A project report on,

INTELLIGENT SPEED BREAKER SYSTEM

submitted in partial fulfillment of the requirements for the degree of

B. Tech
In
Electronics and Telecommunication Engineering

By

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CERTIFICATE

This is to certify that the project report entitled **“INTELLLIGENT SPEED BREAKER SYSTEM”** submitted by

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in partial fulfilment of the requirements for the award of the **Degree of Bachelor of Technology** in **Electronics and Telecommunication Engineering** is a bonafide record of the work carried out under my (our) guidance and supervision at School of Electronics Engineering, KIIT (Deemed to be University).

Signature of Supervisor
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ABSTRACT

The Intelligent Speed Breaker System is an innovative solution designed to enhance road safety and traffic management by dynamically controlling vehicle speeds in high-risk zones such as school areas, hospitals, and sharp turns. Traditional speed breakers are static and often cause discomfort to drivers and passengers. This project proposes an automated speed control system using ultrasonic sensors and an Arduino-based system to detect approaching vehicles and activate a LED warning system only when necessary.

The system employs real-time monitoring to measure vehicle speed and adjusts the speed breaker's height accordingly. If a vehicle exceeds the speed limit, the system raises the speed breaker to enforce deceleration, while compliant vehicles pass smoothly. This smart road infrastructure reduces unnecessary stops, minimizes wear and tear on vehicles, and improves fuel efficiency.

The prototype was tested under simulated traffic conditions, demonstrating its effectiveness in vehicle detection and speed regulation. Future enhancements include integrating IoT for remote monitoring and using solar power for sustainability. This project contributes to the advancement of intelligent transportation systems, aligning with global trends in traffic management and road safety.

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CHAPTER 1
INTRODUCTION

1.1 Motivation

The motivation behind this project stems from the growing need for innovative solutions to enhance road safety and traffic efficiency. Static speed breakers, while simple in design, are often criticized for their inefficiency. For instance:

- They force all vehicles to slow down, even when compliance with speed limits is already observed.
- They contribute to vehicle wear and increased emissions due to frequent acceleration and deceleration.
- In emergency situations, static speed breakers can delay response times for ambulances and fire trucks.

An intelligent speed breaker system addresses these issues by:

- Activating only when a vehicle exceeds the predefined speed limit, ensuring minimal disruption to compliant drivers.
- Providing visual warnings (e.g., LED warning systems) to alert drivers in advance, promoting voluntary compliance.
- Reducing wear on vehicles and improving fuel efficiency by eliminating unnecessary stops.

This project also aligns with the broader vision of smart road infrastructure, where adaptive technologies enhance safety, efficiency, and sustainability. By leveraging real-time monitoring and automation, the system contributes to the evolution of intelligent transportation networks.

1.2 Background Studies /Literature Survey

Road safety remains a critical global concern, with overspeeding being one of the leading causes of accidents, especially in sensitive zones such as school areas, hospitals, and sharp turns. Traditional speed breakers, while effective in enforcing speed limits, are static and often cause discomfort to drivers, unnecessary wear and tear on vehicles, and increased fuel consumption due to frequent braking. Recent advancements in smart road infrastructure and traffic management have paved the way for dynamic solutions that address these inefficiencies.

Research in intelligent transportation systems has explored various technologies for automated speed control, including ultrasonic sensors, infrared sensors, and radar-based systems. Studies highlight the effectiveness of Arduino-based systems in real-time vehicle detection and speed monitoring due to their low cost, flexibility, and ease of integration with other components [1]. Additionally, the use of LED warning systems has been proven to enhance driver awareness and compliance with speed limits, reducing the likelihood of accidents [2].

The concept of an intelligent speed breaker system builds upon these technologies to create a responsive mechanism that activates only when necessary. Unlike static speed breakers, this system dynamically adjusts its height based on the speed of approaching vehicles, ensuring smoother traffic flow while maintaining safety. Such systems align with global trends in smart cities and sustainable urban development, where real-time monitoring and adaptive infrastructure play a pivotal role.

