

Real Time Road Blocker Detection and Distance Calculation for Autonomous Vehicle Based on Camera Vision

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ABSTRACT

Statistics indicate that most road accidents occur due to a lack of time to react to instant traffic. This problem can be addressed with self-driving vehicles with the application of automated systems to detect such traffic events. The Autonomous Vehicle Navigation System (ATS) has been a standard in the Intelligent Transport System (ITS) and many Driver Assistance Systems (DAS) have been adopted to support these Advanced Autonomous Vehicles (IAVs). To develop these recognition systems for automated self-driving cars, it's important to monitor and operate in real-time traffic events. It requires the correct detection and response of traffic event an automated vehicle. In this paper proposed to develop such a system by applying image recognition to detect and respond to a road blocker by means of real-time distance measurement. To study the performance by measuring accuracy and precision of road blocker detection system and distance calculation, various experiments were conducted by using Shalom frame dataset and detection accuracy, precision of 99%, 100%, while distance calculation 97%, 99% has been achieved by this approach.

Keywords: Color Segmentation, Distance Calculation, Autonomous vehicle, Driver Assistant system.

1. Introduction

Autonomous vehicle technologies have been rapidly increasing in recent years due to progress in sensing, translation, speech, computer vision and object recognition software and hardware. As early as four years ago, a range of big corporations confirmed they will get self-driving vehicles on the road by 2020. At the moment, industry experts suggest we can go out and buy a self-driving car for more than 10 years [1]. A current approach in the field of self-driving vehicles is to try to replace the operator with cameras, sensors and computers using with artificial intelligence (AI). It is easy, however, to see where companies invest their money and where the vehicles, they test are genuine rolling labs equipped with radar, LIDAR, ultrasound sensors, cameras, vehicle dynamic sensors, accessories they also need steering, accelerating and braking control equipment. In addition, they need a machine to operate the AI program fast enough. Many training datasets is needed is an essential part of the autonomous vehicle issue. Showing trillion of hours of real time driving footage is the best way to train an autonomous vehicle and use it to teach good driving behavior to the machine. Current machine learning's models are very good if its train have a lot of data, and badly when it trains by a little bit. But data collection is costly for autonomous vehicle [2]. Autonomous vehicle has a significant advantage in enhancing road safety and thereby improve advanced mobility technologies to encourage the efficient usage of everyday commuters. We still need self-driving cars currently becoming to be able to drive hand-driven cars. Self-driving technology is still not possible until other vehicles on the highway are equally authorized. Such vehicles must also have features that authorize them, much like all manually-operated cars, to comply with traffic laws. The ability to identify the stop point of road blockers is a key feature of the autonomous vehicles of today with Advanced Driver (AD). To see a traffic rule as a stop, understand how far and then make the decision to slow down, is not so straightforward for a computer as to make a human being stop within 5 meters of a stop. This paper is an attempt to use computer vision

techniques to bestow such smart behavior upon the car. The experiments described satisfactory results in the proposed approach.

This paper consists from a literature review on the relevant research conducted in the field of autonomous vehicle distance calculation system, in five different sections. The section three describes proposed methodology for road blocker detection and distance calculation and study are summarized in Section four. The last section of the paper deals with the direction of the research performed and its conclusions.

2. Literature Review

The improvement of cameras for road navigation detection is also useful to increase the chance of safety. One of the supporting technologies is Advanced Driving Assistance System (ADAS) which is extremely contributing navigation detection. Authors proposed a new technology to recognize stop signs and calculate the distance. The stop signal falls outside the camera's field of view when the vehicle approaches the stop signal. Stop character recognition is performed using the cascade classification, which is composed of three different types of classifiers: haar-like classifiers, LBP and HOG [3]. This article aims to build such a system using image recognition to identify traffic signals, and correctly classify it using the neural convolution network via an Arduino-controlled autonomous car [4].

