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Research Article

Design and Manufacture a Smart Reminder Device based on Arduino Mega to Inform Patients for Taking Accurate and Timely of Medical Drug

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Abstract

One of the major challenges in the successful treatment of many diseases is the non-adherence of patients to taking medicines on time, which can have serious consequences. Age is associated with a decrease in memory and vision. Also, a person may suffer from dementia such as Alzheimer's or other diseases, all of which require medication, and this is difficult for them. Due to the busyness of life, the use of medicines, especially important medicines, may not be managed in terms of time. In this article, we will design and build a medication reminder device using the Arduino Mega board. This device can store and manage up to 20 reminders per day. The user can set the reminder times in the program and view them through an LCD screen. At the appointed time, the device reminds the user when to take the medicine by turning on the built-in LED and sounding the buzzer.

Key Words: arduino mega; medication reminder; buzzer; LCD; RTC

1.Introduction

Regular use of medicine is necessary for many people, especially the elderly and people with chronic diseases. However, forgetting the time to take medicine can have serious consequences. In modern society, the daily busyness of life involves people to such an extent that their priorities tend towards professional activities, and as a result, personal health care as a Several diseases such as diabetes, blood pressure, cardiovascular diseases are very common nowadays. For example, one of these important diseases is diabetes. Diabetes is a metabolic disorder that causes high blood sugar. In this type of disease, insulin in the body is insufficient or cannot work. The number of people with diabetes will reach 438 million people in 2030 [1], so it is important to take care of this disease so remembering to take insulin can be very helpful. It has become very difficult for sick and elderly people to take medicine on a daily basis, and the number of these medicines is sometimes very large. In traditional treatment approaches, relying on human memory to ensure the timely use of medicines has always been associated with challenges. With the advancement of digital technology, automation of many processes in the health field has become a common thing. Medication reminder devices as auxiliary tools have a significant potential in improving patients' compliance with the medication regimen and thus increasing the effectiveness of the treatment. These devices oblige patients to take their medications by sending audio or visual warnings at predetermined times and prevent them from forgetting or making mistakes in taking medications. Taking medications at inappropriate times can reduce their effectiveness. For example, if you don't take antibiotics as scheduled, your infection may not be treated properly, and forgetting to take medication can lead to serious health consequences.If you don't take your blood pressure medication, you may have a stroke or a heart attack. Medication reminders can help you avoid overdosing. Taking too much medicine can be dangerous and even lead to death. The main step in the treatment of any disease is not only prescribing medicine, but also prescribing the correct medicine, so this device helps patients by creating a precise time schedule for taking medicine, and also It sounds an alarm to remind people to take medicine [2]. According to elderly and sick people, there should be systems for self-care. In the figure below, the reasons for low complience to medicine are given [3].

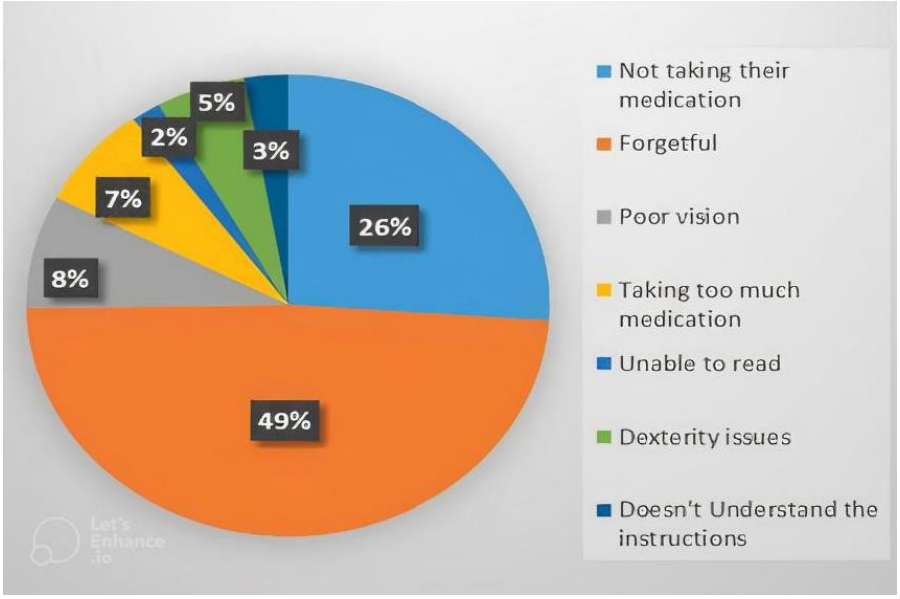

Figure 1: Reasons for non-complience to medication in patients [3].

