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A User-Centric Domestic Medicine Dispensing System with Integrated Health Monitoring

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Abstract - *This work introduces a comprehensive domestic medicine dispensing system aimed at optimizing medication adherence and enhancing healthcare management within a household. The system integrates cutting-edge technologies including face detection, vital sign monitoring (Temperature, Pulse, Saturation etc) alert mechanism emergency communication, water dispensing mechanisms, navigation and timely medicine dispersal creating a sophisticated and user-friendly solution. The face detection system ensures the precise identification of pre-trained family members, allowing the dispenser to administer medications exclusively to the intended recipient. Vital measurement sensors continuously monitor key health parameters such as heart rate, temperature, and blood pressure. If any vital signs fall outside the normal range, the system triggers an alert. These alert mechanisms are crucial for early detection of health issues and for providing timely intervention, particularly in critical care settings or for monitoring patients with chronic conditions. They help ensure the safety and well-being of individuals by promptly responding to any deviations from normal vital signs. In the event of any significant deviations from predefined ranges, the system triggers immediate notifications to emergency contacts, facilitating rapid response and intervention. The dispenser is equipped with a water dispensing module to provide the optimal amount of water required for medication consumption, promoting proper drug efficacy. The entire system is orchestrated by a microcontroller, which serves as the central control unit, managing the synchronization and interaction of various components. Rigorous testing ensures the accuracy and reliability of the system in diverse scenarios, guaranteeing its effectiveness in real world applications. The user interface is designed to be intuitive, featuring alerts, notifications, and feedback mechanisms to enhance user experience and ensure user compliance. Furthermore, robust security measures are implemented to safeguard sensitive user data and maintain the integrity of the system. The deployment of this intelligent domestic healthcare solution involves careful consideration of ethical and legal aspects, with a focus on user privacy and data protection. Additionally, collaboration with healthcare professionals is crucial to align the system with medical best practices and ensure its integration into the broader healthcare ecosystem. Once implemented successfully, this project stands to revolutionize medication management within households, promoting proactive healthcare practices and contributing to improved overall wellbeing.*

Key Words: *Data protection, Face detection, Healthcare management, Vital measurement*

1.INTRODUCTION

The advent of smart technologies has ushered in an era of innovation that extends beyond conventional boundaries, catalyzing advancements in various facets of daily life. In this context, our project endeavours to redefine healthcare management within the confines of a household through the development of an intricate Domestic Medicine Dispensing System. This innovative system integrates state-of-the-art technologies, including face detection, vital sign monitoring, emergency communication, and water dispensing mechanisms. The overarching goal is to create a holistic solution that not only streamlines the process of medication administration but also prioritizes user safety and adherence to prescribed health regimens. The project's genesis lies in recognizing the need for a sophisticated and user-friendly approach to medication management, particularly within the domestic sphere. The traditional pillbox is transformed into an intelligent dispenser capable of recognizing and dispensing medication exclusively to pre-trained family members. By harnessing the power of facial recognition, the system ensures that medication is administered to the intended recipient, The incorporation of vital sign monitoring adds an extra layer of sophistication, enabling the system to detect any deviations from normal health parameters and promptly notify emergency contacts when necessary. Timely dispense of pills trice a day and the pill is stored in a box followed by a water dispenser as it convenient for users to access water without manual intervention.

2. OBJECTIVES

The overarching objective of the Domestic Medicine Dispensing System project is to revolutionize healthcare management within households by creating an intelligent and user friendly system for medication administration. The project seeks to enhance medication adherence by deploying advanced technologies such as face detection, and vital sign monitoring. Through these innovations, the system aims to streamline the process of medication dispensing, ensuring it is exclusive to pre-trained family members. Emphasizing user safety, the system proactively monitors vital signs, promptly notifying emergency contacts in the event of deviations from normal health parameters. The integration of a water

dispensing mechanism further supports medication administration. With a focus on user-friendly interaction, the system employs intuitive facial recognition, catering to users of varying technological proficiency. Privacy and security considerations are paramount, with robust measures in place to protect sensitive health information