Two neural networks are being built during the reconnaissance process to extract the color and shape features. This process is primarily designed in relation to the discipline of fuzzy sets. Tracking was formed through image sequences using a Kalman filter [5]. One such introduces a new technology focused on colors and functions for identification of floating traffic lights. In the case of a red traffic light, the distance from the traffic light is often determined to slow down and stop at the appropriate location [6]. The advanced driver assistance system developed can detect traffic lights. The usefulness of this system was demonstrated during the public test of driverless cars in 2013 by Public Road Urban in Italy [7]. This paper improved performance for the less effective that the sign and registration were linked to the age of the driver, professional status, type of driving and mileage per year. Young drivers, professional drivers and those who drive more often remember the signs better [8]. The traffic signs were seen at a distance much closer than their line of sight. The threshold was 35 ms, which shows that short connections to traffic signs can lead to correct identification [9].

There are two phases discuss in this system recognition and detection. In the recognition phases the relative position of the road sign is recorded more accurately using a prior information, shape and color. In second phase of detection involves two processes: the preparation and research. The training process offers a stronger foundation for MP filter for each road sign [10]. This article describes the monitoring phase of a traffic sign identification system using a Kalman filter estimation tool [11]. Authors present a design for the FPGA platform-based minimum distance classification. The pipeline layout is designed to achieve a compromise between system use and calculation speed [12]. A standard camera is used with a complementary metal oxide semiconductor sensor (CMOS) and a red-green-blue (RGB) Bayer color filter. The taillights are segmented based on a red threshold. A tracking-based detection phase is introduced to improve robustness and manage distortions caused by other light sources and perspective distortions common in automotive environments [13]. A hierarchical coding scheme with

LED lights is provided in this article. When individually modulated, each LED traffic light is also possible to transmit parallel data. The authors suggest a hierarchical coding method based on fast wavelet transformation of 2D hair to resolve this [14]. This paper presents a way of detecting a pedestrian in low light in real time with a smartphone-based thermal imaging camera and of estimating the distance of the camera. Using multi-level waterfall learning devices, a pedestrian detector is created to detect pedestrians in a light environment and the pedestrian zone is detected using the same detector. [15]. This article proposed techniques based on monocular real-time vision for vehicle simultaneous detection and distance calculation, using hair-like vehicle detection adaption, heavy light segmentation, virtual symmetry detection, distance measurement and effective multi-functional single-sensor fusion technology, to improve accuracy and the robustness of the vehicle of our algorithm [16]. This work focuses on the navigation method of an autonomous vehicle to detect road blocker based on a color probability model. Discussion is based on acceptable statements and abstract principles of pre-processing, segmentation and post-processing and distance measurement are clarified in adequate detail. Methodology for classification with machine algorithms Decision Tree (DT) support vector machine (SVM), Naive Bayes (NB), and K-Nearest Neighbor (KNN), algorithms have been identified and shown in an appropriate manner. The study findings are provided with a promising / better outcome for SVM & NB and the comparative review of the work is carried out accordingly [17].

3. Proposed Methodology

The road blocker must be detected and decisions taken in real time, for safe driving and for accident prevention. These works are designed to build a system that autonomously identifies road blockers on a road and calculate its distance from vehicle.