The National Council on Disability (NCD) has shown in its research that despite the dependence of more than 90% of people over the age of 65 on medication, non-adherence to the medication regimen is a major challenge in this age group [4]. Non-adherence to prescription medications is common among adults, and between 40% and75% of adults do not take their prescribed medications on time each day. As a result, people cannot take the right dose at the right time [5].

Medication reminder devices are available in different shapes and sizes and can range from simple to advanced. Some of the common features of medication reminder devices include separate compartments for keeping medications at different times of the day, which helps you keep track of what medications to take and when. A smart alarm equipped with sound is built into the medicine reminder device. Also, the screen of the device shows the time, date.

The medication reminder device also enables the ability to improve in optimization as a remote monitoring device, which requires the design of a monitoring system to apply the desired cases and drugs in real time. The term telemedicine is derived from the combination of the Greek words tele, which means far, and medicine, which means treatment. The use of telemedicine among health care providers has increased due to the replacement of analog forms of communication with digital methods, along with the rapid decrease in ICT costs. This achievement has enabled health care organizations to consider and implement new and more efficient approaches in providing health services as a future vision [6,7].

Many works related to this device have been developed and reviewed over the past years. For example, the medication reminder box is based on a MCS-51 microcontroller, which can remind the drug, using a stepper motor at a programmed time, but there is no condition to record the time of taking another drug by the patient [8]. An IPB smart medication reminder box is designed. IPB takes the medicine out of the box at the right time. If the medicine is not taken, IPB notifies the caregivers through Skype, so the IPB system improves the interaction between the patient and the caregivers, but only if the Internet connection is available, it works well [9]. An electronic medicine box called Medtracker has been developed. Medtracker is designed to record data every time the door is opened or closed and wirelessly transmits it to the user's personal device via Bluetooth, but it does not have the ability to confirm drug consumption [10].

The purpose of this project is to design and build a medication reminder device using the Arduino Mega board. This device has many advantages that are easy to use and adjust. The user can easily set the reminder times through the Arduino program and turn it off with the control button. High storage capacity of this device can store up to 20 reminder times per day. Clear warnings at the appointed time of the device by turning on the LED and sounding the buzzer remind the user when to take the medicine.

2. Material and Method

The medication reminder unit includes the Arduino Mega module board, RTC (Real-Time Clock), LCD screen, potentiometer, LED, buzzer, resistor, button, jumper wires, and the box that holds the drug. The brain of the system is the Arduino module. In this device, the Arduino Mega is embedded, which is a microcontroller with a large number of pins and memory capacity. Microcontrollers, after receiving the input signal, analyze its nature and characteristics and execute predefined processing algorithms.

2.1 Simulation of Circuit

The connections between the Arduino board, the RTC module, the LCD screen, potentiometer, buzzer and LED have been created according to the schematic diagram. The high sensitivity of this circuit to the connections is due to the direct dependence of the device's performance on the integrity of the electric current paths. Any disturbance in these paths can lead to serious errors in the operation of the device. Therefore, it is necessary to be careful in creating electrical connections in this circuit, any connection, short circuit or incomplete connection can lead to noise, reduced efficiency and ultimately failure of the device. One of the most important ones is the connections between Arduino Mega with LCD and RTC. If the connections are not correct, the time will not be read or a message will not be shown on the screen.

In RTC, the SCL base is connected to A5 and SDA to A4 of Arduino Mega. VCC is connected to the 5V power supply and GND is also connected to the ground. As can be seen in the figure, in the Proteus software, VCC is equivalent to VBAT and RST is equivalent to GND. In LCD, the VSS and

RW pins are connected to the ground and VDD is connected to the 5V power supply. The VEE pin in LCD is connected to the VEE pin in Arduino Mega. RS is connected to pin 12 and E is connected to pin 11. Finally, pins D4, D5, D6, and D7 are connected to pins 5, 4, 3, and 2 of the Arduino Mega, respectively. Also, buzzer is connected to pin 13 and push button to pin 9 in Arduino Mega.

