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IoT-based Automatic Pill Dispenser for Hyperlipidemia's Patient

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ABSTRACT

The elderly who stay at home alone, especially those with hyperlipidemia, would have problems taking their medicine if their medicine is too much with a different variety. The current market product that provides a pill dispensing service is costly with limited functionality; some require a monthly subscription fee and do not have passcode protection for safe use. This work proposed an innovative design of a prototype model of a pill dispenser for the elderly with IoT functionality. This prototype provides tolerance to the most general type of pills and hyperlipidemia-related pills in specific. The prototype employed the integration of hardware and software apparatus. The hardware components include the Durian UNO board, ESP8266 Wi-Fi transceiver module, stepper motor, RFID kit, temperature, humidity sensor, push button, solenoid door lock, buzzer and relay module. The hardware part will support different monitoring systems while sending the data through the Internet for real-time monitoring. Solid Work, Arduino IDE, Blynk Apps and Fritzing software will be utilized for the software. This prototype is intended to provide all the essential features while maintaining the moderate cost of the product. The proposed design can greatly reduce the error of taking the wrong medicine. The caregiver can access the surrounding temperature and humidity of the dispenser. Besides, they can know whether the user has taken the medicine and receive emergency notifications from the user.

1. Introduction

According to the statistic by the Department of Statistics Malaysia, the five principal causes of death consist of ischaemic heart diseases (19.3), pneumonia (11.1%), cerebrovascular diseases (7.7%), transport accidents (4.1%), and malignant neoplasm of trachea, bronchus, and lung (2.8%) [1]. Besides transport accidents, critical illnesses are the main contributors to death in Malaysia. Critical illness could be vital if preventive or controllable steps are not taken [2-4].

To control it, taking medicine is one of the best ways. The medicine can be categorized into liquid, solid, gas, and semi-solid [5]. Different physical properties of medicine have respective storage methods. The optimum storage temperature for medicine is between 2° C to 8° C (cold storage) or storage under 30° C [6]. Most medicine is obtainable at government hospitals, clinics, private

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hospitals, or pharmacies. Due to some situations, such as the COVID-19 endemic, it is dangerous for people, especially the elderly, to visit crowded places frequently. The elderly have lower immunity against the virus. Hence, it is harmful to them to get the medicine at frequent times at such places by themselves.

The main concern in this work is the elderly who stay at home alone. They need help understanding the medicine instruction or seeing the label clearly due to illiteracy or vision deterioration. They might need to remember when to have medicine or the number of pills to consume, even if they understood the instruction. Furthermore, the pill dispenser's safety is not promised when kids are around. Another issue is the ambient temperature and humidity of the pill dispenser can affect the quality of medicine consumed. It must keep under optimum temperature, especially in Malaysia, where the weather is always hot and humid.

For the current market, some pill dispensers are made for this purpose [7-12]. The pill dispensers are helpful but with a few limitations in terms of being costly, limited availability in Malaysia, requiring a subscription fee, being unable to observe the patient's condition through the phone, and being unable to detect whether the pills have been taken or not. Some products are not integrated with IoT, which makes it harder for the caregiver to observe the condition of the elderly remotely. Furthermore, there was also some related project that reported the IoT-based pill dispenser [13] - [17]. However, the pill spinners designed using a vibration motor are not working well. Some were not equipped with any buttons for adjusting the medicine time. In this case, there is a need to develop a model that can solve the problems mentioned above.

This project aims to design and develop a prototype model of pill dispensers for Hyperlipidemia patients, integrate the system with the Durian UNO board and Blynk Apps for IoT applications, and test the functionality among the elderly, especially for those who stay home alone. The dispensing mechanism's design must be exact and allow for varying pill sizes to be accommodated. The system's procedure should be able to run under the Arduino IDE and Blynk apps, according to the developed algorithm. Furthermore, the testing parameters should meet the project's basic and user-defined requirements, such as temperature, humidity, stepper motor dispensing time, RFID response, and other additional functions.

2. Methodology

Figure 1 shows the flowchart of the system operation. Firstly, it will check for the temperature and humidity of the storage compartment. If the temperature and humidity are maintained at the required value, it will continue with the next step. It will alert the user if the temperature range is exceeded. The system also provided a push-button for emergency notification to the caregiver. Once the input medicine time is reached, the stepper motor will dispense the pills and alert the user through Buzzer and Blynk apps. It will further detect if any valid RFID card is used to scan. If yes, it will alert the user through the apps that the medicine has been taken, and the solenoid lock door will open, else it will continue for the detection of the card. The flowchart will loop back and provide real-time control to the user.

The system's block diagram is presented in Figure 2. Every component that was used in this project is listed. The Durian UNO board is the system's brain [18]. It is in charge of all operations. The Durian UNO board has been used as the main microcontroller for the hardware part. It has different functionality provided on the board and receives its power from the power adapter. Using an ESP8266 Wi-Fi transceiver module, the Durian UNO board is connected to the internet [19].