3. METHODOLOGY

The pill dispensing mechanism consists of a box containing individual compartments for storing pills. Each compartment is designed to hold a single dose of medication. A push-pull actuator mechanism is employed to dispense pills. When a dosage is required, the actuator pushes the pill out of its compartment. The pill then slides down through an L-shaped frame, making it easily accessible for the user. The pill dispensing mechanism is controlled by an Arduino microcontroller. The microcontroller manages the push-pull actuator mechanism, which is connected to it. When a dosage is required, the microcontroller sends signals to the actuator to push the pill out of its compartment. The Arduino also coordinates the timing and sequence of pill dispensing. - After dispensing the pills, the system includes a water dispenser to provide the user with a drink. An infrared (IR) sensor is positioned to detect the presence of a cup placed by the user. When the IR sensor detects the cup, it triggers a submersible water pump to dispense water into the cup. This hands-free operation ensures convenience and hygiene for the user.

The system incorporates a pulse oximeter sensor to monitor the patient's vital signs, specifically pulse rate and oxygen saturation levels (SpO2).The pulse oximeter sensor is non-invasively placed on the patient's finger. It continuously measures the pulse rate and SpO2 levels. The readings are displayed in real-time on an LCD display, allowing the user to monitor their health status. The pulse oximeter sensor and temperature sensor are connected to the Arduino microcontroller. The Arduino continuously reads data from these sensors. It processes the sensor data to calculate pulse rate, SpO2 levels, and body temperature. - A temperature sensor is integrated into the system to monitor the patient's body temperature. This sensor is also non-invasive and can measure the temperature of the patient's body. If the temperature exceeds preset thresholds, an alert mechanism is triggered to notify the user or caregiver The calculated values are then displayed on the LCD screen connected to the Arduino.

The alert mechanism is designed to notify users or caregivers in case of abnormal health readings. A GSM module is used to send notifications via SMS to designated contacts. These alerts are triggered when the temperature readings fall outside of preset thresholds. The medicine dispenser is equipped with automatic navigation capabilities to ensure it is easily accessible to the user. Sensors are used to detect the user's location, such as a seating area or bed. The dispenser navigates itself to the desired location based on the detected user's position. This feature enhances user convenience and accessibility, especially for individuals with mobility issues. By integrating these technologies, the medicine dispenser system provides a comprehensive solution for medication management and health monitoring, ensuring the safety and well-being of the user.

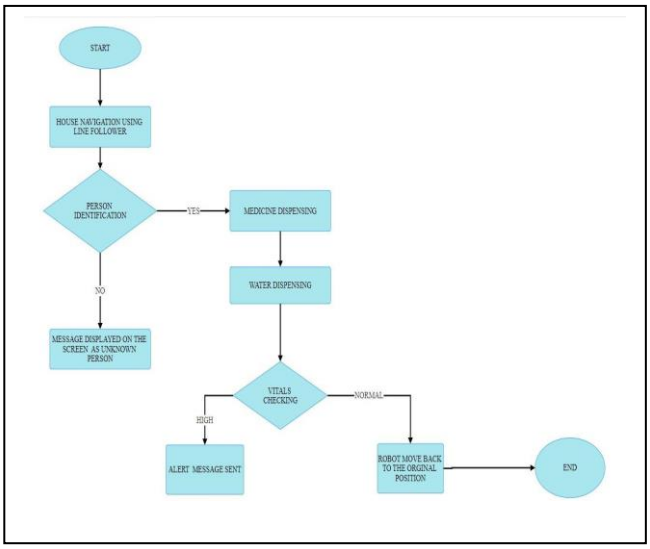

Fig 1: Flow chart

3.1 Medicine Dispensing

The automated pill dispensing system uses a 3D printed apparatus with a linear actuator controlled by an Arduino for precise medication management. The system features seven L-shaped frames, each with three compartments for morning, afternoon, and night doses. Pills are stored in individual boxes within these compartments. The Arduino manages the dispensing process by activating the actuator, which pushes pills out of their boxes at the designated times.

The hardware setup includes a linear actuator, an Arduino board, a motor driver, limit switches, and a power supply, ensuring controlled and reliable dispensing. This integration of 3D printing and Arduino technology offers a customizable, automated solution for accurate and timely medication distribution.