1.3 Objectives

The primary objectives of this project are:

Design and Development:

- Develop an intelligent speed breaker system using ultrasonic sensors for vehicle detection and speed measurement.
- Implement an Arduino-based control system to process sensor data and actuate the speed breaker mechanism.

Automation and Responsiveness:

- Ensure the system activates only when a vehicle exceeds the speed limit, using servo motors or pneumatic mechanisms to adjust the speed breaker height dynamically.
- Integrate an LED warning system to provide real-time alerts to drivers.

Testing and Validation:

- Conduct experiments to evaluate the system's accuracy in vehicle detection and speed calculation.
- Test the prototype under simulated traffic conditions to assess its reliability and effectiveness.

Future Scalability:

- Explore the integration of IoT for remote real-time monitoring and data logging.
- Investigate the use of solar power to enhance the system's sustainability.
- By achieving these objectives, the project aims to demonstrate a practical and scalable solution for modern traffic management, contributing to safer and more efficient roadways.

CHAPTER 2
METHODOLOGY

This chapter provides a comprehensive breakdown of the system design, components, workflow, and implementation strategy for the Intelligent Speed Breaker System. The methodology follows a structured engineering approach from conceptualization to prototyping.

2.1 Applied Techniques and Tools

The Intelligent Speed Breaker System is designed to enhance road safety by integrating automated speed control, ultrasonic sensors, and an Arduino-based system. This section describes the core components, working principles, and implementation strategy in detail.

1. System Components

The system consists of the following hardware and software components:

A. Hardware Components

- Arduino Uno – Acts as the central processing unit, receiving sensor inputs, processing data, and controlling the actuator mechanisms.
- Ultrasonic Sensors (HC-SR04) – Detects vehicles approaching the speed breaker and measures their speed.
- Servo Motor (SG90/MG995) – Raises or lowers the speed breaker dynamically based on vehicle speed.
- LED Warning System – Alerts drivers visually before enforcement is triggered.
- 7805 Voltage Regulator – Provides a stable 5V power supply for the system.
- Power Supply Unit – Ensures reliable operation of all components.

- Mechanical Speed Breaker – The actual physical speed breaker that moves up or down based on control signals.

B. Software Components

- Arduino IDE – Used for programming and uploading codes to the Arduino Uno.
- Embedded C/C++ – The programming language used for real-time data processing and component control.
- Sensor Data Processing Algorithms – Implemented to analyze real-time vehicle speed and presence.

2. System Working Principle

The system follows a four-step operational mechanism:

Step 1: Vehicle Detection and Speed Measurement.

The ultrasonic sensors continuously monitor the road for approaching vehicles.

Once a vehicle enters the detection range, the system calculates its speed based on the time it takes to cross a defined distance.

If the vehicle speed is within the permissible limit, the system remains inactive, allowing the vehicle to pass smoothly.

Step 2: LED Warning Activation

If the vehicle exceeds the predefined speed limit, the LED warning system is triggered.

The LED blinks rapidly to alert the driver to slow down before reaching the speed breaker.

Step 3: Dynamic Speed Breaker Control

If the driver reduces speed after seeing the LED warning, the system does not activate the speed breaker.

If the driver does not slow down, the servo motor is activated to raise the mechanical speed breaker.

Step 4: Real-Time Monitoring and Automation

The system continuously logs vehicle speed, compliance status, and actuator response.

Real-time monitoring ensures that the system adapts to varying traffic conditions dynamically.

3. Circuit Configuration and Working

A. Circuit Setup

- The ultrasonic sensors (HC-SR04) are placed at an optimal distance from the speed breaker.
- The Arduino Uno processes sensor data and makes speed-based decisions.
- The servo motor is connected to the speed breaker to raise or lower it when needed.
- The LED warning lights are activated when a vehicle is overspeeding.

4. Experimental Testing & Optimization

The system was tested under real-world traffic conditions to validate its efficiency. The following tests were conducted:

Sensor Accuracy Test: Compared measured vehicle speed with actual speed to ensure precise detection.

Response Time Test: Evaluated the time taken by the servo motor to activate the speed breaker upon detecting an overspeeding vehicle.

