Experimental Study on Road Accident Prevention System at Kasara Ghat

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Abstracts

Both the population and technological growth are accelerating daily. Recent research indicates that accidents are the leading killers in developing nations. Mountain roads, u-turn roads, tight curve roads, hairpin bend curves, and T-roads are the most hazardous and accident-prone places. Mountains have small, blind corners where drivers cannot see the cars or obstacles coming from the opposite side. This project's primary goal is to reduce the number of accidents that happen on u-turn and mountain roads. An Arduino Uno is used to power the system's sensors, which in this project comprise IR sensors, LED lights, and buzzers. As two automobiles pass one another on the road curve in the mountains. The LED colour turns to red when the IR sensor sees the vehicle, raising the buzzer to signify danger. This warns drivers to avoid collisions on roads with mountain curves.

Keywords: *IR Sensor, LED, Buzzer, Curve roads, accident prevention, sensor, mountain road, hill roads, alerting the driver.*

1. Introduction

Road traffic accidents are a significant public health issue globally, causing widespread-casualties and economic burden. Previously, part of the utility to identify reckless driving was made. Most methods require human attention and involve a lot of effort, which is difficult to achieve. Current vehicles do not have convincing lighting systems. As a result, many incidents occur in the evening, especially in ghats. Normal headlights are often lit on the side of the road when cornering or flashing completely on the road, which can lead to dangerous conditions. The solution for this problem is alerting the driver about the obstacle or vehicle. Usually, horn is used for this purpose. But in the rainy seasons horn will not be heard. Some people will not use horn itself. So horn is not a good solution to solve this problem. These are the major reasons for accidents. To avoid these problems in curve roads we are introducing sensor-based accident prevention system. IR sensors can be used to help drivers navigate curved roads, especially on mountain roads with tight turns or hairpin curves. IR sensors can be used to prevent accidents on curved roads by alerting drivers when a vehicle is approaching from the opposite side. All of the winding and mountainous routes may be made accident-free, saving lives in the process. This project focuses on analysing the causes of road accidents on U-turns at the Kasara Ghat to identify critical risk factors and develop targeted prevention strategies aimed at improving road safety and minimising accident occurrences.

• Some of the recent news of accidents on Kasara ghat are -

1) Five people were injured in a head-on collision between a truck and a private taxi in the Kasara ghat section of the Mumbai-Agra highway.

2) A container hit 6-7 vehicles, injuring 13-14 passengers at new Kasara ghat on Nashik-Mumbai highway.

2. Aim and Objectives

Aim - To perform an Experimental Investigation on preventing accidents by using IR Sensor based accident prevention system at Kasara Ghat, Maharashtra.

Objectives

1. To use IR sensors to detect the presence of vehicles at critical points such as intersections, pedestrian crossings, and accident-prone areas.4. To minimise the risk of accidents caused by human error or signal mismanagement by
providing real-time alerts to both drivers and pedestrians.
5. To develop a low-cost, easy-to-install system that can be widely deployed at accident-prone locations, improving overall road safety.
6. To ensure the system operates in real-time, offering immediate responses to detected vehicles, which is crucial for accident prevention in high-risk traffic areas.

3. Literature Review

Yashwant Kumar, Shubham Patil Et. Al (2023)
The accident prevention system was tested on a mountain road with various obstacles, such as rocks, trees, and other vehicles. The system successfully detected all obstacles and triggered an audio alarm, warning the driver of the obstacle ahead. The system was tested under different weather conditions, such as rain and fog, and it performed well. The system is easy to install, and it can be implemented on any mountain road. IR sensor-based Accident Prevention System for Mountain Roads achieves 95% accuracy in detecting incoming vehicles and alerting drivers without the need for distracting LED screens.

Ranga Sreedhar Galla (2017)
The literature underscores the potential of infrared sensors in reducing road accidents on sharp curves. By providing real-time detection and warnings, these systems can significantly improve driver awareness and behaviour. However, ongoing research and development are necessary to address existing challenges and optimise the deployment of IR sensor technologies for enhanced road safety.

4. Methodology

3.1 System Operation:

1. IR Sensors will be placed at strategic locations along mountain roads, and they will detect the presence of oncoming vehicles.
2. The sensors will send data to the control unit, which will analyse the incoming data.
3. If the control unit detects an oncoming vehicle, it will trigger an alert system. The alert system will then notify drivers of the oncoming vehicle by flashing lights and emitting an audible alarm.

