IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 6, May 2026
Impact Factor: 8.2

Autonomous Surveillance Health Monitoring System

Salamwade[1], Thakre[2], Prof. Pratibha Mahakal[3]
Student, ENC, Usha Mittal Institute of Technology, Mumbai, India[1,2]
Professor, Usha Mittal Institute of Technology, Mumbai, India[3]

Abstract: *The integration of robotics and embedded systems has enabled the development of intelligent systems for surveillance, environmental monitoring, and healthcare applications. This paper presents the design and implementation of an Autonomous Surveillance and Health Monitoring Robot capable of obstacle avoidance, real-time surveillance, and automated patient identification. The system is developed in a phased manner to ensure stability and scalability. In the initial phase, an autonomous mobile robot was implemented using an Arduino Uno, ultrasonic sensor, servo motor, DC motors, and a motor driver module to achieve obstacle detection and intelligent path selection. In the advanced phase, surveillance and health monitoring modules were integrated using the ESP32-CAM for image capture and wireless transmission. An AI-based face recognition system was employed for automatic patient identification. Additionally, biomedical sensors such as pulse sensors, the MAX30102 for* SpO_2 *monitoring, and temperature sensors were incorporated for health parameter measurement. The proposed system offers a low-cost, scalable, and efficient solution suitable for hospitals, quarantine centers, and hazardous environments requiring autonomous monitoring.*

Keywords: ESP32-Based Monitoring System, Face Recognition System, Real Time Health Monitoring

I. INTRODUCTION

The rapid advancement of robotics and embedded systems has significantly enhanced automation in surveillance, environmental monitoring, and healthcare applications. In hazardous, remote, or highrisk environments, human intervention can be dangerous, inefficient, or impractical. To address these challenges, this paper presents the design and development of an Autonomous Surveillance and Health Monitoring Robot, a multi-functional robotic platform capable of intelligent navigation, environmental sensing, and automated patient identification The proposed system follows a phased development approach to ensure reliability and scalability. In the first phase, an autonomous obstacle-avoiding mobile robot was developed using the Arduino Uno microcontroller, ultrasonic distance sensor, servo motor, DC motors, and a motor driver module. The robot performs real-time obstacle detection and directional scanning to determine the safest navigation path without human intervention. This autonomous movement capability forms the foundation of the overall system.

II. LITERATURE REVIEW

Several researchers have explored autonomous robotic systems for surveillance and healthcare applications. Obstacle-avoiding robots based on ultrasonic sensors and microcontrollers such as the Arduino Uno have been widely implemented for basic navigation tasks due to their low cost and simplicity. These systems primarily focus on distance measurement and collision avoidance.

Recent advancements incorporate camera modules such as the ESP32-CAM to enable wireless image streaming and IoT-based monitoring. Face recognition techniques using embedded AI algorithms have been applied in security and attendance systems, demonstrating reliable identity verification. In the healthcare domain, biomedical sensors like pulse sensors and the MAX30102 have been utilized for heart rate and oxygen saturation monitoring. However, most existing solutions operate as standalone systems and lack mobility.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 6, May 2026
Impact Factor: 8.2

III. PROPOSED SYSTEM ARCHITECTURE

The proposed system is a smart Face-Based Health Monitoring Robot designed using the ESP32 microcontroller. It combines embedded systems, sensors, camera technology, and IoT to create an intelligent system capable of monitoring a person's health and enabling remote interaction.

The overall architecture is divided into multiple interconnected modules, including the sensor unit, camera unit, processing unit, motor system, power supply, and web interface. All these components work together to perform real-time monitoring and control.At the core of the system is the ESP32, which acts as the central controller. It collects input data from the temperature and heart rate sensors, processes this data, and transmits it to a web-based dashboard through Wi-Fi. At the same time, it receives input from the camera module for face detection and recognition.The ESP32-CAM module plays a key role in identifying individuals. When a person comes in front of the robot, the camera captures their image and detects their face. This allows the system to associate the collected health data with a specific individual, making the monitoring more personalized and accurate.The sensor subsystem continuously measures important health parameters such as body temperature and heart rate. This data is sent to the ESP32, where it is processed and prepared for display. The processed data is then transmitted to the web dashboard, where users can view real-time readings as well as past records.The web interface acts as a communication bridge between the user and the robot. Through this interface, users can not only monitor health data but also send commands to control the robot remotely. These commands are received by the ESP32 and used to control the robot's movement.The motor system, consisting of a motor driver and DC motors, allows the robot to move in different directions such as forward, backward, left, and right. This makes the system mobile and interactive.The power supply unit, including a battery and voltage regulator, ensures that all components receive a stable and sufficient power supply for smooth operation.