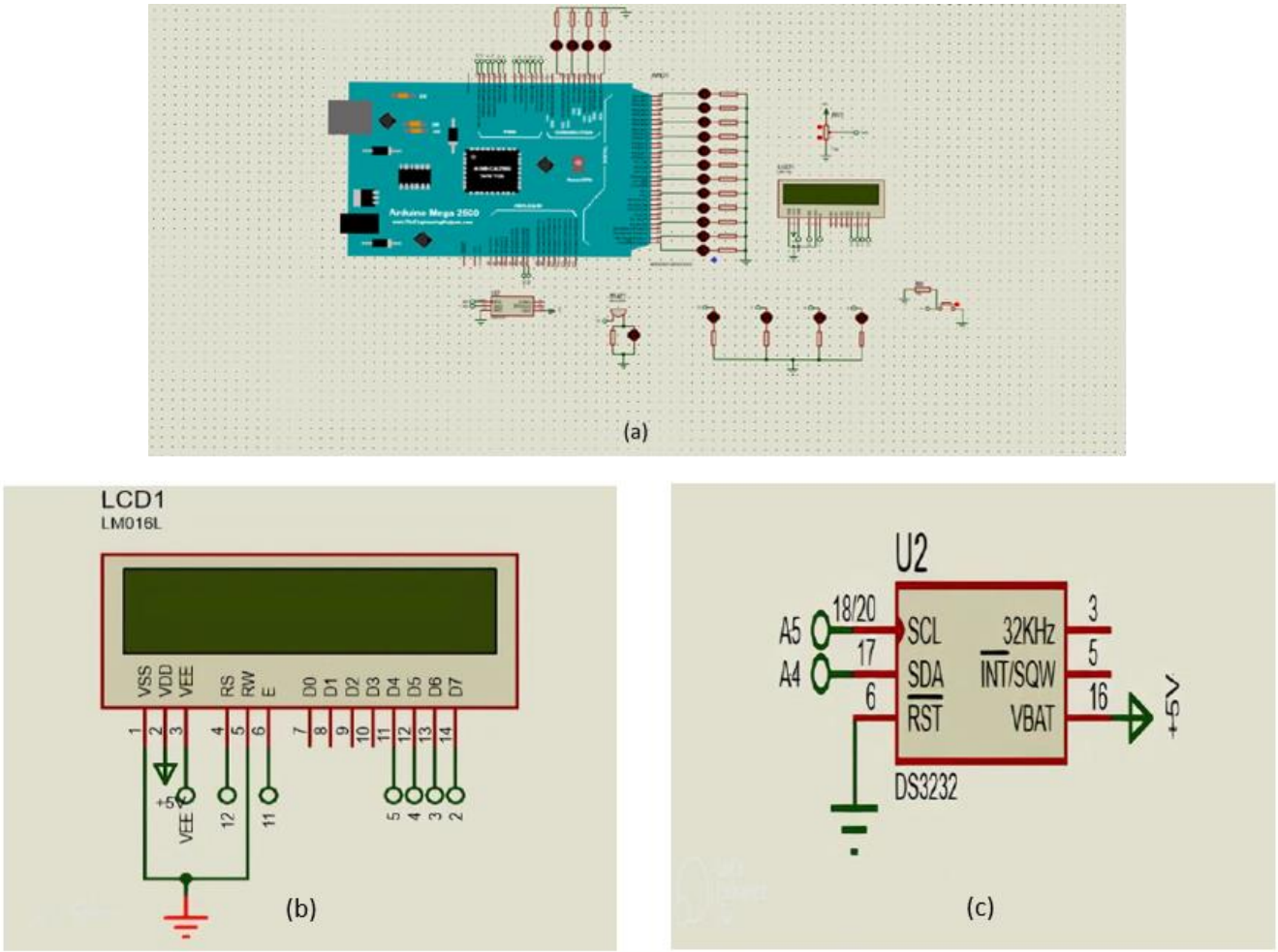

Figure 2: The schematic of the medication reminder device circuit in Proteus software (a) General circuit of the medication reminder device, (b) LCD connections and (c) RTC connections.

2.2 Design of Drug Reminder Circuit

According to the block diagram shown in Figure 3, a set of display LEDs, BUTTON, RTC RESISTANCES and BUZZER are connected to the Arduino Mega 2560 main board.

