MediAid: Automated Healthcare and Smart Medicine Dispenser

Ravichandran M
Department of ECE
Amrita School of Engineering
Chennai, India
m_ravichandran@ch.amrita.edu

Simhadri Ravishankar
Department of ECE
Amrita School of Engineering
Chennai, India
r_simhadri@ch.amrita.edu

Anusri S
Department of ECE
Amrita Vishwa Vidyapeetham
Chennai, India
ch.en.u4cce22002@ch.students.amrita.edu

Madhunisha M V
Department of ECE
Amrita Vishwa Vidyapeetham
Chennai, India
ch.en.u4cce22017@ch.students.amrita.edu

***Abstract*—Elderly individuals often experience serious health issues that need ongoing monitoring of their health and prompt administration of medication to avoid complications. This work introduces an IoT-based Elderly Health Monitoring and Robust Care System which combines biomedical sensors such as an MAX30102 sensor for heart rate and SpO_2 monitoring, an ECG sensor to analyze cardiac activity, and an NTC thermistor to measure body temperature with an ESP32 microcontroller, coupled with a servo motor-controlled automatic medicine dispenser for precise administration of drugs. The system transmits collected health data to the cloud for real-time storage, visualization, and anomaly detection, while incorporating an intelligent alert mechanism to immediately notify caregivers or medical professionals when abnormalities are detected. Additionally, a mobile application has been developed to provide an intuitive interface for doctors, caregivers, and patients to view health records and manage prescriptions. The solution presented provides a low-cost, scalable, and secure method of remote care for the elderly through the integration of real-time health tracking with autonomous medication management, hence enhancing early abnormality detection, drug compliance, and healthcare accessibility for the elderly population.**

***Index Terms*—IoT, elderly health monitoring, ESP32, MAX30102, ECG sensor, ThingSpeak, real-time data, remote healthcare, medicine dispenser.**

I. Introduction

The Internet of Things (IoT) has grown as a pioneering technology linking physical objects through the Internet to facilitate real-time exchange of data and remote monitoring in industries. IoT has revolutionized patient care in healthcare by making it possible for real-time health monitoring, enhanced diagnostic accuracy, and timely intervention. Their application has led to E-Health and M-Health solutions, enhancing the accessibility of healthcare, remote monitoring, and clinical decision-making, particularly among elderly individuals with chronic conditions and mobility disorders.

Nursing homes and aged care facilities are increasingly using wearable devices based on the Internet of Things to track vital signs, detect deviations, and enhance the quality of patient care. Smart wearables equipped with sensors for heart rate, blood pressure, temperature, and oxygen level monitoring provide accurate, real-time health information while easing healthcare providers' workloads. By reducing the need for manual observation and visits to the hospital, these systems enhance patient independence and markedly decrease healthcare costs. They are also an important component in keeping cardiovascular, metabolic, and cognitive function in old age [2].

Cardiovascular disease (CVD) is the leading cause of death all over the world, especially among older adults. IoT-based monitoring of ECG tries to solve this issue by tracking cardiac activity constantly and providing for immediate intervention through real-time alerting [3].

In addition to cardiac monitoring, IoT healthcare systems provide multi-parameter monitoring (heart rate, blood pressure, temperature) and include automated medication dispensers to ascertain therapy adherence [4]. These systems utilize data acquisition using microcontrollers, cloud services like ThingSpeak to allow real-time analytics, and GPS tracking for geolocation monitoring to provide actionable health data without overwhelming medical personnel.

Studies indicate the revolutionary impact of IoT on disability and geriatric care, allowing for increased patient independence and improved health outcomes [5]. Evidence suggests that wearable devices, tele-ECG systems, and smart alarm technologies contribute to a more cost-effective, efficient, and patient-centered healthcare system.

This paper presents MediAid, an end-to-end IoT-driven health monitoring and automated medicine dispenser system for bedridden and elderly patients. By combining real-time vital sign monitoring (SpO_2, ECG, temperature), cloud processing, Twilio SMS alerts, and an intelligent medicine dispenser, MediAid overcomes basic limitations in current solutions. In addition, a dedicated mobile application has been developed to manage patient profiles, enter prescriptions, and provide real-time access to health records, further improving usability for caregivers and patients. In contrast to passive monitoring devices [1]–[3], MediAid facilitates medical intervention via ongoing real-time monitoring, providing timely treatment.

