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Magic box remindeR (MBR) system using IOT technology

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ABSTRACT

Medication non-adherence is major problem for high dependent treatment such as diabetic patients. Several barriers and factors impacting medication non-adherence are, age, ethnicity, literacy, social status, patient–clinician relationship, patient's misunderstanding or lack of knowledge, poor perception of illness and treatment efficacy. Therefore, patients need tools to reminds them to take medicine on time. The role of taking medication is important in the daily life of chronic patients. In addition, the delay in taking medicine will cause adverse health effects, for example, patient's blood sugar level to rise and unstable. Recently, medication neglect in chronic patients, has lead in deaths increase. Therefore, a magic box reminder is developed using Agile methodology to address this problem. It is sophisticated technology using Internet of Thing (IOT) technology that can help patients who forget to take medication. It helps to remind the patients to take medicine using a buzzer from the box and tell the patients about the medicine through the smartphone application. The notifications will display in Android platform. The patients can fully utilize the magic box from its convenient setting and easy functions. Thus, perhaps increase their health and longer life.

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Introduction

Nowadays, many individuals who need medical help, especially diabetic patients and family members of patients are also affected by the time of taking medicine to avoid missing the time of taking medicine. This is because the role of taking medication is so important in the daily life of diabetic patients. Sometimes the patient also skips taking medicine in a day causing the blood sugar level to be unstable. If the patient does not take vitamin B will also experience worse nerve pain. In recent times, an increase in cases of medication neglect has often occurred in diabetic patients, leading to an increase in deaths.

With this in mind, it is clear that medication should be taken at the right time. When the pill quantity and meal time have been set to avoid any complications to our health. In addition, there are also side effects if the medicine is not taken on time such as for diabetic patients the most likely immediate consequence of missing medicines for diabetes is a high blood sugar level. If the level is very high, it causes frequent and copious urination, thirst, and hunger (Muiz, 2015).

As a patient to get the maximum benefit from your medicines, it is very important to take them exactly at the time prescribed by the doctor. In fact, your chances of getting better health outcomes improve when you take your medication as directed. (The Importance of Taking Your Medications Correctly | Pfpfizeruscom, 2021).

Taking medicine at the appointed time is important to ensure that our body has enough medicine to control our disease. Otherwise it will cause complications or resistance will decrease over time. Here are tips that can help you remember to take your medicine on time such as set an alarm so you can take your medication at the same time every day. (Healthymepa, 2018)

The Magic Box Reminder (MBR) will remind the user or patient to take the pill using sound and light-emitting diode (LED) and also able to send notification to patients via phone applications. This project was developed to help problems of mistaking medicines on time.

The objectives of this project are: to detect medicine in the box using ir sensor, to remind user take medicine using buzzer and led, to notify user to take medicine via blnyk application dan to notify user if they run out of medicine via blynk application.

The main goal of the Magic Box Remainder (MBR) project was developed for patients who need to take medicine or additional vitamins continuously. MBR allows patients to determine the type of medicine according to the time of taking medicine for each day. MBR can send notification and sounds on the patient's mobile phone. Furthermore, the size of our MBR is in medium size, so it is easy for patients to carry anywhere at any time. In addition, MBR also uses low cost. This project can also ease the burden of patients and be able to manage the timing of taking medication accurately.

Method

This section will explain the methodology that is used for the development process of MBR system using IoT technology.

System Development

In the development of this system, the Agile Model has been used to drive the system's growth. In IT projects, the success rate is more remarkable in the Agile Model than in Waterfall. More importantly, the failure percentage is lower in Agile, and as the IT project can be very costly, the risk of failure can have a massive impact on the company that tries to create such a project (Hurtoi & Avadanei, 2020). The Agile SDLC model (Figure 1) combines repetitive and additional process models with a focus on customization process and customer satisfaction with fast-functioning software product delivery.

