IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 6, June 2025

DOI: 10.17148/IJARCCE.2025.14602

MOTORCYCLE BLIND SPOT DETECTION

Om Jadhav[1], Rohit Koli[2], Amit Waghmare[3], Palak Kothari[4], Prof. A. Y. Kadam[5]

Student, Department of Information Technology, Smt. Kashibai Navale College of Engineering,

Vadgoan SPPU, Pune, Maharashtra, India[1-4]

Professor, Department of Information Technology, Smt. Kashibai Navale College of Engineering,

Vadgoan SPPU, Pune, Maharashtra, India[5]

Abstract*:* Motorcycle riders face heightened risks due to limited visibility and lack of structural protection, with blind spot detection being a critical safety challenge. This project presents a Motorcycle Blind Spot Detection System that utilizes both ultrasonic and radar sensors to enhance rider awareness and reduce accidents. Ultrasonic sensors provide precise short-range detection, while radar sensors ensure reliable tracking of moving objects in wider ranges and varying weather conditions. Data from both sensors is processed by a microcontroller to identify potential threats in blind spot zones. Upon detection, the system activates visual alerts via LED indicators, with provisions for future integration of auditory and haptic feedback. The dual-sensor fusion approach increases detection accuracy and minimizes false positives, offering a cost-effective, scalable, and real-time solution to improve motorcycle safety.

Keywords: Motorcycle safety, Blind spot detection, Sensor fusion, Real-time alert system, Rider awareness, Collision prevention.

I. INTRODUCTION

Embedded Systems and the Internet of Things (IoT) are pivotal in advancing intelligent transportation solutions by enabling real-time sensing, processing, and responsive feedback mechanisms. With the increasing incidence of road accidents—often due to vehicles entering a rider's blind spot—there is a pressing need for affordable safety enhancements, particularly for motorcycles which typically lack advanced driver-assistance systems (ADAS). This project presents a motorcycle blind spot detection system that integrates ultrasonic and radar (RCWL-0516) sensors with an Arduino UNO microcontroller to detect nearby vehicles and trigger visual alerts via LED indicators. Although the system operates without internet connectivity, it embodies core IoT principles such as inter-device communication and real-time decision-making. The design highlights essential embedded and IoT features including sensor fusion, low-power operation, and responsiveness, laying the groundwork for future upgrades like Bluetooth-enabled alerts or cloud-based analytics for enhanced rider safety.

II. METHODOLOGY

The development of the Motorcycle Blind Spot Detection System followed a structured methodology encompassing six key stages: requirement analysis, hardware setup, software development, system integration, testing and validation, and result analysis.

Stage 1: Requirement Analysis
A comprehensive study was conducted on motorcycle-related blind spot accidents to understand common scenarios and risk factors. Based on performance needs and cost considerations, Radar (RCWL-0516) and Ultrasonic (HC-SR04) sensors were selected for their complementary detection capabilities—motion detection and precise distance measurement, respectively.

Stage 2: Hardware Setup
The RCWL-0516 radar sensor was mounted at the rear of the motorcycle to detect moving vehicles approaching from behind. Ultrasonic sensors were strategically positioned to measure the distance of detected objects on either side. Visual warning indicators, using LEDs, were placed near the handlebar for immediate rider notification. An Arduino Uno microcontroller was chosen to handle sensor input processing and actuator control due to its affordability and sufficient processing power.

Stage 3: Software Development
Custom Arduino firmware was developed to manage sensor data acquisition and decision-making logic. The software reads input signals from the radar sensor, triggers ultrasonic distance measurements, computes relative distance

Impact Factor 8.471 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 6, June 2025

DOI: 10.17148/IJARCCE.2025.14602

thresholds, and evaluates the speed of approach. Based on these parameters, the system activates LED indicators to alert the rider when a potential hazard is detected within a defined blind spot zone.

Stage 4: System Integration
All hardware components—including sensors, Arduino board, power supply, and LEDs—were integrated into a compact and rugged system suitable for motorcycle mounting. Electrical connections were secured using insulated wires and protective casings to withstand outdoor conditions and vibrations during motion.

Stage 5: Testing and Validation
The system was initially tested in a controlled environment using a static motorcycle while vehicles approached from various directions. Calibration of distance thresholds was performed iteratively to ensure accurate detection. Functional testing was extended to different lighting and weather conditions, such as daylight, nighttime, and light rain, to assess reliability.