II. Literature Review

Other researchers have tried IoT-based approaches to elderly care with unique aspects. The following comparison discusses notable works, highlights their strengths and limitations, and positions MediAid as an integrated system extending existing advancements with intervention capability. One of the notable contributions is [1], an IoT system utilizing ESP8266 (NodeMCU) to conduct temperature and pulse oximetry readings, cloud upload to ThingSpeak, GPS location tracking, medicine reminder using a buzzer, and SMS alert. Though useful for monitoring, it does not have automated intervention. Likewise, [2] suggests a low-cost Arduino Uno-based wearable with a pulse sensor, LM35 temperature sensor, and ADXL345 accelerometer for fall detection, providing SMS alerts but not advanced metrics such as SpO_2 or ECG. MediAid improves on these with multi-parameter sensing (ECG, temperature, SpO_2) and an automatic medicine dispenser for both monitoring and punctual assistance.

Another significant study, [3], presents Abuelómetro, a wearable with a biometric wristband (heart rate, temperature, SpO_2), a mobile app, and alert middleware. Although it improves caregiver communication, its app-based alerts may be slower compared to direct SMS notifications. [4] describes an ESP32-based smartwatch with MAX30102 (SpO_2), AD8232 (ECG), and DHT11 (temperature) sensors, sending data to RemoteXY Cloud. However, it lacks medicine dispensing and comprehensive cloud analytics. MediAid fills this void by providing real-time monitoring, auto-dispensing, and cloud-based dashboards for health.

Work in [5] presents an Arduino Uno-based basic monitoring system (pulse and temperature sensors), which was helpful amid COVID-19 but had limited functionality. By contrast, [6] suggests an architectural model (Sensing, Data Storage, Data Communication - SDD) for smart homes with privacy and remote assistance but no actual intervention. MediAid fits into this model, introducing the element of automated treatment dispensation.

Broader reviews, for instance, [7], categorize sensors (homogeneous, dual, heterogeneous) and stress the advantage of heterogeneous sensing (such as ECG & SpO_2) towards precision and predictive analysis. [8] gives a PRISMA-based overview of 56 papers, stressing the requirement for multi-sensor fusion in geriatric management. MediAid follows these guidelines with an ESP32-based multi-sensor board, extending passive monitoring with medicine dispensing for active management.

Elderly sensor accuracy limitations are discussed in [9] as calibration needs of PPG-based solutions. MediAid contradicts this with the MAX30102 sensor for precise heart rate and SpO_2 measurement. Finally, [10] discusses WBAN-based IoT architectures for SpO_2, ECG, and EMG monitoring but falls short of active medical intervention. MediAid fortifies such models with secure cloud storage and automated dispensing, making a full healthcare solution.

The literature reviewed reflects tremendous advancements in IoT-based monitoring of elderly health, ranging from basic vital sign tracking to sophisticated multi-sensor wearable systems. Most existing solutions, however, focus primarily on passive monitoring with limited or no active medical intervention. MediAid addresses this gap by combining real-time health monitoring (ECG, SpO_2, and temperature) with an automated medicine dispenser, ensuring timely treatment along with alert mechanisms. Unlike systems that rely only on standalone mobile apps or basic SMS notifications, MediAid integrates Twilio-based alerts, a cloud IoT dashboard for end-to-end analysis, and a dedicated mobile application that enables prescription entry and patient record management, thereby improving accessibility and compliance. Future enhancements could incorporate machine learning for predictive analytics, further bridging the gap between monitoring and proactive care. Thus, MediAid emerges as a next-generation solution, combining the strengths of previous research while introducing innovative features for holistic elderly healthcare.

III. Methodology

With the worldwide increase in the elderly population, continuous health monitoring is now a necessity. Most elderly patients have chronic diseases, such as cardiovascular and respiratory diseases, that need to be monitored continuously. Conventional healthcare practices based on sporadic hospital visits and paper-based systems tend to cause delays in emergency response. However, IoT-based healthcare solutions now provide real-time monitoring and remote patient management, allowing timely intervention and better patient care.

