Night Patrolling Robot for Women Safety

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ABSTRACT

This autonomous security platform, powered by an Arduino microcontroller and programmed in C/C++, provides a robust solution for real-time surveillance and hazard mitigation. Utilizing an L293D H-Bridge motor driver for precise navigation, the robot identifies unauthorized entities within a 5cm to 10cm range via an IR proximity sensor. For personal safety, an integrated sound sensor triggers a high-decibel alarm when noise exceeds a specific threshold, while an MQ-5 gas sensor simultaneously monitors the environment for combustible hazards like LPG and natural gas. This self-contained system demonstrates the effective use of low-cost hardware to create a responsive, proactive security tool for vulnerable areas. Ultimately, the robot bridges the gap between basic automation and active hazard mitigation, offering a tireless platform for safeguarding environments and personal safety. Through its autonomous execution and immediate audible alerts, it serves as a sophisticated yet accessible example of modern embedded system engineering for security enhancement.

KEYWORDS: ***Patrolling Robot, Personal Safety, Arduino, Real-time Surveillance***

INTRODUCTION

Robotics are rapidly advancing worldwide and are increasingly used to improve security beyond human capability. Unlike fixed CCTV systems, this autonomous robot provides mobile and continuous surveillance for large and risky environments. The Arduino acts as the central controller, processing sensor inputs and enabling real-time decision-making, while the L293D motor driver ensures smooth and controlled movement. IR sensors support navigation through line following and obstacle detection, allowing the robot to maintain its path and respond effectively to threats.

RELATED WORK

Recent studies in autonomous mobile robots highlight the increasing use of Arduino-based systems for low-cost surveillance and navigation tasks. Researchers have developed line-following robots using IR sensor arrays, L293D motor drivers, and microcontroller platforms to achieve stable path tracking and obstacle avoidance in indoor environments. Several works also integrate ultrasonic and vision sensors to enhance real-time monitoring and autonomous decision-making capabilities. In addition, robotic patrolling systems have been proposed for security applications, enabling continuous area surveillance with improved efficiency compared to fixed CCTV systems. Literature further shows that combining sensor fusion with embedded controllers like Arduino improves adaptability in dynamic environments, making such robots suitable for defense, industrial inspection, and smart security applications.

LITERATURE REVIEW

Recent literature on autonomous safety robots highlights the integration of Arduino-based platforms with sensors for real-time surveillance and threat detection. Studies such as Khan and Kumar (2023) demonstrate sound-triggered patrolling robots with night vision and live video streaming for rapid response. Gupta et al. (2026) emphasize IoT-enabled robots using GPS and acoustic detection for precise emergency localization. Divya et al. (2021) and Patel et al. (2020) show the effectiveness of low-cost PIR, sound, and alert systems for women safety applications. Research by Halilaj and Myrto (2025) improves distress detection using speech recognition techniques, while other works integrate gas sensing and buzzer-based deterrents, enhancing multi-layered autonomous security solutions.

EXISTING METHOD

The existing surveillance framework consists of a semi-automated patrolling unit governed by a Node MCU (ESP8266) microcontroller. This system relies on a camera module mounted on a servo motor, which allows a remote user to manually pan and tilt the lens to capture images or video. It incorporates sound and ultrasonic sensors to detect acoustic or physical disturbances. Data is transmitted via Wi-Fi to a web-based interface, where a human operator must monitor real-time updates and manually decide how to respond to detected threats.

PROPOSED METHOD

The proposed system is an autonomous, multi-sensor robotic platform governed by the Arduino microcontroller, specifically designed to bridge the gap between surveillance and active intervention. Unlike traditional systems, this robot is a mobile agent that navigates a predefined area using IR sensors for path-tracking and the L293D motor driver for precise, reliable locomotion. It is equipped with a high-sensitivity Sound Sensor to detect acoustic distress signals—such as screams or shouting—and an MQ-5 Gas Sensor to identify invisible environmental threats like LPG or methane leaks. Programmed in C/C++, the system analyzes inputs in real-time. The moment a safety threshold is breached, the robot transitions from a passive monitor to an active emergency responder by triggering a high-decibel Buzzer to alert the community immediately.