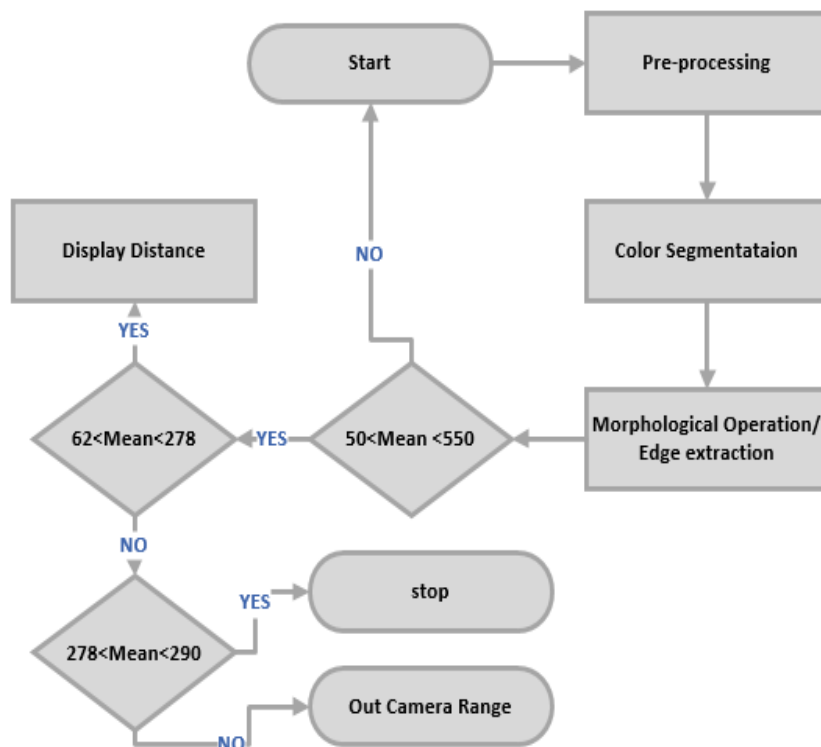


Fig. Error! No text of specified style in document.: Proposed Methodology for Road Blocker Detection

In order to do so, it must be able to capture the road in real time, identify the road blocker accurately and respond in time. Proposed algorithm contains four major phases such as 1) Pre-processing, 2) segmentation, 3) post-processing, 4) and calculating distance.

3.1 Pre-Processing

The input to the proposed algorithm is raw video in RGB format taken from the front camera of the vehicle. In order to eliminate unnecessary road areas, every frame of the image is considered as a single image and preprocessed by cutting out from top the image only 1/3. After cropping of the real video image median filter is applied to remove unnecessary noise in the original frame.

3.2 Color Segmentation

After pre-processing, the raw RGB color image converts to YCbCr color space, which is divided into three channels independently as red, green and blue, and eventually takes into consideration each channel (intensity/pixel value). The obtained binary image as result of color segmentation is shown in equation 1.

$$(I_{i,j}^R \geq Red\ min \ I_{i,j}^R \leq Red\ max) \text{ and } (I_{i,j}^G \geq Green\ min \ I_{i,j}^G \leq Green\ max) \text{ and } (I_{i,j}^B \geq Blue\ min \ I_{i,j}^B \leq Blue\ max) \quad (1)$$

3.3 Post- Processing

The resultant binary image obtain from color segmentation process were assign to post- processing. The morphological and labeling technique is used in post processing, with the goal of reducing the area of color in a road blocker as well, to decide the best characteristics of rectangle shape and the undesirable object contained in the removal of the boundary.

Distance Calculation

The system is designed to determine the distance between the road blocker and the vehicle to maintain a reasonable distance and allow the assisting control system to make the right decisions. A variety of methods are currently being used for calculating the distance between various object in navigation systems such as (lidar, radar, and convolution). But this paper is based on camera sensor data and implements a very simple and reliable architecture as present in algorithm 1, and equation 3, 4, 5.

Algorithm 1: Road Blocker Detection and Distance Calculation

Problem: Detection and Distance Calculation

Input: Road Blocker Image

Output: Road Blocker Detected in Image Using Distance Measurement

START

Read Image= [Input Image (RGB)]

Convert image to YCbCr color model

Extract channel Minimum and maximum value based on histogram.

Use invert mask.

*If Edges are open in 20 pixels **then** //Use morphological operation*

Using strel function close edges

end if

Detect edges using “log” function

*Remove un-connected pixels using **bwareaopen** function*

finding coordinates of bounding boxes.

*Take mean of blocker **width** and **height***

nn=length(boxes);

***FOR** i=1: No of rows*

***FOR** j=1: No of columns*

If** (Mean of width < 550 and mean height > 50) **then

define Mean of classes

***if** (class prob is equal to confidence Mean)*

finding bounding box with class label

nested if bounding box is less than out of class label

END if

***Else if** (class prob is! equal to confidence Mean)*

Out of camera region

END Else

plot bounding box of finding the target region of interest

END if

END FOR

End FOR

At every meter of the road blocker we took a bunch of images, 15 to 5 meters from the vehicle to the road blocker to find bounding box rectangle (road blocker) symmetry and to determine the distance for region of interest. The total measurement (M) of length (L) and width (W) represents the bounding box of the road blocker is initially known. If a road blocker is placed with a known measurement (M) from some distance (D) with a front camera of the vehicle

to find whole pixel (P) for our region of interest which allows us to calculate the focal length (F). After measurement (M), focal length (F), and pixel (P) we calculate the distance (D) between vehicle and road blocker.