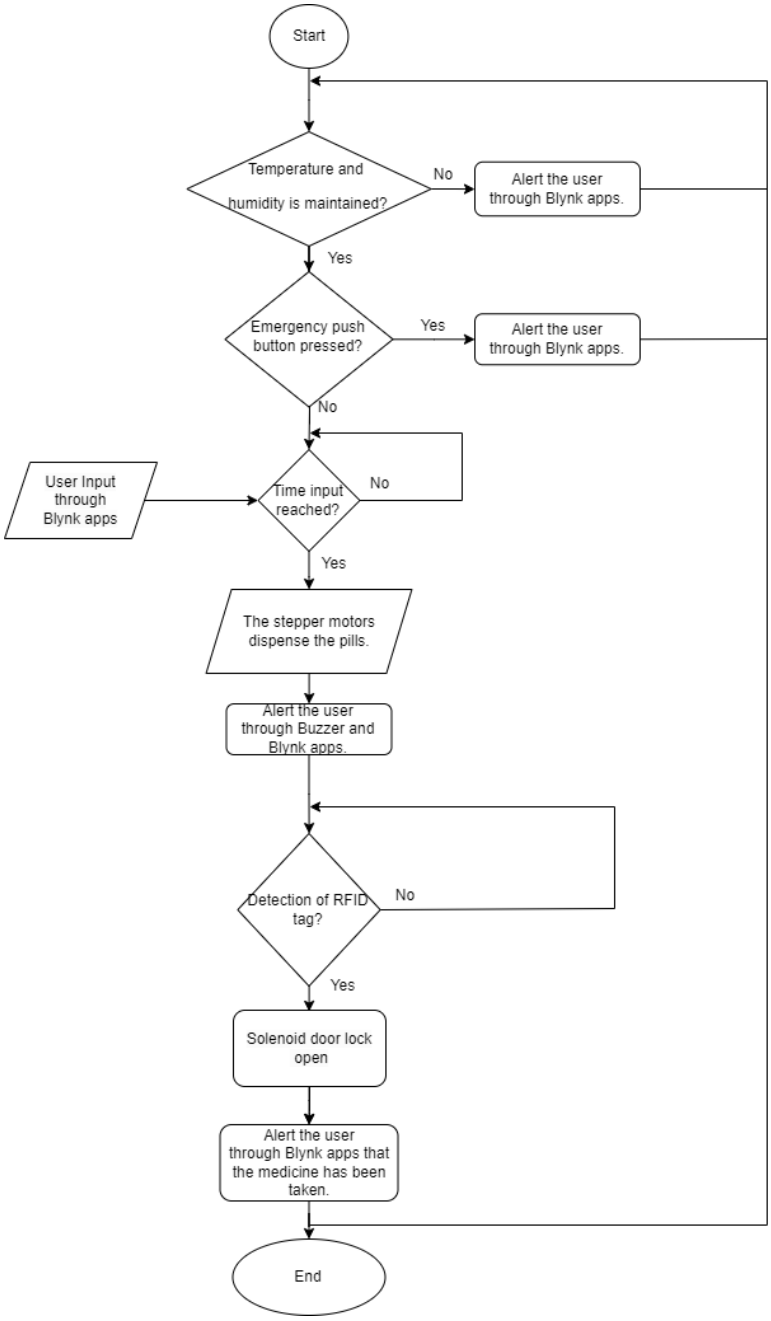


Fig. 1. Flowchart of the system operation

Blynk Apps have been used to perform the IoT function. The Blynk apps can send and receive notifications from the Durian UNO board, allowing two-way communication. The stepper motor can control the angle to control the pill's flow [20].

Besides, an RFID kit unlocks the system for pill acquisition [21]. In addition, a temperature and humidity sensor is used to observe the temperature and humidity inside the pill storage compartment. Furthermore, the push-button is used to provide an emergency call function. Lastly, the solenoid door lock is used to lock the pill dispenser platform before taking by the user, where the relay on the Durian UNO board is used for controlling the solenoid door lock [22-25].

