Imperial Journal of Interdisciplinary Research (IJIR)
Vol-3, Issue-5, 2017
ISSN: 2454-1362, http://www.onlinejournal.in

Vehicle Speed Monitoring And Enhanced License Plate Recognition System Using Raspberry Pi

Ms. Bhadra M V[1] & Mr. Shine P Xavier [2]
[1]Mtech Student,Dept of CSE, Thejus Engineering College, Vellarakkad, Kerala, India
[2]Dept of CSE,Thejus Engineering College, Vellarakkad, Kerala, India

Abstract*: Now-a-days accidents on highways are increasing at a very fast rate. And in most of the cases main reason of accident is over speed. Although all highways have signboards that to indicate maximum speed limit for the sake of drivers safety, but still people does not obey highway speed limit. So that in order to reduce accidents caused by these violations, Vehicle Speed Monitoring and Enhanced Speed Monitoring system using raspberry pi is necessary. This system can detect the speed of vehicles and if over-speeding occurs, it extracts the license number of vehicle by an efficient ALPR system. It can be mainly used for Indian vehicles and can also be modified in order to use it in other countries. If over-speeding is detected by the IR sensor, a camera automatically captures the picture of the vehicle and the number plate of the corresponding vehicle is processed using methods like mathematical morphology, OCR etc in order to extract the number. Then this system reports the violation to user. The proposed system also includes the implementation of same system with the use of Raspberry pi that have the combined effect of 3 algorithms edge detection , Otsu's method and mathematical morphology so that optimization of the this system can be improved.*

1. Introduction

Although there is good road safety performance, the number of people killed and injured on our roads remains unacceptably high. So the roads safety strategy was published or introduced to support the new casualty reduction targets. The road safety strategy includes all forms of invention based on the engineering and education and enforcement and recognizes that there are many different factors that lead to traffic collisions and casualties. The main reason is speed of vehicle. We use traffic lights and other traffic manager to reduce the speed. One among them is the use of cameras to identify the over speeding vehicles. If the vehicle is out of the speed limit provided by the rules, the cameras captures the corresponding number plate and is processed by ALPR system. Then take an action against corresponding owner.

2. Background

Automatic License Plate Recognition(ALPR) is a mass surveillance method that uses optical character recognition on images to read the license plates on vehicles. ANPR can be used to store the images captured by the cameras as well as the text from the license plate, with some configurable to store a photograph of the driver. Systems commonly use infrared lighting to allow the camera to take the picture at any time of day. A powerful flash is included in at least one version of the intersection-monitoring cameras, serving to both illuminate the picture and make the offender aware of his or her mistake. ANPR technology tends to be region conceptual resources. Because of this, various recognition techniques have been developed and number plate recognition systems are today used in various traffic and security applications, such as parking, access and border control, or tracking of stolen vehicles.

It has a wide range of real-life applications such as automatic toll collection, traffic law enforcement, and road traffic monitoring . Reading or locating the license number plate is the main and the first step in determining the identities of parties involved in the traffic incidents. The common aim of these applications is to reduce man power and facilitate to the automatic management. An ALPR system must thus exhibit a high recognition rate and processing speed. For example, drivers normally have little patience when waiting for their vehicle to be recognized by a car parking system. It is also mass surveillance method that uses optical character recognition on images to read vehicle registration plates. They can use existing closed-circuit television or road-rule enforcement cameras, or ones specifically designed for the task. They are used by various

police forces and as a method of electronic toll collection on pay-per-use roads and cataloging the movements of traffic or individuals. It can be used to store the images captured by the cameras as well as the text from the license plate, with some configurable to store a photograph of the driver. Systems commonly use infrared lighting to allow the camera to take the picture at any time of the day. This technology tends to be region-specific, owing to plate variation from place to place. An efficient license plate localization system may become the core of fully computerized road traffic monitoring systems.

3. Literature Review

Different methods that have been addressed for plate detection of vehicles such as license plate detection [5] using edge information, connected component analysis, colour features, texture features, character features etc. Mrs. J. V. Bagade, MSukanya Kamble, Kushal Pardeshi, Bhushan Punjabi, Rajpratap Singh proposed[1] plate localization using edge detection. Initially the pre-processing is done using median filter. Median filter is a nonlinear filter, which replaces the gray value of a pixel by the median of the gray values of its neighbours. In this work, a 3x3 convolution mask is used to get eight neighbours of a pixel and their corresponding gray values. This operation removes salt-and- pepper noise from the image. The magnitude of the vertical gradients is used to detect the plate region [6]. The sobel operator is used for edge detection [7] which is computationally inexpensive and reasonably robust to noise. Car images are taken from various positions outdoors[6]. Because of the variations of angles from the camera to the car, license plates have various locations and rotation angles in an image.