SYSTEM ARCHITECTURE

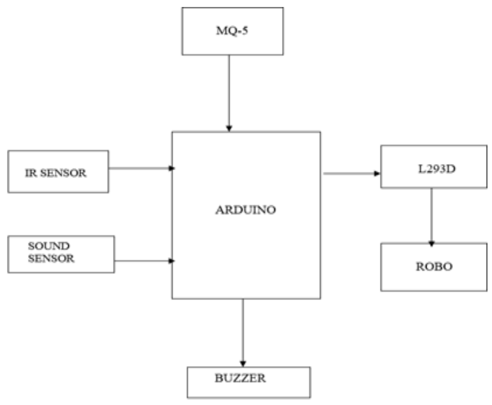

Fig 1: Block Diagram

METHODOLOGY DESCRIPTION

Sensor Data Acquisition Unit

This section collects real-time environmental information using IR sensors, sound sensor, and MQ-5 gas sensor. The IR sensor is used for obstacle detection and path tracking, while the sound sensor identifies unusual or high-intensity noise. The gas sensor continuously monitors the surrounding air for harmful gas leakage to ensure safety.

Processing and Control Unit (Arduino)

The Arduino Uno functions as the main controller of the system, responsible for processing all incoming sensor signals. It executes programmed instructions in real time and makes logical decisions based on detected conditions to ensure proper robotic behavior.

Navigation and Movement Control Unit

This section manages the movement of the robot using DC motors driven by the L293D motor driver IC. Based on processed sensor data, the controller generates commands for forward, reverse, left, right, or stop actions, enabling autonomous navigation.

Alert and Indication System

The buzzer is used to provide immediate audio alerts when abnormal conditions such as obstacle detection, sound triggers, or gas leakage are identified. This helps in notifying nearby individuals and enhancing safety response.

Power Supply and Integration Unit

This section ensures stable power delivery to all components using an external power supply connected through a barrel jack. It integrates all hardware on the robot chassis and maintains continuous and reliable system operation.

SOFTWARE AND HARDWARE COMPONENTS

Arduino:

Fig 2: Arduino

Arduino Uno is the central control unit of the system, based on the ATmega328P microcontroller. It processes sensor inputs and executes programmed instructions for robot movement and decision-making.

IR Sensor:

Fig 3: IR Sensor

IR sensors are used for line tracking and obstacle detection by transmitting and receiving infrared signals. They help the robot maintain its path and avoid collisions during navigation.

Sound Sensor:

Fig 4: Sound Sensor

The sound sensor detects audio intensity using a microphone module and converts it into electrical signals. It is used to identify sudden noises or distress sounds in the environment.

Buzzer:

Fig 5: Buzzer

A buzzer acts as an alert device that produces sound when triggered by the system. It is used to indicate warnings or emergency situations in the robot.

MQ-5 Gas Sensor:

Fig 6: MQ-5 Gas Sensor

The MQ-5 sensor detects gases like LPG, methane, and natural gas using a semiconductor sensing element. It enhances safety by identifying hazardous gas leaks in the environment.

L293D Motor Driver:

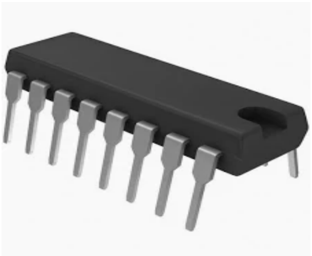

Fig 7: L293D Motor

The L293D IC controls DC motors by providing sufficient current and direction control using an H-bridge configuration. It enables smooth forward, backward, and turning movements of the robot.

Wheels and Caster:

Wheels provide motion to the robot while the caster supports balance and smooth turning. Together they ensure stable and flexible movement across surfaces.

DC Motors:

Fig 8: DC Motors

DC motors convert electrical energy into mechanical motion to drive the robot wheels. They are controlled by the motor driver for precise movement.

Robot Chassis:

The chassis is the mechanical frame that holds all electronic components together. It provides structural support and ensures proper alignment of the system.

Breadboard and Jumper Wires:

A breadboard allows temporary circuit connections without soldering. Jumper wires are used to connect components securely for testing and development.

Power Barrel Jack:

The barrel jack provides a stable connection for external power supply to the Arduino system. It ensures consistent voltage input for reliable operation.

External Power Supply:

An external power source supplies the required voltage and current to run motors and sensors. It ensures uninterrupted operation of the robotic system.

Software Requirements

Arduino IDE:

Arduino IDE is the primary software used to write, compile, and upload code to the Arduino board. It provides libraries and tools for easy embedded system development.