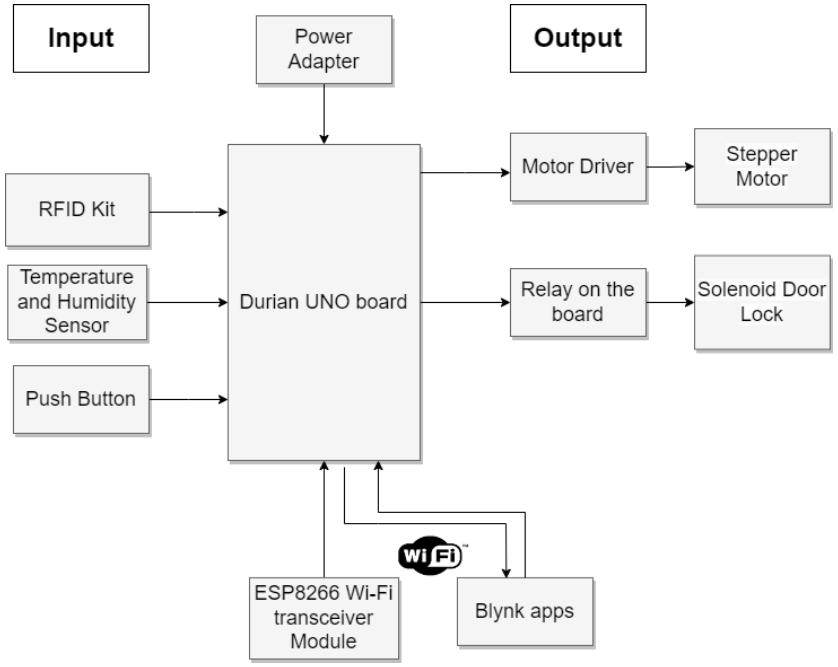


Fig. 2. Block diagram of the developed system

For the building of the prototype, the 3D printing technique was used to develop the specific compartment shape for the dispensing mechanism, together with the acrylic material for the shell. The acrylic material was cut by using a laser cutter. Solid Work 2021 was used for developing the 3D sketch, and the Arduino IDE was used as the programming language for the software apparatus. Additionally, Blynk apps was used to notify the user through the phone, while Fritzing was used for the circuit simulation.

Durian UNO board was chosen because of the variety of functions suitable for the project. The connection of the components and related pin used is shown and tabulated in Figure 3 and Table 1. The ground and VCC connection are connected to the board directly as a designated pin is provided on the board. The Durian UNO board is replaced with Arduino UNO in the simulation work since the pin location is similar.

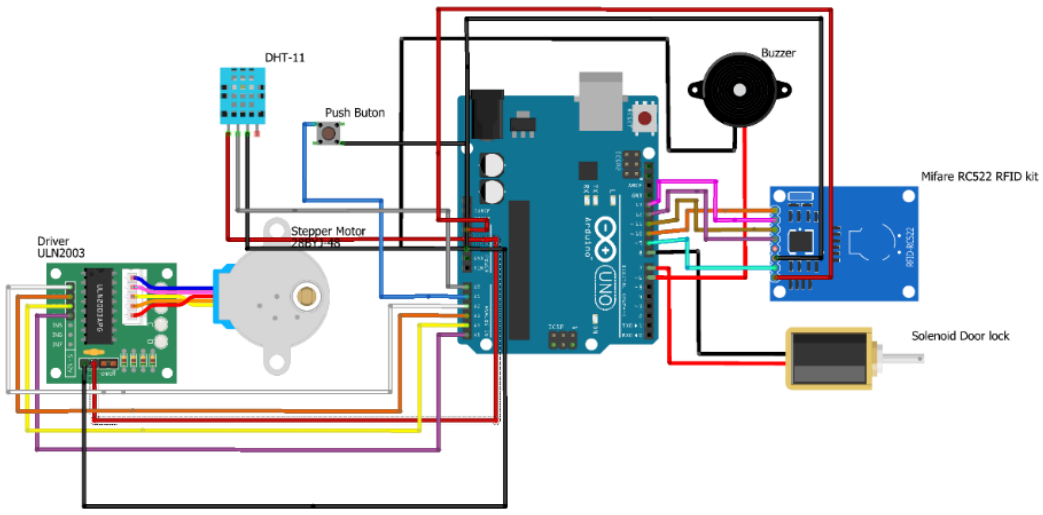


Fig. 3. Connections for the Durian UNO board with components using Fritzing software

Table 1
Connections for the Durian UNO board with components

Durian UNO board pinout	Pin Connection
GND	GND
VCC	5V
A0	DHT-22 Humidity sensor
A1	Push Button
A2, A3, A4, A5	Stepper Motor
6	Buzzer
Relay on the board (Pin 7 and 8 used for relay control)	Solenoid Door lock 12V
9, 10, 11, 12, 13	Mifare RC522 RFID

3. Results and Discussion

This section presents and discusses the results: design of the pill dispensing components using SolidWorks, including the complete view of the developed prototype model, and the functional testing of the pill dispenser, including the pill alarm notification, humidity and temperature monitoring, and emergency button functions.