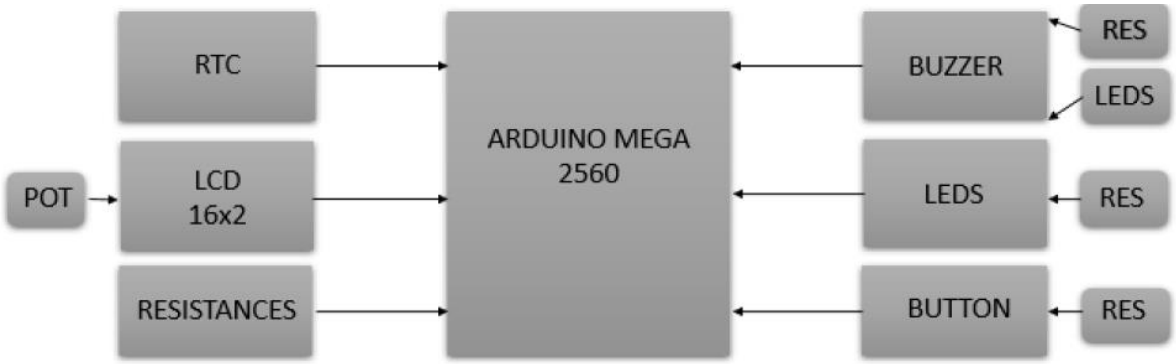

Figure 3: The block diagram of medication reminder device.

Arduino Mega board as a microcontroller development platform with 54 digital pins and 16 analog pins can interact with a wide range of sensors and actuators. Arduino Mega 2560 has higher processing power than some other Arduino models and has 256 KB memory for data storage. The

microcontroller is used to control receiving and sending data to all the components in Figure 3. The real time clock (RTC) acts as a key component in microcontroller based systems and by providing an accurate time reference, it enables the implementation of timed applications. The RTC is able to keep the time even if the power is cut off or the microcontroller is reset. The RTC is only connected to Arduino, and the patient can access the date, time, day, month, and current year, as well as hours, minutes, and seconds to take medicine on time. There are different types of RTCs, but DS3231 is used in this device. The push buttons are responsible for establishing and disconnecting the electrical connection between the points. By applying force to the button, a signal is sent to perform the desired operation, and as a result, the warnings will be stopped In the medication reminder device, the LCD display is connected to the Arduino, potentiometer, and resistor to provide information to the user. Arduino pins 12, 11, 5, 4, 3, and 2 are utilized to initialize the LCD. In this project, 20 LEDs are used, which are connected to the Arduino Mega and are placed under the medicine boxes. The color of the LED is one of the determining factors in calculating the amount of resistance required for its correct operation, so you should be careful in choosing them. Potentiometers, also known as POTs, are connected to the LCD. It can be adjusted by changing the resistance range created by the light potentiometer and the accuracy of the LCD screen in the medication reminder device. In order to function properly and prevent false currents from passing, a resistance of 10Ω is considered for BUZZER and then a communication bridge is established between BUZZER and LED.

