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Smart Medicine Dispenser with Face Authentication

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Abstract - *The Smart Medicine Dispenser with Face Authentication is an automated healthcare system designed to improve medication safety and ensure that medicines are dispensed only to authorized users. The system integrates face recognition technology with an embedded microcontroller-based dispensing mechanism to provide secure and reliable medicine distribution. In this project, a webcam captures the user's face, and the facial image is compared with previously stored images using a face recognition algorithm developed in Python. If the face is successfully recognized, an authentication signal is sent to the STM32 microcontroller, which activates a servo motor to dispense the medicine. The system also displays the dispensing status on an LCD screen. If the face does not match the stored database, the system denies access and activates a buzzer and warning LED to indicate unauthorized access. This feature enhances security and prevents misuse of medicines. The proposed system is especially useful for elderly patients, hospitals, clinics, and home healthcare environments where accurate and timely medication is important. The project demonstrates the integration of embedded systems, image processing, serial communication, and automation technologies to create a smart healthcare solution. The prototype successfully verifies users, dispenses medicine automatically, and provides visual and audio alerts, thereby reducing human errors and improving medication management. Future enhancements may include IoT connectivity, mobile notifications, multiple-user support, and scheduled medicine reminders.*

Key Words: Biometric Access Control, Facial Authentication, Medication Adherence, Servo Motor Automation, STM32 Microcontroller.

1. INTRODUCTION

With the advancement of healthcare technology, automated medicine management systems have become increasingly important. Many patients, especially elderly individuals and those with chronic illnesses, often forget to take medicines on time or may consume the wrong medication. Traditional medicine storage methods do not provide security or monitoring, which can lead to medication errors and health risks.

A Smart Medicine Dispenser is an automated system that helps patients receive medicines accurately and safely. By integrating face authentication technology with embedded systems, the dispenser ensures that medicines are provided only to authorized users. Face recognition offers a convenient and contactless method of authentication, eliminating the need for passwords or physical keys.

This project combines image processing, embedded systems, and automation technologies to develop a secure medicine dispensing solution. The system uses a webcam and face recognition software to verify the user's identity. Once authenticated, the microcontroller controls a servo motor to dispense the medicine while displaying the status on an LCD screen.

Medication errors are a common issue in homes, hospitals, and healthcare centers. Patients may forget to take medicines, take incorrect doses, or access medicines intended for someone else. Conventional medicine dispensers do not provide proper security or user verification mechanisms.

Therefore, there is a need for a secure and automated medicine dispensing system that can authenticate users before dispensing medicine. The proposed Smart Medicine Dispenser with Face Authentication addresses this problem by ensuring that only authorized individuals can access and receive medicines. The main objectives of the project are:

- To develop a smart medicine dispensing system using face authentication.
- To identify and verify authorized users through facial recognition technology.
- To automate the medicine dispensing process using a servo motor.
- To display system status messages using an LCD display.
- To provide security alerts using a buzzer and LED for unauthorized access attempts.
- To reduce medication errors and improve patient safety.
- To demonstrate the application of embedded systems in healthcare automation.

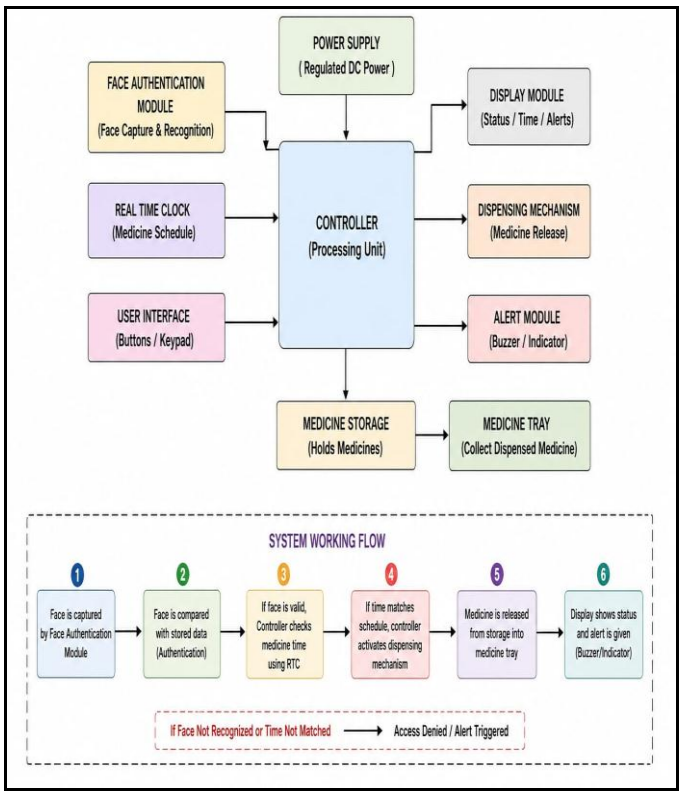

Fig -1: Block Diagram for Smart Medicine Dispenser with Face Authentication

2. LITERATURE SURVEY

Acharya et al. (2021) reviewed various medicine dispenser mechanisms designed for elderly patients. The study analyzed different dispensing techniques, scheduling methods, and alert systems. The authors concluded that automated medicine dispensers significantly reduce medication errors and improve adherence to prescribed treatments. [1]