3.1 Innovative Design of Pill Dispensing Components

The prototype model was sketched using SolidWorks software. The millimetre unit was used, making small-scale design easier. Solid work includes 2D and 3D drawings that enable us to understand the dimensions easily. The design was divided into two parts. Part A is the dispensing mechanism's case, while part B is the spinner plate driven by a stepper motor. The hole is designed concerning the size of the pills, which is a vital component of this design. It was developed with tolerance to support pills of general scope and hyperlipidemia-related pills in specific. Figure 4, the drawing shows the dimension of the casing from different views. The hole for the pill's size and the shell thickness can be viewed. Besides, the height of the casing and the isometric view of the casing can be seen inside the drawing. Part B, which includes one extended pipe for the casing, will be directly connected to the stepper motor.

The dimensions of the pipe and hole are illustrated in Figure 5. Additionally, it displays the extruded pipe used to hold the pill while it spun. The spinning plate is shown in an isometric view as well. Extrusion is used to create a second area that can hold the pill while spinning. The plate contains two different-sized holes to cover two different pill sizes.

The drawing for the casing holder is illustrated in Figure 6. It was made with an open hole so that the casing wing could be attached directly. The hole's 3mm width is identical to the wing's 3mm width. Superglue was used to secure it to the platform so that the casing will not spin and potentially damage the dispensing mechanism.

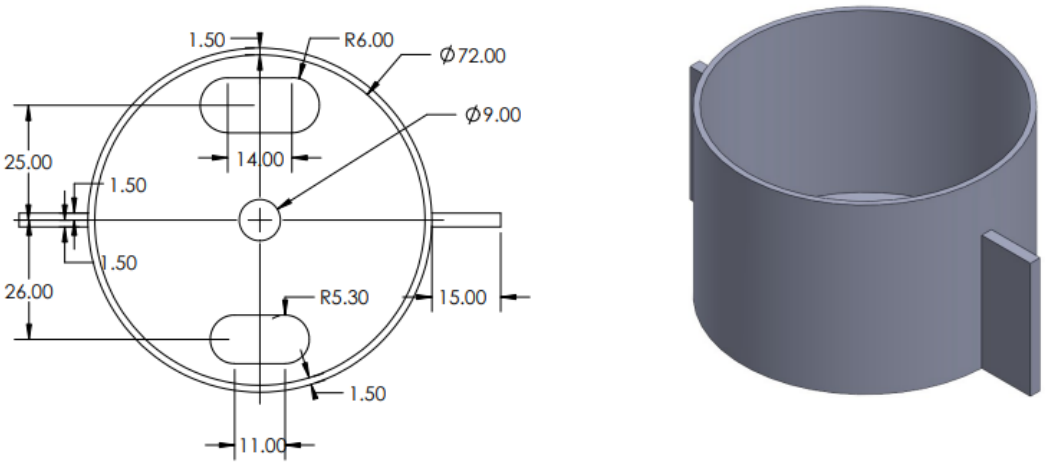


Fig. 4. Drawing for part A (dispensing mechanism's case)