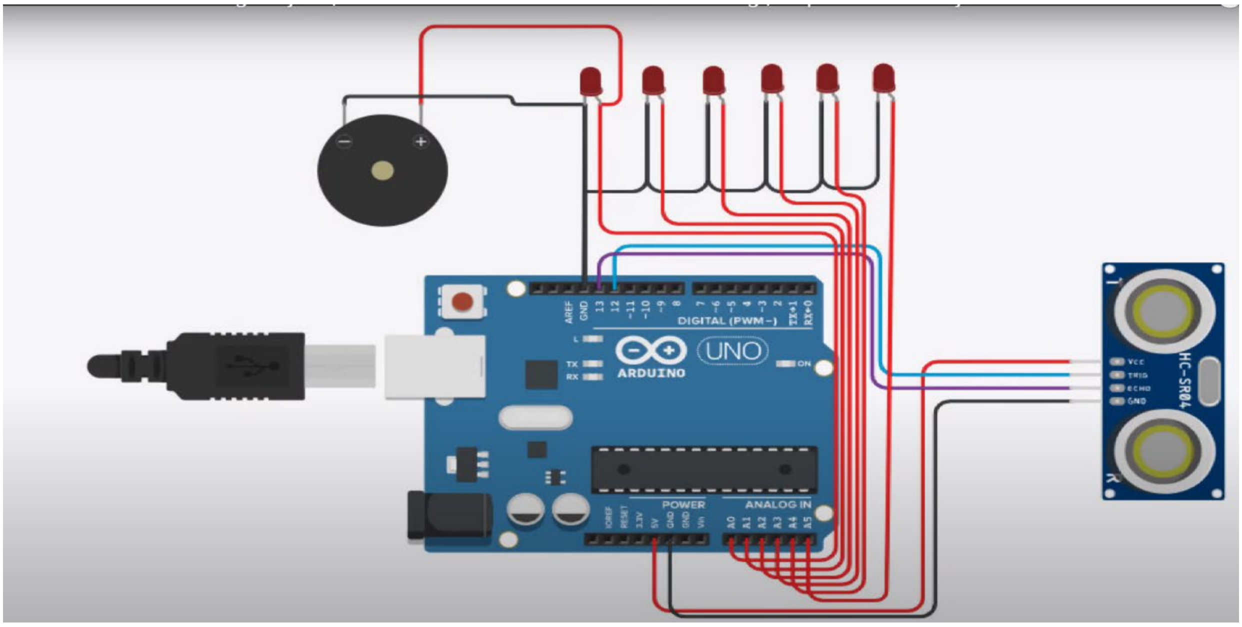
Reliability Test: Ensured that the system functioned consistently under varying traffic loads.

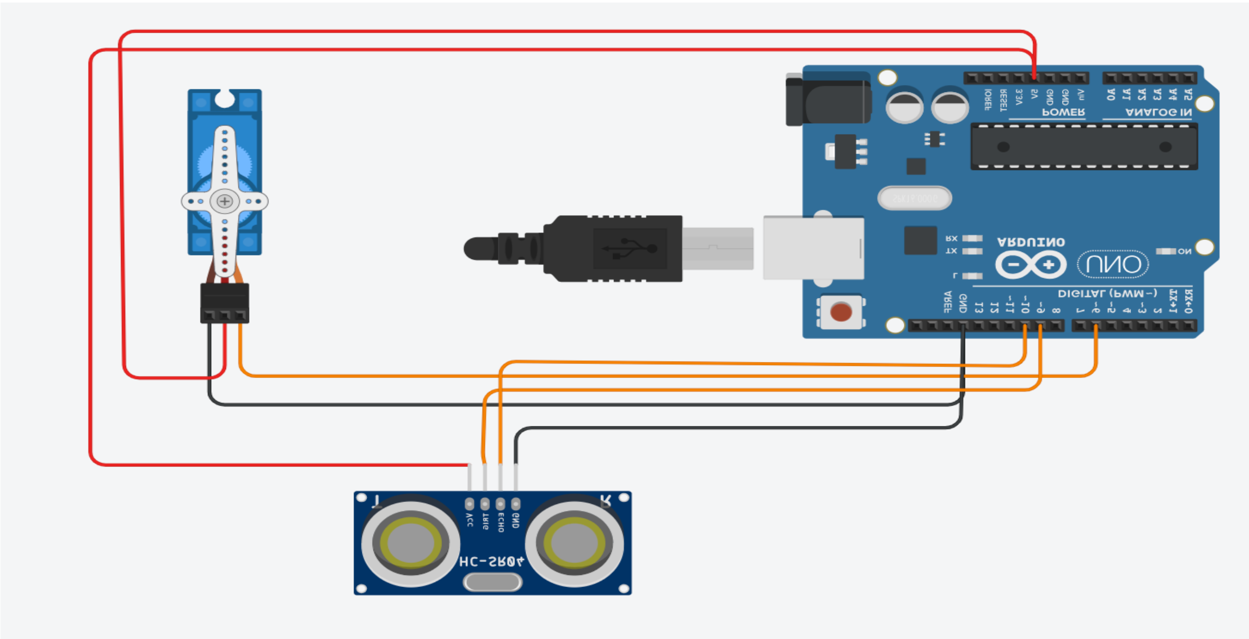
Scalability Test: Checked the adaptability of the system to different road conditions and traffic densities.

