficient models. Technical constraints like battery duration, storage and connectivity in isolated places may influence functionality. The future scope will consist of AI-guided personalized notifications and improved interoperability with healthcare systems to improve monitoring and intervention. Better interfaces that are voice or touch-free and predictive analytics may help facilitate accessibility and warn caregivers about possible health risks in the event of non-adherence. Wi-Fi and cellular network dual connectivity models would improve the reliability in low-connectivity regions. Modular designs have the potential to lower costs through enabling users to choose the features required and wearable devices could provide one with a holistic health profile. Privacy and responsiveness would be further promoted with advanced biometric authentication of data security and emergency alerts in case of unintake doses.

6. Results

An intelligent medicine box with a ESP32 Micro Controller Model B can serve as an important addition to the healthcare sphere because it can increase medication adherence and patient safety. This system provides a powerful and conveniently usable drug management system using the processing power and connection of the Raspberry Pi. The medicine box can be used to track drug consumption using the number of pills consumed and the weight of the containers with the help of sensors. The patients and caregivers can join medication schedules through a custom-built web or smartphone interface, which is compatible with the Raspberry Pi. The program provides real time notifications and reminders to the patients and caregivers to make sure that they take the medication as required. The system automatically alerts the set contacts/ health personnel in case a dose is not taken. LCD screen will offer graphic informatics to reminders, which will be complemented by alarm system that offers auditory reminders to enhance compliance.iance. The device has cloud integration, which enables remote monitoring and data synchronization to enable caregivers and healthcare professionals to access adherence records and adjust medication plans. Wi-Fi and Bluetooth capabilities of ESP32 Micro Controller Model B ensure that the product is an excellent solution to the implementation of the medication management IoT. The system is also cost- effective and efficient which is why it is appropriate in both home and clinical setting. The security features such as encryption and access controls are employed to protect confidential medical information. The device also analyses the information collected so as to be able to prepare comprehensive adherence reports that help in identifying medication-taking behavioral patterns. This knowledge can assist medical practitioners to make informed choices and implement interventions on time. The modular nature of the medicine box ensures that it is easy to customize and it can hold different types of medication, including pills and liquid drugs. This smart medicine box enhances medication management, health outcomes, and proactive healthcare with the help of IoT technology, which involves monitoring the patient intake of their medication as prescribed.

7. Conclusion

The smart medicine box is a good way of enhancing the adherence to drug and corrects, consistent intake of the prescribed medicine. This product is digital, being integrated with IoT and machine learning, and having a mobile app, which provides real-time tracking and instant notifications on missed doses, making it an addition to healthcare. Algorithms in machine learning incorporated into the system analyze the user behavior and adjust the reminder schedules to achieve a higher adherence rate. Other predictive elements, including low medication stock alerts, make it more convenient and prevent interruptions in the treatment. A React Native mobile application can also be leveraged to make it more accessible, which facilitates the interactions between a patient and a caregiver across platforms. The future progress might focus on enhancing the safety of the information with such additional features as the biometric authentication to prevent the unauthorized access. The smart medicine box is also a needed aspect of healthcare management as it can be used to combine future-proof analytics and emergency alerts that help people with chronic illnesses or those of the elderly population. This technology does not only promote medication compliance but also promotes communication between patients, caregivers and healthcare professionals. It assists in enhancing patient outcomes and the quality of life, in general, by creating a more connected healthcare network.

8. Conflict of interest

No

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