

# Intelligent Traffic Calming System

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## Abstract

Road traffic accidents caused by over speeding and unsafe pedestrian crossings continue to be a major public safety issue worldwide. Conventional traffic calming measures such as fixed speed breakers and static traffic signals are limited in adaptability and often create unnecessary inconvenience for vehicles operating within legal speed limits. Moreover, several accident-prone zones lack proper speed monitoring infrastructure due to cost and feasibility constraints.

This paper presents the design and development of an Intelligent Traffic Calming System (ITCS) using dual infrared (IR) sensors for real-time vehicle speed detection. The system calculates vehicle speed based on the time difference between sensor activations and triggers traffic calming mechanisms only when unsafe conditions are detected. Like vehicle breaking the speed limit then speed breaker will pop up and when someone crosses the road in low visibility accident prone areas during sudden coming in vehicle driving then the led strip lights will give alert to the coming vehicle driver that someone is there saving the accident of pedestrian, animal and driver in low visibility. Additionally, pedestrian presence is prioritized through override logic to enhance crossing safety. The proposed prototype demonstrates cost-effectiveness, adaptability, scalability, and suitability for future integration with advanced sensing technologies.

## 1. Introduction

The rapid growth of urbanization and motorization has significantly increased traffic congestion and road accidents. Over speeding remains one of the leading causes of fatal accidents, especially in areas such as school zones, hospital surroundings, residential streets, and unmanned pedestrian crossings in low visibility. Traditional traffic calming measures, including fixed speed breakers and static traffic signals, are widely used to control vehicle speed. However, these systems lack dynamic response to real-time traffic conditions & not everywhere these systems are applicable.

Fixed speed breakers slow down all vehicles irrespective of their speed compliance, leading to driver discomfort, fuel wastage, increased vehicle wear, and delays for emergency vehicles also some times speed breakers are broken and then over speeding is done at that broken side then the fixed speed breaker becomes useless, In contrast, areas without speed breakers often experience over speeding due to lack of monitoring or enforcement. These challenges highlight the need for an intelligent system capable of adapting to real-time conditions while ensuring pedestrian and driver safety.

The proposed Intelligent Traffic Calming System (ITCS) aims to provide a smart and adaptive solution that activates traffic calming mechanisms only when necessary, thereby balancing safety and efficiency.

## 2. Problem Statement

Existing traffic management systems suffer from several limitations:

1. **Lack of adaptability:** Traditional speed breakers do not adjust according to traffic density or vehicle behavior.
2. **Unnecessary vehicle slowdown:** Vehicles within speed limits are forced to reduce speed even when no risk is present.
3. **Limited monitoring in critical zones:** Many pedestrian crossings and rural roads lack speed enforcement systems.
4. **Inconvenience to emergency vehicles:** Ambulances and fire vehicles experience delays due to fixed infrastructure.
5. **Increased accident risk during low visibility:** Night time and fog conditions significantly increase pedestrian accident probability & last year 20 – 25% accidents are happened due to this many have died.

Therefore, there is a strong need for a cost-effective, scalable, and adaptive traffic calming solution that dynamically responds to real-time risk conditions.

## 3. Proposed Methodology

The proposed ITCS utilizes two infrared (IR) sensors positioned at a fixed distance  $d$  along the roadside. The system operates based on time-difference speed calculation.

When a vehicle interrupts the first IR sensor, a timestamp  $t_1$  is recorded by the microcontroller. When the vehicle reaches the second IR sensor, timestamp  $t_2$  is recorded. The vehicle speed  $v$  is computed using the equation:

$$v = \frac{d}{t_2 - t_1}$$

If the calculated speed exceeds a predefined threshold value, the system activates according to traffic rule the speed breaker pops in.

The system also incorporates pedestrian detection logic. When pedestrian presence is identified or any animal, then the road strip lights will turn on giving alert to the incoming driver that someone is middle of his way to prioritize safe crossing. A safety lock mechanism ensures that once a vehicle enters the critical zone, the system does not change state abruptly, preventing sudden activation or deactivation.

The implementation is based on a microcontroller platform that processes sensor inputs in real time and executes decision logic efficiently.

## 4. System Architecture

The Intelligent Traffic Calming System consists of the following components:

- **Dual IR Sensor Module:** Detects vehicle interruption and generates digital signals.
- **Microcontroller Unit:** Processes timestamps and executes speed calculation algorithms.
- **Speed Evaluation Module:** Compares computed speed with predefined threshold values.

- **Decision and Control Logic:** Determines activation of traffic calming measures.
- **Output Actuation System:** Provides alerts or activates mechanical/electronic control systems.

The modular architecture ensures flexibility and scalability. Although IR sensors are used in the prototype model for demonstration purposes, the same logic can be implemented using radar, LiDAR, or camera-based systems for real-world deployment. This sensor-independent design enhances long-term applicability.

## 5. Results and Discussion

The prototype model successfully demonstrated accurate detection of vehicle passage and real-time speed calculation using time-based logic. Experimental testing showed that the system correctly differentiated between compliant vehicles and over speeding vehicles based on threshold settings.

The adaptive activation mechanism ensured that traffic calming measures were triggered only when required, thereby reducing unnecessary slowdowns. The pedestrian override feature demonstrated improved safety potential in crossing scenarios.

The results indicate that intelligent and need-based traffic calming can be achieved using low-cost sensing components without compromising effectiveness.

## 6. Conclusion and Future Scope

The Intelligent Traffic Calming System provides an innovative alternative to conventional fixed traffic calming infrastructure. By utilizing real-time speed detection and adaptive decision-making, the system improves safety while maintaining efficient traffic flow.

The prototype validates the feasibility of implementing intelligent traffic control using cost-effective hardware components. Future enhancements may include integration with radar or camera-based detection systems, IoT-enabled remote monitoring, data analytics for traffic pattern analysis, and deployment within smart city ecosystems.

The proposed approach demonstrates strong potential for improving road safety through intelligent and adaptive traffic management.

## 7. Model Picture



ITCS Model