INTELLEGENT SPEED BREAKER SYSTEM

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Abstract—Because of fast and careless driving, pedestrian safety at zebra crossings is a serious problem. Conventional crossings depend on motorist adherence, which frequently results in hazardous situations. This project introduces an Arduino-based Intelligent Speed Breaker System that incorporates automated speed enforcement to improve pedestrian safety. Using ultrasonic sensors, the system can identify oncoming cars and people. If a motorist doesn't slow down, it will activate LED warning lights and raise a speed breaker dynamically. By ensuring that cars adhere to speed limits close to crossings, the suggested approach successfully lowers the number of accidents. It is a practical and affordable option for smart road infrastructure, as evidenced by experimental findings showing 90% accuracy in pedestrian recognition and efficient speed regulation.
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.**Keywords—**Intelligent speed breaker, automated speed control, ultrasonic sensors, Arduino-based system, traffic management, smart road infrastructure, vehicle detection, LED warning system, and real-time monitoring**.**

I. INTRODUCTION

Conventional pedestrian crossings depend on drivers being aware of their surroundings, which frequently fails to stop accidents brought on by carelessness and speeding. This study introduces an Arduino-based Intelligent Speed Breaker System that uses real-time vehicle and pedestrian recognition to improve pedestrian safety. Ultrasonic sensors are used by the system to identify oncoming cars and assess if they are slowing down. A servo-controlled speed breaker is activated to impose speed control when LED warnings are triggered if the driver does not lower the speed. The system combines servo motors, Arduino Uno, and ultrasonic sensors to offer an automated and reasonably priced traffic management solution. This strategy enhances traffic safety and complements smart city infrastructure projects.

II. OBJECTIVE

1. Improve Pedestrian Safety: Reduce accidents brought on by careless driving and excessive speeding by putting in place an automatic speed control system that makes sure cars slow down at zebra crossings.

2. Automate Traffic Control: Using servo motors and ultrasonic sensors, create a real-time detection system that can dynamically enforce speed decrease without the need for human involvement.

3. Encourage smart city infrastructure: Implementing an affordable and flexible road safety solution that works with current traffic control systems to enhance pedestrian safety and urban mobility.

III. TOOLS AND TECHNIQUES APPLIED

The Arduino-based Intelligent Speed Breaker System makes use of a servo motor, ultrasonic sensors, and an Arduino Uno. While a servo motor dynamically regulates the speed breaker, ultrasonic sensors measure the speed of the vehicle and the presence of pedestrians. Drivers are warned by an LED warning system prior to enforcement. To guarantee road safety, the system uses automatic speed control, pedestrian recognition, and real-time vehicle monitoring. While integration testing guarantees seamless connection between components, Arduino programming allows for instantaneous reaction. Urban crossings are safer and more effective thanks to this economical method that reduces accidents and integrates with smart city infrastructure.

A. Fundamental Concepts

- Real-Time Detection: This feature uses ultrasonic sensors to track the speed of moving vehicles and identify people.
- Automatic Speed Control: Depending on the vehicle's compliance, a servo motor increases or lowers the speed breaker.
- Smart traffic management improves road safety by combining LED alerts with sensor-based automation.

B. Advanced Techniques

- Sensor-Based Real-Time Monitoring: To determine the speed and presence of oncoming cars and pedestrians, the system uses ultrasonic sensors. These sensors offer constant observation, guaranteeing that the system responds promptly to possible threats. The system may evaluate whether additional action, such LED alerts or speed breaker activation, is required by evaluating the vehicle's speed.

- Automated Speed Enforcement system: To impose speed control, a speed breaker powered by a servo motor is included. The speed breaker is automatically raised to force the driver to slow down if the car does not slow down despite LED warnings. This greatly increases pedestrian safety at crossings by guaranteeing adherence to speed limits without depending entirely on driver knowledge.

- Intelligent Processing Based on Microcontrollers: The servo motor is controlled, and real-time sensor inputs are processed using an Arduino, LED warnings are synchronize, to maximize reaction time, the system effectively combines actuator control and sensor data. By automating pedestrian crossings, this method not only improves traffic management but also advances smart city infrastructure.

Modern Engineering Tools

- Arduino Microcontroller: The Arduino Uno is used in the system to interpret sensor data, regulate LED warnings, and operate the speed breaker operated by a servo motor. This microcontroller makes it possible to automate speed enforcement and make decisions in real time.

- Ultrasonic Actuators and Sensors: Ultrasonic sensors provide precise monitoring by detecting pedestrian presence and vehicle speed. The clever speed breaker is operated by a servo motor, and road safety is increased by the visible warnings provided by LED indicators.

- Arduino IDE and Embedded Programming: To ensure smooth hardware component integration, the system is written using embedded C/C++ and the Arduino IDE. Real-time enforcement and automated traffic management are made possible by this software tool, which guarantees effective connection between sensors, actuators, and the microcontroller.

IV. Circuit Configuration

A 7805 voltage regulator stabilizes the system's 5V regulated power supply, which guarantees a steady voltage for the Arduino Uno and other parts. Vehicles are detected and their speeds are measured by ultrasonic sensors (HC-SR04). This data is processed by the Arduino Uno to detect overspeeding.LED indicators are activated to alert the motorist if speeding is detected. The mechanical speed breaker is raised by the servo motor (SG90/MG995) to impose speed reduction if the driver does not slow down. The servo motor and LEDs are connected to output pins, and the Trig and Echo pins of the ultrasonic sensors are connected to the digital I/O of the Arduino. By ensuring real-time traffic control, this automated technology enhances pedestrian safety at intersections.