$$\text{Measurement} = \text{Length} * \text{Width} \quad (2)$$

$$\text{Focal} = (\text{Pixel} * \text{Distance}) / \text{Measurement} \quad (3)$$

$$\text{Distance} = (\text{Measurement} * \text{Focal}) / \text{Pixel} \quad (4)$$

5. Result and Discussion

The tests are conducted at a distance of 15 meters to Shalom Road blocker. We are performing two separate experiments to demonstrate the capabilities of our algorithm. The first is detection of the road blocker, and the second is calculation of the distance. Each image has a resolution of 400 x 400 pixels, and the average number of frames taken per second is 15. At the moment we are especially concerned in our work with automated distance calculation of road blocker and for this purpose sequences are performed as batch processes.

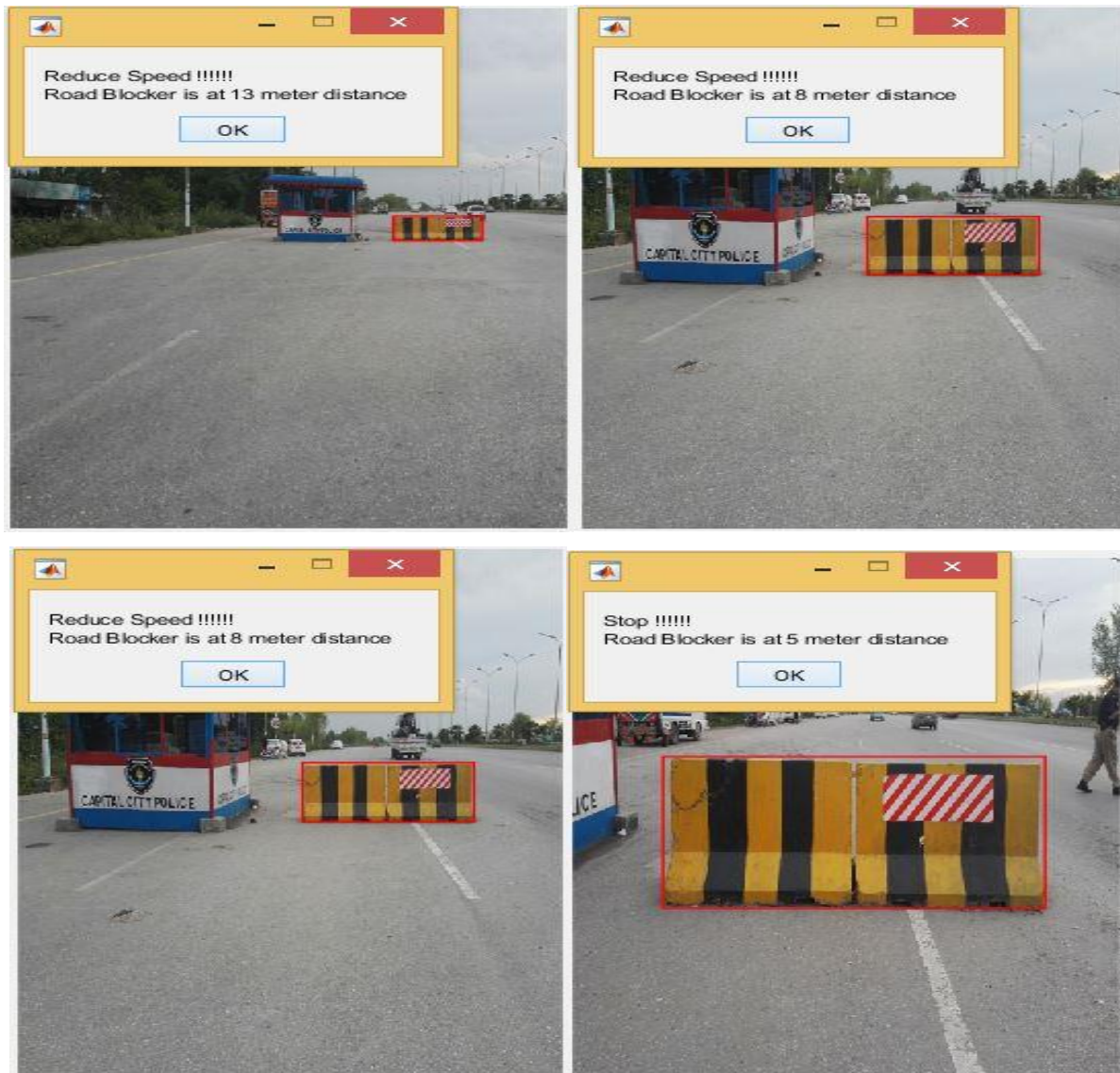


Fig.2: Detection and distance calculation between Vehicle and Road Blocker (a) 13 meter (b) 10 meter (c) 8 meter (d) 5 meter

The confusion matrix is most commonly used to evaluate performance of the segmentation and classification model. The confusion matrix specifies the most common matrix such is accuracy, precision, recall and F1-score.

$$Accuracy = (TP + TN)/(TP + FP + FN + TN) \quad (5)$$

$$precision = TP/TP + FP \quad (6)$$