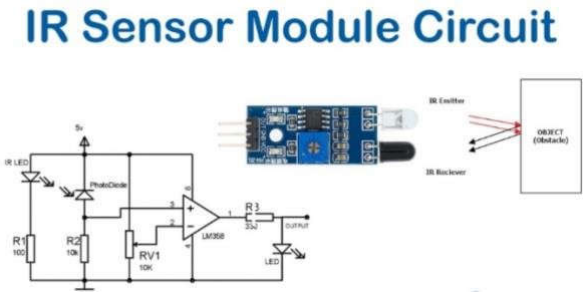


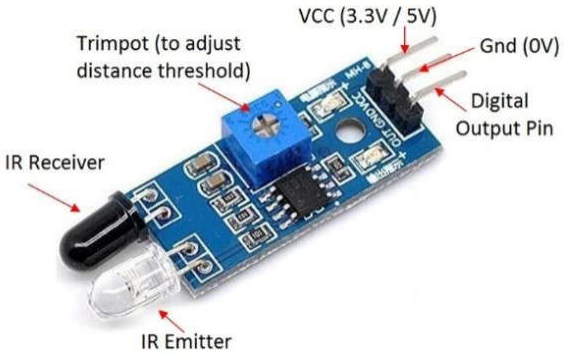
Figure 3.1: IR sensor module circuit

Warning System: The warning system consists of a red light and a beep buzzer that warn the driver of any danger on the road. The warning system is triggered by the microcontroller when a vehicle is detected on the road. The red-light flashes to alert the driver, and the beep buzzer sounds to grab the driver's attention. The warning system is designed to be easily visible and audible to the driver, even in adverse weather conditions.

3.2 Components required

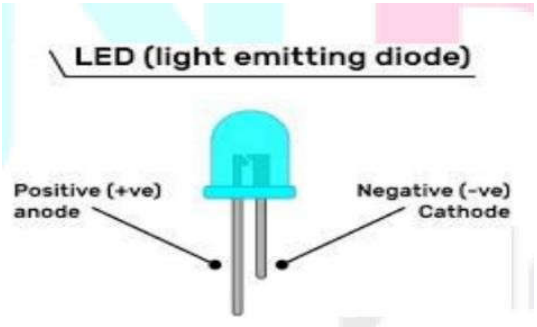
1. IR SENSOR

• An electrical device that monitors and detects infrared radiation in its environment is called an infrared (IR) sensor.



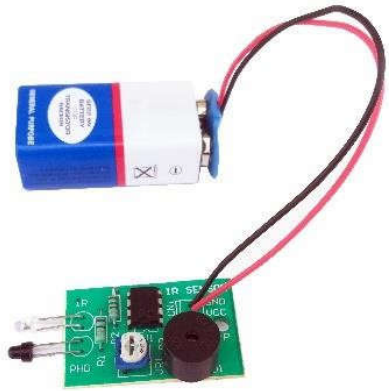
2. LED

• A semiconductor light source with two leads is known as a light-emitting diode.



3. BUZZER

• A beeper or buzzer, for example, could be electromechanical, piezoelectric, or mechanical in design.



3.3 Working of sensor under different accident conditions on curved roads

Case 1: The IR1 sensor identifies the vehicle when it is approaching from side A. The buzzer is ON and RED signal is visible to side B. Whereby it warns the driver of the car on side B to slow down so they can cross the curved road.
Case 2: When a vehicle is present on side B, the IR 2 sensor recognises it and sends a RED signal with a beep sound to side A. It lets vehicles on side A know that a vehicle is approaching from that direction, allowing them to slow down and navigate the bend.
Case-3: When both vehicles are found by the IR sensors, both sides receive a RED signal and a beep sound. To warn the traffic on both sides to slow down and be cautious so they can safely navigate the curve. In order to avoid accidents, drivers can pay attention while navigating mountain roads with tight turns or hairpin curves.

3.4 Cost Estimation for Implementing on Ghat Road

If we implement this project with **IR sensors capable of covering 12 to 15 meters** (about 40 to 50 feet) on a **real ghat road**, the cost will increase due to higher-quality sensors, multiple units for coverage, and infrastructure requirements. Here's a detailed cost estimation in **Indian Rupees (INR)** for a real-world setup.

For an IR sensor capable of covering a range of **40 to 50 feet (about 12 to 15 meters)**, a typical sensor used in smaller projects will not suffice, as such long-range IR sensors are specialized and more expensive.