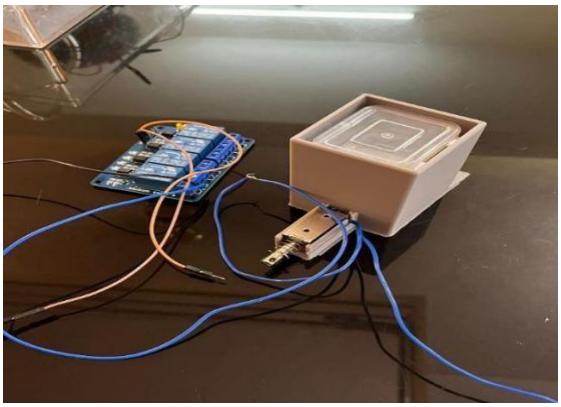

Fig 2 : Pill Dispenser Design

3.2 Water Dispensing

The water dispensing system utilizing an IR sensor, 5V relay module, and submersible water pump wire connection provides a simple and efficient solution for automated water dispensing. The system is initiated when the IR sensor detects the presence of an object, typically a cup or container, triggering the relay module to activate the submersible water pump. The 5V relay acts as a switch, controlling the flow of electricity to the pump. Once activated, the submersible water pump draws water from a reservoir and dispenses it into the container placed below the sensor. This setup ensures a hands-free operation, making it convenient for users to access water without manual intervention. The integration of these components creates a reliable and straightforward system suitable for various applications, from home water dispensers to commercial setups.

Fig 3: Water dispensing system

3.3 Face Recognition

The face detection and recognition project uses TensorFlow, OpenCV, and 3D printing for automated face recognition and medication dispensing. It integrates OpenCV's Haar Cascade for face detection and a pre-trained CNN via TensorFlow for recognition, distinguishing between family members to personalize medication administration. A standard webcam captures live video for the algorithms, supported by a power supply and a processing unit to manage software and hardware coordination. This project combines advanced technologies to enhance medication adherence and showcases the potential of facial recognition in domestic applications.

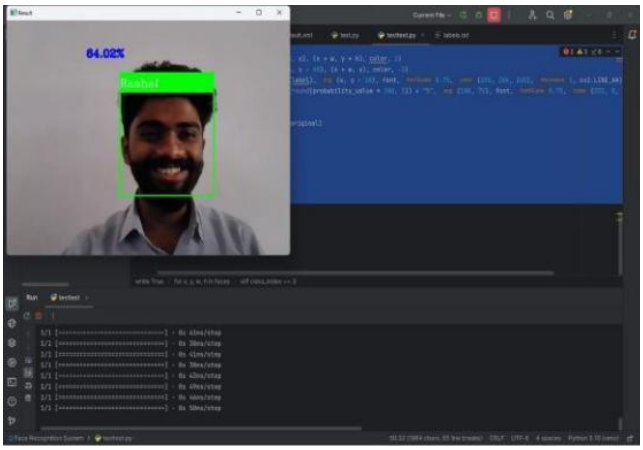

Fig 4: Face Detected and Recognized

3.4 Vitals Checking

Pulse, temperature, and oxygen saturation (SpO2) are key health indicators, with pulse measured in beats per minute, temperature assessed via noncontact infrared thermometers, and SpO2 determined by pulse oximeters using light absorption to gauge oxygenated hemoglobin. Our device employs a non-contact infrared sensor to measure temperature, converting infrared radiation into electrical signals displayed on a screen, and provides alerts for abnormal readings via visual signals or notifications to a connected smartphone through a GSM module.

The integrated pulse oximeter measures SpO2 and pulse rate by emitting light through a fingertip and analyzing absorption to display results on the medicine dispenser's LCD screen. The hardware setup includes an Arduino Uno microcontroller, an I2C LCD display for clear message presentation, and a GSM module like the SIM800L for real-time SMS alerts. A battery ensures portability, with a resistor controlling the LCD backlight brightness, creating an autonomous system that integrates comprehensive health monitoring with medication management.

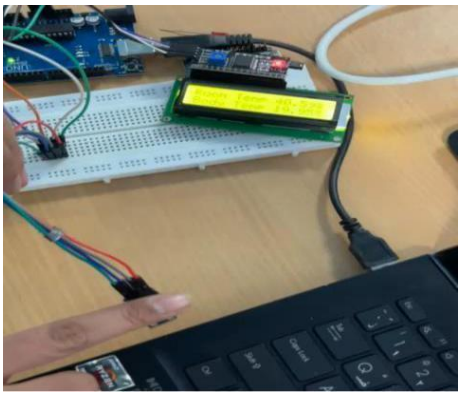

Fig 5: Body temperature detection and display reading.