Overall, the architecture follows a data flow cycle:

1. Sensors and camera collect data
2. ESP32 processes the data
3. Data is sent to the web dashboard
4. User interacts through the interface
5. Commands are sent back to control the robot

IV. SYSTEM METHODOLOGY

The proposed system was developed in two major phases:

Phase 1: Autonomous Navigation System

- Hardware Components: Arduino Uno
- Ultrasonic sensor (for distance measurement)
- Servo motor (for directional scanning)
- Motor driver module
- DC motors with 2WD chassis

Working Principle:

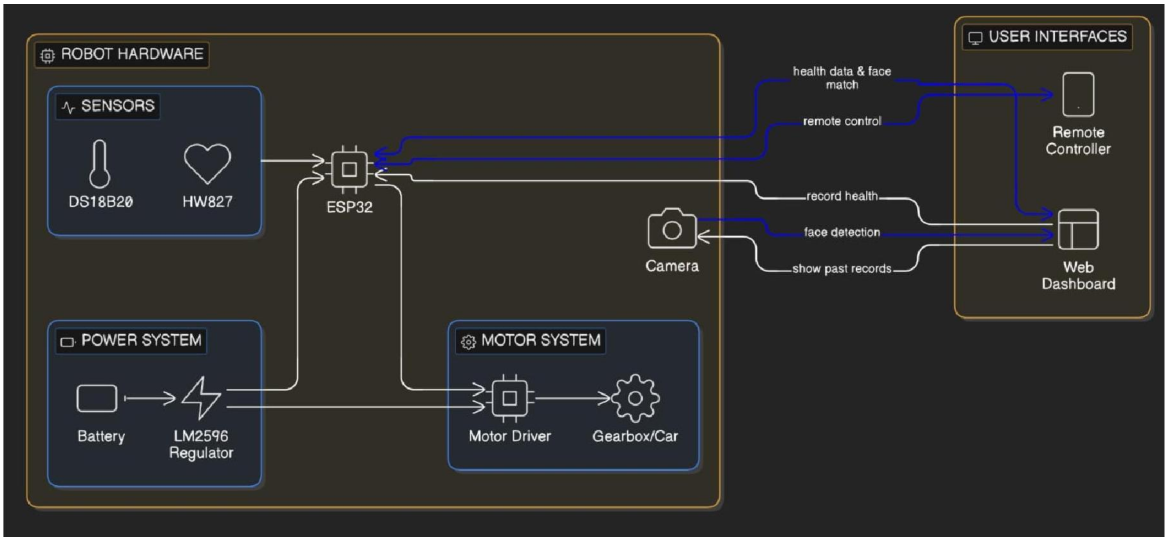
The ultrasonic sensor measures the distance to nearby obstacles. The servo motor rotates the sensor left and right to scan surroundings. The microcontroller processes distance data. Based on threshold values, the robot selects the safest path. DC motors are controlled via the motor driver to move forward, backward, or turn. Phase 2: Surveillance and Health Monitoring Integration Surveillance Module: ESP32-CAM captures real-time images. Captured images are processed using a face recognition algorithm.

If a face matches stored data, the patient is identified automatically. If no match is found, a new record is created. Health Monitoring Module :Pulse sensor for heart rate monitoring.MAX30102 sensor for SpO_2 measurement. Temperature sensor for body temperature. Environmental sensors (gas, humidity, temperature) for surroundings.

Data Processing: Sensor data is collected and processed by the microcontroller. Results can be displayed or transmitted wirelessly. The system operates autonomously without manual intervention.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 6, May 2026
Impact Factor: 8.2

V. BLOCK DAIGRAM



This system is a smart robot used for both health monitoring and surveillance. It uses sensors like DS18B20 for temperature and HW827 for heartbeat detection. All sensor data is processed by the ESP32 microcontroller, which acts as the main controller of the system.

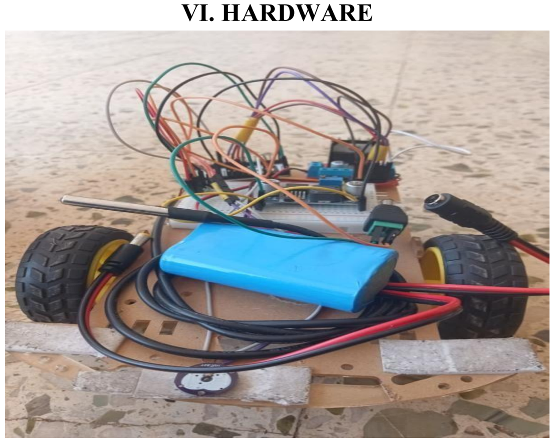
A camera module is used for live monitoring and face detection. The robot movement is controlled through a motor driver and gearbox motors. Power is supplied using a battery and LM2596 voltage regulator.

