Design and Implementation a Smart Pillbox

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Abstract. Nowadays, Taiwan has been moving closer to aging society. An increasing number of elderly needs related medical equipment to assist their lives, such as medicine boxes and walking aids. Many aging people suffer from chronic diseases and they take pills and nutritional products. However, the elderly sometimes forgets to take medicines, such as hypertension medicines and other medicines since their memory degradation. If older person forgets to take pills, it may cause consequence diseases such as stroke. In addition, it is important for patients with chronic diseases to follow doctor's orders. However, there are too many elderly people with "medication adherence", this research uses a smart phone with a smart pill box to supervise and remind the elderly to take medicine. Considering that most of the users are elderly people who are not familiar with the operation process of the mobile APP in the smart phone, a novel real-time transmission of electronic drug orders was developed in the system. It supports a simple and useful user interface for elderly. In the proposed system, the doctor completed the diagnosis and sent the electronic drug list from Near-field communication (NFC) to the APP of the elderly through the doctor's mobile phone APP at first. Then, the information such as setting the medication time and the number of days to return to the doctor are set. When it is time to take the medicine for elderly, the mobile phone APP starts the alarm to remind the user to take the medicine. In the proposed smart pillbox, we use the Arduino UNO development board to design, control, and add a time RTC clock module on the board to control the time. When it is time to take medicine, the servo motor will open/close the pillbox's medicine port.

Keywords: Internet of Things · Smart pillbox · Technology assistant tool · Near-field communication (NFC)

1 Introduction

With the advent of an aging society, many problems have been entrained. According to the research and analysis of the prevalence of multiple chronic patients, the prevalence

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of chronic conditions among the elderly (the population over 65 years old) is 73.39%, and the prevalence of multiple chronic conditions 62.63%. In other words, the average elderly person suffers from one or more chronic diseases. Therefore, to compliance with medical order is particularly important for patients with chronic diseases. This article mainly develops a multi-functional smart pills box based on a smart phone. Since Taiwan has become an aging society, many elders need to take chronic disease drugs. Due to the different time and number of drugs, the elders may be confusing or forgetting to take medicine. In the proposed smart pill box system, it is mainly used to remind the elderly to take medicine and record the time of medication.

The main functions include: 1. To remind the elderly to use medicine. 2. To send the doctor's electronic medicine list to the smart mobile device APP for the elderly. 3. To supervise the medication for the elderly. In this paper, designing the alarm function of the mobile APP reminds the elderly to take medicine on time since they sometimes forget to take the medicine. In addition, the elderly people are not suitable for operating mobile device applications. This paper uses NFC technology to transfer the medicine information to the elderly mobile devices. The elderly people do not need to perform related APP operations. It reminds the elderly people to take medicine. The smart pillbox will automatically open the medicine intake port when the medicine is taken. When the medicine intake port is not closed, it will automatically record that the elderly person does not take medicine. The APP device proposed in this article will automatically calculate the time to reclaim the medicine, reminding the elderly to remember to take the medicine. This article considers the power consumption of the smart pillbox. The relevant calculations are mainly based on mobile devices to avoid that the pillbox is disable since the power problems.

We use the Arduino UNO development board as the control of the smart pillbox and network transmission communication. In the proposed smart pillbox, we use the micro switch and the servo control to control it to open, and use Bluetooth technology in the communication part [10] and NFC [9] for transmission, using Bluetooth and NFC technology for communication transmission can reduce the power consumption of the transmission. In addition, this paper also designs a mobile device APP to facilitate the connection with the smart pillbox and design the APP interface for doctors. It is used to facilitate the transmission of electronic drug orders with the elderly. The system architecture proposed in this paper has been implemented.

2 Related Works

In [1], remote medical treatment is mainly carried out through the concept of the Internet of Things. It is assumed that each medicine has an RFID tag. The elder wears a wearable device to detect physiological information. The doctor can review the health of the elders through the physiological information. Elders can sense what kind of medicine they take through wearable devices. This plan mainly uses the concept of Internet of Things to capture the physiological information of elders.

In the literature [2, 3, 5], the main function of the smart pill box is to remind people to take the medication. The elderly will be reminded to take the medicine since they do not take the medication. However, the elderly's physiological information is not

recorded and analysis, so that the doctor cannot understand the adaptation of the elderly to medication.

In [4], physiological information is mainly retrieved through a wearable device. If the physiological information is collected and then analyzed effectively, it will be great help to the use of chronic diseases or acute drugs. It also uses physiological information analysis to understand the elders 'physical condition after taking medication.

In [6], the main purpose is to detect the aching state of the body through the wearable device. The long-term detection of physiological information through the wearable device can effectively make the doctor easier to grasp the disease.

In literature [7] mainly provides the concept of intelligent medical care. Patients with wearable devices can monitor physiological information for a long time, which allows doctors to diagnose the condition more accurately. Doctors can also conduct remote medical consultations to reduce medical costs. Because wearable devices belong to Low power consumption devices can increase the life span of power.

In the literature [8], it mainly evaluates the needs of the elderly for smart kits. In the research results, it is found that the elderly has a positive preference for technological assistance, but the ability to use technology products is low. When using a pill box, it is necessary to consider the interface operated by the elderly.

