Intelligent Vehicle Speed Controlling and Pothole Detection System

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Abstract- **Speed is the single largest killer on India's roads. The higher the speed, the greater the impact and the more the chances of grievous injury and death. This is why speed management is something which needs to be seriously considered. Here is an approach to build a system which reduces the number of accidents due to driver's negligence of over speeding. We are proposing a Dynamic Speed Limiter with the help of machine learning algorithm which will help in reducing the accidents caused due to over speeding and rash driving of vehicles on road. The proposed system set the maximum speed of vehicle with the help of sign board available on the roads which define the safe driving speed of vehicle for that area or road. Also, to solve the potholes we are using ML algorithm and mobile phone accelerometer to detect the potholes, accelerometer vibrations are set. After detecting the vibrations, the location (i.e. longitude and latitude) is marked on the GPS, commuters will get information about potholes.**

Index terms- **Speed Limiter, Camera, Image Processing, Sign-Board, CNN, SVM, OpenCV, MCU (Raspberry Pi)**

I.INTRODUCTION

According to the World health organization, around the world approximately 1.35 million die every year due to road accidents. Injuries caused on the road are one of the sixth leading causes of death in India with a higher percentage of hospitalization, loss of lives, disabilities and socio- economic losses to the mankind. We have come up with the solutions of two of the major causes of accidents.

Firstly, speeding, speeding endangers everyone on the road. According to Central Ministry of Road Transport and Highway India [1], in 2017 speeding on road was reason for death of 9717 peoples accounting for more than a quarter (26%) of all the traffic caused fatalities. Speeding endangers not only the life of the speeder but also all the commuters around them. To solve this cause, we are designing and implementing a dynamic speed limiter through image processing technique. As, the speed-limit sign board recognition system has two separate tasks: first is the detection stage and second is the recognition stage. The detection stage is responsible for detecting the sign board from the image, and in the recognition stage the values specified in the sign board will be identified.

In the recognition stage, template matching or learning- based classification techniques are usually used [2,3]. For learning- based classification, Artificial Neural Networks and Support Vector Machines (SVMs) have been widely investigated. Recently, Convolutional Neural Network (CNN) has been used to recognize traffic signs and has high accuracy [4], however, huge computation resource is usually required either in training or test phases. In this paper, we introduce an automatic detection and recognition system of speed- limit sign board that can handle different conditions of lighting and blurriness in images [5,6]. The system uses a detection method based on MSER detection and recognizes speed-limit signs with Histogram of Oriented Gradient (HOG) features by a SVM classifier. Further this limit is provided input to the speed limiter through MCU. The speed limiter then sets the maximum speed of the vehicle which restricts the vehicle to over speed.

Fig. 1. A typical speed limit sign board

Second one is the pothole; potholes are also one of the major reasons of accidents [1]. According to the data shared by states to Centre Uttar Pradesh, India logged most such deaths at 987.In the year 2017, 4250 people died nearly on the roads which were under construction.   To solve this cause, we are using ML algorithm and mobile phone accelerometer to detect the potholes, accelerometer vibrations are set. When a user passes on the potholes for the first time, Accelerometer in mobile phones detects the pressure of potholes based on the vibration. After detecting the vibrations, the location (i.e. longitude and latitude) is marked on the GPS, commuters will get information about potholes via updated Maps and also the location will be sent to the corporation to fix the potholes.

II. LITERATURE SURVEY

According to the traditional Systems and prior research, the methodologies and technologies used to control the vehicle speed using the sign board where the speed limit is mentioned but we can still exceed that limit and move with a higher speed. This is the major reason for fatal accidents and loss of lives. Following we have mentioned some important researches which have some advantages and limitations which are been surveyed.