4. NAVIGATION

The introduction of the project focuses on introducing a domestic medicine dispensing system with the primary goal of enhancing medication adherence and healthcare management within households. This system incorporates various advanced technologies, one of which is a line follower mechanism for navigation. This navigation system is a crucial component that ensures the medicine dispensing system can move accurately within the household environment. In the methodology, the approach to designing and implementing the system is explained. This includes detailing the roles and interactions of the components involved, such as the 100rpm gear motors, motor driver, Arduino Uno, and infrared array. Each of these components plays a vital role in ensuring the proper functioning of the navigation system. For instance, the 100rpm gear motors are responsible for driving the movement of the medicine dispensing system, while the motor driver controls the speed and direction of these motors. The Arduino Uno serves as the central processing unit, receiving data from the infrared array and sending commands to the motor driver based on this data.

The working of the navigation system involves the infrared array detecting lines on the floor, commonly referred to as the path to follow. The infrared array then sends signals to the Arduino Uno, which processes this data and determines the appropriate actions to control the gear motors via the motor driver. This control mechanism enables the medicine dispensing system to follow the desired path accurately. Hardwiring the navigation system involves physically connecting the various components together. This includes wiring the gear motors to the motor driver and the motor driver to the Arduino Uno. Additionally, the infrared array needs to be connected to the Arduino Uno. This ensures proper communication and functioning between these elements, allowing for seamless navigation of the medicine dispensing system.

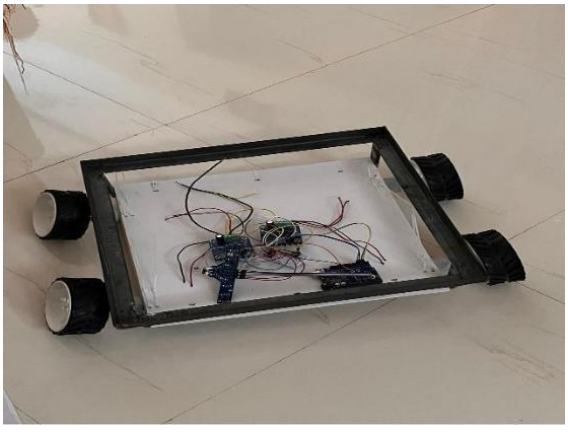

Fig 6: Base frame

5. RESULT

The work introduces a domestic medicine dispensing system that optimizes medication adherence and enhances healthcare management within households. It integrates technologies like face detection, vital sign monitoring, alert mechanisms, emergency communication, water dispensing, navigation, and timely medicine dispersal. The face detection system identifies family members, ensuring medication is administered to the right person. Vital sign sensors monitor health parameters; deviations trigger alerts for timely intervention. Emergency contacts receive immediate notifications for significant deviations. The system provides water for medication consumption and is controlled by a microcontroller, tested for accuracy and reliability. The user interface is intuitive with alerts and feedback for compliance. Robust security safeguards sensitive data, with ethical and legal aspects considered. Collaboration with healthcare professionals ensures alignment with best practices. Once implemented, it revolutionizes medication management, promoting proactive healthcare and improving wellbeing.

6. CONCLUSIONS

The comprehensive domestic medicine dispensing system introduces a transformative approach to home healthcare management, leveraging advanced technologies to ensure precise medication adherence and enhance overall well-being. With features like face detection, vital sign monitoring, and timely alert mechanisms, the system accurately administers medications to the intended recipients while continuously tracking key health parameters. This proactive monitoring enables early detection of health issues, crucial for timely interventions and managing chronic conditions effectively. The system is designed with user experience and safety at its core. The microcontroller orchestrates the interaction of various components, ensuring seamless operation. An intuitive user interface provides clear alerts, notifications, and feedback to enhance user compliance. Additionally, the integrated water dispensing module ensures proper medication intake, promoting drug efficacy. Robust security measures protect sensitive user data, maintaining the integrity and privacy of the system. Successful implementation of this intelligent healthcare solution, supported by rigorous testing and collaboration with healthcare professionals, promises to revolutionize household medication management. By promoting proactive healthcare practices and facilitating rapid responses to health deviations, the system significantly contributes to improved safety, health outcomes, and overall wellbeing within the home environment.

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