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Intelligent IoT and Machine Learning Architecture for Continuous Elderly Surveillance and Automated Medication Delivery (PILLS)

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Abstract — The increasing elderly population and the growing need for continuous healthcare monitoring have created demand for intelligent and automated healthcare support systems. This paper presents an Intelligent IoT and Machine Learning Architecture for Continuous Elderly Surveillance and Automated Medication Delivery (PILLS), designed to improve the safety, health management, and independence of elderly individuals. The proposed system integrates Internet of Things (IoT) devices, machine learning algorithms, health monitoring sensors, and an automated pill dispensing mechanism to provide real-time elderly care and medication assistance. The system continuously monitors important health parameters such as body temperature, heart rate, and blood oxygen levels using wearable sensors connected through IoT technology. Machine learning techniques analyze patterns in patient behaviour to detect abnormal situations and generate instant alerts to caregivers through mobile notifications and web dashboards. The automated medication delivery unit dispenses pills at scheduled times, minimizing missed doses, overdose, and medication errors. The proposed architecture offers a low-cost, reliable, and scalable healthcare solution for smart elderly assistance in homes, hospitals, and assisted living environments.

Keywords — IoT; Elderly surveillance; Automated medication delivery; Machine learning; Health monitoring; Arduino; Smart healthcare; Pill dispenser

I. INTRODUCTION

The advancement of Internet of Things (IoT) technology has significantly transformed modern healthcare systems by enabling continuous patient monitoring and automated medical assistance. Elderly individuals and patients with chronic illnesses often require timely medication and regular health supervision to maintain their well-being. However, traditional caregiving methods suffer from issues such as missed medication schedules, lack of continuous monitoring, and increased dependency on caregivers. To address these challenges, an intelligent IoT-based automated medication delivery and elderly surveillance system has been developed.

The proposed system integrates IoT devices, embedded systems, and automation technologies to provide smart healthcare support for elderly patients. The system consists of a rotating pill dispensing mechanism controlled by a microcontroller. Medicines are stored in separate compartments within a circular container, and a motor-driven rotating platform automatically dispenses pills at predefined time intervals through an outlet tray, ensuring accurate and timely medication delivery without manual intervention.

Machine learning algorithms further enhance the system by analyzing patient health data to detect abnormalities and predict potential medical emergencies. In case of unusual health conditions or missed medication intake, alerts are automatically sent to caregivers or healthcare providers for immediate action. This intelligent healthcare solution reduces medication errors, improves patient compliance, minimizes caregiver workload, and supports independent living for elderly individuals.

II. LITERATURE SURVEY

Dayananda et al. [10] (2024) proposed the development of SPEC 2.0, a Smart Pill Expert System based on IoT. The system focuses on intelligent medication management for patients, especially elderly individuals, providing automated reminders, pill scheduling, and real-time monitoring through connected IoT devices.

Patel et al. [9] (2024) studied the usability of an automated medication dispensation device along with a medication adherence dashboard. The research evaluated user interaction, ease of operation, and effectiveness of automated medicine dispensing systems, demonstrating significant improvement in patient compliance.

Gargioni et al. [6] (2024) presented a systematic review on pill and medication dispensers developed between 2000 and 2023. The study analyzed various automated dispensing technologies, including IoT-enabled and smart healthcare devices, highlighting major advancements in medication adherence systems.

Shaik et al. [4] (2023) reviewed the role of artificial intelligence in remote patient monitoring systems, emphasizing the use of AI algorithms for analyzing patient health data collected through IoT sensors and wearable devices for early disease prediction and real-time decision-making.

Alnaim et al. [3] (2023) introduced a machine-learning-based IoT and edge computing healthcare architecture. The proposed framework uses machine learning techniques to process healthcare data efficiently at the edge level, reducing latency and improving real-time response.

Abdulmalek et al. [1] (2022) reviewed IoT-based healthcare monitoring systems, discussing various IoT sensors, wearable technologies, and communication protocols. The study analyzed challenges such as data privacy, reliability, and interoperability in IoT healthcare systems.

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Sunny et al. [2] (2022) proposed an anomaly detection framework for wearable healthcare data, applying machine learning algorithms to identify abnormal health patterns and unusual physiological activities from wearable sensor data.

Mason et al. [7] (2022) discussed technologies for medication adherence monitoring, reviewing smart devices, mobile applications, and automated reminder systems designed to improve medicine intake compliance among elderly patients.

Roumaissa et al. [8] (2022) proposed an IoT-based pill management system for elderly patients, automating medicine scheduling, reminder generation, and monitoring using IoT communication technologies with cloud connectivity.

Fiorini et al. [5] (2021) presented the characterization of a wearable PPG sensor based on the MAX30102 module for healthcare monitoring, showing that low-cost wearable sensors can effectively support real-time physiological monitoring.

III. PROBLEM STATEMENT

Elderly individuals and patients suffering from chronic illnesses require continuous health monitoring and timely medication intake. Traditional healthcare methods depend on manual supervision by caregivers, which may not always be effective due to human limitations and busy schedules. Elderly patients may forget to take medicines on time, consume incorrect dosages, or remain unattended during emergencies, leading to serious health complications.

Delayed detection of abnormal health conditions such as irregular heart rate, high temperature, or low oxygen levels increases health risks and reduces chances of timely medical intervention. Additionally, manual medication management often leads to non-compliance, missed doses, and increased caregiver dependency.