Sr. no	Title of Paper	Author Name	Advantages	Techniques Used	Drawbacks
1.	Automatic Recognition of Speed Limits on Speed-Limit Signs by Using Machine Learning	Shigeharu Miyata	This study describes a method for using a camera to automatically recognize the speed limits on speed-limit signs	Machine Learning with local binary pattern recognition, Image Processing with HSV, Neural Network	number extraction was not successful due to signs with faded colors, signs that were backlit, or signs that were partially hidden by trees or other objects
2.	Wireless Speed Controlling Module For Two Wheelers	1. P.R.Sonawane 2.Vinayak Kaviskar 3. Abhinav Kumar 4.Debabrata Karmakar	Intimate the driver about the zones and to automatically maintain the speed is accomplished by Means RF technology.	micro controller along with a RF transmitter, speed sensor, RF receiver, Servo motor	Implemented system works only for two wheelers
3.	Real Time Pothole Detection using Android Smartphones with Accelerometers	1. Artis Mednis 2. Girts Strazdins 3. Reinholds Zviedris 4. Georgijs Kanonirs	The paper is describing a mobile sensing system for road irregularity detection using Android OS based smart-phones.	Android OS based smart-phone, accelerometer sensors	System only detects the potholes without alerting the users.
4.	Roads: A Road Pavement Monitoring System for Anomaly Detection Using Smart Phones	1.Fatjon Seraj 2. Berend Jan van der Zwaag 3. Arta Dilo 4. Tamara Luarasi	In this paper we proposed a system that detects road surface anomalies using mobile phones equipped with inertial sensor accelerometers and gyroscopes.	Smartphone orientation inside the vehicle, accelerometer, anomaly detection supervised machine learning techniques	time consuming process of manual labeling
5.	Vehicle Collision Avoidance with Dynamic Speed Governor	1. Kashyap A R 2. Mohankrish na K	The proposed system is based on microcontroller for collecting data related to speed and Transmitting it through a transceiver to a base station that analyzes the transmitted data and takes decisions related to speed limit.	Microcontroller, Software: MPLAB IDE, CAD Software: EAGLE, Ultrasonic sensors	Traces are placed manually as done in the traditional method where you change the path of the trace every time you click the mouse.

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III. RESEARCH ELABORATION

We have come up with the solutions of two of the major causes of accidents. Firstly, speeding, speeding

endangers everyone on the road. According to Central Ministry of Road Transport and Highway, in 2017 speeding on road was reason for death of 9717 peoples accounting for more than a quarter (26%) of all the traffic caused fatalities. Speeding endangers not only the life of the speeder but also all the commuters around them.

To solve this cause, we are designing and implementing a dynamic speed limiter through image processing technique. The camera installed in front of the vehicle captures real time images of the speed limit sign board and then MCU receives the images as input for image processing. With the help of image processing detection and recognition algorithm from the captured image we detect the speed limit of that particular area. Further this limit is provided input to the speed limiter through MCU. The speed limiter [7] then sets the maximum speed of the vehicle which restricts the vehicle to over speed.

A. System Description

The flowchart in Figure 2 shows the complete process of speed controlling using image processing the speed limit signboard. Second one is the pothole; potholes are also one of the major reasons of accidents. According to the data shared by states to Centre Uttar Pradesh logged most such deaths at 987. In the year 2017, 4250 people died nearly on the roads which were under construction. To solve this cause, we are using mobile phone accelerometer to detect the potholes, accelerometer is set
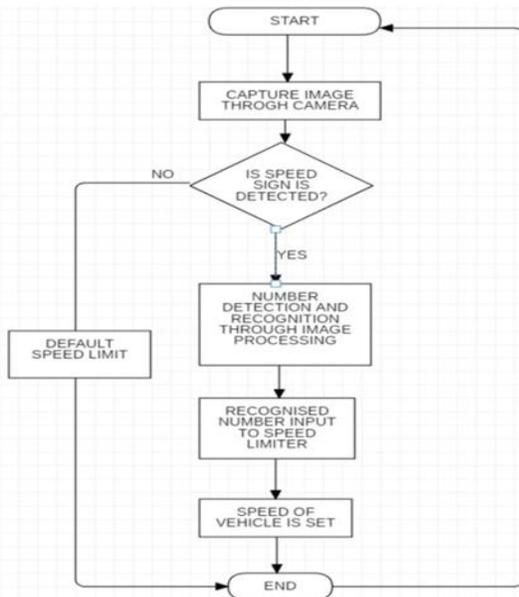
When a user passes on the potholes for the first time, Accelerometer in mobile phones detects the pressure of potholes based on the vibration. After detecting the vibrations, the location (i.e. longitude and latitude) is marked on the GPS, commuters will get information about potholes via updated Maps and also the location will be sent to the corporation to fix the potholes. The flowchart in the figure 3 shows the complete process of pothole detection using mobile accelerometer [8,9] and GPS to mark location of pothole on the Map.
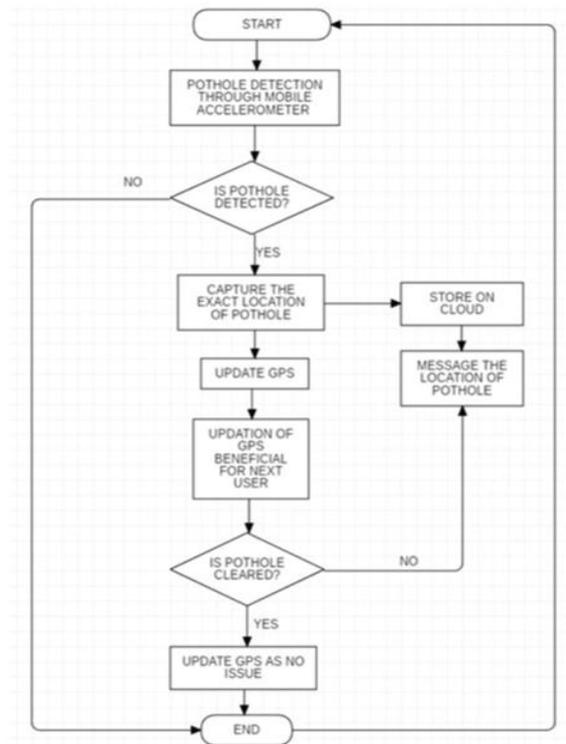