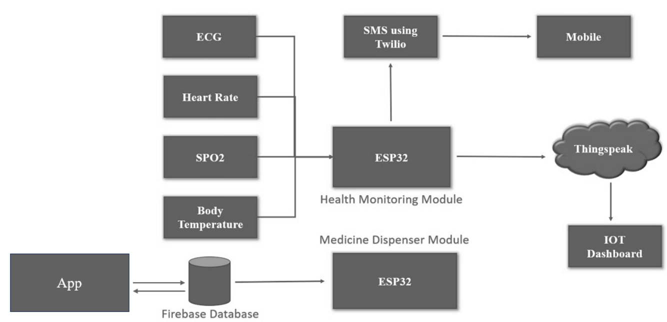

Fig. 1. A multi-sensor ESP32 system monitors vitals, uploads data to ThingSpeak, sends SMS alerts, and controls medicine dispensing through Firebase schedules.

A. MAX30102

The MAX30102 is a small, low-power pulse oximeter and heart rate sensor suitable for precise biometric measurement. It incorporates two LEDs (infrared and red), a high-sensitivity photodetector, optimized optics, and low-noise analog signal conditioning. The sensor passes light through the skin (often at the tip of the finger) and monitors the reflected light. Blood oxygen saturation (SpO_2) is estimated based on the red and infrared absorption ratio and heart rate detected based on light reflection variations of blood volume.

MAX30102 is connected to an ESP32 microcontroller via the PulseOximeter library, providing uninterrupted real-time observation of SpO_2 and heart rate. The IR LED current is also optimized to enhance signal quality, and a callback function is invoked whenever a heartbeat is sensed, enabling instant recognition. The system is constantly taking SpO_2 and heart rate measurements, providing accurate and reliable monitoring of health. For enhanced remote monitoring capabilities, the collected biometric data is uploaded to the ThingSpeak cloud platform for storage and visualization. Anomaly detection is applied for abnormal health condition detection. The moment the SpO_2 percentage drops below 90% or the heart rate goes above 100 bpm, the system gives an alarm. Yet another widget, "Lamp," has also been developed on the ThingSpeak dashboard that gives a visual alert when there is an anomaly. The lamp widget lights up, giving a quick and easy notification, and generates an alarm when it senses an abnormal condition. Physicians and other caregivers can monitor vital signs remotely and respond promptly to life-threatening conditions through the ThingSpeak service, ensuring improved patient care and timely action.

B. AD8232 Sensor

The AD8232 is a three-lead analog ECG sensor for heart rate measurement. It captures weak bio-electric signals, amplifies, and filters them using an on-chip signal conditioning module to provide a clean, stable ECG waveform. Commonly used in wearables for remote health monitoring, the sensor uses three electrodes (RA, LA, RL) to detect heart impulses, decode them, and output an analog signal for further analysis.

The AD8232 is connected to an ESP32 micro-controller, and the analog signal of the ECG is read and processed continuously for R-peak detection. A fixed threshold is utilized for the identification of R-peaks that denote single heartbeats. BPM is found using the measurement of the time distance between consecutive peaks. Pins for lead-off detection are utilized to avoid erroneous readings through the effective confirmation of electrode contact upon the skin. Upon disconnection of a lead, an error warning is given by the system to the user against erroneous reading. This real-time monitoring helps in identifying abnormal heart rhythms, which can be symptoms of underlying cardiovascular issues. In remote health monitoring, the data is uploaded to the ThingSpeak cloud, where it is represented utilizing various widgets. The real-time values of heart rate and SpO_2 levels have been represented using a gauge widget so that caregivers can monitor the condition of the patient remotely. In addition, an anomaly detection system has been implemented, where a warning is raised if the BPM goes above 100 or the SpO_2 percentage decreases below 90%. The cloud-based visualization and alert system provides real-time intervention in the event of health anomalies to ensure patient safety and continuous monitoring.

C. NTC thermistor

An NTC thermistor is a temperature sensor whose resistance drops with increasing temperature. It is utilized in medical monitoring due to its sensitivity and precision. Powered by an ESP32 microcontroller via a voltage divider circuit, the resistance of the thermistor is determined from the voltage drop and translated to temperature using the Steinhart-Hart equation or beta coefficient approximation, allowing precise fever and other anomaly detection.