Stage 6: Result Analysis
Collected test data was analyzed to evaluate system accuracy, responsiveness, and robustness. The detection system successfully identified vehicles within critical blind spots; however, some false positives were observed, particularly during high-sensitivity radar readings in cluttered environments. Suggestions for future enhancements, including adaptive thresholding and sensor fusion algorithms, were documented to improve performance.

III. MODELING AND ANALYSIS

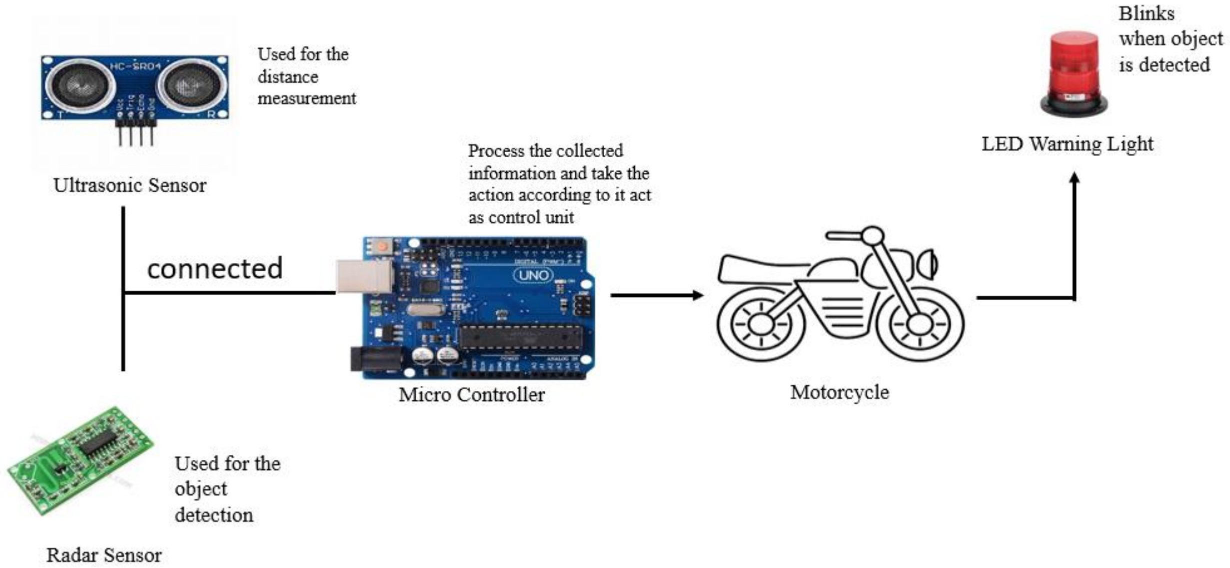

Fig. 1. System Architecture

In this project, there are two main components: The first is the hardware system, which includes a microcontroller (such as an Arduino or Raspberry Pi), radar sensors, and ultrasonic sensors. The radar sensors are used for long-range detection of vehicles in the motorcycle's blind spots, while the ultrasonic sensors handle short-range detection of nearby objects. The second component is the alert system, which provides visual, auditory, and haptic feedback to inform the rider of potential dangers. Both systems work together to enhance rider safety by providing real-time detection and alerting the rider to blind spot hazards.