In J. V. Bagade proposed technique[7], the edges created by the characters within the license plate are extracted.Sobels edge operator is used for detection of edge gradients. It is seen that when the characters of the license number are written horizontally, the vertical edges of each character appear at regular interval and they have a specific height. The pattern and concentration of the vertical edges also remains in conformity with the pattern of the license number.

Humayun K. Sulehria, Ye Zhang, Danish Irfan [11],proposed a technique for the extraction of vehicle number plates consists of the following five processes. Image enhancement, morphological transformation, morphological gradient, combination of the two images obtained from the top or bottom hat transformations and morphological operations, resulting in the vehicle number plate designate confirmation. The two steps morphological transformation and morphological gradient may be performed in parallel using the parallel processing software or hardware. Image enhancement is used for pre-processing in the image before any morphological operations are performed. The system proposed in this paper used the morphological gradient for the detection of plate designated area. First the image was eroded by a disk shaped structuring element. Then the original image was again eroded using the same structuring element. After that the eroded image was subtracted from the dilated version.

4. Proposed System

In the current over speed tracking system, the identification of license number from the number plate of captured image of the vehicle is done manually. It is very slow and painstaking process. The result after identification may not be accurate. So developing of Indian vehicle speed detection and tracking system provides an efficient and cost effective way to implement an automatic tacking system in real time with using raspberry pi.

4.1 System Architecture

Vehicle speed monitoring and enhanced number plate recognition system mainly consist of IR sensor to sense the speed of the vehicle, and cameras to capture the image of those over speeding vehicle.

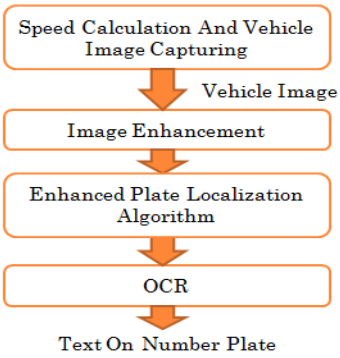

Figure 1. The Proposed System Architecture

4.1.1 Speed Calculation And Vehicle Image Capturing

First identify the speed of the vehicle by using 2 IR sensors .then that speed is compared with the speed limit to determine whether it is over speeding or not. If it is found that it is over speed, those camera will capture the image. This image is then given to next step that is image enhancement.

4.1.2 Image Enhancement

The image enhancement is mainly done for better processing. The image from the previous step can be enhanced using different enhancement techniques such as intensity enhancement, contrast enhancement and converting RGB colour apace into grey level etc. Here RGB image is converted into gray level image because gray level image consumes less memory as compared to that of RGB image. That result is given to enhanced license plate localization algorithm.

4.1.3 Enhanced Plate Localization Algorithm

Instead of using single plate localization algorithm, here using combination of three plate localization methods.ad of using single one. They are

- Otsu's Method
- Mathematical Morphology
- Edge Detection

(a) Otsu's Method

Otsu automatically performs clustering-based thresholding of the image. The algorithm assumes that the image contains two classes of pixels following bi-modal histogram (foreground pixels and background pixels), it then calculates the optimum threshold separating the two classes so that their combined spread (intraclass variance) is minimal, or equivalently (because the sum of pair wise squared distances is constant), so that their interclass variance is maximal.

(b) Mathematical Morphology

It is the procedure for the examination and preparing of geometrical structures, in light of set hypothesis, grid hypothesis, topology, and so forth. It is the most commonly applied to digital images, but it can be employed as well on graphs, surface meshes, solids, and many other spatial structures. This method has stages such as image enhancement, morphological transformations, morphological gradient, combination of resultant images and extracting the number plate from the objects that are left in the image.

