IoT-enabled Smart Pill Dispenser with ESP8266 for Automated Medication Management and LED Indication

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ABSTRACT

It is essential to give elderly people their medication on time. The purpose of an automatic medicine dispenser is to help people who take prescription drugs without careful medical monitoring. The user is relieved of the error-prone task of giving the wrong medication at the wrong time. A microcontroller interfaced with an alphanumeric keypad, an LED display, a motor controller, an alarm system, a multiple pill container, and a dispenser are the main parts of this medication dispenser. The main function is to make it easier for the user to establish the timings so that several pills are dispensed at the appropriate times. Two different kinds of signals are provided by the alarm system's design: an LED that lights up and an alert notification that sounds. To retrieve the pill and reset the alarm button, the user must set an alarm. Four alarms can be programmed to dispense the pills: the second, third, and fourth alarms can all accommodate up to four boxes. The main goal is to maintain the gadget's affordability and simplicity. The programme in use is stable and dependable. This gadget can help the elderly population because it eliminates the need for costly in-home medical care.

I. INTRODUCTION:

Taking care of the elderly is a top responsibility in developing nations. Family members are in charge of looking after and managing the elderly. In the modern society, it might be difficult for family members to always be there for the elderly. In majority. While it is in their natural interest to be independent, elderly people's children have concerns. Sometimes elderly individuals fail to take their medications on time, even with the best of intentions. The automatic medication dispenser is one such tool that helps patients take their drugs as directed. Due to the rising cost of in-home care, people are finding themselves under increasing pressure to select a home health care provider.

As the cost of in-home medical care continues to rise, people are increasingly choosing to use gadgets that effectively manage their prescription regimens. The automatic medicine dispenser makes this possible.

The Automatic Pill Dispenser (APD) is a drug administration invention for individuals who must take their pills on a regular basis. The increased need for in-home medical solutions and the escalating expenses of healthcare have made APDs a popular and practical tool for ensuring medication adherence.

Accordingly, the purpose of this research is to explore the development and implementation of a novel APD system tailored to meet the needs of both persons and carers. By leveraging IoT connectivity, contemporary sensor technologies, and user-friendly interfaces, the proposed APD system seeks to expedite medicine dispensing processes and enhance patient safety and autonomy.

It is incredibly challenging to care for elderly relatives or those with chronic medical conditions in a time of busy schedules and nuclear households. Traditional medication management approaches frequently fail to ensure the timely and appropriate administration of medication. As a result, the idea of an Automatic Pill Dispenser (APD) emerges as a workable solution to successfully address these problems. The ensuing sections will provide a detailed explanation of the suggested APD system's features, design, and benefits. The system's ability to save healthcare costs, boost medication adherence, and enhance the general quality of life for both users and carers will be underlined.

This paper's remaining sections are arranged as follows: The administration of pharmaceuticals that assist devices in a variety of ways for non-professional users is covered in Section II. The majority of them are manual and comprise many components that serve as pill trays. In Section III, you will find the Arduino IDE and learn how to use the Node MCU, an open-source development kit and firmware, to prototype your Internet of Things product. It includes devices based around the ESP-12 module and firmware for the ESP8266's Wi-Fi SoC. In this session, we go over using the Arduino IDE with a Node MCU. App Inventor is a free cloud-based tool that allows you to write your own mobile apps using a block-based programming language. You utilise web browsers (Safari, Firefox, Chrome) to access App Inventor. These simple courses in Section IV will teach you the basics of developing apps for Android and iOS smartphones and tablets.

The functioning mechanism of the pharmaceutical information system is covered in Section V. The drugs are securely kept inside the dispenser. Usually, trays or sections set aside for each pill make this easier. In order to avoid confusion, these sections guarantee that the various drugs are correctly arranged and divided. This medication dispenser's primary components are an alarm system, an LED display, a motor controller, an alphanumeric keypad interfaced microcontroller, multiple pill containers, and a dispenser. In summary, medication dispensers are an essential tool for drug management and have a number of advantages for patients, carers, and medical professionals. Prescription adherence, medication mistakes, and patient outcomes can all be positively impacted by the usage of pill dispensers because of their automated dispensing capabilities, intuitive interfaces, and safety features. Pill dispensers will only become more sophisticated due to the needs of healthcare and technology breakthroughs, which could enhance patient outcomes, medication compliance, and general quality of life.

