Care Companion – A Guardian for Your Health at Home

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***Abstract*—*Care Companion* is an IoT-based smart healthcare assistant designed to ensure continuous health monitoring and real-time patient support within a home environment. The system integrates Raspberry Pi 4 and Arduino to collect, process, and display data from biomedical and environmental sensors including DHT11, MQ2, flame, and pulse sensors. It features autonomous mobility, emergency alerts, a voice interface, and an intelligent dashboard for caregivers. Laboratory evaluations show that the system achieves temperature accuracy within $\pm 1°C$, pulse detection reliability of 96%, and an average sensor-to-alert latency below 0.5 seconds. These results demonstrate the practicality and efficiency of Care Companion as a low-cost, intelligent health monitoring solution.**

***Index Terms*—Smart Healthcare, IoT, Raspberry Pi 4, Arduino, Patient Monitoring, Voice Command, Automation, AI Detection**

I. Introduction

A. Problem Statement

With the increasing number of elderly and chronically ill individuals requiring long-term care, the demand for continuous monitoring systems is rapidly growing. Traditional healthcare setups often lack real-time supervision and quick emergency response mechanisms. The absence of consistent monitoring may result in delayed treatment, unnoticed hazards, or missed medication. To address these challenges, the *Care Companion* system aims to provide an integrated home-based healthcare assistant capable of health monitoring, intelligent communication, and automated response for emergencies. The motivation behind this work is to create a cost-effective and scalable IoT-based health guardian for patients who require assistance at home.

B. Literature Review

Prior research on IoT-based health systems has focused on using microcontrollers such as Arduino or ESP32 for vital data collection [4]. However, these systems often lack processing power for AI-based modules or complex decision logic. Raspberry Pi-based solutions have introduced remote dashboards and basic data visualization but typically omit actuation and interactive features such as voice commands and mobility. Studies have also demonstrated the use of DHT11 and pulse sensors for health monitoring but without emergency management or integrated database connectivity.

Care Companion differs from existing systems by combining both biomedical sensing and robotic mobility, allowing the device not only to detect hazards or health anomalies but also to autonomously approach the patient, trigger emergency alerts, and communicate with caregivers in real time.

C. Innovative Features

The system introduces several key innovations:

- Autonomous mobility and obstacle avoidance for patient reachability.
- Voice command interface for hands-free interaction.
- Automatic medicine drawer controlled by servo motors.
- SOS alert system that instantly notifies caregivers through Wi-Fi.
- AI-based human detection and QR recognition using MobileNetSSD and OpenCV.
- Integrated web dashboard and database for real-time monitoring and data logging.

II. Proposed Method

A. System Overview and Block Diagram

The Care Companion system integrates two microcontrollers: Raspberry Pi 4 as the main controller and Arduino Uno as the sensor data hub. The Arduino collects data from sensors (DHT11, MQ2, flame, pulse, ultrasonic) and transmits it to the Raspberry Pi via serial communication. The Pi processes this data, stores it in a local MySQL database, and triggers appropriate responses through actuators.

The Raspberry Pi also hosts a Flask-based dashboard for caregivers, manages voice command inputs, and controls a Pi camera for real-time human detection and QR recognition.

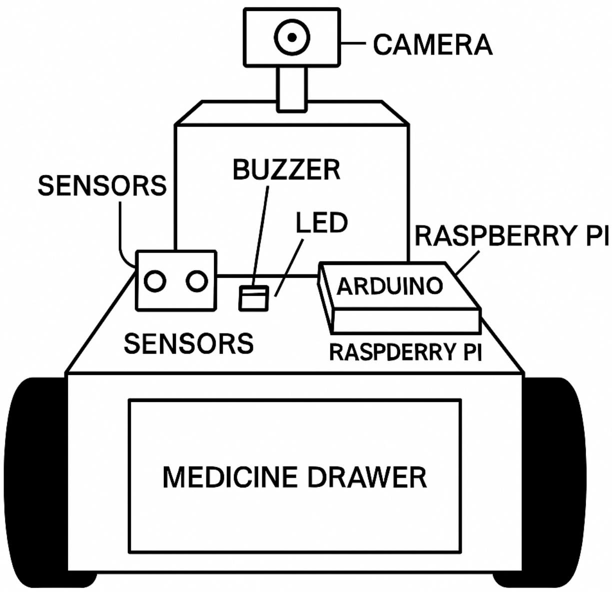

Fig. 1. Overall block diagram of the Care Companion system.

