Alerting Medicine Cabinet by Using IoT and Web Application

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Abstract

Forgetting to take medication or taking an overdose can occur in patients of all ages, particularly the elders. This can lead to adverse health outcomes or hinder the treatment of certain chronic diseases. In response to this problem, researchers have developed Alerting Medicine Cabinet by Using IoT and Web Application. The purposes of this study were: 1) to design and create Alerting Medicine Cabinet by Using IoT and Web Application, 2) to test a working of Alerting Medicine Cabinet by Using IoT and Web Application, and 3) to evaluate a satisfaction of the users' Alerting Medicine Cabinet by Using IoT and Web Application. The development of the medication dispenser involves the integration of Alerting Medicine Cabinet by Using IoT and Web Application. The primary components of the dispenser include a NodeMCU-ESP32 microcontroller, a piezo buzzer, and an LED. The system is consisted of three main components: 1) a server providing a web application and database, 2) a device control module, and 3) a notification module. The medication dispenser underwent a 7-day performance test that it was activated sequentially according to the established procedures. The sample consisted of 15 purposefully selected participants, including experts, caretakers, patients, and the elders from Panthong District, Chonburi Province. Research instruments included a performance test and a satisfaction survey. Statistical analysis was conducted on the collected data. The study aimed to calculate the mean and standard deviation of the medication reminder system's accuracy and user satisfaction. The researchers hypothesized that the system would have an accuracy rate of at least 80% and a high level of user satisfaction. The results showed that Alerting Medicine Cabinet by Using IoT and Web Application was highly effective, with an average accuracy rate of 91.81% for both visual, auditory, and mobile app notifications. The overall user satisfaction rating was 4.48, indicating a high level of satisfaction among the participants.

Keywords: Alerting Medicine Cabinet, Internet of Things (IoT), IoT Technology

Introduction

The elderly population is disproportionately burdened by chronic diseases, such as hypertension, diabetes, and hyperlipidemia. Consequently, medication adherence is often a cornerstone of their healthcare management. However, age-related physiological changes and the concomitant use of multiple medications can increase the risk of adverse drug events in this vulnerable population.

A recent study conducted by the nursing department of Siriraj Hospital revealed significant differences in medication adherence between chronically ill patients with and without caretakers. Patients without caretakers were more likely to experience medication non-adherence, characterized by missed doses or incorrect timing. Interestingly, both groups demonstrated a common practice of polypharmacy, with many patients taking 3-5 medications per meal.

In response to the identified challenges in Alerting Medicine Cabinet by Using IoT and Web Application, researchers have designed Alerting Medicine Cabinet by Using IoT and Web Application for oral medications, aiming to enhance patient quality of life.

Materials

1. An ESP32 is a microcontroller that supports Wi-Fi connectivity and Bluetooth Low-Energy (BLE, BT4.0, Bluetooth Smart). It is widely used in various applications, ranging from smart home devices to industrial applications.

2. An LCD 1602A I2C is a 16x2 character LCD module that uses I2C technology to interface with a microcontroller. It displays text and data on a 2-line that a line is consisted of 16-character screen. Typical applications include displaying sensor readings, program status, alerts, calculation results, and controlling electronic devices.

3. A Piezo Buzzer is a magnetic or piezoelectric speaker with a built-in oscillator circuit. It operates on a 3.3 - 5V power supply and can produce various alert sounds or signals. Typical applications include status indication.

4. LED bulbs are miniature LED bulbs that measure approximately 10 millimeters in diameter. It is designed for a wide range of applications including DIY projects, crafting, and electronics, these compact light sources are perfect for use in indicator lights, alarms, and status displays.

Methods

The process of developing Alerting Medicine Cabinet by Using IoT and Web Application includes the following steps:

1) Analyze various problems associated with forgetting to take medication or taking an overdose. It can occur in patients of all ages, especially the elders. This can have adverse effects on health. Therefore, researchers have developed a concept for Alerting Medicine Cabinet by Using IoT and Web Application to address these issues and their consequences.

2) Design and develop our innovation.