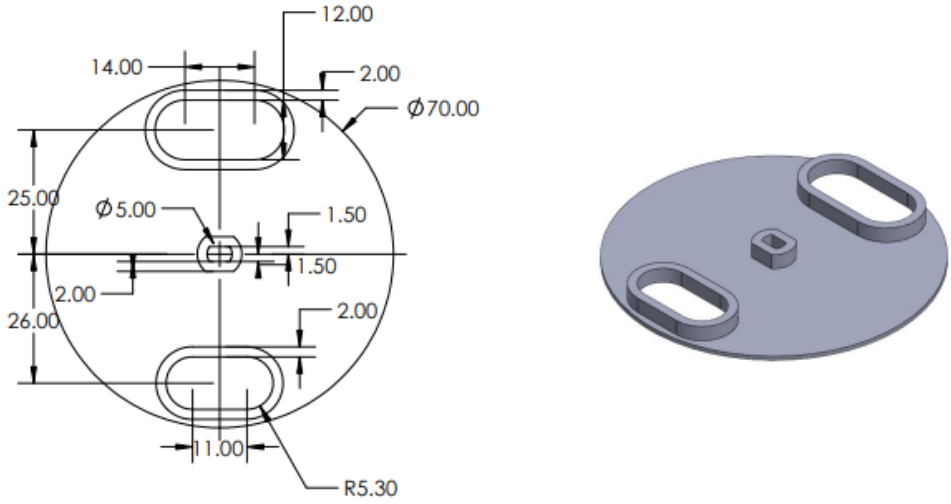


Fig. 5. Drawing for spinning plate

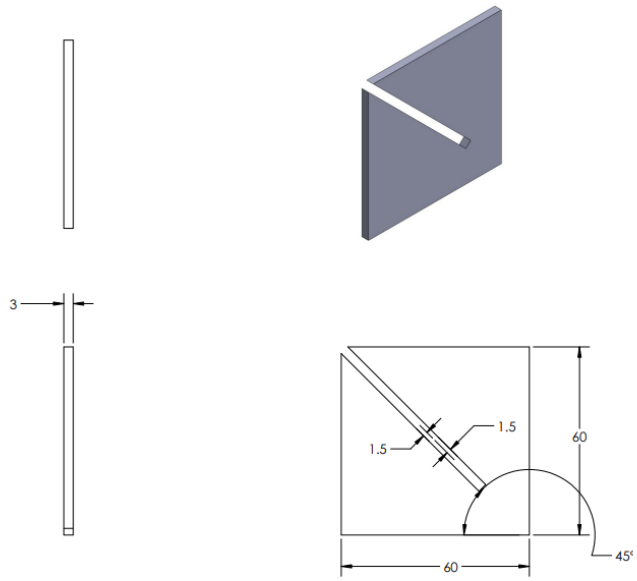


Fig. 6. Drawing for casing holder

3.2 A Complete View of the Developed Prototype Model

Figure 7 shows the front view of the developed prototype design. The prototype model was constructed utilizing acrylic sheets that are A4 size. Straight-line cutting, which is required for box construction, has been made possible by the laser cutter. Additionally, the machine cuts the hole needed for the wire of the RFID module to pass through. The L-shaped stabilizer for supporting the middle plate and the door for putting the medicine in were also made with the aid of the laser cutter. Drill was used to making the passageway for the wires of the door lock solenoid, button, and adapter. Before drilling the hole, clear tape is required to prevent a rupture in the affected area. The acrylic is then bonded using epoxy and superglue. The side and back walls have been adhered to with sticker paper to keep the box from being exposed to direct sunlight.

The position of the LED, input timer, gauge, and super chart can all be chosen within the Blynk apps. The user interface can be modified to suit their preferences. The project's user interface is depicted in Figure 8. The apps can be used by the user or caregiver when their phone has an internet connection. They will receive push notifications from the apps. From the Blynk app, the user or caregiver can get a notification on several main conditions, such as an emergency alert from the pill dispenser user at home, abnormal temperature and humidity level from the dispenser, the medication time, and the pill is taken condition.