II. LITERATURE SURVEY:

There is a large selection of pharmaceutical administration assistance devices available for non-professional users. Most of them are manual and comprise multiple portions referred to as pill trays. Several of the pill tray's slots can hold medication. Each container can hold different sizes and combinations of drugs. The user needs to take the medication from each tray every day for a maximum of one month. There is not an alarm on it to remind you to take your prescription. The Pill-dispenser is a gadget that notifies the user through both audio and visual cues. It offers a scheduled reminder for things like taking medication or attending particular activities. The goal of a smartphone app is to help patients prevent mistakes. It serves as a reminder for users to take their prescribed prescriptions on time and to record their in-take patterns for subsequent evaluation by medical specialists.

- ESP32: ESP32 is a family of low-cost, low-power microcontrollers that are designed on a chip and come equipped with dual-mode Bluetooth and integrated Wi-Fi. It serves as an interface between the equipment and the app.
- LED: This light-emitting diode display will look like a regular red light and will show information like power on, emergency alert, and flashing while the speaker beeps to get the user's attention.
- LCD DISPLAY: It also gives the patient pre-selected safety measures with reference to the drugs that are now being prescribed.
- An ordinary 16-key alphanumeric keypad is used as the keypad input. It permits the system to be programmed by the user. The user can view the time that has been set or reset using the alpha numeric display unit. It gives the viewer a visual depiction of the container's contents. When a warning is needed, the same unit may be used to provide it.

The design of the automatic medication dispenser (AMD) is discussed in this study. After gathering the specifications required to construct this device, the design is carefully considered. The last step is the proposal of a pharmaceutical dispenser design process. The programmable automatic medicine dispenser allows the carer to reliably provide a patient's medication without physically being present every time it is scheduled.

An ergonomic interface with an LCD monitor and an alphanumeric keypad allows the carer to pre-program the AMD to accommodate up to five different drug regimes. Pre-programming the AMD to perform the same cycle continuously for a month is feasible.

The clients who use this technology are primarily concerned about performance, dependability, serviceability, cost, and safety. To prevent potential tampering, the device needs to be lightweight, easy to use for both the patient and the carer, well-built, have a bright warning LED, sound alerts that are louder than 70 decibels, and have a good display unit. The AMD product has a long lifespan and is simple to fix. An enclosure ensures the longevity and safety of the mechanical components, and the software is robust. Its main characteristics are its small size, low weight, and system reset function. A locking mechanism is often required to stop the device from being misused. For safety, parts like electrical, SMPS, and motors, among others, need to be enclosed.

Several things are considered before the design process starts. The following considerations were used when designing the pharmaceutical box: The device needs to have a circle base with thirty fans that form parts and resemble blades. Each compartment should be used to store pills and capsules. Software must be trustworthy and capable of documenting the dispensing of prescription drugs, both present and future. There needs to be a mechanical lock on it to keep it safe from tampering. An LED display is necessary to indicate the operating state and to deliver pertinent instructions. A microcontroller interface featuring an alpha numeric keypad, stepper motor, alarm, and LCD display is included. It is necessary to provide notifications in both visual and audio formats.

A survey of the literature on pill dispensers reveals a broad spectrum of research, projects, and implementation techniques aimed at improving medication delivery for individuals with various needs. Pill dispensers are crucial for enhancing patient outcomes, promoting medication adherence, and lowering prescription errors. They are also known as automated medication systems or medication adherence devices.

Many academic domains, such as engineering, psychology, medicine, and human-computer interaction, are researching pill dispensers. Among other things, these studies examine the efficacy, usability, design, and influence of pill dispensers on patient care.

A common subject in the literature is the use of state-of-the-art technologies into pill dispensers to enhance their functionality. It is standard procedure to provide features like automated dispensing, dose tracking, medication reminders, and remote monitoring using sensors, actuators, Internet of Things (IoT) connectivity, and automation mechanisms.