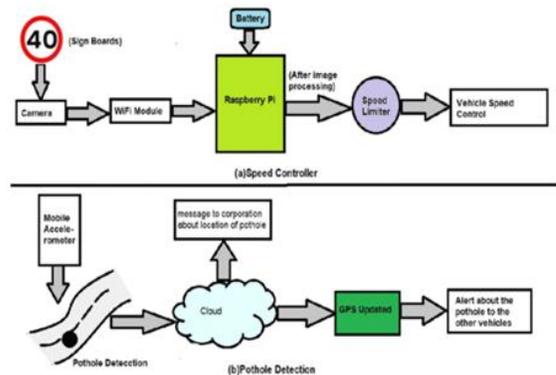Fig. 3. Flowchart of Pothole Detection System

B. System Architecture

Fig. 4. Proposed Architecture

Fig. 2. Flowchart of Speed Control

In the proposed speed controlling system, the speed-limit sign board detection and recognition system work in three different stages: first preprocessing of the image, second is detection of the sign board, and third is the recognition of speed limit in the sign board. The first step, in the preprocessing stage is responsible for enhancing the input image taken from the live video so that the speed-limit sign board in real time can be more obvious. The second step, the detection stage, uses MSER detection to find speed-limit sign candidate regions. Finally, the last step, in the recognition stage is responsible for extracting the HOG features from the candidate regions and feeds it to a SVM and the class of a speed-limit sign will be classified.

Before detection, the input image needs to be processed for the detection stage to work properly and efficiently. Since the input to the MSER computation requires grayscale image, we need to convert the input RGB image to a grayscale one. Also, the speed-limit signs limit signs are designed to have bright red colors, so we can take advantage of this feature and emphasize the pixels that have dominant red channel values. Therefore, we adapt the red color enhancement approach. For every pixel $x = [x_R, x_G, x_B]$ in the sign board image, where x_R, x_G, and x_B are the red channel, green channel, and blue channel of the image, in the image the red color enhancement is provided by

$$f_R(x) = \max\left(0, \frac{\min(x_R - x_G, x_R - x_B)}{x_R + x_G + x_B}\right) \qquad (1)$$

And the final grayscale image can be obtained by

$$Red(x) = \begin{cases} f_R(x), & x_R \geq x_G \text{ and } x_R \geq x_B \\ & \text{and } x_G/(x_R - x_G) \leq T_R \quad (2) \\ 0, & otherwise \end{cases}$$

Where T_R is a parameter that obtained from experiment results. The grayscale image $Red(x)$ obtained from this way has the advantage that the outer circle of sign board in red color signs becomes more apparent.