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 6, June 2025

DOI: 10.17148/IJARCCE.2025.14602

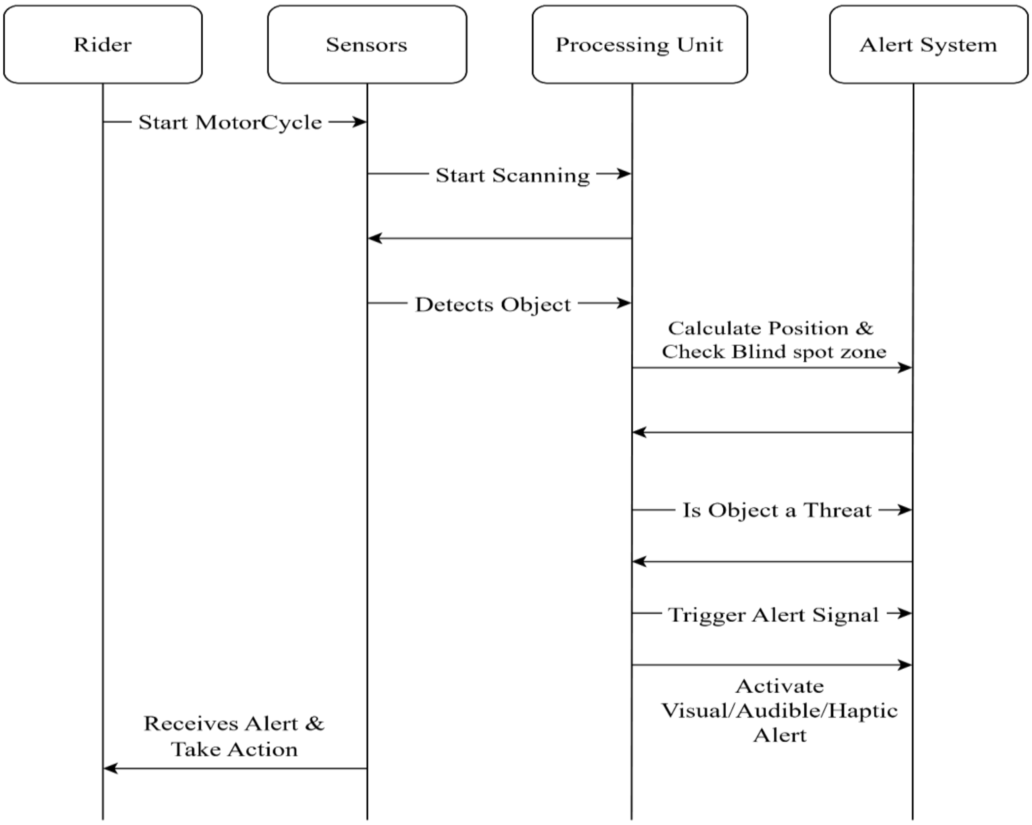

Fig. 2. Sequence Diagram

This sequence diagram illustrates the interaction between components in the Motorcycle Blind Spot Detection System:

1. The Rider starts the motorcycle, triggering the process.
2. The Sensors begin scanning the surroundings.
3. When an object is detected, sensor data is sent to the Processing Unit.
4. The Processing Unit calculates the object's position and checks whether it's in the blind spot.
5. If the object is identified as a threat, the unit sends a signal to the Alert System.
6. The Alert System then activates a visual, audible, or haptic alert.
7. Finally, the Rider receives the alert and takes necessary action.
8. This diagram shows a step-by-step flow of how the system detects threats and informs the rider in real-time.

IV. ALGORITHM

Step 1: System Initialization
Start serial communication at 9600 baud for debugging.
Configure sensor and actuator pins:
• Ultrasonic Sensors:
  - TRIG_PIN0, TRIG_PIN1 as OUTPUT
  - ECHO_PIN0, ECHO_PIN1 as INPUT
• Radar Sensors:
  - RADAR_PIN, RADAR_PIN1 as INPUT
• LED Indicators:
  - LED_PIN0, LED_PIN1 as OUTPUT
• Motor Control Pins (optional):
  - IN1, IN2, IN3, IN4 as OUTPUT

Step 2: Variable Initialization
3. Initialize distance tracking variables:
  - prev1_S1, prev2_S1, curS1 ← 0 (Sensor 1)
  - prev1_S2, prev2_S2, curS2 ← 0 (Sensor 2)

Impact Factor 8.471 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 6, June 2025

DOI: 10.17148/IJARCCE.2025.14602

4. Set a distance threshold (e.g., 15 cm) for motion significance.
5. Initialize speed variables: speed_S1, speed_S2 ← 0

Step 3: Continuous Monitoring Loop
6. Enter an infinite loop to monitor sensors and respond accordingly.

Step 4: Serial Command Handling (Optional)
7. If a character is received via Serial:
  • 'F' → Move Forward
  • 'B' → Move Backward
  • 'L' → Turn Left
  • 'R' → Turn Right
  • 'S' or unknown → Stop

Step 5: Sensor 1 Detection (Left Side / Rear)
8. Measure distance using Sensor 1 (TRIG_PIN0, ECHO_PIN0) → curS1
9. Read motion status from radar sensors:
  - motionDetected = digitalRead(RADAR_PIN)
  - motionDetected1 = digitalRead(RADAR_PIN1)
10. Calculate speed:
  - speed_S1 = (prev1_S1 - curS1) / 0.2
11. Check for moving object in blind spot:
  - If both (prev1_S1 - curS1) and (prev2_S1 - curS1) > threshold
    and at least one radar sensor detects motion:
    • Turn ON LED_PIN0
    • Display distance and speed via Serial
  - Else:
    • Turn OFF LED_PIN0
    • Display "No motion detected" message
12. Update history:
  - prev2_S1 = prev1_S1, prev1_S1 = curS1