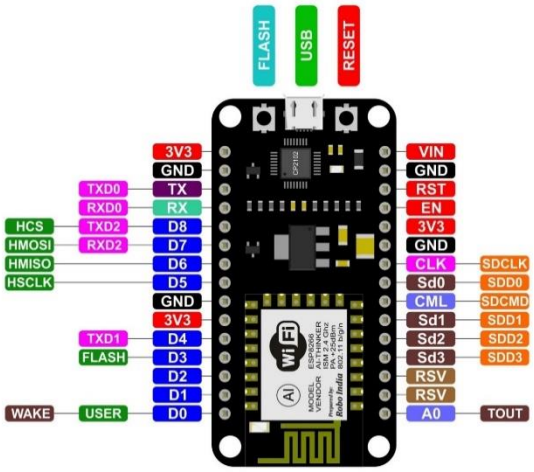
Another interesting topic in the literature is the creation of pill dispensers utilising principles of user-centred design. Researchers emphasise the importance of designing pill dispensers with accessibility, simplicity, and customisation options in mind, to meet the diverse needs and preferences of consumers. Iterative design techniques, usability testing, and user input are combined to create drug dispensers that are easy to use, intuitive, and well-liked by patients and carers.

The ability of a pill dispenser to perform properly is essential to guaranteeing medication adherence in cases when individuals struggle with complex prescription regimens or cognitive impairments. This is a thorough explanation of all the components, mechanisms, and safety measures of a typical pill dispenser.

A pill dispenser starts to work when prescription data is entered. Users or carers provide details about the medications to be administered, including dosage, frequency, and exact administration times. This information is necessary for the dispenser to appropriately distribute drugs in accordance with the prescribed regimen.

III. NODE MCU:

- The Node MCU is an open-source firmware and development kit that helps you to prototype your IoT product with Arduino IDE or in few Lau script lines.
- It includes firmware which runs on the ESP8266 Wi-Fi SoC. And hardware which is based on the ESP-12 module. In this tutorial we explain how to use Node MCU with Arduino IDE.



How to Connect Node MCU with Arduino IDE

1.Start up the Arduino IDE.
2. Select File -> Preferences -> Additional Boards Manager URLs from the followingURL: http://arduino.esp8266.com/stable/package_esp8266com_index.json
to Press OK.
3. Close the IDE and reopen it.
4. Select your version of Arduino under Tools -> Board -> Boards Manager. Locate the ESP8266 and click Install. It should now be possible to utilise the ESP8266 like an Arduino. All you have to do to get started coding is choose the NODEMCU 1.0 as your board with Port.
5. We can now programme Node MCU directly in the Arduino IDE after installing the ESP8266 board.

- Shanghai, China-based Espresso Systems is a fabless semiconductor firm that produces the ESP8266 series, or family, of Wi-Fi chips. The ESP8266EX and ESP8285 chips are currently part of the ESP8266 series.
- The ESP8266EX, sometimes known as just ESP8266, is a system-on-a-chip (SoC) that combines filters, power management modules, antenna switches, RF baluns, conventional digital peripheral interfaces, power amplifiers, low noise receive amplifiers, and 32-bit Ten silica microcontrollers into a compact package.
2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16 GPIO), inter-Integrated circuit (I^2C), analogue-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I^2S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM) are among its features.
- The CPU core, dubbed "L106" by Espresso, operates at 80 MHz (or can be overclocked to 160 MHz) and is based on Tensilica's Diamond Standard 106Micro 32-bit processor controller core. It features an 80 KiB user data RAM, 32 KiB instruction RAM, and 64 KiB boot ROM. (In addition, there is 16 KiB ETS system data RAM and 32 KiB instruction cache RAM.)
Through SPI, external flash memory can be accessed. The silicon chip is contained in a 5 mm x 5 mm Quad Flat No-Leads packaging that has 33 connection pads: one big thermal/ground pad in the centre, and eight pads on each side.

