Vehicle Accident Prevention on Mountain Roads

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Abstract. Vehicle accidents on mountain roads have been a major concern for many years. The narrow roads, acute turns, and steep slopes of these areas can make it difficult for drivers to see approaching vehicles, leading to a high incidence of collisions. This research paper aims to propose a solution to this problem using emerging modern technology to prevent and reduce the number of accidents on mountain roads. The proposed model consists of techniques such as image processing to detect the type of vehicle present at the other end of a blind spot, alerting the driver and thus allowing them to make safe decisions while taking turns also there is a system to detect vehicle using sensors and also to manipulate the signal so proper instruction can be conveyed. Through this research, we aim to demonstrate the effectiveness of this system and show how it can be used to reduce the loss of life and property on mountain roads.

Keywords. Accident prevention, Arduino microcontroller, Infrared sensors, Image processing, MATLAB.

1 Introduction

In this research paper, we aim to address the global issue of road accidents, which result in an estimated 1.2 million deaths annually, particularly in mountain terrains. The increasing population growth and a corresponding increase in the number of vehicles on the road make it crucial to take measures to ensure the safety of passengers in these regions. Due to the extreme weather conditions and perilous infrastructure of mountain roads, these areas are particularly susceptible to accidents, which often result in high mortality rates.

Previous studies have shown relationships between actual roads and safe driving, but the complex road system on mountain terrains requires further study. One of the main challenges is the difference between actual and perceived vision, which can greatly impact a driver's behaviour. Our objective is to solve this issue by alerting drivers of approaching vehicles on both ends of a turn and building a sophisticated system for traversing mountain curves.
Existing systems that address this issue include the use of mirrors, LCD screens, and CCTV footage to display approaching vehicles. However, these systems have limitations. There are only mirrors present at a blind spot on a mountain road in India. These prove to be ineffective as during winters and in monsoons fog accumulates on the surface of mirrors so reflection can’t be seen properly. Also during nightfall they are proven to be useless. In the

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case of the CCTV the LCD size should be big enough to get the proper footage of vehicle present at other end. As the mountain roads in India are not wide so there could be a problem to install LCD and also its timely maintenance would be a big challenge.

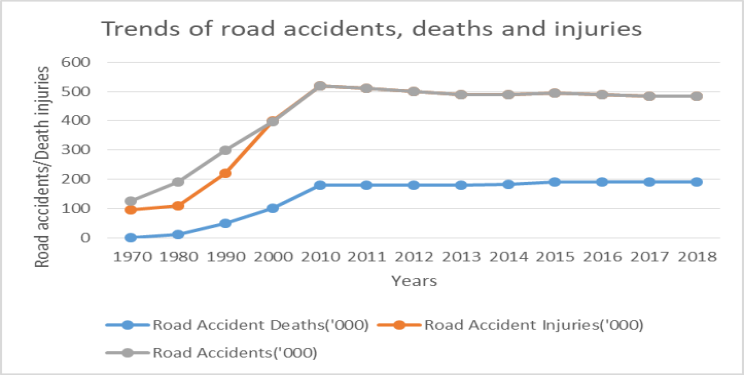

Fig. 1. Statistical chart on trends of increasing road accidents

The current situation indicates that the population growth is at 0.9% which has analogous increase in exigencies. This means, that the number of vehicles: cars for personal transport and/or trucks for deliveries across cities has taken a leap

Previous studies show relationships between actual roads and safe driving but the complex road system on terrains requires further study. There is an essential difference between actual and perceived vision, what the driver may perceive from their visions determines their driving behaviour.

Due to low visibility near a turn, many times head on collision occur causing huge loss of life and property since the drivers cannot determine if a vehicle is approaching from the other side. Our objective is to solve this issue by alerting the vehicles on the two ends and build a sophisticated system for traversal on curves. A few existing systems address this issue at mountain curves however, it's rare that these topics are given attention [3].

Our proposed system makes use of controlled sensors to continuously monitor real life parameters to apprise drivers of approaching vehicles from the other end and avoid crashes at a sharp turn. It suggests that drivers at both ends will be indicated to stop and go using our common traffic LED signals and a large LCD display at the center which is visible from both ends. The display outputs messages regarding the path ahead whether it is clear or there is an approaching vehicle. The system shows the type of vehicle approaching continuously. In this way, the users are always aware of their surroundings and can safely manoeuvre at a blind curve. It is further improvised by the use of buzzers to overcome the downfall of LCD displays during extreme weather conditions (fog, rain, electrical cut-outs, etc.) which are common in mountain terrains. Also in these extreme conditions sensors still continue its job. Also just to display vehicle I present ahead or not and its type (if present) we need not require a big LCD.