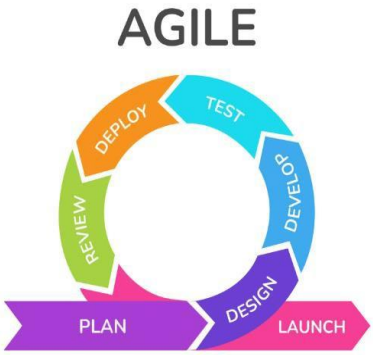


Figure 1 <Agile Methodology Phase (source:convercon.com)>

This development phase marks significant progress in transforming the MBR concept into a functional device, with attention to technical excellence, user safety, and operational reliability. The testing phase ensured that the MBR meets high standards of functionality, reliability, and usability, preparing it for deployment and use by diabetic patients and caregivers. The deployment and documentation phase of the Magic Box Reminder (MBR) project focused on ensuring smooth implementation and comprehensive documentation. In the final phase of the MBR project, thorough review, analysis, and presentation were conducted to ensure project success and stakeholder satisfaction

Plan Phase

In the needs analysis phase involves the process of identification and evaluation of requirements. The first step should be to successfully develop an effective developing system (Bleich, 2018). In this phase, some actions need to be done to get information about the system requirements that is developed. Interviews is conducted with the hospital and patients to find out how this project can help solve user problems. In addition, the design and function of the MBR must be according to the user's needs and availability. The project should be under the

project's budget and resource requirements. There are also detailed Gantt chart that outlining the project tasks and timelines for control purpose.

User interface and hardware devices prepared such as sensors, actuators, and CPUs, backend software, and connection make up an Internet of thing (IoT) prototype (Singh Parihar, 2019). Therefore the hardware and software components that required for the IoT project are as listed in Table 1.

Table 1 <The Hardware and Software elements in the IoT Architecture>

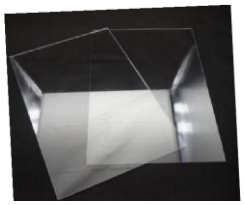
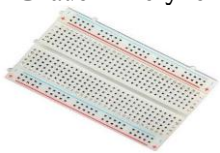
Hardware	Description
 **NodeMCU Lua V3 ESP8266 WIFI with CH340C**	This is the well-known NodeMCU, which has an ESP8266 WiFi SoC foundation. This is version 3, and it uses the ESP-12E (a WiFi module based on the ESP8266). In just a few LUA script lines, NodeMCU is an open-source firmware and development kit that enables you to quickly prototype your Internet of Things (IoT) device. Of course, the Arduino IDE may be used to program it as well.
 **BUZZER**	This is a standard buzzer. It will beep when powered up Operating voltage: 2-6V DC PCB type Diameter: 1.2cm.
 **LED**	A semiconductor device known as a light-emitting diode (LED) releases light when an electric current passes through it. An LED emits light when current flows through it because the electrons recombine with the holes. LEDs permit current to flow forward while obstructing current from flowing backward.
 **IR Infrared Sensor**	It's quite simple to utilize this infrared obstacle/object detecting sensor. A potentiometer is included to change the sensitivity. Since the output is a digital signal, it may be easily interfaced with any microcontroller, including the Raspberry Pi or Raspberry Pi Zero, Maker UNO, Mega, Leornado, Zero, and 101. By using infrared reflection, this infrared sensor provides quick, easy, and non-contact obstacle detection.
 **Jumper Wired Cable**	Used to join parts of a test circuit, prototype, or breadboard together internally or with other parts or equipment without the need for soldering.
 **Container**	Standard size 30cm x30cm x8cm Wood Color Solid pine board instead of plywood
 **Grade A Acrylic**	Transparent acrylic, often known as acrylic sheet or perspex, is a strong, flexible plastic that is valued for its strength and clarity. Made of polymethyl methacrylate (PMMA), it has a far stronger impact resistance than glass while yet providing outstanding optical clarity.
 **Breadboard**	Breadboard is a piece of board used for circuit building or prototyping. It enables building circuits without soldering by arranging parts and connections on the board. The connections are handled by the holes in the breadboard, which electrically connect components or wires inside the board while also firmly grasping them.

Table 1 <The Hardware and Software Elements in the IoT Architecture (Continue)>

Software tools	Description
ARDUINO	A platform that can turn a finger on a button into an output by reading inputs from a light source or sensor, starting a motor, turning on an LED, or posting content online. In this project to configure node MCU.
Blynk	Blynk has several fascinating features, including remote hardware control, sensor data display, data storage, data visualization, and much more. The platform consists of three main parts Blynk App, Blynk Server and Blynk Libraries.