1. **High-Range IR Sensors (Commercial-Grade):**

- **Cost:** Around **₹3,000 - ₹6,000** each for sensors with reliable detection over 40 to 50 feet. These sensors are usually more sophisticated, offering precise long-range detection and sometimes additional features like environmental resistance (dust, rain, etc.)

- **Hardware Components (per unit) –**

Component	Quantity	Unit Cost (approx.)	Total Cost (approx.)
Long-Range IR Sensors	2-4	₹3,000 - ₹6,000 each	₹6,000 - ₹24,000
LED Indicators	2-4	₹80 - ₹250 each	₹160 - ₹1,000
Buzzer	1-2	₹250 - ₹400 each	₹250 - ₹800
Microcontroller	1	₹1,600 - ₹3,300	₹1,600 - ₹3,300
Power Supply	1	₹830 - ₹1,700	₹830 - ₹1,700
Wiring & Connectors	-	₹400 - ₹830	₹400 - ₹830
PCB (if custom)	1	₹830 - ₹1,700	₹830 - ₹1,700
Mounting Hardware	-	₹400 - ₹830	₹400 - ₹830

Approx. Cost of Hardware Components

2. **Additional Setup Requirements:**
   - **Weatherproof Enclosures:** Needed to protect the system on outdoor ghat roads.
     Cost: ₹830 - ₹2,500 each.
   - **Traffic Monitoring Cameras** (optional): ₹2,500 - ₹4,200 each.
   - **Backup Power (Solar or Battery):** Backup power supply can be valuable in remote areas.
     Cost: ₹3,000 - ₹5,000.

3. **Total Per Unit Cost:**
   - **Basic Unit:** ₹10,000 - ₹30,000, covering primary sensors and indicators.
   - **With Optional Features:** ₹20,000 - ₹40,000, including cameras and backup power.

4. **Installation and Infrastructure Cost:**
   - **Installation Labor:** ₹4,000 - ₹8,000 per site.
   - **Poles and Mounting for Sensors:** ₹1,500 - ₹3,000 each location.

5. **Total Cost for a Real Ghat Road:**
   1. **Per Unit:** For a single-point detection (one sensor pair covering 12-15 meters), the cost would be approximately **₹20,000 - ₹40,000**.
   2. **For Multiple Locations:** A typical ghat road might need several detection points to cover curves, blind spots, and intersections. Estimating **5 to 10 points**, the total cost could range from **₹1,00,000 to ₹4,00,000**.

Maintenance and Operational Costs: Additional **₹20,000 - ₹50,000 annually** for maintenance, sensor recalibration, and possible repairs.

3.5 Working Model Photos

5. Results & Discussions

1. **Reduction in Road Accidents:**
   A noticeable reduction in **near-miss accidents** and collisions was observed at critical points after the system was implemented.
2. **Improved Traffic Flow:**
   The automated green signal helped optimize traffic flow by ensuring vehicles moved efficiently through blind spots and narrow areas on the hilly road. The system prevented unnecessary stops and starts, contributing to smoother traffic movement and reducing the risk of congestion-related accidents.
3. **System Robustness:**
   The system performed reliably under different weather conditions, including fog and rain, which are common in hilly areas. The **IR sensors** were able to maintain detection accuracy without significant interference.
4. **Ease of Implementation and Cost-Effectiveness:**
   The system was relatively low-cost and easy to install at key locations along the road, making it a viable solution for accident-prone areas with limited infrastructure budgets.

6. Conclusions

1. Accident prevention road safety model with light control using IR sensors in mountain roads is a promising approach for enhancing road safety.
2. The literature review highlights the effectiveness of IR sensors in detecting potential hazards in low visibility conditions and alerting drivers in real-time.
3. The proposed model utilizes IR sensors to detect the presence of vehicles and pedestrians and controls the traffic lights accordingly to prevent accidents.
4. The model was evaluated through simulations, and the results demonstrate a significant reduction in the number of accidents and an improvement in road safety
5. It concluded that system is able to reduce type of accidents observed on U-turns at Kasara Ghat.

7. References

- Https://www.ijarp.org/published-research-papers/nov2017/Diminishing-Road-Accidents-On-Sharp-Curves-Using-Arduino.pdf
- Https://www.irjmets.com/uploadedfiles/paper//issue_4_april_2023/35818/final/fin_irjmets1681386382.pdf
- Https://en.wikipedia.org/wiki/Passive_infrared_sensor
- https://timesofindia.indiatimes.com/city/nashik/5-injured-in-head-on-collision-between-truck-taxi-in-kasara/articleshow/105052588.cms6