1.1 Literature Review

Advance Road Safety for Ghat Road's At Hairpin Bend suggested that 2 LCD screens should be installed on the either side of the turn and using the CCTV live footage should be displayed on that screen. So when the driver approach near a turn he can clearly see on the LCD screen if any other vehicle is approaching from other end simultaneously [4].

Another vehicle accident prevention system IOT Based Vehicle Accident Prevention System suggested a new system for preventing accidents of vehicles. They are already vehicles equipped with smart sensors to detect objects and the road ahead. But these sensors have a lot of limitations like the detection range being too small, obstacles not getting detected because they are in the sensor's blind spot and detection getting heavily affected in adverse weather conditions [5].

An Arduino Based Accident Prevention and Identification System For Vehicles describes method uses GPS and GSM technology to locate the accident and accelerometer to obtain essential information while driving. When the value of the velocity and tilting will exceed the range then a SMS will be sent through Arduino with real time coordinates. However, this system is not efficient to prevent accidents on sharp curves but only automatically send the necessary information.

Another method exists that is based on technological improvements and demonstrates the use of GPS (Global Positioning System) and GMS (Global Management System) to determine the exact location of an accident across the world. GPS provides the coordinates of the accident location while GMS is used to notify the necessary authorities regarding its occurrence. Even though the present system is highly accurate and helpful to detect an accident, it does not prevent it. Hence, it has its shortcomings to saving lives.

2 Methodology

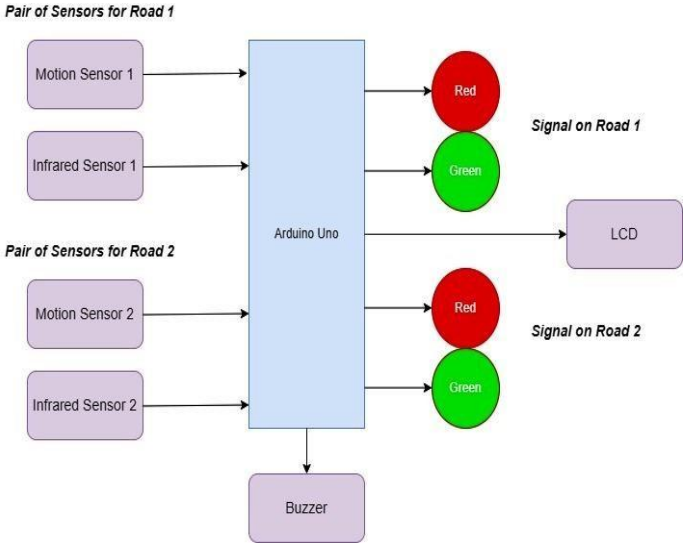

Fig. 2. Schematic representation of the proposed vehicle detection & accident prevention system

We have used an Arduino Uno board to interface various sensors and control the process. Infrared sensors are used to detect the presence of an object, the use motion sensors is to double-check if the object detected is really a vehicle and not a static object like a large rock. We have also used a Pixy2 camera module to capture images of the vehicle. The LED then gives the signal to the vehicles to either stop or move.

The components used are as follows;

1. Arduino Uno board: This is a 'Development board' designed by Atmel Company. We have used this board along with an Arduino IDE software. This is our core component and

is used to interface various sensors and control the process. The ATmega328P is an 8-bit AVR microcontroller with strong performance and low power consumption. We have selected Arduino Uno as our microcontroller since the Arduino board supports multiple sensors and have multiple digital and analog input output pins. Also interfacing of MATLAB with Arduino is quite easy.

2. Infrared Sensors: Active Infrared Sensors can detect and emit infrared light. Active Infrared Sensors are made up of two components: a light emitting diode (LED) and a receiver. When an object approaches the sensor, the LED's infrared light reflects it off and is recognized by receiver. Thus, the presence of an object is detected.

3. Motion Sensors: A passive infrared sensor (PIR) detects motion using a low power source. PIR sensors detect objects' heat signatures that are in their field of view. The sensor monitors variations in the amount of infrared radiation it gathers, and it will activate when a threshold limit is met. Thus even at night or in dark motion sensors can sense the motion. The use of motion sensors is to double check if the object detected is really a vehicle and not static object like large rock.