Therefore, there is a need for an intelligent IoT-based healthcare system that provides continuous elderly surveillance, automatic medication delivery, and real-time alert mechanisms capable of monitoring vital parameters, reminding patients to take medicines, automatically dispensing pills accurately, and notifying caregivers during emergencies.

IV. OBJECTIVES

- To design and develop an IoT-based healthcare system for continuous elderly surveillance and automated medication delivery.
- To monitor important health parameters such as heart rate, body temperature, and blood oxygen level using sensors.
- To provide automatic and timely medicine dispensing through a rotating pill delivery mechanism.
- To generate reminders and alerts using an LCD display and buzzer for scheduled medication intake.
- To enable remote monitoring of patient health information and medication status through IoT communication.
- To reduce medication errors, missed doses, and dependency on manual caregiving.
- To develop a low-cost, reliable, and user-friendly smart healthcare solution for elderly care applications.

V. SYSTEM DESIGN

A. Overall System Architecture

The proposed system consists of the following major modules: Input Module, Processing and Control Module, Medication Dispensing Module, Alert and Notification Module, IoT Communication Module, and Monitoring Module. The architecture is designed to ensure smooth communication between sensors, controllers, and output devices.

B. Hardware Components

Sl. No	Component	Purpose
1	Arduino Uno	Main controller of the system
2	LCD Display (16x2)	Displays medicine reminders and status
3	Servo Motor	Rotates the pill dispensing wheel
4	Rotating Pill Container	Stores medicines in compartments
5	Buzzer	Generates alert sounds for reminders
6	IoT Wi-Fi Module	Remote monitoring and communication
7	Health Sensors	Measures heart rate, temperature, SpO2
8	Power Supply	Provides power to all components

Table I: Hardware Components List

C. Software Components

- Arduino IDE for microcontroller programming
- Embedded C/C++ for sensor and motor control
- IoT platform for remote health data monitoring
- Machine learning module for health anomaly detection

VI. IMPLEMENTATION

A. Arduino Controller Setup

The Arduino Uno acts as the central processing unit of the system. It receives inputs from sensors, controls the servo motor for pill dispensing, activates reminders, and manages IoT communication. The LCD is connected to digital pins, the servo motor to the PWM pin, sensors to analog pins, and the buzzer to an output pin.

B. Pill Dispensing Mechanism

The pill dispensing mechanism uses a rotating circular container divided into multiple compartments. Each compartment stores different medicines. A servo motor rotates the container at predefined intervals to release medicines into the dispensing tray. The working process checks medication time, rotates the servo motor, aligns the required compartment with the outlet, drops the pill into the tray, and generates a patient alert.

C. Alert and Notification System

The LCD display provides medication reminders such as "Take Medicine" and "Medicine Dispensed," while the buzzer generates an audible alert when medicine is dispensed. Alerts continue until the medicine is acknowledged by the patient. If the medicine is not consumed within a defined period, the system generates additional notifications to caregivers through the IoT module.

D. Health Monitoring Implementation

The system interfaces with multiple health sensors to continuously monitor elderly patients. Heart rate sensors, temperature sensors, and optional SpO2 sensors are connected to the Arduino controller for real-time data collection. Abnormal conditions trigger immediate alert notifications to caregivers.

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E. IoT Communication

The IoT communication module enables remote monitoring and caregiver notifications using Wi-Fi-based wireless communication. The system supports real-time data transmission to a cloud monitoring platform, making health and medication data accessible to caregivers from any location.

VII. RESULTS AND DISCUSSION

The Intelligent IoT-Based Continuous Elderly Surveillance and Automated Medication Delivery System was successfully designed and implemented. The system was tested under different operating conditions to evaluate performance, reliability, alert generation capability, and medication dispensing accuracy.

A. Automated Medicine Dispensing

The automated pill dispensing mechanism successfully delivered medicines at predefined scheduled intervals. The servo motor accurately rotated the circular medicine container and aligned the correct compartment with the dispensing outlet. Medicine dispensing occurred automatically at scheduled times with stable and accurate servo motor rotation. The LCD notification and buzzer alert further improved patient awareness.

B. Health Monitoring Performance

The health monitoring sensors successfully collected and displayed physiological parameters such as heart rate and body temperature. Sensor readings were updated continuously in real time, and abnormal conditions triggered alerts effectively, demonstrating reliable monitoring performance.

C. IoT Communication Performance

The IoT communication module was tested for remote monitoring and notification transmission. Data transmission was successful, remote monitoring worked effectively, and caregiver notifications were received properly with stable wireless connectivity.

D. Overall Performance Summary

Parameter	Performance
Medicine Dispensing Accuracy	High
Alert Generation	Successful
Sensor Monitoring	Continuous
IoT Communication	Stable
Ease of Use	User-Friendly
Response Time	Fast
Reliability	Good

Table II: System Performance Summary

VIII. CONCLUSION

The proposed Intelligent IoT and Machine Learning Architecture for Continuous Elderly Surveillance and Automated Medication Delivery successfully achieved automated medicine dispensing, continuous health monitoring, and remote IoT-based supervision. The system demonstrated reliable performance in medication scheduling, alert generation, and patient monitoring. The results show that the proposed solution can significantly improve elderly healthcare management, medication adherence, and patient safety while reducing caregiver workload and supporting independent living.

In the future, the system can be enhanced with advanced AI algorithms capable of predicting severe health conditions before they become critical. Deep learning models can be integrated to improve accuracy in activity recognition and fall detection. The project can also be expanded by integrating cloud-based healthcare platforms and voice assistants to allow elderly users to interact through voice commands.

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