ESP32 continuously reads the analog signal of the thermistor and converts the same into temperature values in degrees Celsius. The sensor is calibrated by nominal resistance at 25°C, pull-up resistor, and the beta coefficient of the thermistor. The system performs mathematical operations in real-time to compute the actual temperature. Thus, when the detected temperature goes more than a threshold value, e.g., 30 degrees Celsius, it is an anomaly and likely a health condition. Possible triggering of an alarm for timely identification of fever, possibly the first symptom of infection or illness. To enable remote monitoring in real-time, the processed temperature data is sent to the ThingSpeak cloud. There is a lamp widget used for providing a visual indication of anomalies—if the temperature exceeds the threshold, the lamp lights up, alerting caregivers to potential health complications. The health parameters, such as heart rate, SpO_2 levels, and temperature, are monitored by remote monitoring in the form of cloud-based visualization to enable the patient to be taken care of at all times and in advance.

D. ESP32

ESP32 is a low-consumption, high-performance, IoT-oriented SoC designed by Espressif Systems. ESP32 has a dual-core LX6 Tensilica processor, integrated Wi-Fi and Bluetooth, and multiple GPIO pins that support real-time data acquisition as well as wireless communication. ESP32's low power consumption, along with onboard ADC, also makes it appropriate for efficient interfacing of sensors in health care monitoring systems.

Here in this project, the ESP32 is tasked with reading data from various sensors like the AD8232 ECG sensor and NTC thermistor. It receives analog signals from the sensors, processes the signals, and decodes them into useful health measures like heart rate, SpO_2 levels, ECG signal, and body temperature. These processed signals are then sent to the ThingSpeak cloud via the onboard Wi-Fi module for remote real-time monitoring. The ESP32 enables accurate data collection and good wireless communication, hence making the system reliable for continuous health monitoring. In addition, the ESP32 supports interrupt-driven processing, making real-time anomaly detection possible. If there are unexpected values, say SpO_2 dropping below 90%, heart rate increasing beyond 100 bpm, or temperature increasing beyond 30°C, the system initiates an alarm. The alarms are displayed on the ThingSpeak cloud through a lamp widget to enable prompt interventions. The microcontroller's flexibility, power efficiency, and ease of connecting to the cloud make it an integral part of the system used for monitoring old people's health.

E. Servo motor

A servo motor is a rotary actuator that accurately manages acceleration, speed, and position. It integrates a controller, a position sensor, and a DC motor to rotate to a precise angle according to input commands. Because of their accuracy and efficiency, servo motors are extensively used in robotics and automation.

A servo motor has been employed for the control of the dispensing unit in this medicine dispenser project. The container of the medicine has a bottom hole that fits precisely for one tablet, which is the design for ensuring single-tablet dispensing at any given time. To prevent tablets from falling multiple times, there is a lid system, where there is an opening and closing mechanism facilitated by the servo motor. The servo motor is operated on a power supply of 5V to ensure effective running. The operation of dispensing is automated and scheduled based on an ESP32 microcontroller incorporated with the Firebase Realtime Database. The ESP32 loads the pre-programmed schedule and, upon reaching the specific time, instructs the servo motor to rotate and open the hole for a short time interval to release a tablet. After 0.5 seconds, the servo motor comes back to close the hole to prevent other tablets from dropping. This offers accurate medicine dispensing at the right time. ESP32 with Wi-Fi loads new schedules from Firebase for remote monitoring and control. ESP32, Firebase, and servo motor collectively give a simple, automated, and reliable medicine dispensing solution, which is especially suitable for elderly care and remote health care monitoring.

We designed an IoT-based Elderly Health Monitoring System that could monitor important health parameters, store data in a cloud environment, analyze trends, and raise alerts on discovering any anomalies Fig. 1.

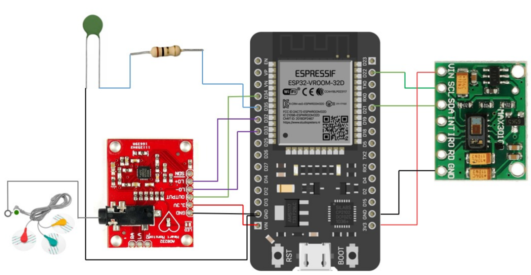

Fig. 2. The circuit shows the ESP32 connected to pulse, temperature, and ECG sensors through analog and I2C for real-time health monitoring.

