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IOT Based Virtual Patient Monitoring System

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Abstract

Electronic Pill Dispenser and a Patient Monitoring System to manage medication and track vital health parameters. The dispenser uses servo motors, an LCD display, for accurate and timely medication delivery, powered by a rechargeable USB-C battery. The monitoring system employs sensors for pulse, SpO2, and temperature, with data processed by a AT Mega 328p. A joystick-controlled rover adds mobility, while Bluetooth ensures real-time caregiver updates. This scalable solution promotes independent living and safety for the patient, with promising initial results and plans for further optimization.

Keywords: Electronic Pill Dispenser, Patient Monitoring System, AT Mega 328p, Esp32.

1. INTRODUCTION

The increasing elderly population worldwide has intensified the demand for innovative solutions to support their health and well-being. Many older adults face challenges such as managing complex medication regimens and monitoring vital health parameters, which are critical for maintaining their quality of life and independence. Traditional caregiving methods often struggle to meet these needs efficiently due to resource constraints and the growing number of elderly individuals requiring assistance. This project introduces +an integrated robotic assistant designed to enhance elder care by combining an Electronic Pill Dispenser and a Patient Monitoring System. The system is engineered to support elderly individuals by ensuring timely medication administration and continuous monitoring of key health indicators, such as pulse rate, oxygen saturation, and body temperature.

A. Electronic Pill Dispenser

An Electronic Pill Dispenser is a device designed to automatically dispense pills or medication at scheduled times, ensuring that patients take their medicine accurately and on time. Using a servo motor and AT Mega 328p, this system can be programmed to dispense the correct number of pills when needed, based on time, user input, or pre-set schedules. Patient Monitoring System is equipped with Pulse/Oxy sensor along Temperature sensor which detects respective parameters of the patient body and transmits data to main Pill dispenser Unit. Bluetooth Communication is used to transmit data from wearable unit to main unit. Both of the Devices are Battery powered and can be charged using USB- C type connector.

B. Patient Monitoring System

The servo motors are fitted on to a PVC enclosure which stores the medicine. The servo motors are controlled by AT Mega 328p controller which activates these servos, whenever pill dispensing scheduled or whenever the push button is pressed. Entire Pill Dispenser unit is mounted on a movable rover, this rover has 4 BO motors which are connected to L298N Motor Driver. L298N Motor driver is connected to ESP32 Controller which controls their operation according to the input given by user using Joystick module mounted on the wearable unit. ESP32 also has a LCD display connected to it via I2C

Communication which is used to display parameters measured by the wearable unit. There is total 3 input components on wearable unit Joystick, MAX30102 sensor and Lm35 Sensor. Joystick is used to operate the movement of the rover on which electronic pill dispenser is mounted. MAX30102 and LM35 are used to measure Pulses, Sp02 and Body temperature of the patient. All these data are processed by a AT Mega 328p on wearable unit and is transmitted to central pill dispenser unit using HC-05 Bluetooth module. Pill Dispenser doesn't require another Bluetooth to receive this data, since ESP32 is already equipped with inbuilt WIFI and Bluetooth.

2. Literature Review

The advancement of healthcare technologies has increasingly focused on integrating Internet of Things (IoT) systems to improve patient monitoring and automate medication management. Many researchers have proposed systems that either monitor patient vitals or automate pill dispensing, but few solutions offer a seamless combination of both. Patil and Pawar (2017) designed an automated pill dispenser integrated with an alert system via SMS, which made medication reminders more reliable for patients. However, their system lacked real-time health monitoring features. Singh and Sharma (2020) advanced the concept by integrating heartbeat and temperature sensors alongside a smart medicine dispenser, yet their model did not support real-time cloud data access or remote monitoring, limiting its usability in telemedicine setups.

Goyal and Verma (2019) developed an IoT-based smart health monitoring system that emphasized wireless continuous monitoring of patient vitals. Despite its potential, the system was highly dependent on network connectivity, making it less practical in areas with unstable internet access. Similarly, Prasad and Patel (2021) proposed an automatic pill dispenser using IoT modules that could efficiently handle medication schedules but did not incorporate features like electronic health record (EHR) integration or detailed patient data logging. Mehta and Sharma (2018) also contributed to this field by introducing a GSM-based smart medication dispenser, although it suffered from network delays and lacked a robust real-time communication protocol.