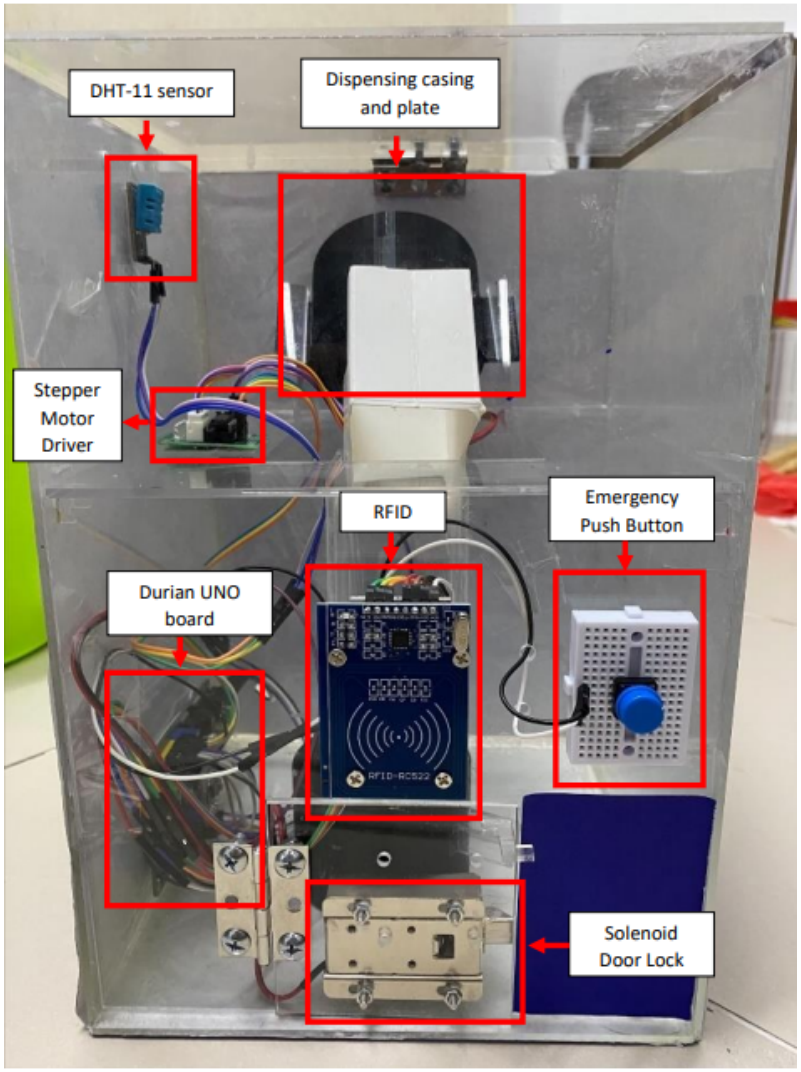


Fig. 7. Front view of the developed prototype model

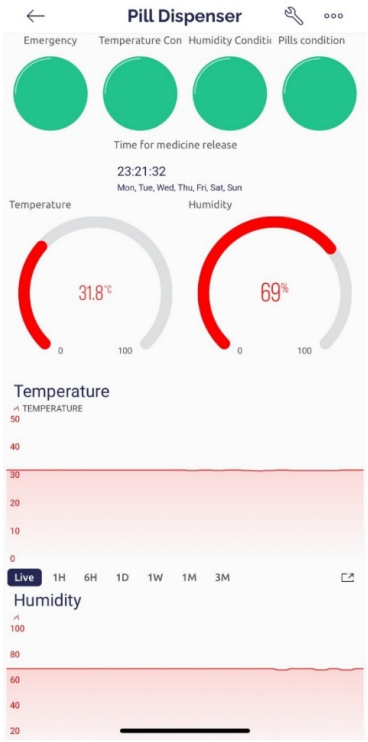


Fig. 8. User interface of the Blynk apps

3.3 Functionality Testing

The caregiver can set the time for taking medicine. The stepper motor will operate to spin 360 degrees when the input time and present moment are the same. At the first 180 degrees, it will reach the lower part of the casing. The following section is where the pills will be acquired. It will then make another 180-degree revolution and return to its starting location.

Nutrilite Bio C Plus and Dissoflam capsules were used as testing pills because hyperlipidemia-related pills are controlled and difficult to obtain. The pills were fed into the hole and were spun back to their initial position for dispensing. The pill can be dispensed from this position through a tube to the cup at the bottom of the dispenser. Following this procedure, the user will receive a notification for medication time, and the buzzer will begin to play music.

The door can be unlocked by the user using an RFID tag. It is crucial to stop children from mistaking medicines for candy. Additionally, the caregiver will be notified again once the user has taken the tablets; otherwise, the LED will remain red, indicating that the user has not yet taken the medication. Figure 9 displays the notification showing the pill has been taken, and the red LED return to its original green colour.

If there is an emergency, the user can press a button. The caregiver will be immediately notified if the user presses it. The LED condition will remain red, indicating the emergency unless the user releases the press button. This important feature gives the user a faster option than placing a call. Figure 10 shows the photo of the emergency notification received at the Blynk app once the user presses the emergency button.