Embedded C/C++:

Embedded C/C++ is used for programming the microcontroller to control sensors and actuators. It allows efficient real-time processing and hardware interaction.

Arduino Libraries:

Arduino libraries provide pre-written code for sensors, motors, and communication modules. They simplify development and improve code efficiency and reliability.

RESULTS AND DISCUSSION

The L293D motor driver smoothly controlled the motors during direction changes, enabling quick and stable transitions without any delay or stuttering. It also maintained thermal stability throughout operation, proving its reliability for continuous autonomous robot navigation.

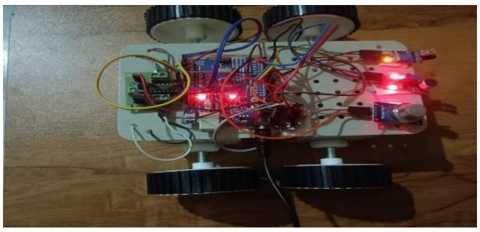

Fig 9: Output of L293D Motor Driver

I placed various objects in the robot's path to evaluate the IR sensors' reactive capabilities. I observed that the robot maintained a consistent "safety bubble," identifying obstructions the moment they entered the 5cm to 10cm detection range. As soon as the infrared beam was interrupted, I saw the robot immediately execute a pre-programmed turn to bypass the object. This confirmed that the sensors provide the real-time spatial awareness necessary for the hardware to operate without any manual.

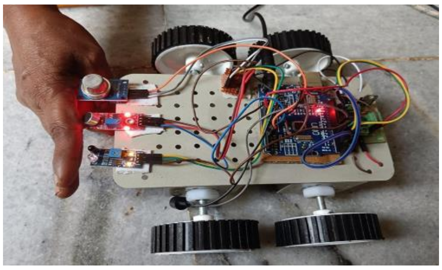

Fig 10: Output of IR Sensor

I tested the secondary security layer by creating sharp, sudden noises—such as a loud clap or a metallic strike—at various distances from the robot. I noted that as long as the sound exceeded the pre-programmed decibel threshold, the sensor reliably signaled the microcontroller to issue a security alert. These observations proved that the system remains vigilant to environmental cues that fall outside the camera's line of sight.

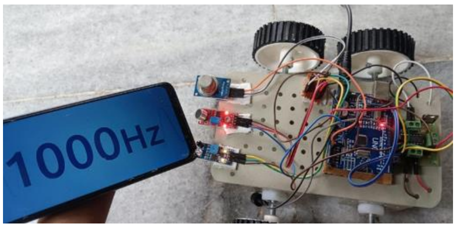

Fig 11: Output of Sound Sensor

During the live trial, I introduced a controlled gas source near the MQ-5 sensor to simulate a hazardous leak. I observed that the system responded almost instantly, with the sensor readings spiking the moment the gas reached the module. This triggered the onboard logic to activate the high-decibel alarm, confirming that the platform can successfully transition from a silent patrol to an active emergency broadcaster when it detects a chemical threat.

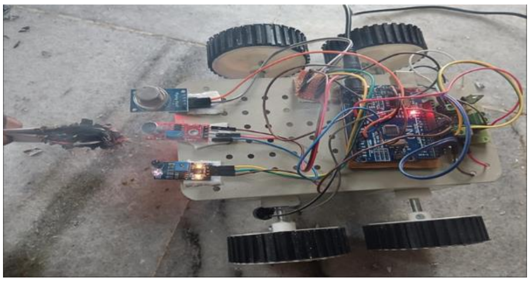

Fig 12: Output of Gas Sensor

CONCLUSION

The developed patrolling robot demonstrates an effective integration of Arduino, sensors, and motor control systems to enhance women's safety and environmental monitoring. It successfully performs real-time detection of obstacles, sound anomalies, and hazardous gases while ensuring smooth autonomous navigation. The system provides a reliable, low-cost, and efficient solution for modern surveillance needs in public and private spaces.

FUTURE SCOPE

The system can be further enhanced by integrating AI and computer vision to enable intelligent threat detection such as weapon recognition and gesture-based alerts. Advanced navigation techniques like LIDAR and SLAM can be incorporated to achieve fully autonomous mapping and movement. Additionally, IoT cloud connectivity and solar-based power systems can improve real-time monitoring, endurance, and scalability of the robotic platform.

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