Further developments by Joshi and Kulkarni (2020) leveraged IoT sensors and cloud computing to enable remote patient monitoring. Their system allowed real-time access to patient data but was again dependent on constant internet connectivity. Verma and Saini (2022) created an IoT-based automated medication dispenser targeted towards elderly patients, combining real-time data tracking through mobile applications with user-friendly interfaces. Nonetheless, these systems required reliable internet and uninterrupted power supply, limiting their broader application in rural or resource- constrained settings.

Several researchers have explored the design and evaluation of smart pillboxes. Liao et al. (2016) reviewed various pillbox designs focusing mainly on medication adherence but did not address real-time health status updates or automated mobility features. Other studies like those by Kumar and Rajasekaran (2016) proposed multifunctional healthcare kits using Raspberry Pi and sensor integration; however, their solutions often lacked user-friendliness for elderly patients. Chakraborty et al. (2019) discussed cloud-based smart pill dispensers, highlighting concerns about data privacy and synchronization issues.

Although significant progress has been made, a gap remains in systems that combine medication management, vital health monitoring, mobility support, and wireless real-time communication. To bridge this gap, our project introduces a comprehensive solution integrating an Electronic Pill Dispenser and a Patient Monitoring System. Using microcontrollers (ESP32 and ATMega328p), Bluetooth and RF communication modules, servo motors, wearable sensors (pulse, SpO_2, and temperature), and mobile

robotic movement, our system offers real-time health tracking, automatic medication dispensing, mobility for patient approach, and local and remote alert generation. This integrated approach enhances patient independence, improves healthcare access, and ensures better adherence to treatment schedules, especially in elderly care and telemedicine applications.

3. METHODOLOGY

Requirement Analysis: Identify the needs of elderly care, such as medication schedules, patient monitoring, and mobility assistance. Define hardware and software specifications (e.g., pill dispenser capacity, sensor integration).

Pill Dispenser unit: Design a mechanism using servo motors and AT Mega 328p to automate pill dispensing. Incorporate ESP32 for communication and rover mobility control.

Patient Monitoring System: Develop wearable components with MAX30102 (pulse/SpO2) and LM35 (temperature) sensors for real-time health data monitoring.

Hardware Development: Assemble hardware components: servo motors, controllers, sensors, and LCD. Design and fabricate the pill dispenser unit and rover structure. Integrate power management with a Li-Ion battery and USB-C charging.

Software Development: Program the AT Mega 328p and ESP32 for pill dispensing, rover control, and communication. Develop firmware to collect and process health data from sensors via Bluetooth. Implement an interface for displaying data on the 16x2 LCD.

Integration: Integrate the wearable monitoring system with the pill dispenser unit. Establish Bluetooth communication between wearable sensors and the main system.

Testing and Validation: Test the pill dispenser unit for accuracy and reliability in dispensing pills. Validate the sensors for consistent monitoring of vitals (pulse, SpO2, temperature). Test Bluetooth connectivity for uninterrupted data transmission.

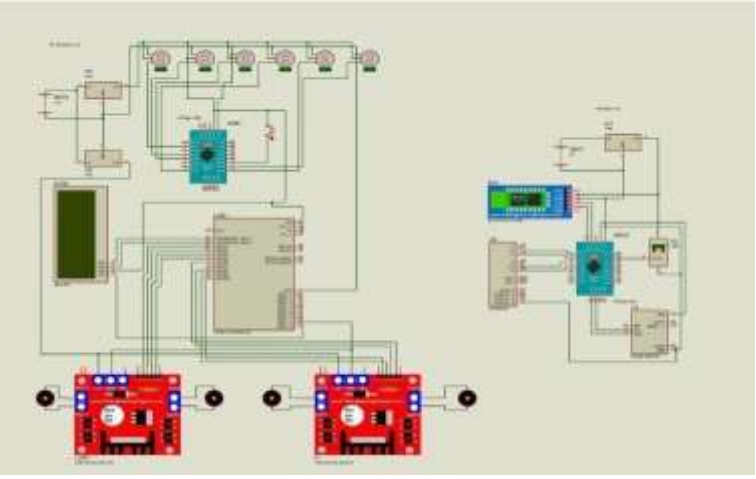

Fig.1. Circuit Diagram

Deployment and Demonstration: Deploy the system in a simulated healthcare environment for usability testing. Demonstrate pill dispensing, vital monitoring, and rover movement.