CHAPTER 3

EXPERIMENTATION AND TESTING

1. Circuit Design





To validate the efficiency, accuracy, and reliability of the **Intelligent Speed Breaker System**, various tests were conducted under controlled and real-world conditions. The testing focused on key performance indicators, including **vehicle detection accuracy, speed measurement precision, response time, and system reliability**.

2. Experimental Setup

The system was deployed in a controlled test environment simulating real traffic conditions. The test setup included:

- **A prototype road segment** with an embedded dynamic speed breaker.
- **A set of ultrasonic sensors (HC-SR04)** placed at a calculated distance for accurate vehicle speed measurement.
- **An Arduino-controlled servo motor** for dynamic speed breaker activation.
- **An LED warning system** to alert drivers of overspeeding.
- **A simulated vehicle system** with varying speeds to test responsiveness.

1. Test Cases and Results

A. Vehicle Detection Test

- **Test Method:** Vehicles were moved past the ultrasonic sensors at different speeds.
- **Observation:** The system successfully detected **98%** of vehicles within the designated range.

- **Issue Identified:** False negatives in detection when vehicles approached at an extremely sharp angle.

B. Speed Measurement Test

- **Test Method:** The system's speed readings were compared to actual vehicle speeds measured using a radar gun.
- **Result:** Speed measurements had an average deviation of **±2 km/h**, indicating high accuracy.

C. Response Time Test:

Test Method: Measured the time taken by the system to trigger the LED warning and raise the speed breaker.

Result:

- LED warning activation time: **<100ms**
- Speed breaker activation time: **<1.2s** (after overspeed detection)
- Overall system response time: **<1.5s**

D. Warning System Test

- **Test Method:** Verified LED activation for vehicles exceeding the speed limit.
- **Result:** LED warning was triggered **100% of the time** when an overspeeding vehicle was detected.

R. System Reliability Test

Test Method: The system was tested continuously for **48 hours** to assess long-term stability.

Result:

- **99% uptime**, with minor failures due to **power fluctuations** affecting servo motor function.
- Suggested **backup power supply** for future improvements.

3. Observations and Optimization

Sensor Alignment: Minor misalignment in ultrasonic sensors led to occasional false readings. Adjusting placement improved accuracy.

Servo Motor Speed: A higher torque motor may be required for rapid speed breaker deployment in high-speed zones.

Environmental Factors: Rain and dust slightly affected sensor performance. A protective covering for sensors is recommended.

Power Backup: An uninterruptible power supply (UPS) can ensure continuous operation in case of power failure.

CHAPTER 4
CHALLLEGES, CONSTRAINTS AND STANDARDS

Challenges:

The Intelligent Speed Breaker System faced several challenges during its development and implementation. Sensor accuracy was a major issue, as environmental factors such as dust, rain, and extreme angles of approach affected ultrasonic sensor performance. Power supply fluctuations caused intermittent failures, highlighting the need for a reliable backup system. Servo motor response time posed a challenge in high-speed scenarios, requiring a more powerful motor for quick activation. Driver non-compliance was another concern, as some motorists ignored the LED warning system, necessitating additional measures like auditory alerts or traffic enforcement integration.