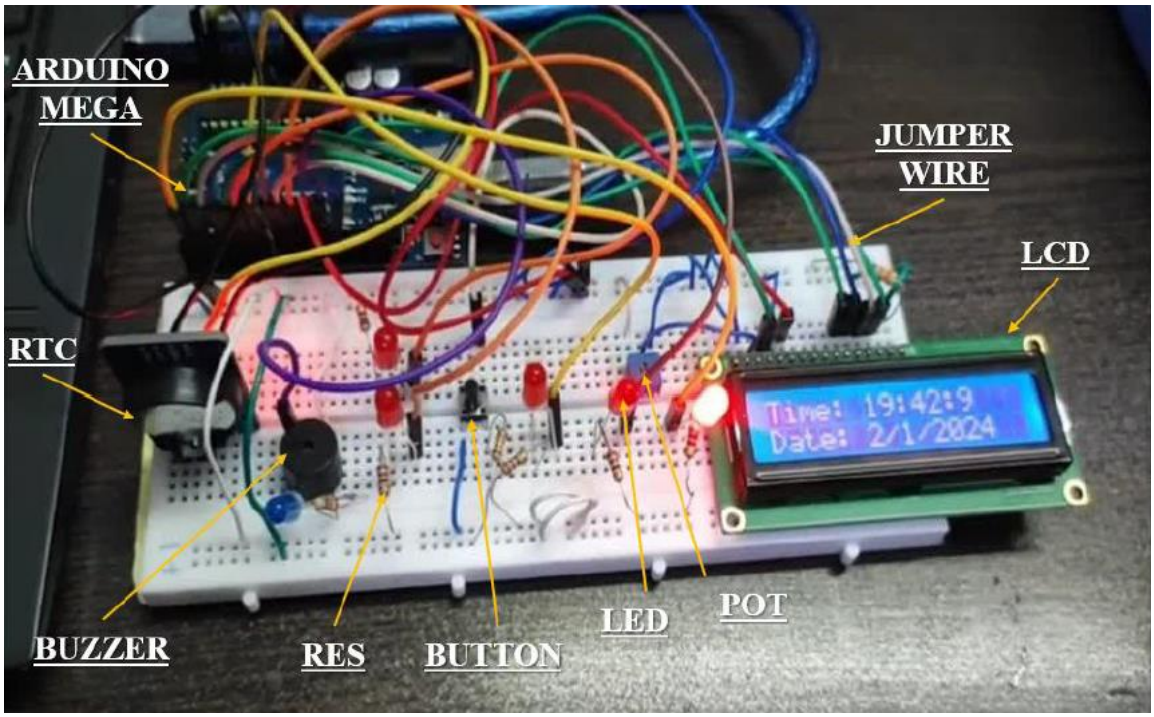

Figure 4: The segmentation and important parts of the smart medication reminder circuit.

We connected the Arduino Mega board to the computer and installed the Arduino IDE software, downloaded the program code for the medication reminder device and rewrote and added codes to it so that the device fulfills the features we intended. After finishing the programming, we uploaded the code on the Arduino board. The basic structure of this program is based on two main functions "void setup ()" and "void loop ()". And in the Arduino programming structure, the void setup () function acts as the starting point of the program. This function is called only once at the beginning of program execution and is responsible for configuring hardware and software. In this section, the libraries required to control the LCD display, real time clock (RTC) and other system components are loaded, the state of the input and output pins are determined, and the variables used in the program are initialized. The instructions written in void loop () are executed as an infinite loop, and all the commands that need to be repeated continuously are admitted inside this function, for example, turning the LEDs on and off, sounding the buzzer inside the void loop () function are implemented. The program is designed so that the patient can easily enter the desired time. This device is able to remind 20 times a day. The instructions are related to the selection of the input and output pins and the sentences are on the LCD display and the LED pins. In the void loop function, the microcontroller continuously reads the current time from the DS3231 real clock and displays it on the LCD screen. The project introduced at the beginning includes determining the exact time of taking the medicines. Also, at the moment of matching the set time with the system clock, a signal is sent to the Arduino and according to the received signal, the HIGH signal is sent to the Buzzer and LEDs. The display of the device reminds the patient of the exact time of taking each medicine and if the set time does not match the current time, no signal will be sent to the system and we will have no output.

A medication reminder device was successfully designed and built using the Arduino Mega board. This device can store and manage up to 20 reminders per day. The user can view the reminder times through an LCD screen and set them with the control button. At the appointed time, the device reminds the user when to take the medicine by turning on the LED and sounding the buzzer. The purpose of designing and building this device is to remind elderly people and patients who suffer from amnesia to take medicines, especially time-sensitive medicines, with the right dose. The data is stored on the Arduino board, so there is no need to re-run the program during use, unless there is a change in the time of drug administration according to the

patient's doctor's order. The optimal design of this device and the use of low-energy electronic components have led to a significant reduction in electricity consumption.

3. Conclusion

The medication reminder device is a vital tool for people of any age who need to take medication regularly, especially for people with chronic diseases or people who are forgetful. The medication reminder device based on Arduino Mega helps to control the disease, prevent side effects and improve the overall quality of life by reminding the use of medicines. It can be easily adjusted and used and can help improve patient compliance with medication. In this project, a 3231DS chip and Arduino Mega were used to show the time and date as a warning to take medicine. After implementing the program in the Arduino environment and connecting all the hardware, the device successfully displayed the desired output on the LCD, turned on the LED and produced the sound by the buzzer. The importance of taking medicine on time in many treatments is not a secret to anyone. This model, by using a continuous and provocative reminder mechanism, in addition to informing the exact time of taking the medicine, encourages the user to do this until the time of explicit confirmation. Despite the many advantages, this system is also associated with limitations. The initial use of this device requires spending considerable time; Therefore, the development of a fully automatic system to remind the use of medicine in the future can be an effective step towards solving this challenge; Also, by connecting the device to the Internet, using IOT and using a mobile application, it is possible to remotely monitor the exact time of drug administration.

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