- The System on a Chip (SoC) ESP8266 is produced by Espresso, a Chinese startup. It is made up of a Wi-Fi transceiver and a Ten silica L106 32-bit micro controller unit (MCU). In addition to an analogue input, it contains 11 GPIO pins* (General Purpose Input/Output pins). This indicates that it can be programmed in the same way as a standard Arduino or other microcontroller. Furthermore, it comes with Wi-Fi communication, which you can use to host a web server with actual web pages, connect to the Internet, connect to your Wi-Fi network, and more... There are countless options! It makes sense that this chip has grown to be the most widely used IOT gadget.
- With its inbuilt TCP/IP protocol stack, the ESP8266 WiFi Module is a self-contained SOC that can provide access to your Wi-Fi network for any microcontroller. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that is just out of the box)! The ESP8266 can either host an application or offload all Wi-Fi networking functions from another application processor! The ESP8266 module is a very affordable board with a sizable and continuously expanding community.
- Through its GPIOs, this module may be coupled with sensors and other application-specific devices with minimal upfront development and minimal loading during runtime thanks to its robust on-board processing and storage capabilities. Because

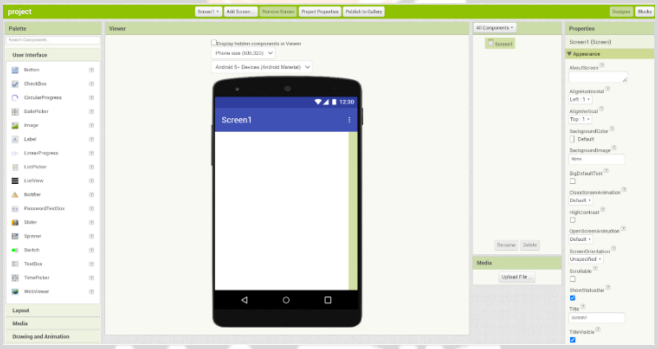
of its high level of on-chip integration, it requires very little external circuitry; in fact, the front-end module is made to take up little space on the PCB.

- The ESP8266 is compatible with Bluetooth co-existence interfaces and APSD for VoIP applications. It doesn't require any extra RF components and has a self-calibrated radio frequency that enables it to function in all operating situations.

IV. MIT APP INVENTOR:

• App Inventor is a free cloud-based tool that lets you use a block-based programming language to create your own mobile applications. You use a web browser (Safari, Firefox, Chrome) to access App Inventor. These easy-to-follow courses will teach you the fundamentals of creating apps for Android and iOS smartphones and tablets.
•You'll require:

• A Windows or Mac computer (see to the system requirements)
• A connection via Wi-Fi
• Since you're going to be creating a mobile application, it's entertaining to test it on a phone or tablet both during and after development. Your apps must be set up in order to operate.
•To run your apps, select the connection method you want to use and then follow the links for setup instructions:
• Chromebook;
• Android device (phone or tablet) with a USB cable;
• iOS or Android device (phone or tablet) and Wi-Fi
• An emulator that runs on screens



V. WORKING:

Once the pharmaceutical information has been input, the medications are stored inside the dispenser in a secure manner. This is usually made easier with trays or divisions designated for each drug. These sections ensure that different medications are arranged and separated to prevent confusion.

The elderly must receive medication on a timely basis. An automatic medicine dispenser is made especially for people who take their drugs under the supervision of a healthcare provider.
After that, the user sets up the dispenser in line with the suggested medication schedule. This involves timing each dose in compliance with the patient's prescription regimen. To assist users in remembering to take their medications on time, features such as alarms and reminders can be put up.

To retrieve the pill and reset the alarm button, the user must open the box. To alert the user to replenish the dispenser with the necessary number of pills, the second alarm will sound to show when the pills are most optimally available within the container.

Medication must be given to the elderly on schedule. Medication takers who do not have tight professional supervision are the target audience for automatic medication dispensers.

The user is relieved of the error-prone task of giving the wrong medication at the wrong time.
A microcontroller interfaced with an alphanumeric keypad, an LED display, a motor controller, an alarm system, a multiple pill container, and a dispenser are the main parts of this medication dispenser.

The main goal is to make it easier for the user to configure the timings so that several pills can be dispensed at the appropriate times.

The alarm system is intended to deliver two different kinds of indications: an LED light and an audible alert sound.