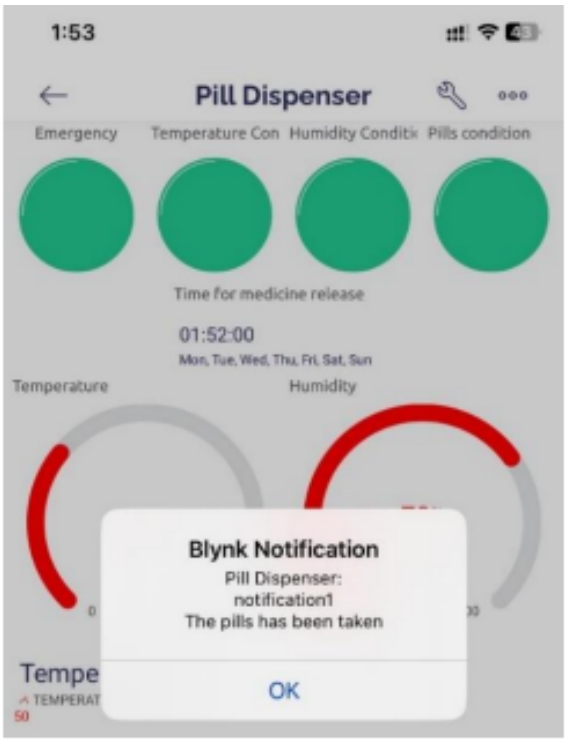


Fig. 9. Pill has been taken notification

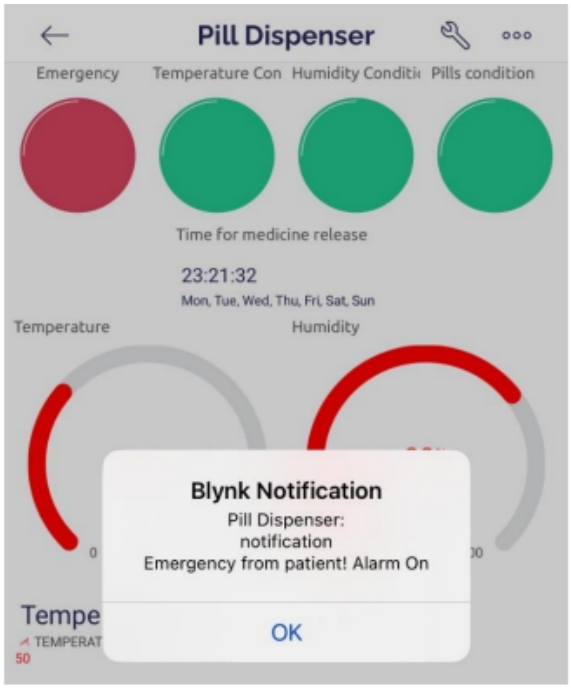
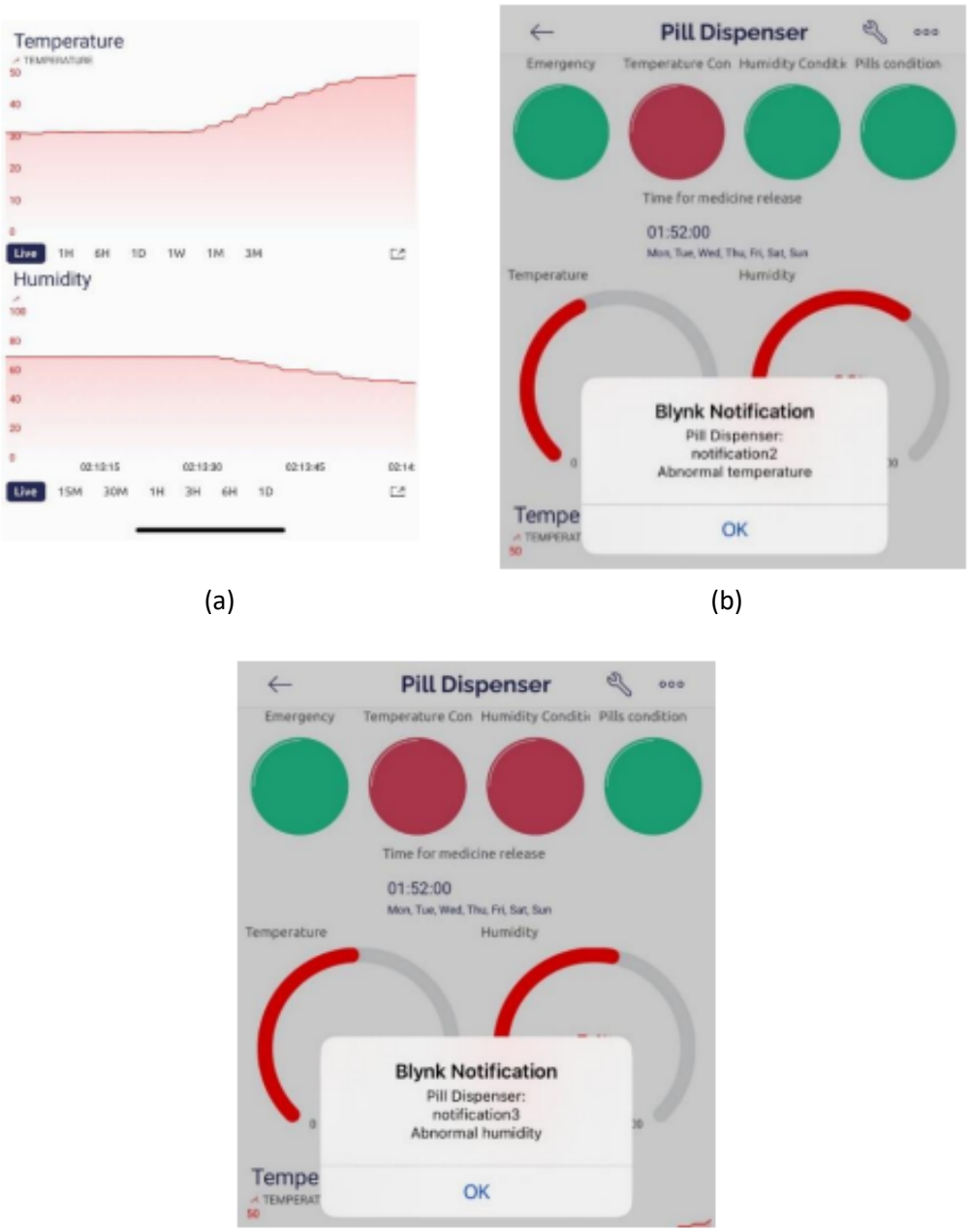


Fig. 10. Notification for emergency button

The caregiver can also be notified of an abnormality in the temperature or humidity. This function can aid in maintaining the pill's ideal storage environment. The preset temperature ranges from 15 °C to 40 °C. The preset parameter for humidity is between 60 % and 85 %. The room's relative humidity is around 71 %, so the humidity was adjusted higher. It is important to prevent the alarm from activating randomly. In addition, this feature, which includes a super chart, can assist in instantly alerting the caregiver. The caregiver can determine whether the casing has been exposed to direct

sunlight, a fire, or floods. Figure 11 shows (a) the super chart with real-time changing data, (b) the abnormal temperature with the LED turning red, indicating the temperature is still abnormal, and (c) the notification for abnormal humidity with the red LED turned on, indicating the condition remained the same.