The collected health data and camera information are sent to a web dashboard and remote controller through Wi-Fi for real-time monitoring and control.

Main Features

* Temperature and heartbeat monitoring
* Face detection and surveillance
* Remote robot control
* Live data monitoring through web dashboard
* Wireless communication using ESP32

VI. HARDWARE



VII OUTPUT

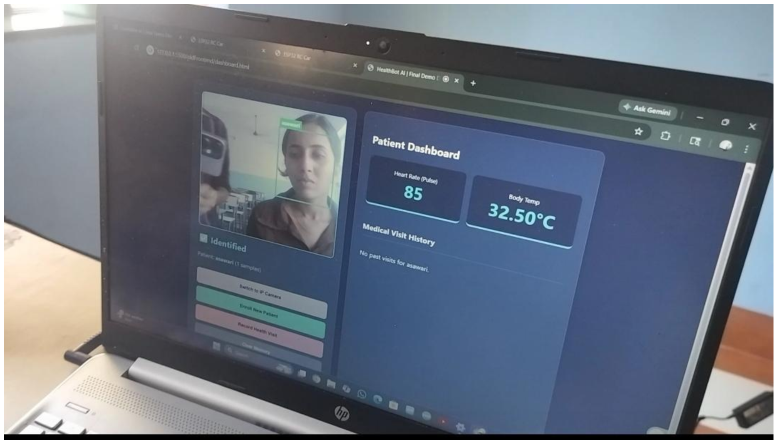


Fig. Autonomous Surveillance Health Monitoring System

VIII. CONCLUSION

The Autonomous Surveillance and Health Monitoring Robot demonstrates an effective integration of robotics, surveillance, and healthcare monitoring technologies. The phased development advanced monitoring capabilities. The system provides a scalable and cost-effective solution suitable for hospitals, quarantine centers, and hazardous environments. With further improvements, it can evolve into a fully automated smart healthcare assistant

IX. ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the project coordinator and faculty members of the Department of Electronics and Communication Engineering for their valuable guidance, continuous support, and constructive suggestions throughout the development of this project. We are especially thankful to our project guide for providing technical insights, motivation, and encouragement at every stage of the design and implementation process. Their guidance helped us in understanding the practical aspects of embedded systems and robotic applications. We also extend our appreciation to the laboratory staff for providing the necessary resources and infrastructure required for the successful development of the fire fighting robot. Finally, we would like to thank our institution for offering the academic environment and facilities that enabled us to complete this work successfully

REFERENCES

[1] Arduino Official Documentation, "Arduino Uno Rev3," 2024.

[2] Espress if Systems, "ESP32-CAM Technical Reference Manual," 2023.

[3] MAXIM Integrated, "MAX30102 Pulse Oximeter and Heart-Rate Sensor," Datasheet. [4] S. Thrun, W. Burgard, and D. Fox, Probabilistic Robotics, MIT Press, 2005.

[5] R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.

[6] Andrea Prati, Caifeng Shan, and Kevin I-Kai Wang, "Sensors, Vision and Networks: From Video Surveillance to Activity Recognition and Health Monitoring," Journal of Ambient Intelligence and Smart Environments, vol. 11, no. 1, pp. 5–22, 2019. DOI: 10.3233/AIS-180510.

[7] A. Li, E. Bodanese, S. Poslad, P. Chen, J. Wang, Y. Fan, and T. Hou, "A Contactless Health Monitoring System for Vital Signs Monitoring, Human Activity Recognition, and Tracking," IEEE Internet of Things Journal, vol. 11, no. 18, pp. 29275–29286, 2024. DOI: 10.1109/JIOT.2023.3336232.

[8] Arash Shokouhmand, Samuel Eckstrom, Behnood Gholami, and Negar Tavassolian, "Camera-Augmented Non-Contact Vital Sign Monitoring in Real Time," IEEE Sensors Journal, vol. 22, no. 12, pp. 11965–11978, 2022. DOI: 10.1109/JSEN.2022.3172559.

[9] Khushi Gupta, Srinivas M. B., Soumya J., Om Jee Pandey, and Linga Reddy Cenkeramaddi, "Automatic Contact-Less Monitoring of Breathing Rate and Heart Rate Utilizing the Fusion of mmWave Radar and Camera Steering System," IEEE Sensors Journal, vol. 22, no. 22, pp. 22179–22191, 2022. DOI: 10.1109/JSEN.2022.3210256.

[10] Prabal Verma and Sandeep K. Sood, "Fog Assisted-IoT Enabled Patient Health Monitoring in Smart Homes," IEEE Internet of Things Journal, vol. 5, no. 3, pp. 1789–1796, 2018. DOI: 10.1109/JIOT.2018.2803201.