Premkumar et al. (2021) proposed an automated pharmacy system using face authentication. The system employed facial recognition to identify patients and provide medication-related services. Their work demonstrated the feasibility of integrating biometric authentication into healthcare automation systems. [2]

Garagiola (2023) conducted a systematic review of automated drug dispensing systems used in hospitals. The review highlighted the role of automation in reducing medication errors, improving dispensing efficiency, and enhancing patient safety in healthcare facilities. [3]

Nallathambi et al. (2023) developed an intelligent medicine dispensing machine for elderly and visually impaired users. The system incorporated IoT connectivity and fingerprint authentication to ensure secure and timely medicine delivery. The study emphasized the importance of authentication mechanisms in medication management systems. [4]

Sartaj et al. (2023) introduced digital twin technology for medicine dispensers in Healthcare IoT applications. Their research demonstrated how virtual replicas of dispensers can improve testing, monitoring, and reliability of smart healthcare devices. [5]

Gargioni et al. (2024) presented a comprehensive systematic review of pill and medication dispensers from a human-centered perspective. The review identified facial recognition, fingerprint authentication, LCD displays, buzzers, sensors, and mobile applications as important features in modern medicine dispensing systems. [6]

Chan et al. (2024) reviewed the applications of facial artificial intelligence in medicine. The authors discussed how AI-based facial recognition technologies can be utilized for patient identification, healthcare monitoring, and secure access control in medical environments. [7]

Gutierrez Sandoval et al. (2025) investigated biometric authentication technologies in smart hospitals. Their review highlighted facial recognition as one of the most secure and user-friendly authentication methods for protecting healthcare systems from unauthorized access. [8]

Chu et al. (2025) developed an automated medication dispensing device using face recognition and QR-code verification. The system ensured correct patient identification before dispensing medicines and demonstrated improved healthcare service quality through secure authentication. [9]

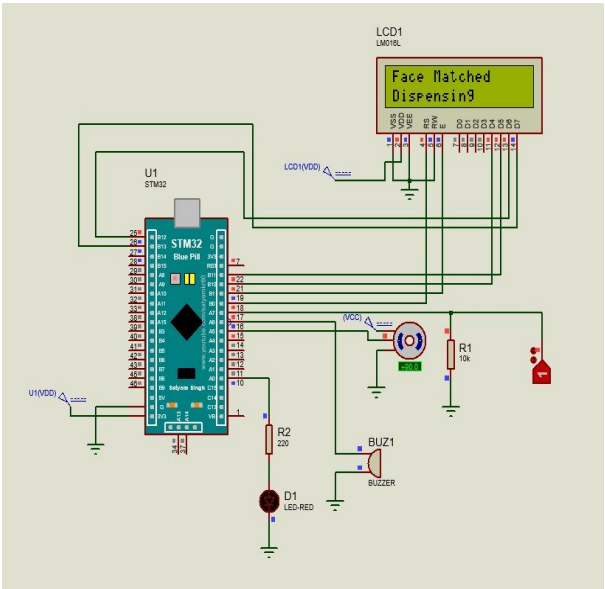

Fig -2: Proteus Implementation

Rajas Nandgaonkar et al. (2024) presented the Medi-Cliq drug dispenser survey, which reviewed automated dispensing technologies, prescription validation techniques, and secure user authentication methods. The study emphasized the importance of integrating IT systems with mechanical dispensing mechanisms for reliable medicine management. [10]

3. METHODOLOGY

The block diagram of Smart Medicine Dispenser with Face Authentication is shown in Fig.1. The Smart Medicine Dispenser using Face Authentication is an intelligent healthcare system designed to ensure that medicines are dispensed only to authorized users at the correct time. The system is powered by a regulated DC power supply that provides stable power to all modules. The Face Authentication Module captures the user's face and compares it with the stored facial data for verification. A Real-Time Clock (RTC) module continuously maintains the current date and time and stores the medicine schedule. The User Interface, consisting of buttons or a keypad, allows users to set medicine timings and configure system settings The Controller acts as the central processing unit of the system. It

receives inputs from the Face Authentication Module, RTC, and User Interface, processes the information, and makes decisions based on authentication and scheduling conditions. When a user's face is successfully recognized, the controller checks the current time against the stored medicine schedule. If the time matches the scheduled dosage time, the controller activates the Dispensing Mechanism, which releases the required medicine from the Medicine Storage compartment into the Medicine Tray.