Design Phase

In the design phase, a flow chart for the MBR process to function as a whole is determine. Next, appropriate microcontroller and how MBR delivers notifications to users is set. A block diagram is also produced to show the connection to all the equipment. In addition, the interface for the application is also designed. Finally, a prototype is created with suitable size, comfortable and safe design.

Block Diagram

MBR block diagram shows how various components within the system are interconnected and interact with each other as in Figure 2.

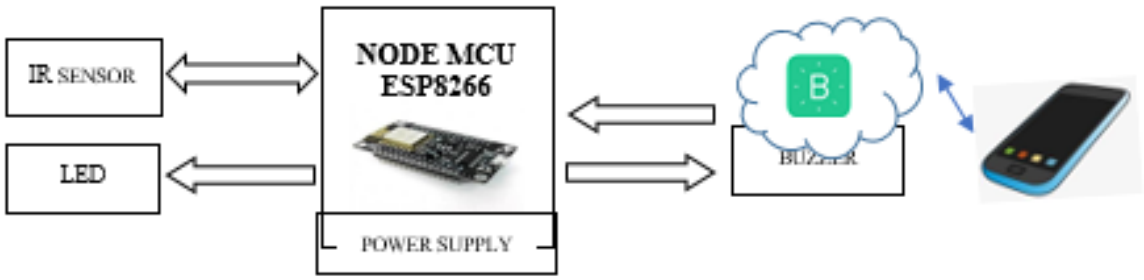


Figure 2 <Block Diagram>

1.1 Flow Chart

Figure 3 has the details for the MBR overall flow.

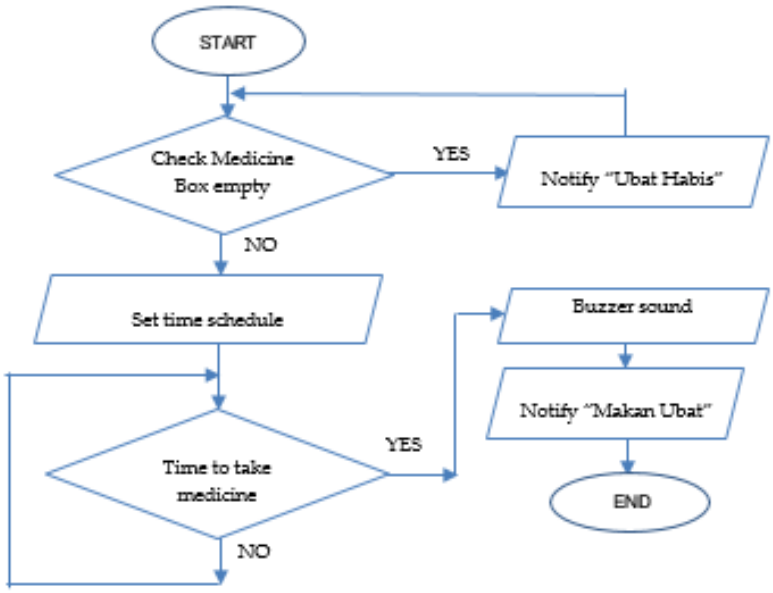


Figure 3 <MBR Flow Chart>

Development Phase

In this phase, we focus on connection and integration so that all equipment is correct and working properly apart from that configuration to all equipment is implemented. Safety elements are also applied in this project so that users can use it comfortably and safely. If there is any error in this phase, it must be troubleshooted as best as possible to ensure that the MBR works according to the user's needs.

We will begin coding the firmware for the device using Arduino IDE and Integrate Google Assistant functionality if required. We also develop the interface for remote monitoring and control using Blynk (Ramalingam et al., 2019). Figure 4 show the interface how we setup and build coding using Arduino IDE and Blynk.