To obtain the medication and reset the alarm, the user must open the box. The purpose of the second alarm is to alert the user when the pill supply in the container is at its best and prompt them to restock the dispenser with the necessary number of pills.

The main goal is to maintain the gadget's affordability and simplicity. The programme in use is stable and dependable.

This gadget can help the elderly population because it eliminates the need for costly in-home medical care.

It is essential to give elderly people their medication on time.

Medication takers who do not have tight professional supervision are the target audience for automatic medication dispensers.

The user is relieved of the error-prone task of giving the wrong medication at the wrong time.
In addition to dispensing pills automatically, pill dispensers also feature alarm systems that notify users when it is time to take their prescription.

These alerts could be sent as auditory alarms, flashing lights, or notifications to a caregiver's phone or other mobile device. Reminders serve as cues to take medication, which helps people follow their doctor's instructions.
The drugs are safely kept inside the dispenser after the pharmaceutical information has been entered. Usually, trays or compartments set aside for each medication make this easier. To avoid mix-ups, these compartments guarantee the arrangement and segregation of various drugs.

The user then configures the dispenser in accordance with the drug schedule that has been prescribed. This entails determining the time of each dose in accordance with the patient's prescription schedule. Users can also set up features like alarms or reminders to help them remember to take their medications on time.

It is necessary to provide medication to the aged in time. Automatic medication dispenser is designed specifically for users who take medications without close professional supervision.

It relieves the user of the error-prone tasks of administering wrong medicine at wrong time.

The major components of this medication dispenser are a microcontroller interfaced with an alphanumeric keypad, an LED display, a Motor Controller, an Alarm system, a multiple pill container and dispenser.

The overall operation is to facilitate the user to set the timings to dispense multiple pills at required timings.

The Alarm system is designed to provide two types of indications – one by lighting an LED and the other by providing a alarm sound.

The user is required to open the box to get the pill and reset the alarm button. The second alarm is to indicate the optimal availability of the pills in the container to warn the user to refill the dispenser with the required quantity of pills.

The major objective is to keep the device simple and cost efficient. The software used is reliable and stable.

Elderly population can benefit from this device as it avoids expensive in-home medical car

It is necessary to provide medication to the aged in time.

Automatic medication dispenser is designed specifically for users who take medications without close professional supervision.

It relieves the user of the error-prone tasks of administering wrong medicine at wrong time.

Pill dispensers have alarm systems that tell consumers when it's time to take their prescription in addition to automatic distribution.

These warnings may come in the form of notifications to a caregiver's phone or mobile device, flashing lights, or audio alarms.

Reminders function as triggers for taking medication, assisting users in adhering to their prescribed regimen.

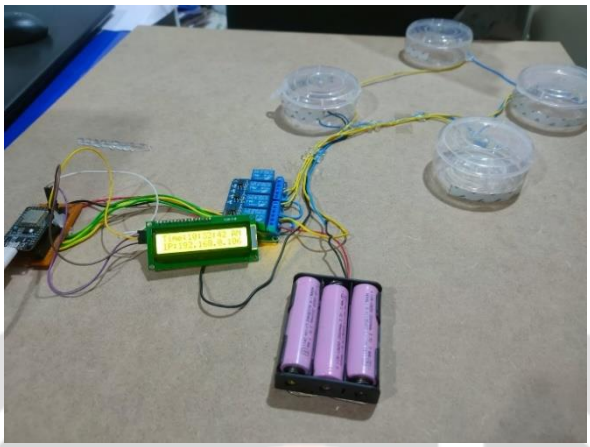


Fig 1: Hardware kit1.

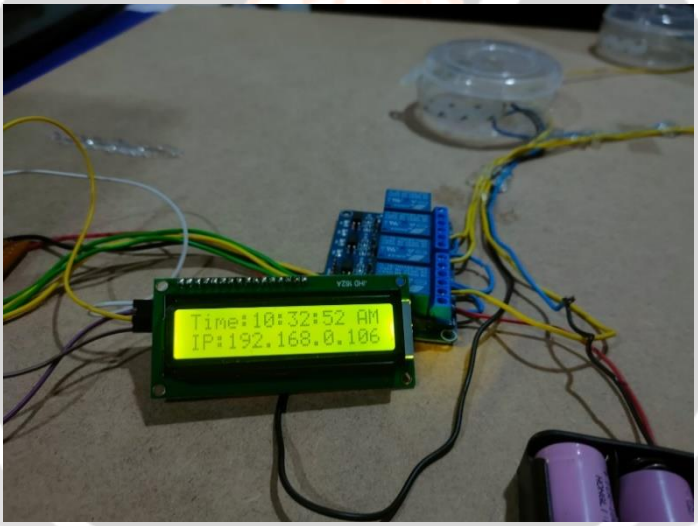


Fig 2: Hardware kit2.