In the detection part, the system will detect MSERs and find potential speed-limit sign regions among them. The main advantage of this approach is that the detection of MSERs is robust under different environmental conditions, such as lighting and weather of the scene or the complexity of the background. MSERs are regions in an image that maintain their shapes when the image is thresholder at several levels. The detection of MSERs is

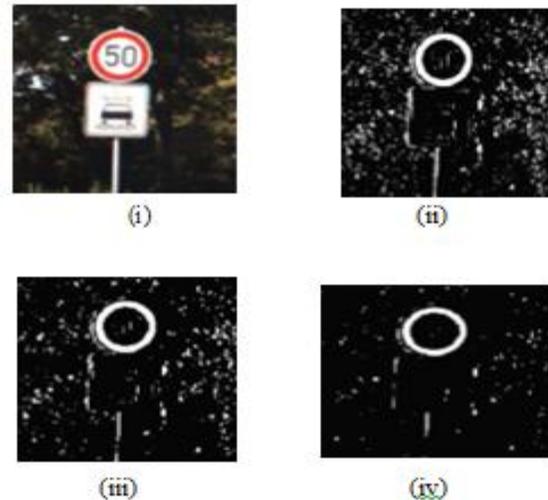performed on a grayscale image that comes from the result of the preprocessing stage.

Fig. 5 The speed-limit sign maintains its shape under different thresholds. (i) Original image. (ii.) The preprocessed image. (iii.) Threshold = 150. (iv.) Threshold = 250.

The recognition stage is responsible for verifying a candidate region as a speed-limit sign board. If the candidate region is actually a speed-limit sign board then, the speed-limit values present on the sign board will be determined. Otherwise, the candidate region verified by recognition stage will be discarded. In the recognition stage, the HOG features of the sign board will be extracted from the candidate region. Since speed-limit signs have strong appearance—circle shapes and high-contrast edges, HOG features are very suitable to capture these characteristics. HOG feature is computed for each candidate region and a vector will be generated. For speed and simplicity, SVM is used as a tool for the recognition stage.

After detection of the speed we set the that speed limit to the vehicle by changing the limit of speed limiter by providing it the limit by using raspberry pi. Thus, the vehicle maximum speed is set automatically by using the speed limit sign board and speed limiter.

In the proposed pothole detection system using mobile phone accelerometer to detect the potholes, accelerometer vibrations are set. When a user passes on the potholes for the first time, Accelerometer in mobile phones detects the pressure of potholes based on the vibration sensed by the mobile phone and recorded by the change in coordinates of the accelerometer. After detecting the vibrations, the

location (i.e. longitude and latitude) is marked on the map by fetching the location by using mobile phone GPS, then after commuters will get information about potholes via updated Maps and also the location of the pothole will be sent to the corporation by GSM service of mobile phone to fix the potholes.

IV. RESULTS

A. Automatic Vehicle Speed Controlling
A PC was used to perform the training and testing of the proposed system. Altogether 3000 sets images, 1000 sets for each speed limit signs are used for training purposes. 100 images are used for testing. Three types of traffic speed limit sign boards (20,40,80) have been successfully trained by the network. It is visualized that detection stage successfully detects and labels all images contained speed limit signs. Some speed limit sign boards are unable to detect due to poor maintenance sign boards. After speed limit sign board is detected using live camera feed and speed limit is recognized for that region the maximum speed of the motor is set.
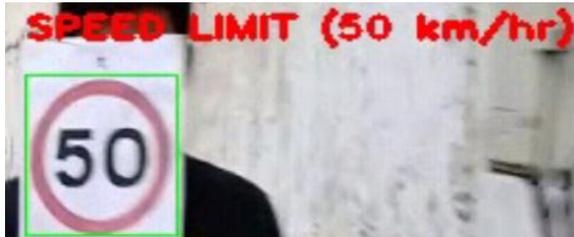

Fig.6 Speed limit sign board detection

B. Pothole Detection
We have successfully detected the potholes using Machine Learning algorithm and mobile phone accelerometer. When user passes through the potholes, accelerometer in mobile phone detects the potholes and respective location (i.e. longitude and latitude) is marked on the Google map. Hence the commuters can get information about potholes via the updated maps. We also send the location of potholes to corporation.

Fig.7 Pothole detection and marking the location on map by black dots

Fig.8 Database of location of potholes

Fig.9 Location of pothole is send to the Corporation

V. CONCLUSION

This paper proposes a model for the Intelligent Speed Controlling and Real Time Pothole Detection and monitoring system, after detection of signboard the vehicle maximum speed will be set by using speed limiter so as to limit the vehicle maximum speed to the speed limit decided for that road and a mobile phone will be used to detect the pothole and alert the users and concerned authorities about the location of pothole. Thus, proposed system ensures the safety of user in terms of controlling the over speeding, pothole notification on map and suggesting alternative path, that he drives in an area and safety to all of the people on road around them.

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