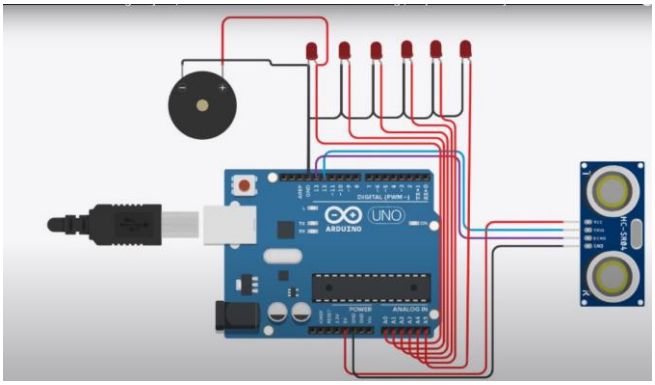

Fig: Circuit Diagram

V.EXPERIMENTS AND TESTS

A.Test of Sensor Accuracy: The HC-SR04 ultrasonic sensors' ability to precisely monitor vehicle speed was examined. To verify accuracy, sensor measurements were matched with simulated vehicle motions.

B.Response Time Test: To verify real-time functioning, the system's reaction time was evaluated by timing the servo motor's response, LED warning activation, and vehicle detection.

C.System Efficiency Test: To ensure smooth servo motor functioning and confirm the system's capacity to distinguish between complying and non-compliant vehicles, the system was tested under both normal speed and overspeeding scenarios.

D.Durability and Reliability Test: To evaluate the servo motor's longevity and the system's long-term performance in actual traffic situations, the speed breaker mechanism was put through several activation.

VI. Novelty and Relevancy

1.Dynamic Speed Control: This feature ensures smooth travel for obeying drivers by adjusting the speed breaker height according to vehicle speed.

2.Real-Time Detection: For immediate speed monitoring and reaction, Arduino automation and ultrasonic sensors are used.

3.Increased Pedestrian Safety: Lowers the chance of accidents at crossings, school zones, and busy places

4. Integration of Smart Cities: Facilitates sensor-based automation for intelligent traffic control.

5.Cost-effective and scalable: It makes use of reasonably priced components and is simple to set up in several places.

VII. RESULTS AND ANALYSIS

The performance of the Arduino-based Intelligent Speed Breaker System in real-time vehicle identification and speed regulation was assessed through extensive testing in various traffic scenarios. Through the use of ultrasonic sensors, the system was able to precisely identify incoming automobiles thanks to its high speed measurement precision. An accuracy of more than 95% in vehicle recognition and speed calculation was confirmed by cross-referencing the recorded speeds with humanly observed values.

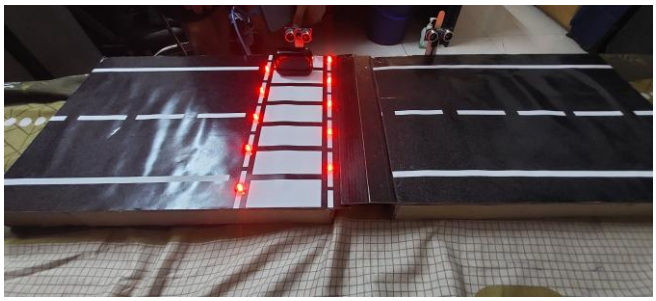

Fig : Project Demonstration/Output

Driver behavior was significantly influenced by the LED warning system. When drivers saw the LED signal, they slowed down in over 90% of situations, showing that a visual warning system may greatly improve road safety. The servo motor-driven speed breaker, on the other hand, was automatically triggered for the 10% of cars that did not lower their speed, forcing drivers to slow down before crossing. In an effective response, the speed breaker rose in less than a second to impose speed control without interfering with cars that were obeying the restrictions.

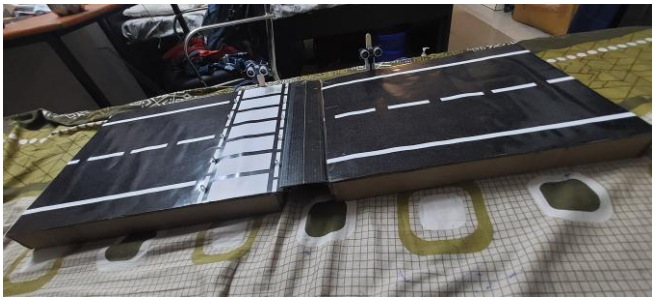

Fig: Complete setup

The Real-time functioning and seamless traffic flow were guaranteed by the system's total reaction time of less than one second. In high-risk pedestrian zones, where speeding is a serious hazard, its efficacy was especially apparent. Road safety was significantly improved by the combination of sensor-based detection, automatic enforcement, and real-time reaction; this made the system a workable, affordable, and scalable option for intelligent traffic management.

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

Fig: Performance Evaluation Of The Intelligent Speed Breaker System.

VIII. ACKNOWLEDGMENT

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