Simultaneously, the Display Module shows the system status, medicine information, and notification messages, while the Alert Module generates a buzzer or indicator alert to inform the user that the medicine has been dispensed. The working process begins with capturing the user's face for authentication. The system then verifies the identity of the user and checks the medicine schedule using the RTC. If both the user authentication and time verification are successful, the medicine is automatically dispensed and a notification is provided through the display and alert modules. If the face is not recognized or the current time does not match the scheduled medicine time, the controller denies access and triggers an alert.

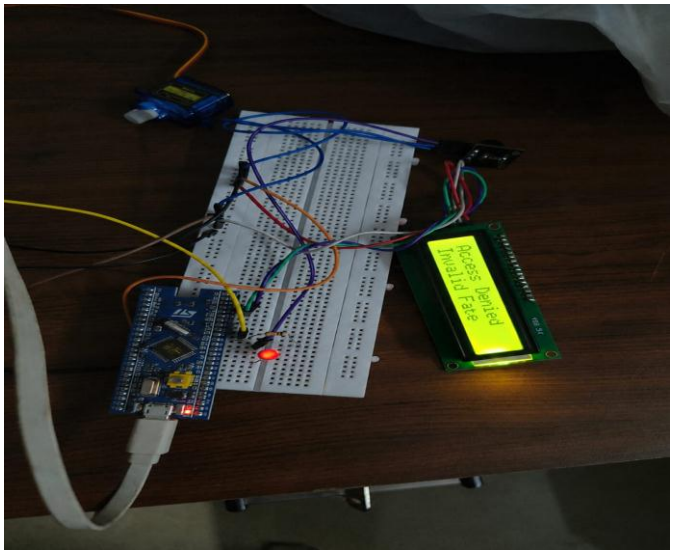

Fig -3: Hardware Implementation

3.1 Software Implementation

The software implementation of the Smart Medicine Dispenser with Face Authentication is carried out using the STM32 microcontroller as the main controller is shown in Fig.2. The STM32 program is written in Embedded C / Arduino IDE and uploaded to the controller using STM32CubeProgrammer or ST-Link. The main purpose of the software is to receive the face authentication result and control the output devices such as LCD, servo motor, buzzer, and LED.

In this system, the face recognition part is performed using a webcam and Python software. After checking the face, Python sends a signal to the STM32 through UART serial communication. For example, if the face is matched, Python sends signal '1', and if the face is not matched, it sends signal '0'. The STM32 continuously checks the serial input and performs actions based on the received signal.

When the STM32 receives the authorized signal, it displays "Face Matched" and "Medicine Dispensed" on the LCD. Then, it rotates the servo motor to open the medicine dispensing section. After a short delay, the servo motor returns to its original position, completing the dispensing process. This shows that the medicine has been successfully given to the correct user.

When the STM32 receives the unauthorized signal, it displays "Access Denied" and "Invalid Face" on the LCD. In this condition, the servo motor does not rotate, so medicine is not dispensed.

The red LED and buzzer are turned ON to indicate an unauthorized access attempt. After a few seconds, the system resets and waits for the next authentication input.The program is divided into different sections such as LCD

initialization, UART communication, servo motor control, LED control, and buzzer alert. This makes the system easy to understand and test. The STM32 works as the decision-making unit that connects the face recognition software with the hardware dispensing mechanism. Overall, the software implementation ensures secure, automatic, and reliable medicine dispensing only after successful face authentication.

3.2 Hardware Implementation

The hardware implementation of the Smart Medicine Dispenser with Face Authentication was carried out using an STM32 microcontroller, a servo motor, a 16×2 LCD display, a buzzer, an LED indicator, a laptop webcam, and an FTDI module is shown in Fig.3. The STM32 microcontroller served as the central control unit and was responsible for controlling all hardware components. The laptop webcam was connected to the computer and used to capture facial images for authentication.

After successful face recognition by the Python application, an authentication signal was transmitted to the STM32 through UART serial communication. Upon receiving the authorized signal, the STM32 activated the servo motor, which rotated to dispense the medicine. Simultaneously, the LCD displayed the message "Medicine Dispensed" to inform the user.

