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Design and Development of an Arduino Based Medication Reminder System to Help Patients Stick to their Medication Schedules

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Abstract: Medication adherence is a critical factor in patient health management, especially for individuals with chronic diseases and elderly patients. Forgetting to take prescribed medication on time can lead to severe health complications. This research presents the design and development of an Arduino-based medication reminder system to assist patients in adhering to their medication schedules. The system utilizes a microcontroller (Arduino) integrated with an LCD display, a real-time clock (RTC) module, and a buzzer to alert patients at the correct dosage time. When the scheduled time arrives, the buzzer sounds, and the LCD displays the medication details, ensuring timely consumption. Additionally, the system can be enhanced with a mobile application or SMS alert for remote notifications. The proposed system is cost-effective, easy to use, and customizable for different medication schedules. Experimental results demonstrate its effectiveness in improving medication adherence. This solution has the potential to reduce hospital visits due to missed doses and improve overall patient health outcomes.

Keywords: Smart medication reminder. Automated drug reminder. Lcd display system. Medication adherence.

1. Introduction:

Medication adherence is a crucial aspect of patient healthcare, particularly for individuals with chronic illnesses, elderly patients, and those with complex medication schedules. Many patients forget to take their prescribed medications on time, leading to serious health complications, ineffective treatment, or prolonged recovery. To address this issue, technological solutions have been developed to assist patients in following their medication schedules accurately.

One promising approach is the use of microcontroller-based systems, such as Arduino, to create an automated medication reminder. Arduino is an open-source platform that allows for the development of customizable and cost-effective healthcare solutions. By integrating an Arduino microcontroller with a real-time clock (RTC), an LCD display, and an alarm system, it is possible to design a smart medication reminder that notifies patients when it is time to take their medicine.

This study explores the development of an Arduino-based medication reminder system that alerts patients through visual and auditory signals. When the scheduled time arrives, the system activates a buzzer and displays the medication details on an LCD screen, ensuring that the patient is aware of their dosage requirements. Additionally, the system can be enhanced with SMS or mobile notifications for remote alerts.

By implementing such a system, medication adherence can be significantly improved, reducing hospital visits due to missed doses and enhancing overall patient health. This research highlights the importance of integrating technology into healthcare to provide efficient and accessible solutions for medication management.

2. Project Objectives:

1. Improve patient adherence to medication schedules by developing a smart alert system based on Arduino.
2. Reduce forgetting medication schedules by using audio and visual notifications to alert the patient at the specified time.
3. Design a low-cost and easy-to-use system to be available to all groups, especially the elderly and patients who take multiple medications.
4. Enhance patient independence by providing a self-operating system without the need for continuous follow-up by healthcare providers.
5. Support the improvement of healthcare by reducing the negative effects resulting from not taking medication on time.
6. The possibility of developing the system in the future to include additional features such as sending notifications via mobile phone or integrating it with electronic healthcare systems.
7. Conduct practical experiments to test the efficiency of the system in real environments and ensure its accuracy and effectiveness in improving patient adherence to taking their medications.

3. Project components:

3.1. Arduino Nano:

Arduino Nano is a small-sized microcontroller board based on the ATmega328P. It is used in electronic projects and embedded systems. The Nano's compact size makes it ideal for applications requiring minimal space. It features 14 digital input/output pins (6 of which support PWM) and 8 analog inputs, allowing the connection of various sensors and electronic components.

The Arduino Nano operates at 5V and can be powered via a Mini-B USB port or an external power source ranging from 6-12V. It supports serial communication protocols such as UART, I2C, and SPI, making it easy to integrate with other components. It is programmed using the Arduino IDE, a user-friendly development environment based on C/C++. Due to its small size and low cost, the Arduino Nano is widely used in smart systems, robotics, and Internet of Things (IoT) applications.

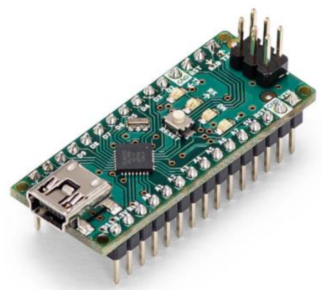

Fig (1): Arduino Nano.

3.2. LCD 16x2:

The LCD 16x2 is a display module based on Liquid Crystal Display (LCD) technology, commonly used in electronic projects to display data clearly. This screen has 16 columns and 2 rows, allowing it to display 32 characters at a time. It uses the HD44780 controller, which simplifies communication with microcontrollers like Arduino and Raspberry Pi.

The display operates at 5V and can be controlled using 4-bit or 8-bit parallel communication. It has four data pins (in 4-bit mode) or eight data pins (in 8-bit mode), along with control pins RS, E, and RW. The display contrast can be adjusted using a potentiometer for better visibility.

LCD 16x2 is widely used in applications such as alarm systems, digital counters, educational projects, and measurement devices due to its low power consumption and ease of programming.

Fig (2): Lcd16x2

3.3. RTC DS3231:

The RTC DS3231 is a high-precision Real-Time Clock (RTC) module used to keep track of time and date accurately. It features an integrated temperature-compensated crystal oscillator (TCXO), ensuring stability and reducing time drift caused by temperature changes. The module operates with low power consumption, making it ideal for battery-powered projects.