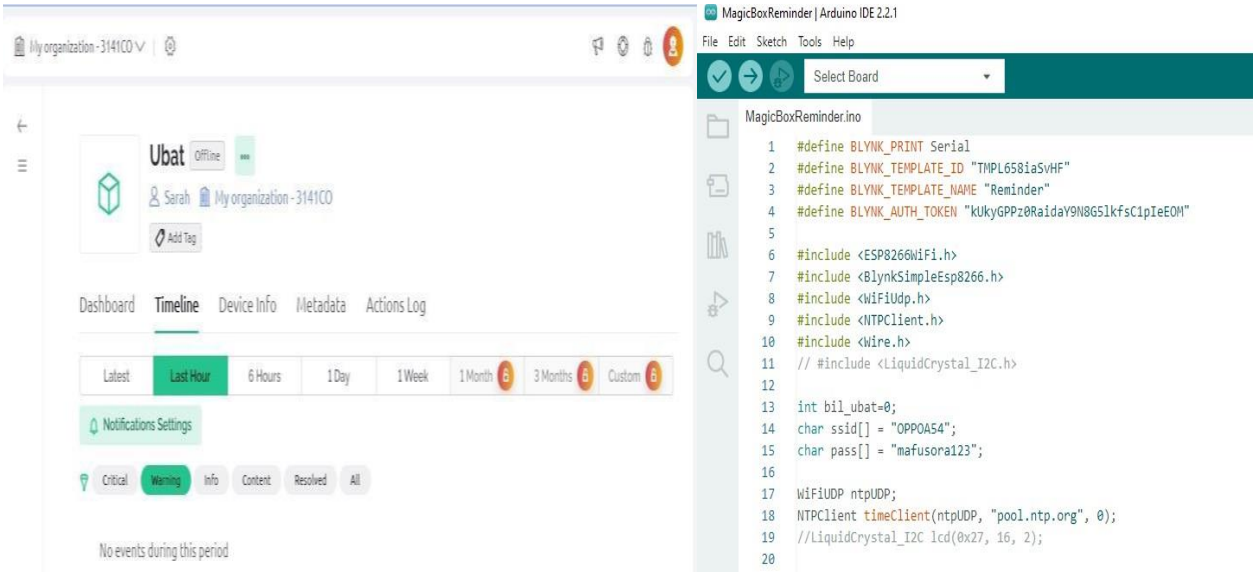


Figure 4 <System Configuration Using Arduino IDE and Blynk Console Application>

Testing Phase

After development, we will conduct testing of the mobile application for usability and functionality. Ensure that the IoT device interfaces seamlessly with the application and address any issues or usability concerns identified during testing. Rectify any errors or bugs in the IoT device's firmware. Then, we will perform a comprehensive final test of the entire system.

Unit Testing Plan

This testing includes checking the functionality of Arduino IDE software, blinking LED, the sensor buzzer, Blynk application console setting and NodeMcu Esp8266. All these components is successfully functioning.

Integration Testing Plan

Through integration testing, the integration of the Arduino IDE, COM port identification, and device manager port selection is verified. Connection of Arduino IDE to Blynk application on the phone is validated. Next to ensure successful integration between NodeMcu Esp8266 and Arduino IDE also done. Finally to confirm the integration of pop-up notifications through the Blynk application on the phone.

Deployment Phase

After the testing phase is carried out, deployment to the system is carried out by ensuring the user uses the MBR and giving any feedback if there are any improvements that need to be made to meet the user's needs. Apart from that, we also provide a user manual to the user to make it easier for the user to use MBR. We will also prepare a technical report to documenting the project's development, deployment, and functionality.

Review Phase

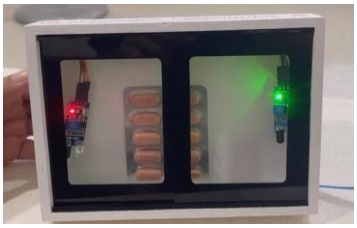
After all phases are completed, review and analysis functionality of MBR is carried out by the user to ensure any weakness of MBR that can be improved to ensure that MBR can be used effectively and efficiently. In this phase, we analyze MBR's ability to solve the problem of users who overeat taking medicine on time.

Results and Discussions

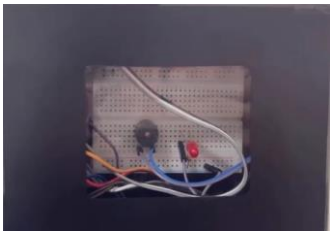
Objective 1 : Creating prototype

To prove the first objective of our project, we have built MBR based on user needs. Prototype design to MBR must be compact and easy to carry anywhere. MBR also has safety features by building a suitable casing to prevent falling and easy breakage or damage as a figure 5.

MBR from top view



MBR from front view



MBR from back view

Figure 5 <Prototype view of Magix Box Reminder (MBR)>

Objective 2 : To detect medicine in box

To prove the second objective of our project, we use IR sensor to detect the medicine in MBR. If the medicine is not in the box as a figure 6, the system will detect the number of medicines equal to 0 (figure 7). Then the system will notify the user via Blynk Application that the medicine is not in the box and needs to be filled as a figure 8.