CONCLUSION:

In conclusion, pill dispensers are a useful tool for patients, carers, and medical professionals to manage prescriptions and offer several benefits. Pill dispensers are vital because of their automated dispensing capabilities, user-friendly interfaces, and safety features, which all help to improve patient outcomes, reduce prescription errors, and encourage medication adherence.

Pill dispensers are effective in improving medication adherence, as the research has shown. These devices have been shown in numerous trials to have favourable benefits on a variety of patient populations, including older persons, individuals with chronic diseases, and individuals with cognitive impairments. Pill dispensers organise medications, provide regular reminders, and ensure proper dosage, all of which assist patients adhere to their prescribed prescription regimens and improve quality of life and health results. Furthermore, medication dispensers are useful tools for carers, offering comfort and support during drug administration tasks. Thanks to features like adherence tracking, real-time notifications, and remote monitoring, carers can keep an eye on their loved ones' medication intake, respond appropriately when necessary, and provide individualised support even when they are far away.

Pill dispensers provide healthcare providers insights into patient adherence patterns and medication usage, thereby promoting personalised care management and improved decision-making. Healthcare professionals may monitor medication adherence and identify any issues or concerns early on to optimise treatment outcomes and prevent unfavourable occurrences.

Pill dispensers have limitations, such as usability concerns, reliability challenges, and moral quandaries, despite all their benefits. To solve these problems, researchers, engineers, doctors, legislators, and patients must work together continuously to develop new ideas, improve user experience, and ensure the safe and effective use of drug dispensers in a range of healthcare settings.

In conclusion, medicine dispensers are crucial to modern healthcare because they offer a convenient, effective, and safe method of managing medications. The capabilities of pill dispensers will grow because of technological advancements in healthcare and patient outcomes. This could improve medication adherence, patient outcomes, and overall quality of life.

REFERENCES:

Dew, K., Stubbe, M., Signal, L., Stairmand, J., Dennett, E., Koea, J., … Simpson, A. (2016). "Doctors do batter: Interprofessional and medical hierarchy-related stress within New Zealand operation departments." Health Sociology Review, 25(2), 187–197.

Dobbels, F., Kurt, E., De Freemont, S., De Bleser, L., De Geist, S., & Rupar, T. (2020). "Adherence to the immunosuppressive regimen in paediatric kidney transplant recipients: A systematic review." Paediatric Transplantation, 24(3), e13644.

Flynn, A. B., Howell, D., Wohlford, S., & Tudor Car, L. (2020). "Remote management of chronic disease: Are we being supported to do this?" BMJ Health & Care Informatics, 27(1), e100140.

Gelled, W. F., Grenard, J. L., & Marcum, Z. A. (2019). "A systematic review of barriers to medication adherence in the elderly: Looking beyond cost and regimen complexity." The American Journal of Geriatric Pharmacotherapy, 7(1), 1–11.

Granger, B. B., DosReis, S., Edgerton, J. R., & Dew, M. A. (2019). "A qualitative exploration of primary care providers' perceptions about medication nonadherence and its management in heart failure patients." Patient Preference and Adherence, 10(1), 1–10.

Koh, Y., Park, J., & Kim, D. (2018). "Design and implementation of a home medication dispenser using an IoT platform." International Journal of Distributed Sensor Networks, 14(7), 1–10.

Rostami, M. R., Karami, E., & Khushnudi's, S. (2020). "Design and development of a smart pill dispenser to improve medication adherence using the Internet of Things (IoT) technology." Computers in Biology and Medicine, 122, 103828.