It communicates with microcontrollers like Arduino using the I2C (Inter-Integrated Circuit) protocol, requiring only two pins (SDA and SCL). The DS3231 can store seconds, minutes, hours, day, date, month, and year, with built-in support for leap years. Additionally, it includes an alarm function that can trigger events at specific times.

The module operates at 3.3V or 5V, making it compatible with various development boards. It also features an internal battery backup (CR2032), allowing it to maintain accurate time even when the main power is disconnected. The EEPROM memory in some versions can be used for storing additional user data.

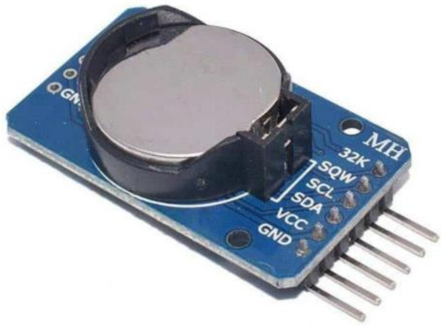

Fig (3): RTC DS3231.

3.4. Push Button:

A push button is a simple switch used to control electronic circuits by making or breaking a connection when pressed. It consists of two metal contacts that close the circuit when the button is pressed and open it when released. Push buttons are commonly used in control systems, user interfaces, and embedded projects.

They come in various types, including momentary and toggle switches. Momentary push buttons return to their original state after release, while toggle switches stay in their new state until pressed again. In microcontroller projects like Arduino, push buttons are often used for input control, resetting systems, or triggering events.

A pull-up or pull-down resistor is usually required to ensure stable operation and avoid floating signals. Push buttons are widely used in appliances, automation systems, and interactive devices.

Fig (4): Push Button.

3.5. LED:

A set of leds that can be used in the project for lighting.

Fig (5): LED.

3.6. Buzzer:

It is an electronic device that emits a sound when executed and is operated and connected through the Arduino controller.

Fig (6): Buzzer.

3.7. 10k Pot:

This is a 10k pot and is used to adjust the brightness of the LCD screen.

Fig (7) :10k Pot.

3.8. Zero PCB:

is a type of printed circuit board (PCB) that is designed without pre-existing circuit traces or components, allowing users to manually add their own components and wiring. It is often used for prototyping and custom circuit designs, providing flexibility and ease of modification in electronics projects.

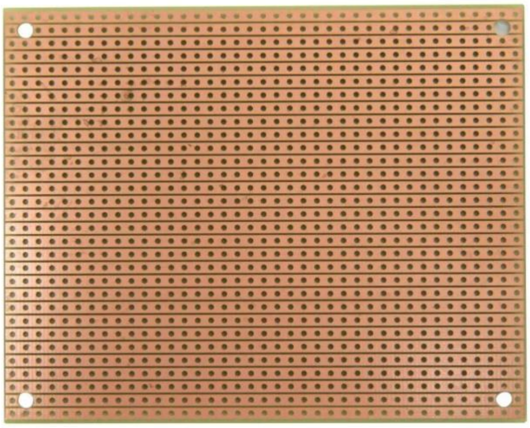

Fig (8): Zero PCB.

3.9. Jump Wires:

Jump wires are electrical wires used to connect different components in electronic circuits without soldering, making testing and modifications easier. They come in various lengths and colors, with male-to-male, male-to-female, or female-to-female ends, and are commonly used with breadboards and microcontrollers like Arduino.

Fig (9): Jump Wires.

4. Project Work:

The project is designed to be straightforward. Upon initiating the system, the real-time clock is activated on the LCD screen. To configure the alarm time for medication, the user must press the set_button. Following this action, the LCD screen will show "Set Time 1." Subsequently, the desired time for the medication can be adjusted using the INC button and the next button from the previous operation to modify the time again. After the second and third adjustments, the LCD screen will display the correct time and date. When any alarm is triggered, the LCD indicates Group Medicine 1, Group Medicine 2, and Group Medicine 3. Additionally, the modified alarm time is stored in the internal EEPROM of the Arduino to prevent data loss in the event of a failure.

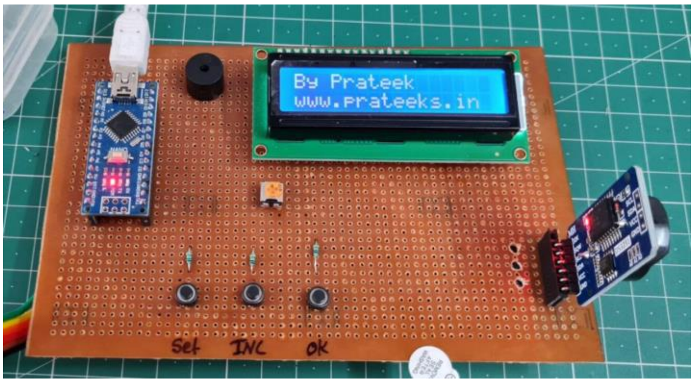

Fig (9): Project Working Principle.