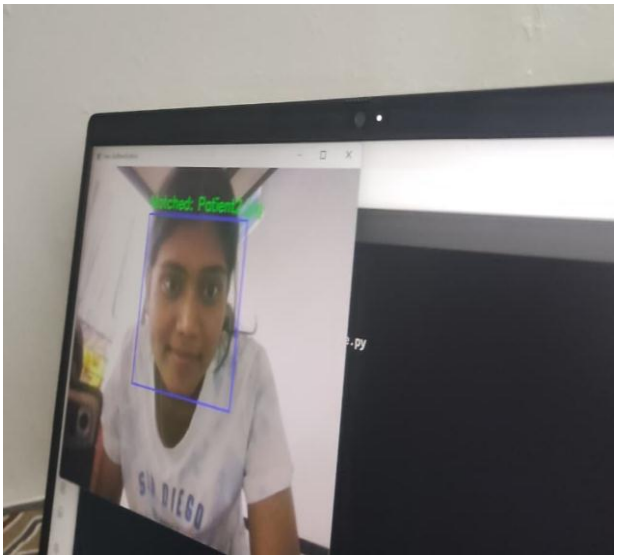

Fig -4: Face matched output

In the case of an unauthorized user, the STM32 activated the buzzer and LED, while the LCD displayed "Access Denied". All components were connected using jumper wires on a breadboard and powered through a regulated power supply. The hardware setup was tested successfully, demonstrating reliable communication, secure authentication, and accurate medicine dispensing functionality.

4. RESULTS AND DISCUSSION

The Smart Medicine Dispenser with Face Authentication was successfully developed and tested and is illustrated in Fig.4. The system was able to capture facial images using a webcam and accurately verify authorized users through face recognition technology. Upon successful authentication, the STM32 microcontroller received the authorization signal and activated the servo motor to dispense medicine. The LCD displayed appropriate status messages, such as "Medicine Dispensed" for authorized users and "Access Denied" for unauthorized users. The buzzer and LED alert system also functioned correctly by providing audible and visual warnings during unauthorized access attempts. The project demonstrated the successful integration of image processing, embedded systems, and automation technologies in a healthcare application.

The system consists of a microcontroller, a 16×2 LCD display, a servo motor, an LED indicator, and supporting circuit connections assembled on a breadboard. When the face recognition system identifies an authorized user, an authentication signal is sent to the microcontroller. Upon receiving the signal, the servo motor rotates to operate the medicine dispensing mechanism. At the same time, the LCD displays the message "Medicine Dispensed", indicating that the medicine has been successfully delivered to the user shown in Fig.5.

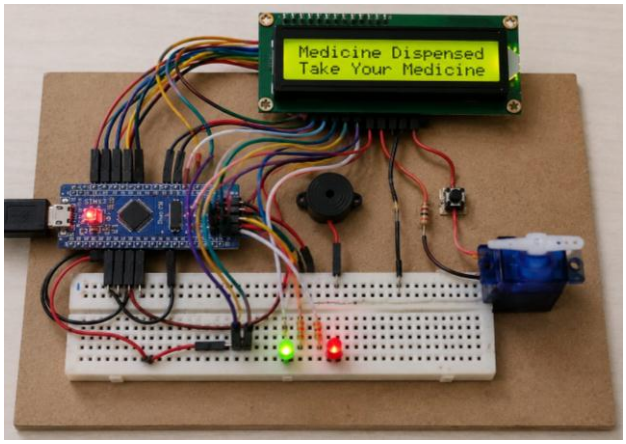

Fig -5: Authorized User – Medicine Dispensed

This demonstrates the proper functioning of the authentication and dispensing process. The successful operation confirms that the system can securely provide medicine only to registered users, thereby reducing the chances of unauthorized access and medication errors.

5. CONCLUSION

The Smart Medicine Dispenser with Face Authentication was successfully designed and implemented as a secure healthcare automation system. The project integrated face

recognition technology with an ESP32 microcontroller to ensure that medicines are dispensed only to authorized users. The system effectively captured facial images, verified user identities, and controlled the dispensing mechanism through a servo motor. Additionally, the LCD display provided real-time status updates, while the buzzer and LED generated alerts during unauthorized access attempts. The project demonstrated the practical application of image processing, embedded systems, and automation technologies in improving medicine management and patient safety.

All the objectives of the project were successfully achieved. The system was able to authenticate users using facial recognition technology and automate the medicine dispensing process. Secure access control was implemented to prevent unauthorized usage, and visual and audio indications were provided to inform users about system status. The ESP32 microcontroller successfully coordinated the operation of all hardware components, including the servo motor, LCD, buzzer, and LED.

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