(a) (b)

(c)

Fig. 11. (a) Super chart with real time changing data, (b) abnormal temperature notification, and (c) abnormal humidity notification

4. Conclusions

In conclusion, the proposed prototype model has accomplished the project's objectives, an innovative design of a prototype model of a pill dispenser for the elderly with IoT functionality. The elderly who are home alone and have certain diseases, such as hyperlipidemia, can benefit from this designed pill dispenser. Additionally, even if the user is healthy, supplements like calcium or vitamin

C might be substituted for the pills. In addition to giving the user medication, it allowed them to interact with a family member or caregivers daily. It can greatly reduce the error of taking the wrong medicine. The created prototype can assist in daily interaction and send an urgent notification to the user's or caregiver's phone, one of the most used devices in their daily lives. The push button can respond much more quickly than pressing numerous buttons on the phone to place a call. The prototype also can detect changes in the humidity and temperature of the ambient environment inside the pill's storage. It can aid in determining whether the location of the pill storage is ideal. The caregivers or user may be alerted too if the humidity range rises. Lastly, the prototype created is operational, and the integration with the Internet and Blynk apps is excellent.

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References

[1] D. S. D. M. U. MAHIDIN, "Statistics on Causes of Death, Malaysia, 2021," *Department of Statistics, Malaysia*, 2021.
[2] Mumthaj, P., P. Natarajan, A. Janani, J. Vijay, and V. Gokul. "A global review article on hyperlipidemia." *International Journal of Pharmaceutical Sciences Review and Research* 68, no. 1 (2021): 104–110. https://doi.org/10.47583/ijpsrr.2021.v68i01.018
[3] Shattat, Ghassan F. "A review article on hyperlipidemia: types, treatments and new drug targets." *Biomedical and pharmacology journal* 7, no. 1 (2015): 399-409. https://doi.org/10.13005/bpj/504
[4] Naser, Iman Hussein, Zahraa Abd Alkareem, and Amal Umran Mosa. "Hyperlipidemia: pathophysiology, causes, complications, and treatment. A review." *Karbala Journal of Pharmaceutical Sciences* 1, no. 19 (2021).
[5] Ananthakumar, R., and M. Pharm. "Types of dosage forms and their definitions." *School of Pharmaceutical Sciences Vels Institute of Science, Technology and Advanced Studies (VISTAS)* (2019): 2-15.
[6] Hayati Alwani bt.Yahaya, "Safe and proper storage of medicines," *MyHealthy Kementerian Kesihatan Malaysia* (2015).
[7] Hero Pill Dispenser & Medication Manager. 2019. "Hero Medication Manager and Pill Dispenser." *Hero Health*. (2019).
[8] "Med Smart product information," Epill.com. 2024.
[9] "Automatic Pill Dispenser Evaluations: Hands-on - Tech-Enhanced Life." *Tech-Enhanced Life* (2021).
[10] "Medminder Pill Dispenser," Medminder Systems, Inc, (2022).
[11] "Pria-How it works," Stanley Black & Decker, Inc., (2022).
[12] "GMS 28 Day Automatic Pill Dispenser," Amazon.com, Inc., (2022).
[13] Farah Binti Rahim, "IoT-based automated pill dispenser for Alzheimer patient," (2018).
[14] Othman, Nurmiza Binti, and Ong Pek Ek. "Pill dispenser with alarm via smart phone notification." In *2016 IEEE 5th global conference on consumer electronics*, pp. 1-2. IEEE, 2016. https://doi.org/10.1109/GCCE.2016.7800399
[15] Nur Syahirah Binti Md Aznam, "Medical Pill dispenser with buzzer notification," (2017).
[16] Muhammad Afifuddin Bin Mohd Ali, "IoT-based smart pill dispenser prototype with Arduino," (2018).
[17] Kama Afiqah Binti Haris, "Smart kit pill dispenser for traveler with NodeMCU," (2019).
[18] N. Kwang Chen, "Durian UNO ESP8266 IOT Starter Kit User Manual," (2022).
[19] "ESP8266-01 WIFI SERIAL TRANSCEIVER MODULE," MYBOTIC, (2022).
[20] "5V 28BYJ-48 Stepper Motor + ULN2003 Driver Board," Cytron Technologies Sdn Bhd, (2022).
[21] "Mifare RC522 RFID Kit," Cytron Technologies Sdn Bhd, (2022).
[22] "DHT11 Sensor Module Breakout," CYTRON, (2022).
[23] "B3F PUSH BUTTON ROUND (RED HAT)," MYBOTIC, (2022).
[24] "12VDC Solenoid Door Lock," Cytron Technologies Sdn Bhd, (2022).
[25] "5V BUZZER- PCB MOUNT," MYBOTIC, (2022).