Future Scope Planning: Explore IoT integration for remote monitoring and control. Incorporate voice recognition and AI for personalized assistance. Increase pill capacity and improve device portability.

Key Features: The Electronic Pill Dispenser and Patient Monitoring System automates medication schedules and monitors vitals like pulse, SpO2, and temperature in real time. Controlled by an AT Mega 328p microcontroller, it dispenses pills on schedule, while wearable sensors transmit health data via Bluetooth. An ESP32-powered rover enables remote- controlled delivery, making it ideal for elderly care, hospitals, and home healthcare with features like portability, dual microcontrollers, and a 50-ft range.

4. Result & Conclusions

a. Outcome:

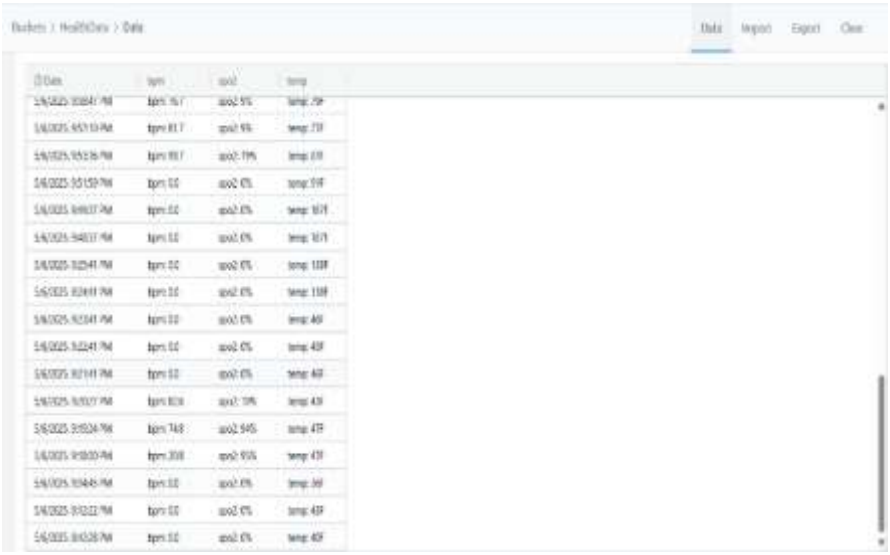

Fig.2. outcome parameters

b. Conclusion:

The Electronic Pill Dispenser and Patient Monitoring System is an innovative solution that addresses critical needs in healthcare, particularly in elderly care and home healthcare environments. By automating medication dispensing and providing real-time monitoring of vital signs, it ensures more accurate and efficient management of patient health. The integration of wearable components, Bluetooth communication, and a movable rover for medication delivery provides a seamless and user-friendly experience. With its potential for future enhancements such as AI- driven health analysis, voice control, IoT connectivity, and multi- drug dispensing, this system holds great promise for improving patient outcomes and making healthcare more accessible and effective. It represents a significant step towards smarter, more personalized healthcare solutions.

c. Future Scope:

The future scope of the Electronic Pill Dispenser and Patient Monitoring System includes several exciting advancements that could significantly enhance its capabilities. Integrating artificial intelligence (AI) would enable the system to analyze a patient's health data over time and predict potential health issues, allowing for automatic adjustments to medication schedules based on real- time conditions. Adding voice control would make the system more accessible, especially for elderly users, allowing them to interact with the device using simple commands. Future versions could also be connected to cloud platforms, enabling healthcare providers to monitor patient data remotely and manage multiple patients effectively. The system could evolve to handle multi-drug dispensing, supporting complex medication regimens, with features like automatic refills and low medication alerts. Expanding the sensor capabilities to monitor additional health metrics such as blood pressure, ECG, or glucose levels would make the system more comprehensive in tracking overall health. Finally, integrating the system

with smart home devices could create a fully connected healthcare environment, allowing the pill dispenser to interact with other devices, like adjusting home settings based on health conditions, to further improve patient care.

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