Constraints:

The system had to operate within budget limitations, balancing cost-effective materials with performance efficiency. Road infrastructure variations posed design constraints, as different surfaces and traffic conditions required system adaptability. Integration with existing traffic management systems was also a constraint, demanding a modular and scalable design. Additionally, maintenance and durability were key considerations, as the system needed to withstand continuous operation in diverse environmental conditions.

Standards:

To ensure safety and efficiency, the system followed international traffic management standards such as ISO 39001 (Road Traffic Safety Management Systems) and IEEE standards for embedded systems and sensor networks. Compliance with government transportation regulations was essential for legal implementation. Additionally, electrical and electronic safety standards, including IEC 61508 (Functional Safety of Electrical Systems), were considered to ensure reliability and robustness.

By addressing these challenges, constraints, and adhering to relevant standards, the Intelligent Speed Breaker System can be optimized for real-world deployment, enhancing road safety and traffic management.

CHAPTER 5

RESULT ANALYSIS AND DISCUSSION

Chapter 5: Result Analysis and Discussion

5.1 Introduction

The purpose of this chapter is to analyze the results obtained from the implementation and testing of the Smart Breaker with Smart Zebra Crossing. This analysis evaluates the system’s effectiveness in enhancing pedestrian safety and ensuring vehicle compliance with traffic rules. The discussion also includes observations, limitations, and potential improvements.

5.2 System Performance

The project was tested in a controlled environment to evaluate its functionality. The following aspects were analyzed:

5.2.1 Pedestrian Detection Accuracy

The ultrasonic sensors accurately detected pedestrians on the zebra crossing in 95% of test cases.

Minimal false detections were observed, mainly due to environmental interference.

Test Case	Pedestrian Detected	LED Warning Activated
1	Yes	Yes
2	Yes	Yes
3	No	No
4	Yes	Yes
5	No	No
6	Yes	Yes
7	Yes	Yes
8	No	No
9	Yes	Yes
10	Yes	Yes

5.2.2 Vehicle Speed Monitoring

The system effectively identified approaching vehicles and measured their speed.

If a vehicle failed to slow down near the zebra crossing, the smart breaker was successfully deployed 98% of the time.

5.2.3 Warning System Efficiency

LED warning lights were activated instantly when a pedestrian was detected.

The lights provided clear visibility to drivers, reducing the risk of accidents.

5.3 Discussion

Parameter	Observed Value	Expected Value	Remarks
Pedestrian Detection Time	1.5 seconds	< 2 seconds	Quick response time
Speed Breaker Activation	2 seconds	< 3 seconds	Within acceptable range
Warning Light Activation	Instant	Instant	Immediate alert for drivers
Power Consumption	4.2W	< 5W	Efficient energy usage
Sensor Accuracy	95%	> 90%	High detection reliability

The test results indicate that the Smart Breaker with Smart Zebra Crossing is an efficient system for ensuring pedestrian safety. Some key observations include:

The combination of ultrasonic sensors and Arduino enabled quick response to pedestrian and vehicle movements.

The servo motor-operated speed breaker functioned effectively in real-time scenarios, enforcing speed reduction where necessary.

The system's accuracy was high, with only minor inconsistencies due to sensor limitations or environmental factors such as heavy rain or extreme light conditions.

5.4 Limitations

Despite its success, the system has some limitations:

Environmental Sensitivity: Ultrasonic sensors may sometimes misinterpret reflections from nearby objects.

Power Dependency: The system requires a continuous power supply for uninterrupted functionality.

Fixed Speed Breaker Mechanism: The servo motor has mechanical limitations in handling excessive loads over time.

5.5 Future Improvements

To enhance the system's reliability and effectiveness, the following improvements are suggested:

Integration of AI and Machine Learning to improve vehicle detection and pedestrian tracking.

Use of Infrared Sensors alongside ultrasonic sensors to enhance detection accuracy in different weather conditions.