3 Proposed Methods

3.1 The System Architecture

There are three functions in the proposal system:

(1) Medication reminder: After the seniors are treated, the doctor will set the medication time through the mobile device APP and set the consultation time. When the medication time expires, the smart pillbox will automatically open and the mobile device will remind the medication to be used. If it has not been turned off and the time for taking the medicine is exceeded, the alarm signal will be sent to the smartphone, and the smartphone will record that the pill has not been taken.
(2) Medication time setting: There will be a doctor's order when the elderly goes to the doctor. It can be setting on the smart pillbox APP. Consider that most elderly people are not familiar with the operation process of APP, the real-time transmission of electronic medicine slips are designed in the proposed system. Therefore, the elderly just goes home and put the medicine into the medicine box according to the daily points without setting and operating the APP, as shown in Fig. 1.
(3) Supervise medication status: This article will record the medication status of the elderly and will remind the elderly to re-take the medicine.

3.2 The Development for Doctors

In this article, the function of the doctor-side APP is mainly to record patient data, transmit the time of taking medicine and the number of days of taking medicine. In the proposed smart pillbox system, it uses the NFC to transmit the data and the database to

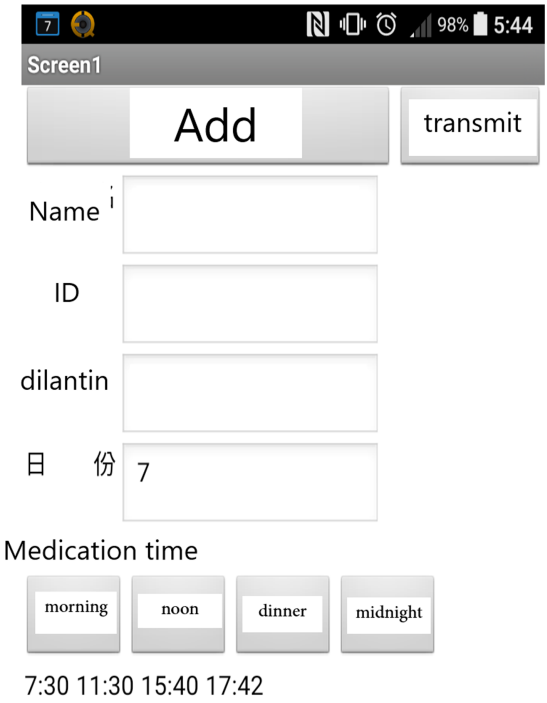

Fig. 1. Doctor's order

record the retrieved data. It will display the personal information section of the elderly and display the name of the medicine used by the elderly and the number of days the medicine is used. In addition, the time for the elderly to use the medicine can also be set. The doctor-side APP will use NFC to send relevant information to the database of the elderly app and delete the information of the last medication to facilitate the use of database space. In addition, the doctor-side APP will also set the reminder time of the elderly app. This function is to reduce the incompatibility of the elderly in operating IT.

3.3 The Mobile Application Development for Elderly

The designed APP includes the following functions: It displays the current time and sets alarm to remind the elders to take medication. It reminds elders before they should go to the doctor. It records the situation of the pillbox using Bluetooth and the time to take the medication by NFC. In addition, they can also close the pill box through the APP and set the time of the last medication. In the proposed system, most settings have been completed by the doctor's APP through NFC. Therefore, the APP interface for the elders do not require additional settings, reducing the complexity of the elderly operating the APP.

4 The Implementation Result

This article implements the smart pillbox and the APP program for doctors and seniors. App inventor 2 is used in the APP development software, and the Arduino development is used in the hardware part. Table 1 shows the hardware and software devices developed in this system. Figure 1 and Fig. 2 are the experimental result.

Table 1. The component of software and hardware.

Hardware
1. Arduino UNO R3 2. Servo Motor 3. RTC clock module 4. Bluetooth module Component: 1. Resistance 2. Microswitch
Software
1. Development of the Arduino with C 2. App Inventor

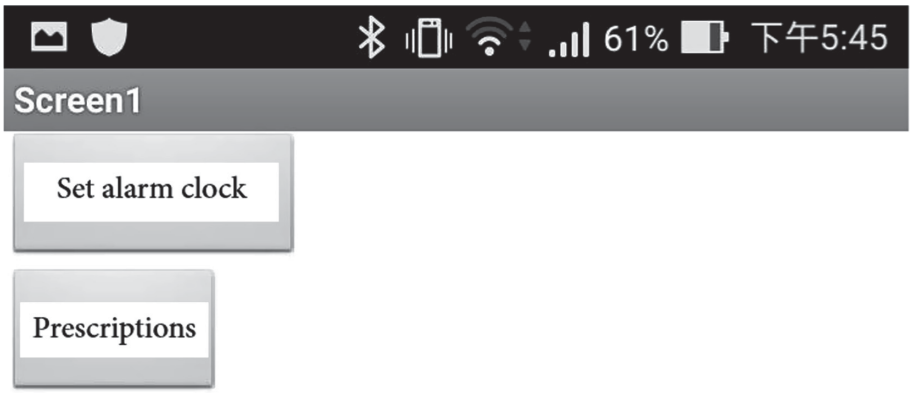

Fig. 2. Implementation result

5 Conclusion

With the convenience of a smart phone, the proposed smart pillbox system can easily set the time for taking medication. When the time is up, the smart phone will automatically remind, and the pillbox can only be opened. The proposed smart pillbox can improve the problem that the senior patients often forget the plight of taking medicine and taking the

wrong medicine. The system can be further improved by increasing sensor modules to retrieve the physiological status of the elderly. In addition, elderly people's families can also know about the elderly's physical condition and medication status through remote programs. We will also further consider power management and operability to make the system more complete in the future.

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