4. Pixy2 camera module: It is a camera module which we have used to capture images of vehicle. These images are sent to trained program in MATLAB to find the class and type of vehicles.

5. MATLAB: Matlab is one of the software used in image processing and computer vision. We used MATLAB in order to find the type of vehicle present at the opposite end.

2.1 Implementations

This project consists of two modules:

1. Vehicle detection and accident prevention system.
2. Vehicle type detection using image processing.

In the first module we have implemented the hardware part which detects and manages the prevention system efficiently. We have placed an IR sensor and a Motion Sensor at either side of the turn or curve. The IR sensor basically detects the object. But sometimes on mountain roads there can be large boulders or rocks due to various reasons like rockslide or landslides.

So, in order to differentiate between a vehicle and other obstacles we have installed Motion Sensor on each side. When both Motion sensor and IR sensor become HIGH we can say that vehicle is present at that end. When IR sensor is HIGH and motion sensor is LOW we can say that some obstacle might be present and driver can be alerted accordingly.

For the accident prevention system we have installed a Signal at both the end consisting of Red and Green LEDs, camera module to take images and provide to algorithm in matlab to find the type of vehicle (LMVs, Cars, Trucks, Buses, etc) and a LCD screen to display the instruction like Stop if vehicle is detected at other end, the type of that vehicle, and Go when one of the vehicle has successfully crossed the curve or turn.

When only no vehicle is detected on other side the signal at both ends will be Green and LCD will show a message "Path is clear!" If both ends detect vehicle simultaneously then Red led will turn on at both end indicating vehicle to stop and alert message will be displayed on the LCD screen. Then signal at one of the end will turn green indicating vehicle at that end to take the turn first. When one of the vehicles successfully crosses the turn the other led will also turn green and that vehicle can also take turn safely.

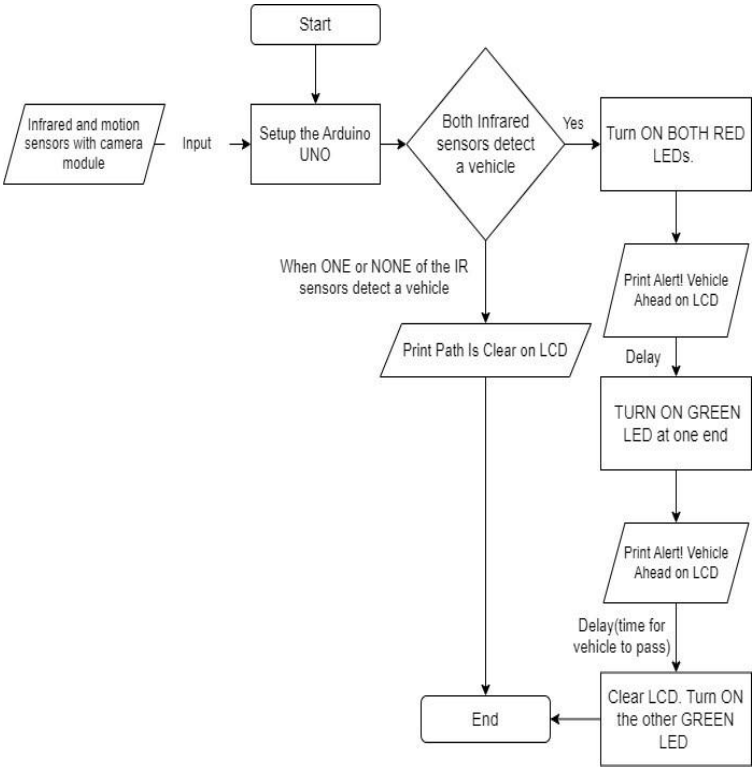

Fig. 3. Flowchart explaining working of vehicle detection accident prevention system.

The second module comprises of vehicle type detection system. Using the pixy2 camera module we constantly monitor the road. When vehicle is detected the camera module takes the picture which is sent to matlab where it compares that image with a trained dataset. According to the similar characteristic of the image and those from the dataset we can detect the type of vehicle present at that end. This type is displayed on LCD at the other end making the driver easy to decide how to take the turn safely without damaging the vehicles.