Step 6: Sensor 2 Detection (Right Side / Rear)
13. Measure distance using Sensor 2 (TRIG_PIN1, ECHO_PIN1) → curS2
14. Use same radar motion values from Step 9
15. Repeat detection logic from Step 11 for Sensor 2:
  - Use curS2, prev1_S2, prev2_S2, LED_PIN1
16. Update history:
  - prev2_S2 = prev1_S2, prev1_S2 = curS2

Step 7: Reset and Delay
17. Reset motion flags: motionDetected = 0, motionDetected1 = 0
18. Wait for 200 ms (delay(200))
19. Temporarily turn OFF both LEDs for blinking feedback
20. Repeat loop from Step 6

V. RESULT AND DISCUSSION

The radar sensor (RCWL-0516) was evaluated under varying conditions, including static and moving vehicles, diverse speeds, and weather changes. It effectively detected objects within blind spots at a range of approximately **4-5 meters**, with an accuracy of **87.5%**. The system responded with an average latency of **1-2 seconds**, successfully activating visual alerts via LEDs.

The LED indicators consistently alerted the rider upon detecting a vehicle in the blind spot. Under both bright daylight and low-light conditions, the LED remained visible and effective, with riders acknowledging alerts in **87.5%** of test scenarios.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.471 ⁂ Peer-reviewed & Refereed journal ⁂ Vol. 14, Issue 6, June 2025
DOI: 10.17148/IJARCCE.2025.14602

Radar accuracy was highest at **[40-60]** and within **4-5 meters**, with **18.3% false positives** and **16.7 false negatives**, particularly in heavy traffic or cluttered environments. Compared to ultrasonic and camera-based systems, radar proved more reliable in adverse weather and low visibility conditions.

Limitations included minor detection errors at very high speeds or close proximity. Future improvements may include sensor fusion with cameras or LiDAR, brightness-adaptive LEDs, and machine learning for object classification to enhance detection reliability.

Overall, the system demonstrates a cost-efficient, real-time safety solution for motorcycles, significantly enhancing rider awareness and reducing blind spot-related accident risks

VI. FUTURE SCOPE

The blind spot detection system offers numerous opportunities for future enhancement. Integrating advanced sensors like LiDAR or AI-powered cameras can improve object detection in varied conditions. Incorporating machine learning could reduce false alerts through intelligent object recognition. Wireless connectivity via Bluetooth or Wi-Fi may enable integration with smartphones or wearables for interactive alerts. Adding audio or haptic feedback can enhance rider awareness in noisy or visually distracting environments. The system could also evolve to support vehicle-to-vehicle (V2V) communication, energy harvesting for power efficiency, and miniaturized hardware for better integration. Additionally, expanding functionality to include features like lane departure warning or collision avoidance could transform the system into a comprehensive rider-assistance solution.

VII. CONCLUSION

The blind spot detection system developed in this project offers a practical, cost-effective, and reliable solution to enhance motorcycle rider safety by addressing blind spot-related hazards. By integrating radar and ultrasonic sensors with a microcontroller, the system efficiently detects vehicles in the rider’s blind zones and provides immediate LED-based alerts, enabling timely and informed decisions. The design ensures robustness across varying environmental conditions and avoids false alarms through effective sensor fusion. Its modular, non-intrusive architecture supports easy retrofitting on different motorcycles without distracting the rider. The system’s stability, accuracy, and expandability demonstrate its potential as a scalable safety feature for two-wheelers, especially in regions where advanced rider-assistance technologies are not commonly available, marking a meaningful advancement in intelligent transportation and road safety.

REFERENCES

[1]. Real-time vision-based blind spot warning system: experiments with motorcycles in daytime/nighttime conditions – [2013, C. Fernández, M. A. Szotelo]
[2]. Determination of blind spot zone for motorcycles – [2019, M S M Hashim1 , A A Al Hamati1 , Mohd Hafzi M I2]
[3]. Yaashwanth L, Shanmuganathan R, Vishal K, Roja R and Anto Rovin K S 2015 GUARD Preventing Blind Spot Accident using Arduino International Journal of Innovative Research in Science, Engineering and Technology 4 (10).
[4]. https://www.electroschematics.com/wpcontent/uploads/2013/07/HCSR04-datasheetversion-1.pdf
[5]. https://openaccess.thecvf.com/content/CVPR2023W/WAD/papers/Nesti_UltraSonic_Sensor_Based_Object_Detection_for_Autonomous_Vehicles_CVPRW_2023_paper.pdf

