Life Under Wheels: Smart Animal Safety System

Abstract

Urban and semi-urban environments witness a rising number of animal injuries and fatalities caused not only by moving vehicles but also by parked vehicles. Small animals such as cats, dogs, and rodents often seek warmth and shelter beneath vehicles, especially near the engine or undercarriage. This poses a serious risk when the vehicle is started, leading to unnoticed and preventable accidents. Existing road safety systems primarily focus on collision avoidance and highway animal crossings, leaving the under-vehicle blind spot largely unaddressed. This paper presents **Life Under Wheels**, a smart, low-cost, sensor-based animal safety system designed to detect the presence of animals beneath parked vehicles and alert the driver before ignition. The proposed system integrates PIR sensors, ultrasonic sensing, and thermal detection with a microcontroller-based processing unit to provide audible and visual alerts. The solution emphasizes affordability, scalability, and ethical engineering, making it suitable for both two-wheelers and four-wheelers.

Keywords: Animal Safety, Under-Vehicle Detection, PIR Sensor, Thermal Sensor, Arduino, Ethical Engineering

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1. Introduction

With increasing urbanization and vehicle density, the interaction between animals and vehicles has become an unavoidable concern. While significant research and development efforts have been directed toward preventing roadkill during vehicle movement, a less-discussed yet equally critical issue is the safety of animals hiding under parked vehicles. Animals often crawl beneath vehicles to escape harsh weather, predators, or to seek warmth from residual engine heat.

When a driver starts the vehicle without noticing the animal underneath, it can result in severe injury or death to the animal, vehicle damage, and emotional distress to the driver. Manual checking methods such as honking horns, tapping the hood, or using mobile flashlights are unreliable and inconsistent. This gap highlights the need for an automated, reliable, and user-friendly detection mechanism.

The **Life Under Wheels** system aims to bridge this gap by providing a proactive safety solution that operates before vehicle ignition, thereby preventing avoidable harm.

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2. Problem Statement

Despite advancements in automotive safety technologies, there is no standardized system to detect animals present beneath parked vehicles. Existing solutions focus on: - Highway animal detection systems - Roadside motion sensors - Driver-assist collision avoidance systems

These approaches fail to address: - The **under-vehicle blind spot** - Detection of **small animals at close range** - Reliable operation in **low-light or stationary conditions**

Hence, there is a need for a compact, cost-effective system capable of accurately detecting animals under vehicles and alerting the driver before engine ignition.

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3. Gap Analysis

The proposed system is motivated by the following identified gaps:

- **Reactive Safety Measures:** Current methods rely on human intervention and awareness.
- **Road-Centric Focus:** Most animal detection systems are designed for moving vehicles and highways.
- **Lack of Underbody Monitoring:** No dedicated mechanism exists for monitoring the undercarriage of parked vehicles.
- **Sensor Limitation:** Single-sensor systems are prone to false positives due to heat or environmental noise.

The **Life Under Wheels** system addresses these gaps using sensor fusion and strategic placement.

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4. Objectives

The primary objectives of the proposed system are:

- To detect the presence of animals hiding under parked vehicles.
- To reduce animal injuries and fatalities caused by vehicle ignition.
- To provide real-time alerts to drivers through audio-visual indicators.
- To design a low-cost, scalable, and vehicle-compatible solution.
- To promote ethical and responsible engineering practices.

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5. System Architecture

The system consists of multiple sensors interfaced with a microcontroller that processes input data and triggers alerts based on predefined logic.

5.1 Components Used

Component	Description
Arduino Uno	Central processing unit for sensor data
PIR Sensor (HC-SR501)	Detects motion and heat signatures
Ultrasonic Sensor	Measures distance to confirm presence
Thermal Sensor (MLX90614)	Detects body temperature accurately
Buzzer	Provides audible alert
LED Indicators	Visual warning signals
LCD Display (16x2 I2C)	Displays system status

Component	Description
Battery & Voltage Regulator	Power supply and voltage control
Housing & Brackets	Protection and mounting

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6. Working Methodology

The system operates in the following steps:

1. **Initialization:** On power-up, the Arduino initializes all sensors and display modules.
2. **Motion Detection:** PIR sensors continuously monitor for movement beneath the vehicle.
3. **Distance Confirmation:** Ultrasonic sensors verify the presence of an object within a critical range.
4. **Thermal Validation:** The thermal sensor checks for body heat to differentiate animals from non-living objects.
5. **Decision Logic:** Sensor fusion logic reduces false positives by requiring multiple confirmations.
6. **Alert Generation:** If an animal is detected, the buzzer sounds, LEDs illuminate, and a warning message appears on the LCD.

This multi-layer verification ensures reliability even in challenging environmental conditions.

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7. Sensor Positioning Strategy

Proper sensor placement is crucial for system accuracy:

- PIR sensors are mounted near the front and rear undercarriage.
- Ultrasonic sensors are positioned to cover low-clearance areas.
- The thermal sensor is centrally placed to capture heat signatures effectively.

This configuration ensures full underbody coverage without interfering with vehicle mechanics.

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8. Cost Analysis

Component Category	Estimated Cost (₹ INR)
Microcontroller & Sensors	1,210
Alert & Display Modules	300
Power & Regulation	70
Housing, Wiring & Mounts	950
Total Estimated Cost	**2,530**

The low overall cost makes the system suitable for mass adoption, including retrofitting older vehicles.

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9. Results and Discussion

The prototype demonstrates effective detection of animals under stationary vehicles with minimal false alerts. The integration of thermal sensing significantly improves accuracy by eliminating false triggers caused by engine heat or debris. The system is easy to use, requires minimal maintenance, and provides immediate feedback to the driver.

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10. Future Scope

The system can be further enhanced through:

- Ignition interlock integration with vehicle OEMs
- AI-based thermal imaging and animal classification
- IoT and Bluetooth-enabled mobile notifications
- Fixed community sensor units in parking areas
- Data analytics for animal safety monitoring

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11. Conclusion

The **Life Under Wheels: Smart Animal Safety System** presents a practical and ethical solution to an overlooked real-world problem. By combining multiple sensors and intelligent processing, the system effectively detects animals beneath parked vehicles and alerts drivers before ignition. Its affordability, scalability, and adaptability make it a strong candidate for real-world deployment. This project demonstrates how engineering can be leveraged not only for human safety but also for compassionate coexistence with animals.

References

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