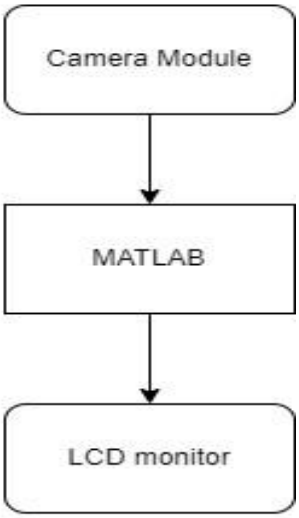

Fig. 4. Block diagram explaining working of vehicle type detection.

3 Results

The proposed system is shown in the fig 5. In the accident prevention system multiple scenarios were taken into account. Based on various possibilities the results obtained are described in the table 1. Talking about the vehicle detection system we tested different types of images and the accuracy was found to be 92%. The surface area of vehicles was taken into account and then with help of pre-trained the classification was successful. Thus following results were there: 1. The vehicle detection detects the type of vehicle perfectly.

2. The accident prevention system also is in good shape, whenever two vehicles approach a turn, message is accurately displayed on LCD and the signal also turn Red in time indicating vehicle to stop.

3. In addition, the purpose of motion sensor can be clearly observed as it confirms the obstacle is in motion or not. Only after cross-checking the signal will change. If it is a static obstacle like boulder, rock etc Go slow message appears. So driver have a more clear idea of how he must drive. Hence the safety of driver is increased.

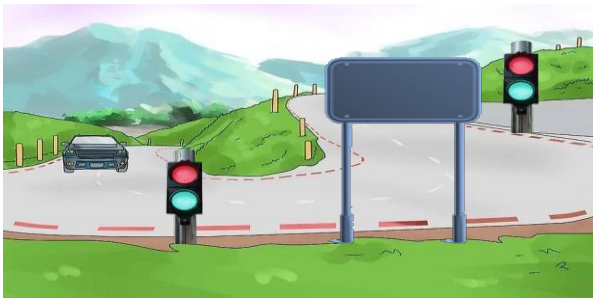

Fig. 5. Proposed system

Table 1. Output table for different cases.

INPUT				OUTPUT	
IR sensor 1	**Motion sensor 1**	**IR sensor 2**	**Motion sensor 2**	**ROAD 1 ROAD 2**	**LCD display**
LOW	LOW	LOW	LOW		Path is clear!
LOW	LOW	HIGH	HIGH		
HIGH	HIGH	LOW	LOW		
HIGH	LOW	X	X		GO SLOW Chances of obstacle
X	X	HIGH	LOW		GO SLOW Chances of obstacle
HIGH	HIGH	HIGH	HIGH		Alert! Vehicle Ahead. Stop
AFTER CERTAIN DELAY					
HIGH	HIGH	HIGH	HIGH		Alert! Vehicle Ahead. Stop
LOW	LOW	HIGH	HIGH		Path is clear!

4 Future Scope

Today we all are living in a world where Internet of Things is an essential factor of our life. The rapid growth of technology and internet has helped a lot in Iot. There are various technologies like V2V (Vehicle to Vehicle) which will play a major role in near Future. This will provide a massive assistance to our current system as the approaching vehicles can detect themselves earlier than the system. Also using Artificial Intelligence we can prioritize which vehicle would be easy to cross the turn based on space available and the type of vehicle ahead. This addition in our system might play a vital role in self-driven vehicles which are being developed.

5 Limitations

There are a few limitations of this system. The sensors placed at the ends should be tested time to time. If the sensors are malfunctioning the system would be inefficient to prevent the accidents. Also the sensors are prone to damage where there are rockslides and landslides. Thus we need to find a solution over these issues so the durability of our system is increased. The accuracy of the vehicle type detection should also be increased.

6 Conclusion

In India we predominantly have mountainous terrain. These mountain roads have many acute turns and blind-spots. Generally Mirrors are present at these spots to spot the vehicle from other end. But they prove to be inefficient during foggy days and at nightfall. These loopholes can be overcome using our system. We have only used sensors and created a Signal sort of mechanism. So even in dark or in foggy days driver can easily see the signal because it is covered with radio-luminescent paint. Also the content displayed on LCD can aid about what type of vehicle is ahead. This will give a driver clear idea how should he approach the turn. The infrastructure required doesn't consume too much space and can be easily installed narrow mountain roads. Thus we can reduce the number of accidents happening on mountain roads efficiently.

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