The system incorporates: a MAX30102 sensor for real-time heart rate and SpO_2 monitoring; an ECG sensor for cardiac activity monitoring; an NTC thermistor to sense body temperature fluctuations Fig. 2. All sensor readings are passed through an ESP32 microcontroller, which forwards them to the ThingSpeak cloud at regular intervals. ThingSpeak widgets, like a virtual lamp, provide real-time visualization, and the color becomes red when sensor readings exceed fixed safe thresholds. To enable prompt medical care, an SMS alarm system powered by Twilio is employed to notify caregivers or medical professionals in case of an emergency.

Additionally a mobile application was developed to act as the interface between patients, caregivers, and the dispenser. The app maintains patient profiles, stores prescriptions, and automatically syncs medication schedules with the dispenser via the cloud. It also displays real-time health data (SpO_2, heart rate, temperature, ECG) collected from sensors, providing alerts and reminders to improve treatment compliance.

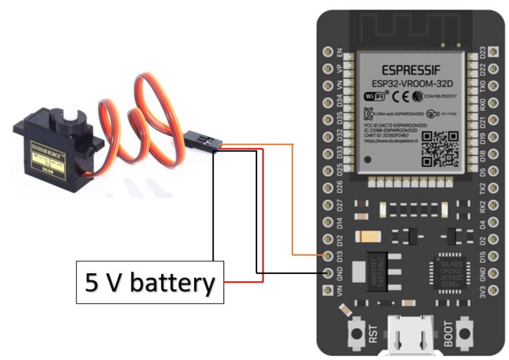

Fig. 3. The circuit shows an ESP32 controlling a servo motor via PWM, powered by an external 5V supply for automated medicine dispensing.

Besides monitoring, the system provides an automatic dispensing of medicines to help aged patients with their medicine schedules. The dispenser employs servo motors, which rotate at a programmed interval to dispense the required medication Fig. 3, thus dispensing drugs on schedule without human observation. This is especially useful for individuals with memory-related ailments like Alzheimer's or dementia, as it reduces missed doses and ensures uniform drug adherence. The new system offers an affordable, real-time health solution for remote checking, early abnormality detection, and self-medication control. Utilizing IoT technology, cloud computing, and automated processes, the system significantly enhances the quality of old-age care by providing instant medical assistance and cost savings in healthcare.

IV. Results and Discussions

We included several biomedical sensors to monitor the most important health parameters in real-time, such as the MAX30102 for heart rate and SpO_2 levels, an NTC thermistor for temperature, and the AD8232 ECG module for cardiac health analysis. The real-time sensor information is sent to the ThingSpeak cloud platform, allowing centralized access, secure data storage, and remote monitoring.

This integration in the cloud allows for trend analysis of the past, thus allowing clinicians and caregivers to identify potential health risks over a period. To provide an intuitive user interface, we designed an IoT-based dashboard that provides real-time visualization of these parameters. Heart rate disturbance indicators are implemented as lamp indicators, with green lights signaling both very low heart rate (bradycardia) and very high heart rate (tachycardia) conditions for consistent visual feedback. Another LED is dedicated to SpO_2 levels, turning blue in the case of decreasing levels below 90% of oxygen saturation in the blood, thereby warning of the risk of hypoxia Fig. 4 and 5.

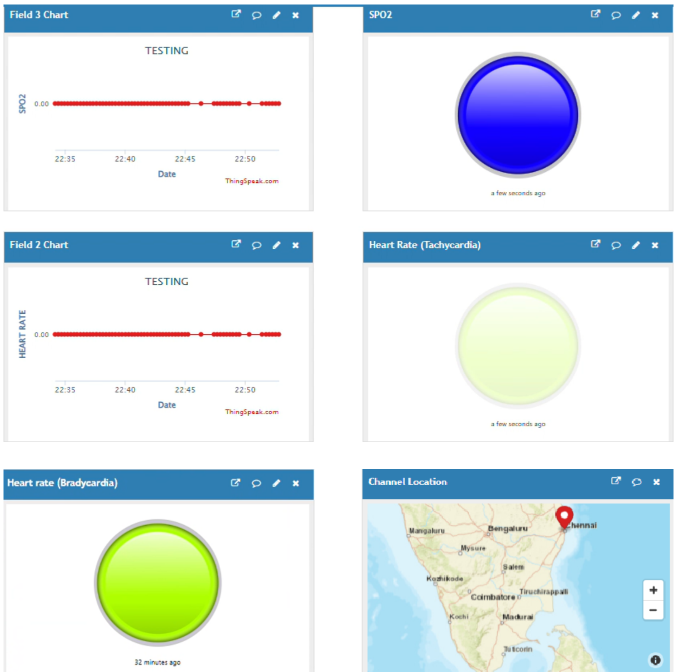

Fig. 4. Real-time dashboard showing SpO_2 and heart rate with live charts, condition indicators, and patient location tracking.