2.1) Alerting Medicine Cabinet operates on a two-tier architecture: software and hardware. A web application serves as the user interface, enabling users to schedule medication reminders. Upon reaching the scheduled time, the system activates auditory and visual alerts at the specific compartment. Concurrently, a push notification is sent to the user's LINE application. The system's alerting function persists until the user acknowledges the reminder by opening the designated compartment. This interaction signals the system to cease the alerts.

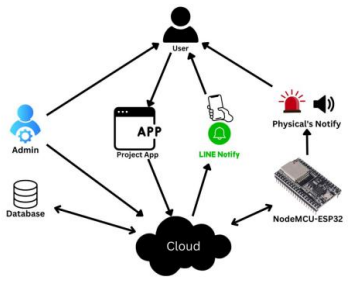

Figure 1: Design Alerting Medicine Cabinet by Using IoT and Web Application

2.2) The pill dispenser is designed with a single-compartment alert system. It allows for seven-day continuous reminders through light, sound, and LINE application. The dispenser has 28 compartments and 49 channels to accommodate before and after meal medications for four daily doses: breakfast, lunch, dinner, and bedtime.

3) The security booth will undergo a 7-day functional test, followed by adjustments and bug fixes.

The primary testing principle is the accuracy of notifications. The measured value is ”Precision”. It measures the accuracy of notifications. The calculation formula is as follows:

$$\text{Precision} = \frac{\text{Number of times the notification was correctly received.}}{\text{Total number of notifications}}$$

4) Implementation & Satisfaction Evaluation

The medication cabinet, after undergoing efficiency testing, will be used and data will be collected. The evaluation is divided into two aspects: structure and operation.

Results

1. Working of Alerting Medicine Cabinet by Using IoT and Web Application (7 Days)

Day	Working Details							Accuracy (%)	Error
	T1	T2	T3	T4	T5	T6	T7		
1	✓	×	✓	✓	✓	✓	✓	85.71	T2: It didn't notify with led
2	✓	✓	✓	✓	✓	✓	✓	100.00	-
3	✓	✓	✓	✓	×	✓	✓	85.71	T5: It didn't notify with sound
4	×	✓	✓	✓	✓	✓	✓	85.71	T1: It didn't notify with led
5	✓	✓	✓	×	✓	✓	✓	85.71	T4: It didn't notify with led
6	✓	✓	✓	✓	✓	✓	✓	100.00	-
7	✓	✓	✓	✓	✓	✓	✓	100.00	-
							Total Average	**91.84**	-

The experiment aimed to evaluate the precision of notifications in relation to scheduled times. The average of accuracy was 91. 84%.

2. The results of satisfaction among a sample group of 15 individuals, comprising patients, caretakers, and the elders, revealed an average satisfaction rating of 4.48 at high level.

Discussion and Conclusion

Alerting Medicine Cabinet by Using IoT and Web Application dispenser was developed to address medication non-adherence, particularly among the elders. The device is constructed using electronic components such as a NodeMCU-ESP32 microcontroller, a piezo buzzer, and LED indicators. The system is divided into three primary modules: a server for web applications and databases, a device control module, and a notification module. A 7-day trial was conducted to evaluate the device's performance.

The performance evaluation of the medication reminder system revealed an average notification accuracy of 91.81% across visual, auditory, and mobile app-based alerts, along with system operational controls. Minor hardware malfunctions were observed in some LED lights and piezo buzzers due to lose fittings.

Testing and user satisfaction evaluation revealed that Alerting Medicine Cabinet performed according to specifications, providing accurate notifications through visual, auditory, and mobile app-based alerts.

Tailored to meet user requirements, Alerting Medicine Cabinet by Using IoT and Web Application promotes self-reliance among users, particularly the elders. It mitigates the risk of medication non-adherence and alleviates the caretaker burden. When it compared to other reminder devices, this system offered user-friendly operation, customizable scheduling for up to a week, and reliable notifications. Limitations include a bulky design, lack of portability, and the inability to dispense liquid medications. Future development may focus on a smaller, portable form factor capable of accommodating both solid and liquid medications.

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