5. Circuit Diagram:

In the circuit diagram, the Arduino is the main controller and the main part and it is connected to the DS3231 RTC and the connection is:

- ✓ Vcc to 5Volt.
- ✓ Scl to Gnd.
- ✓ Gnd to Gnd.
- ✓ SDA to A4.

When the system starts up, the real-time clock on the LCD will be turned on, and the LCD will dial the PIN.

- ✓ D3,D4,D5,D6,D7,D8.

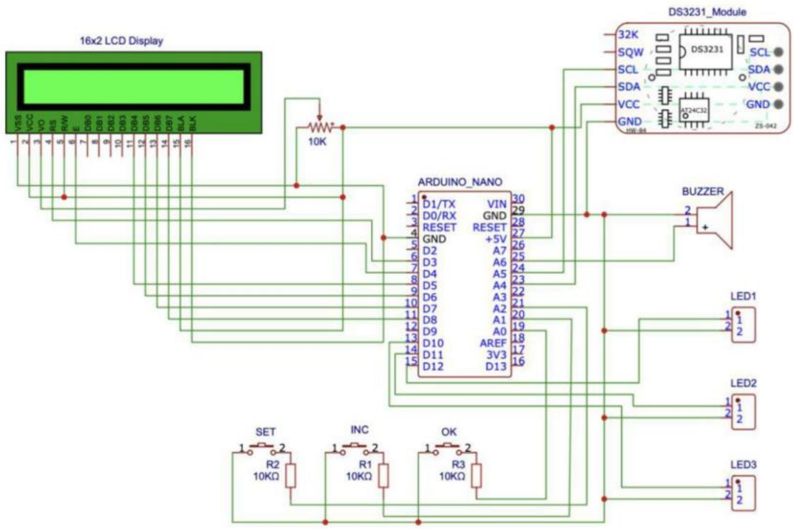

Fig (10): Circuit Diagram.

The time designated for medication will be established using the INC and NEXT buttons, while the Previous button will be linked to the PIN numbers A0, A1, and A2. The LED indicators and buzzer will be connected as follows: the red LED will be connected to pin number D10, the yellow LED to pin number D11, and the green LED to pin number D12. Additionally, the buzzer will be connected to pin number A6.

6. Project Demo:

When all components are connected, the programming code is added, and the wires are connected, we connect the computer cable and when the power is turned on, the screen will display a welcome message. With the help of the button, we set the medication group reminder, where the time and date are displayed on the LCD screen.

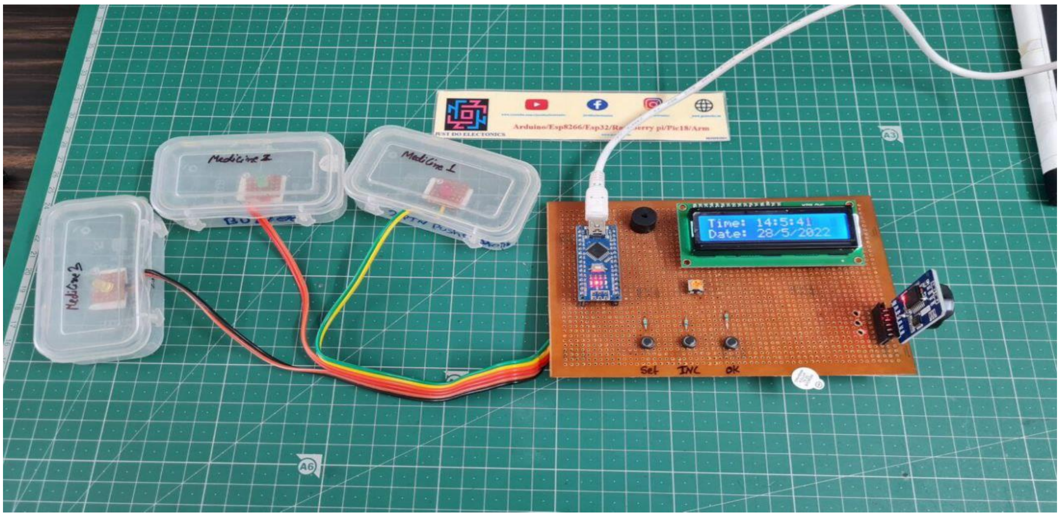

Fig (11): Project Demo.

7. Results:

The developed Arduino-based medication reminder system successfully enhances patient adherence to prescribed medication schedules. Experimental tests demonstrated that the system accurately alerts patients at the designated times using an LCD display and an audible buzzer. The integration of the real-time clock (RTC) ensures precise timekeeping, minimizing missed doses. The device's low-cost design and ease of use make it accessible for elderly patients and individuals with chronic conditions. Additionally, the system can store medication schedules in EEPROM, preventing data loss in case of power failure. Future enhancements could incorporate mobile notifications for remote alerts. Initial user feedback indicates improved adherence rates, leading to better health outcomes. The system's reliability and accuracy were confirmed through multiple trials. Compared to manual reminders, the automated system significantly reduces the chances of missed doses. These results highlight the potential of technology in improving medication adherence and patient care.

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