As a pre-processing technique here enhancement is used . The technique used for intensity adjustment is histogram equalization. It is the distribution of intensity values equally through-out the image to get more contrast than the original image. Top-hat transformation is applied after enhancement which aims to suppress the dark background and highlights the foreground objects. Top-hat operation is actually the result of subtraction of an opened image from the original one, mathematically:

$$th = f - (f \circ b) \qquad (1)$$

Where, f is the input image and b is the structuring element. The selection of structuring element is based on the application and is not fixed. The available structuring elements are of shape square, rectangle, diamond and disk. Here the disk shaped structuring element is used. Next to measure the local gray level variation in the image morphological gradient operation is performed. It is the subtraction of an eroded image from its dilated version.

After this step the resulting image changed into binary [12] and all the noise components were removed. Next the plate region is confirmed based on the properties of the plate such as aspect ratio, area of the plate etc.

(c) Edge Detection

Edges are the point where the brightness changes sharply are typically organized into a set of curved line segments termed edges. It is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and extraction.Canny edge detection is one type of edge detection method.

The result from this enhanced plate localization method is then given to OCR for recognition of the characters on the plate region extracted. Here the proposed system uses Tesseract Ocr.[paper no].After these steps the recognized license number is uploaded to the server and server will find out the owner then take appropriate actions. This entire system is implemented with the help of raspberry pi. So that either we can share load on the entire system into two or can implement completely in raspberry pi.

4.2 Methodology

In this system, two algorithms are mainly performing. They are

1.enhanced plate localization algorithm
2.ocr (tesseract ocr) algorithm

4.2.1Enhanced Plate Localization Algorithm

1. Compute histogram and probabilities of each level

2. Set up initial class probability $\omega_i(0)$ and initial class means $\mu_i(0)$
3. Step through all possible thresholds t =1…Max intensity
    a. Update ω_i and μ_i where $\omega_i = \Pr(C_i)$ and $\mu_i = \sum_{j=0}^{k} j * \Pr\left(\frac{j}{c0}\right)$
    b. Compute between-class variance σ_b^2 (t) where

σ_b^2 (t) = (μT ω(k)-μ(k)) ²/ ω(k)(1-ω(k))

4. Desired threshold corresponds to maximum σ_b^2 (t) and convert image into black and white image ,I
5. Choose a structuring element of shape disc with radius 1
6. Dilate and erode the image I using structuring element
7. Subtract eroded image from dilated image
8. Convert image into logical matrix
9. Perform erosion operation and subtract eroded image from result of step 10
10. Perform canny edge detection
11. Apply image filling and perform erosion operation

4.2.2 Ocr (tesseract ocr) Algorithm

The algorithm is as follows

1. Perform line and word finding
    a. Perform line finding
    b. Perform Base line fitting
    c. Perform pitch detection and chopping
2. Recognize the words
    a. Chop joined characters
    b. Associate broken characters
3. Take the feature points of each characters
4. Based on that feature points classify each characters with help of trained character set

4.3. Advantages

Vehicle speed monitoring and enhanced plate localization algorithm using raspberry pi has so many advantages. They are improved performance, very cost effective why because raspberry pi is very less cost as compared to our pc,high speed,autonomus data verification and fining. Since we can embed this raspberry pi with camera on the roadsides, the server load also get reduced.

5. Results And Discussions

The experimental results and the performance analysis of the proposed system are described in the following sections.

5.1 Experimental Results

This section shows some results. Figure 2 shows the result of sensor module. From which we can identify that the vehicle is over speed. So that the camera will capture the image of the vehicle. The image will be like in figure 3.The figure 4 shows the result of single plate localization algorithm. The enhanced plate localization algorithm's result less noise compared to that of single algorithm and it is shown in the figure 5.The figure 6 indicate the OCR result.