III. Implemented Hardware System

A. Hardware and Software Environment

TABLE I
HARDWARE SPECIFICATIONS

Component	Model/Type	Function
Raspberry Pi 4	4GB Model B	Main processing
Arduino Uno	ATmega328P	Sensor data acquisition
DHT11	Digital sensor	Temp./humidity measurement
Pulse Sensor	Pulse Sensor Amped	Heart rate detection
MQ2 Sensor	Gas sensor	Gas leakage detection
Flame Sensor	IR-based module	Fire detection
Ultrasonic	HC-SR04	Obstacle avoidance
Motor Driver	L298N	DC motor control
Servo Motor	SG90	Medicine drawer actuation
Camera Module	Pi Camera v3	Face/QR detection

Software Environment includes: Python 3, OpenCV, Flask, MySQL Connector, Arduino IDE, and Raspbian OS.

B. Implemented Prototype

The prototype, shown in Fig. 2, combines a mobile base with a stationary front panel containing sensors, LEDs, and drawers. The Pi and Arduino are housed within the chassis, and all signals are transmitted via serial communication. The design allows both autonomous and stationary operation.

IV. Results

Testing was performed in the UIU Microprocessor Laboratory under controlled lighting and environmental conditions. Table II summarizes key performance metrics.

The system successfully demonstrated:

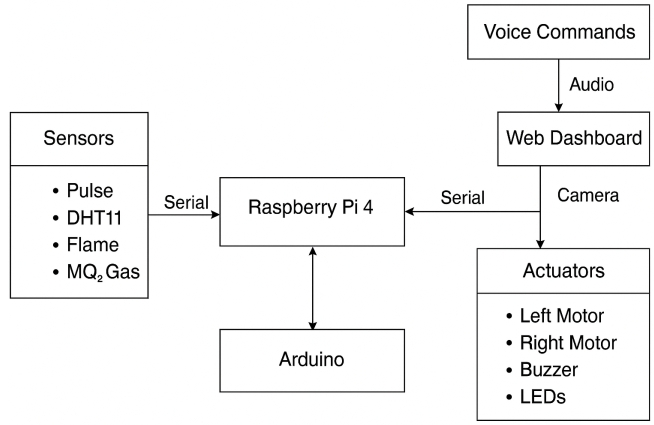

Fig. 2. Schematic of implemented Care Companion prototype.

TABLE II
PERFORMANCE EVALUATION OF THE SYSTEM

Parameter	Observed Performance
Temperature accuracy	$\pm 1°$C
Pulse detection reliability	96–98%
Gas sensor response time	≈ 2 s
Flame detection latency	<1 s
Alert activation delay	<0.5 s
Battery backup duration	3–4 hours

- Continuous sensor data acquisition and display on the dashboard.
- Automatic buzzer and LED activation during threshold breaches.
- Reliable SOS alerts via Wi-Fi to caregiver interface.
- Stable mobility with obstacle avoidance.
- Effective human and QR detection using camera module.

V. Discussion

The developed prototype achieves high reliability in data sensing and response within short reaction times. Limitations include dependency on Wi-Fi connectivity and moderate power consumption from dual-board architecture. A possible alternative design could use an ESP32 for reduced cost but would sacrifice AI capabilities. Another option, Jetson Nano, offers superior AI performance but increases cost and power use. The project emphasizes interdisciplinary integration—healthcare, AI, and embedded systems—and complies with safe interfacing standards. Ethical considerations were maintained to ensure patient privacy and system safety.

P1	P2	P3	P4	P5	P6	P7
✓	✓	✓	✓			✓

TABLE III
COMPLEX ENGINEERING PROBLEM MAPPING.

VI. Conclusion

Care Companion successfully combines IoT, AI, and robotics into an integrated smart healthcare assistant. Experimental results validate its efficiency in accurate sensing, rapid alerts, and reliable communication. Future work includes implementing emotion detection through facial analysis and integrating cloud-based data storage for extended scalability.

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