Fig. 5. Live interface showing SpO_2 and heart rate trends with LEDs indicating abnormal conditions.

There is also a pulse meter widget that dynamically shows the actual values of ECG, offering simple and direct visualization of heart activity Fig. 6. ECG signals were also processed and displayed in the form of PQRST waveform plots using the Processing IDE to allow clinicians to diagnose cardiac rhythms

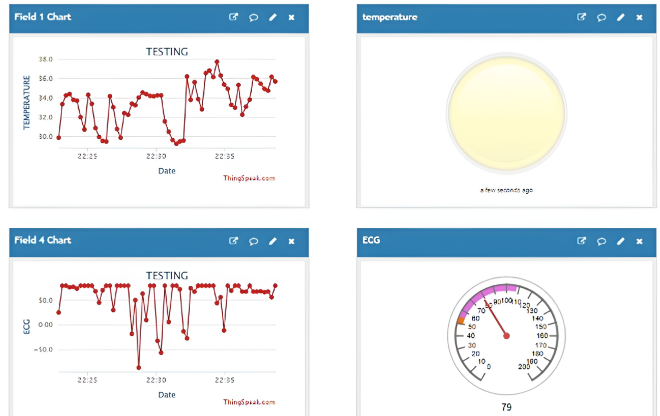

Fig. 6. Real-time temperature and ECG display with line charts and gauge widgets for quick health tracking.

and detect abnormalities such as atrial fibrillation, premature ventricular contractions, and brady-arrhythmias Fig. 7. The system uses sophisticated noise filtering methods like Butterworth low-pass filtering to minimize signal distortion and enhance signal accuracy. The system also displays real-time patient locations directly on the ThingSpeak IoT dashboard Fig. 4, enabling caregivers to quickly locate individuals during emergencies while maintaining all existing health monitoring and medication dispensing functions.

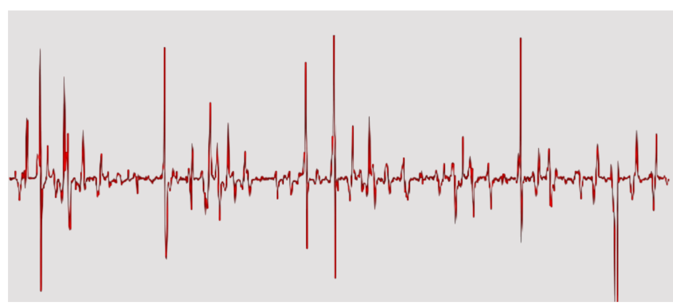

Fig. 7. Real-time ECG waveform showing P, QRS, and T wave patterns captured from electrode sensors.

Apart from enhanced patient safety, there is also an auto-anomaly detecting system that keeps running in the background to track the output from the sensors and sends real-time SMS alerts through Twilio Fig. 9 when certain thresholds are breached. The alerts are triggered for a heart rate below 50 BPM (bradycardia) or above 120 BPM (tachycardia), SpO_2 below 90%, or body temperature over 100.4°F (38°C), suggesting a fever. These alerts are received immediately by caregivers, family members, or healthcare professionals, allowing immediate medical attention in case of an emergency.

The integration of sensors, cloud computing, and IoT visualization provides a strong remote health monitoring solution to enable improved patient care to a great extent. Real-time continuous monitoring allows round-the-clock monitoring of

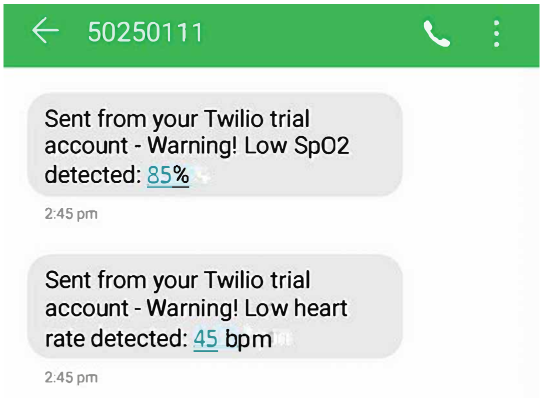

Fig. 8. Automated SMS notifications triggered via the Twilio platform in response to abnormal SpO_2 and heart rate levels.