Figure 6 <Empty box>

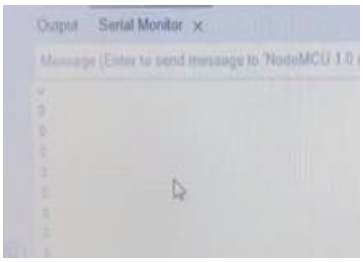


Figure 7 <System detect box is empty , the value is 0>

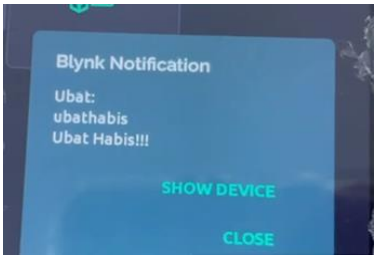


Figure 8 <Blynk notification to smartphone>

When there is medicine in the box as a figure 9, the system will detect the number of medicines equal to 1 (figure 10) and notify the user via Blynk Application on smartphone when it is time to take the medicine.

Figure 9 <There are Medicine in Box>

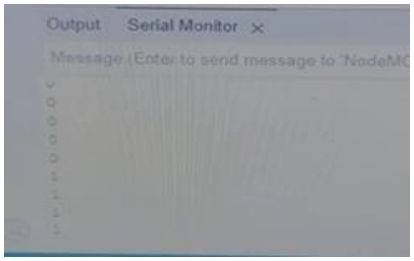


Figure 10 <System detect medicine in the box, the value is 1>

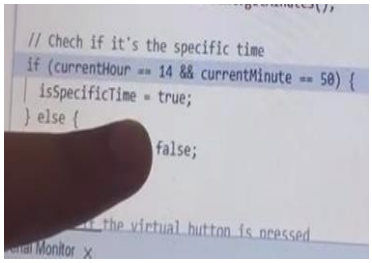


Figure 11 <Setting time on system at 2.50 pm>

Our project's main goal is to remind patients to take their medicine on time. To achieve this, the MBR will make a sound and light up an LED when it's time for medication. Additionally, patients will receive notifications

through the Blynk app along with the buzzer and LED alerts. Figure 11 show the setting time on system at 2.50pm. When the server time shown 2.50pm as figure 12, MBR will notify the patient at that time through sound of buzzer, blinking LED as figure 13. and Blynk notification on smartphone (figure 14).

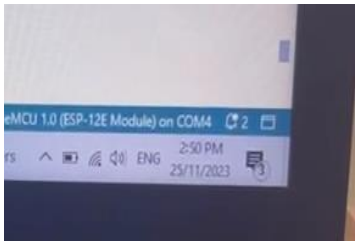


Figure 12 <Server Time Shown 2.50 pm>

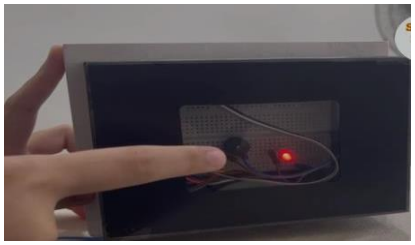


Figure 13 <Sound of Buzzer and Blinking LED is Active>

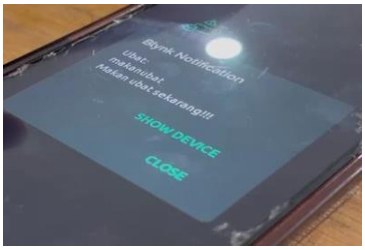


Figure 14 <Blynk Notification on Smartphone>

Conclusion

In conclusion, the Magic Box Reminder (MBR) project, developed using IoT technology, has successfully achieved its primary objective of assisting patients with their medication adherence and continuously monitoring their medication intake times. The MBR provides real-time reminders to ensure patients take their medicine as prescribed. The Magic Box Reminder is helpful for patients by alerting them when it's time to take their medication and notifying them when the medicine supply is running out. Additionally, the built-in sound sensor ensures that patients take their medicine on schedule. To enhance the MBR product's stability and user-friendliness in the future, it is essential to implement additional improvements. These include integrating an LCD screen to display real-time information such as current time, medication status, and related updates.

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