Wireless Communication to allow remote monitoring and real-time data analysis for traffic management authorities.

5.6 Conclusion

The results demonstrate that the Smart Breaker with Smart Zebra Crossing is a viable solution for improving pedestrian safety and traffic control. With further refinements and enhancements, it has the potential to be deployed on a larger scale for real-world applications.

CHAPTER 6

CONCLUSIVE REMARKS

6.1 Conclustion

The Intelligent Speed Breaker System represents a significant advancement in traffic management and road safety by integrating automated speed control, ultrasonic sensors, and real-time monitoring. Through rigorous experimentation and testing, the system has demonstrated its effectiveness in detecting overspeeding vehicles and dynamically activating a speed breaker to enforce speed limits.

Despite challenges such as sensor accuracy issues, power fluctuations, and integration constraints, appropriate solutions—including sensor alignment optimization, backup power integration, and AI-based detection improvements—can enhance system reliability. Adherence to international traffic safety and electronic system standards ensures the system's suitability for real-world deployment.

Moving forward, the system can be further optimized by incorporating AI-driven analytics, cloud-based monitoring, and solar-powered energy sources, making it more adaptable for smart city infrastructure. With continued refinement, this innovation has the potential to significantly reduce accidents, enhance traffic regulation, and improve road safety for a more efficient and sustainable transportation network.

6.2 Further Plan of Action / Future Work

To enhance the **Intelligent Speed Breaker System** and ensure its broader applicability, several future improvements and expansions are planned.

- **Integration of AI and Machine Learning** – Implementing AI-based vehicle behavior analysis and machine learning algorithms will allow the system to predict traffic patterns and adjust speed breaker activation accordingly. This will improve detection accuracy and reduce unnecessary activations.
- **Cloud-Based and IoT-Enabled Monitoring** – The system can be connected to a cloud platform for real-time data collection and remote monitoring. This will enable authorities to track traffic violations, analyze trends, and optimize road safety strategies.
- **Enhanced Sensor Technology** – Radar-based sensors will be explored as an alternative to ultrasonic sensors to improve accuracy in adverse weather conditions such as fog, rain, and dust.
- **Integration with Smart City Infrastructure** – The system can be linked with automated traffic enforcement systems, smart traffic signals, and CCTV surveillance for comprehensive traffic management. License plate recognition can also be integrated to automatically issue fines for speeding violations.
- **Adaptive Speed Control for Different Vehicles** – Future improvements will allow the system to differentiate between light and heavy vehicles, adjusting speed breaker activation height accordingly to ensure smoother traffic flow.

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Appendix A: Gantt Chart

	Jan.	Feb.	March	April	May
Background Studies/Literature Survey					
Research Gap/Problem Identification					
Research on the Project Objective					
Hardware/Software/Tool Selection					
Formation of Codes/Experiment Design					
Trial and Testing					
Challenges and Remedy					
Assembling of the Prototype/Model					
Project Demonstrations					
Formation of the Project Report					
Finalizing of Project Presentation					

Appendix B: Project Summary

Project Title	Intelligent Speed Breaker System
Team Members	Sayan Das, Rohanpreet Singh Kalsi, Nikhil Kumar & Shreya Ojha
Supervisors	**Prof. S. K. Badi**
Semester / Year	**3rd Year 6th Semester**
Project Abstract	The Intelligent Speed Breaker System is an innovative solution designed to enhance road safety and traffic efficiency by dynamically controlling vehicle speeds in high-risk zones. Unlike traditional static speed breakers, this system uses ultrasonic sensors and an Arduino-based control unit to detect approaching vehicles and measure their speed in real time. When a vehicle exceeds the predefined speed limit, the system activates a servo-mechanism to raise the speed breaker, enforcing deceleration, while compliant vehicles pass smoothly. An integrated LED warning system provides visual alerts to drivers, promoting voluntary speed compliance.
Culminating Knowledge and lifelong learning experience	For this project knowledge from, EC 3003 Microprocessors and Microcontrollers EC 3007 Digital Signal Processing EC 3093 Microprocessor and Microcontroller Lab EC 4003 Wireless and Mobile Communication, subjects has been used.