$$Fscore = 2 * TP / 2 * TP + FP + FN \quad (7)$$

$$Recall = TP / TP + FN \quad (8)$$

The algorithm performed well on the test data set we collected.

Table Error! No text of specified style in document.: Result With respect to Accuracy and precision

Methods	Accuracy	Precision	Recall	F1-Score
Detection	96%	100%	93%	96%
Distance Calculation	90%	93%	87%	90%

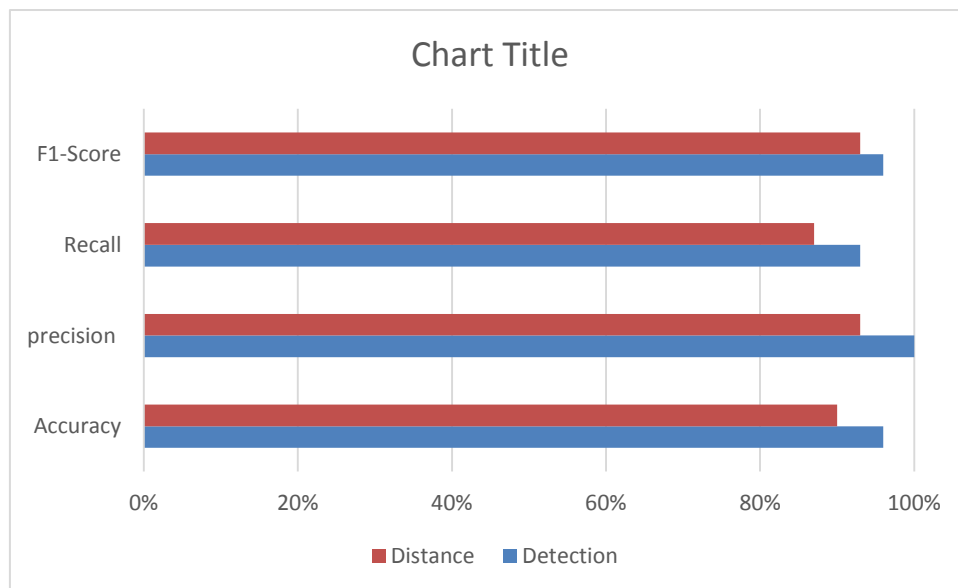


Figure 2: Performance Comparison of Proposed Algorithm

6. Conclusion

We broaden the limits of autonomous vehicle in this paper through efficient distance measurements, detection between vehicle and road blocker. The proposed model for autonomous vehicle with the accurate detection of a road blocker and distance measurement with a high accuracy rate of detection of 99% and an accuracy rate of 100% as shown in Table 1. We assume our system of distance estimating may tackle such a scenario as allowing road blockers that are near to the car. We plan in the future for broader data sets to train our model to detect the multi-known road blockers found in other areas. The ability of the model to identify road blockers in deep neural networks is another attribute that could be enhanced.

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