Figure 2. Sensor Module

Figure 3. Captured Image Of Over Speeding Vehicle

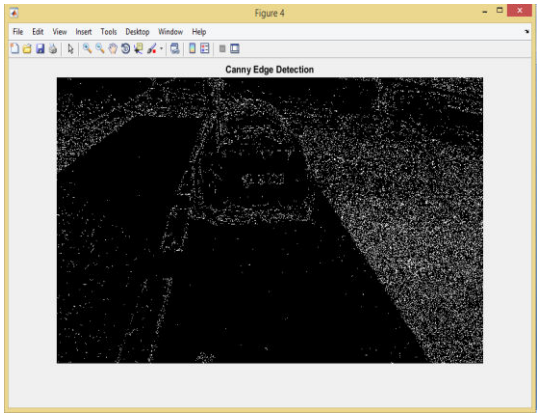

Figure 4. Result Of Canny Edge Detection

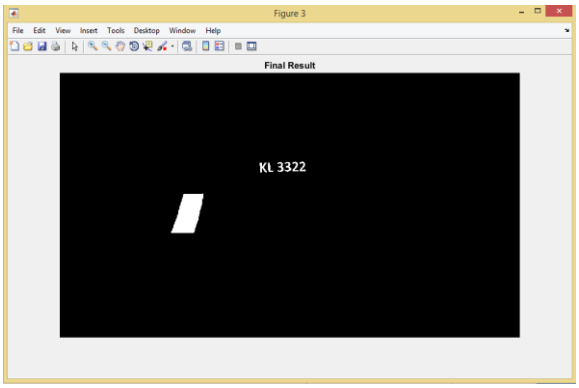

Figure 5. Result Of Enhanced Plate Localization Algorithm

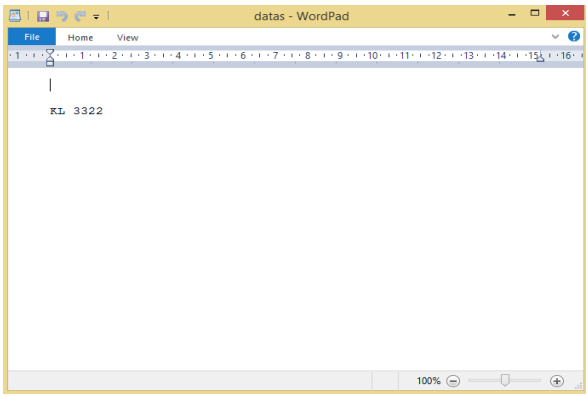

Figure 6. OCR Result

5.2 Performance Analysis

To analyze the performance of the entire system, three metrics have been used. They are

- Computation time
- Cpu load
- Efficiency/accuracy

5.2.1 Computation Time

The total time taken for the entire computations for the system can be measured by means of a command known as tic-toc.While tic command is encountered a timer get started and while encountering toc command the timer get stopped. That difference in that time can be taken as computation time for the entire system. Figure 7 shows the computation time taken for the entire system.

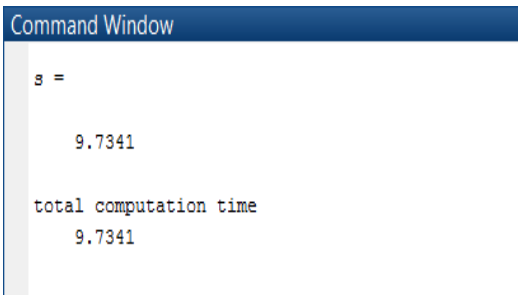

Figure 7. Overall Computation Time For Intel Core I3(Mobile Version)

5.2.1 Cpu Load

Cpu load is defined as average system load over a period of time.

Figure 8 shows a graph which indicates the overall computation time and cpu time taken by different system for this process.

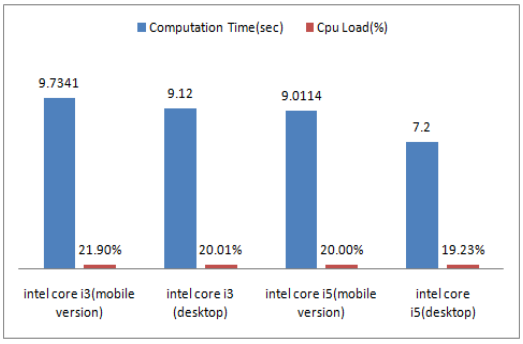

Figure 8. Overall computation time cpu load for different systems

6. Conclusion

Indian vehicle speed detection and tracking system is an efficient and low automatic over speed vehicle tracking system implemented in Raspberry Pi.Which mainly done the crucial step of plate localization by means of an enhanced algorithm which combines efficiency of 3 existing method thus the recognized license

number will be more accurate. Since it is implemented in Raspberry Pi, it is possible to embed this entire system in the cameras on road side. So after capturing the image of vehicle, it is possible to done recognition in camera system itself. So there is no need of uploading images to the server and thus it reduces server load. It is also possible to enhance the entire system to support digital number plate and to support different countries number plates.

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