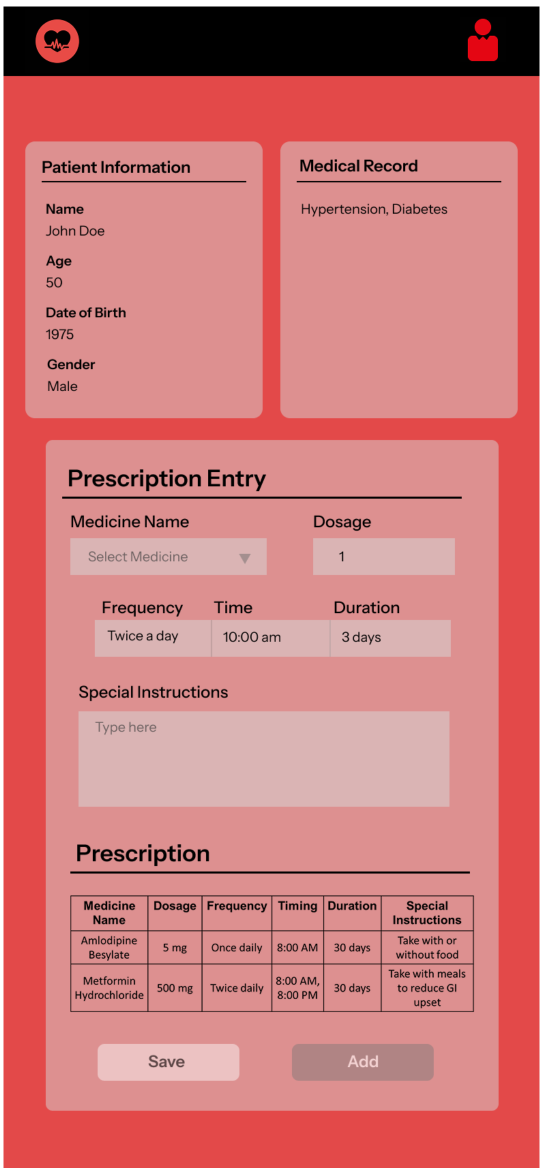

Fig. 9. Mobile app interface showing patient profile and prescription entry.

vital signs 24/7, which decreases dependence on periodic manual monitoring.

The system enables pre-symptomatic diagnosis of cardiac defects through real-time analysis of PQRST waveforms to prevent life-threatening situations. Twilio SMS notifications enable immediate response to crises through the delivery of alerts to caregivers in real-time upon reaching critical levels. Cloud connectivity on ThingSpeak facilitates analysis of past data for predictive diagnosis and long-term health tracking. With the integration of IoT and cloud analytics, the solution takes smart healthcare to the next level by making timely intervention and better patient outcomes possible.

In addition to cloud-based dashboards, a mobile application was implemented to simplify patient management. Fig [9] shows the app interface, where patient details such as name, age, gender, and medical history are stored for quick reference. Below this, the prescription entry form allows doctors or caregivers to add medicine name, dosage, frequency, and duration. Once entered, these details are automatically synchronized with the dispenser to ensure timely drug delivery.The structured design of the app provides a user-friendly way to link medical records with automated dispensing. Caregivers can easily track what has been prescribed, while patients receive reminders to avoid missed doses. This integration of patient information and digital prescriptions makes the system more practical and reliable in real-world scenarios.

V. Conclusion

The project integrates real-time health monitoring (SpO_2, heart rate, temperature, and ECG) with an automated, Firebase-controlled medicine dispenser as a comprehensive patient care platform for enhanced compliance and immediate treatment. With IoT sensors, ThingSpeak cloud analytics, and Twilio-based SMS notifications, it offers ongoing remote tracking with timely intervention, and accurate medication dispensing at advised times through a servo motor-driven dispenser.A dedicated mobile application further strengthens usability by enabling patient profile management, prescription entry, and real-time visualization of health data, ensuring seamles interaction with the hardware. Adding PQRST waveform visualization and anomaly detection enhances diagnostic power. With the potential scalability in the direction of AI-based predictions in the future, light wearables, and edge computing, the system sets the stage for a proactive, patient-oriented healthcare model with an illustration of how smart automation and real-time data, and app-based access can reimagine medical outcomes by minimizing human errors, increasing compliance, and shortening emergency response times in critical situations.

VI. Future Work

The system can be extended to wearable devices like smartwatches using flexible PCBs and low-power Bluetooth for continuous monitoring. LSTM-based AI models may be used to predict health anomalies in real time. Edge computing with platforms like TensorFlow Lite can enable on-device analysis.

RFID integration in the dispenser can help prevent medication errors. Blockchain and federated learning can ensure secure and private data management.

REFERENCES

[1] R. S. Gopi, R. Suganthi, J. J. Hephzipah, G. Amirthayogam, P. Sundararajan, and T. Pushparaj , Trans., "Elderly People Health Care Monitoring System Using Internet of Things (IOT) For Exploratory Data Analysis", *Babylonian Journal of Artificial Intelligence*, vol. 2024, pp. 54–63, Jun. 2024, doi: 10.58496/BJAI/2024/008.

[2] Angelina A. Silverio, Angelito A. Silverio Al Mathew Remot, "Low-Cost Elderly Healthcare Monitoring System," *Journal of Physics: Conference Series (JICETS)*, 1529 (2020) 032061.

[3] Luis A. Durán-Vega 1, Pedro C. Santana-Mancilla, Raymundo Buenrostro-Mariscal, Juan Contreras-Castillo, Luis E. Anido-Rifón, "An IoT System for Remote Health Monitoring in Elderly Adults through a Wearable Device and Mobile Application," *Multidisciplinary Digital Publishing Institute (MDPI)*, vol 4, issue 2, May 2019.

[4] Shashank Bhat, Dhruva S., Kavyashree H. P., Manjushree B. S., Dr. Aswathappa P, "Iot-based Healthcare Monitoring Smartwatch," *International Journal of Creative Research Thoughts (IJCRT)*, vol. 12, issue 3, pp.768 - 772, 2024.

[5] P. Reshma, G. Vandana, V. Divya, V. Geethika, B. S R Krishna, "Health Monitoring System for Elderly People," *Journal of the Maharaja Sayajirao University of Baroda*, vol. 55, pp. 168 – 171, 2021.

[6] Abeer Alsadoon, Ghazi Al-Naymat, Oday D.Jerew, "An architectural framework of elderly healthcare monitoring and tracking through wearable sensor technologies," *Multimedia Tools and Applications*, vol. 83, pp. 67825 – 67870, June 2023

[7] Chioma Virginia Anikwe , Henry Friday Nweke, Anayo Chukwu Ikegwu, Chukwunonso Adolphus Egwuonwu, Fergus Uchenna Onu, Uzoma Rita Alo, Ying Wah Ted, "Mobile and wearable sensors for data-driven health monitoring system:State-of-the-art and future prospect," *Expert Systems With Application*, vol. 202, Sept. 2022.

[8] José Oscar Olmedo-Aguirre, Josimar Reyes-Campos, Giner Alor-Hernández, Isaac Machorro-Cano, Lisbeth Rodríguez-Mazahua and José Luis Sánchez-Cervantes, "Remote Healthcare for Elderly People Using Wearables: A Review," *Multimedia Tools and Applications*, vol. 12, Jan 2022.

[9] Eduardo Teixeira, Hélder Fonseca Florêncio Diniz-Sousa, Lucas Veras, Giorjines Boppre, José Oliveira, Diogo Pinto, Alberto Jorge Alves, Ana Barbosa, Romeu Mendes and Inês Marques-Aleixo, "Wearable Devices for Physical Activity and Healthcare Monitoring in Elderly People: A Critical Review," *Multimedia Tools and Applications*, vol.6, Apr 2021.

[10] Kelil Guizani, Sghaier Guizani, "IoT Healthcare Monitoring Systems Overview for Elderly Population," *International Wireless Communications and Mobile Computing (IWCMC)*, Limassol, Cyprus, 2020.