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# Automated Traffic Detection System Based on Image Processing

Fahad Faisal[1]*, Sumon Kumar Das[1], Abdul Hasib Siddique[2], Mehedi Hasan[2, 3,]*, Samia Sabrin[4], Chowdhury Akram Hossain[5] & Zhou Tong[6]
[1]*Department of Computer Science and Engineering, Daffodil international University, Dhaka 1207, Bangladesh*
[2]*Department of Electrical and Electronic Engineering, University of Science and Technology Chittagong, Chattogram 4202, Bangladesh*
[3]*Department of Electrical and Computer Engineering, North South University, Dhaka 1229, Bangladesh*
[4] *Department of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology, Chattogram 4349, Bangladesh*
[5] *Department of Electrical and Electronic Engineering, American International University-Bangladesh, Dhaka 1212, Bangladesh*
[6]*College of Engineering, IT and Environment, Charles Darwin University, NT 0810, Australia*
**Corresponding Author:** Mehedi Hasan, E-mail: mehedi.hasan01@northsouth.edu

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**ABSTRACT**

This paper proposes a low-cost automated traffic detection system based on image processing. Dhaka is one of the crowded cities in the world with highly challenging traffic system. There is substantial lack of awareness among the drivers of transport system. As a result, citizens do not follow the rules and regulation while driving in Dhaka city. The tendency of violating the traffic regulation is noticeable throughout the country. As a result, the whole traffic system collapses very often and sometimes it ends-up with severe accidents. In recent days, the government has taken different initiatives including enlargement of pedestrian walkways, building new flyovers and foot-over bridges, expansion of existing roads. But, violation still the outcome of all these initiatives could not improve the situation significantly. The proposed system will automatically detect the traffic through live streaming video so that the detected images can be used to detect traffic violation. Later on, the law enforcement agency will be able to take necessary legal steps based on the stored information on the database.

## 1. Introduction

Dhaka city has already been recognized as one of the most crowded cities in the world and the current situation of traffic management in the city shows why it got such a ranking (Ahmed et al. 2019). The uncontrolled growth of incoming people every day in this megacity is influencing the unexpected growth of vehicle in the transportation sector. The residents of Dhaka city suffer daily due to this traffic jam. To reach a distance of 5/6 kilometers can take up to two hours or more. It is becoming increasingly difficult to commute from one place to another. Sometimes the whole traffic management system face inordinately complicated situation due to a simple incident in the road as there is no alternative way to travel. Besides this, the tendency of violating the traffic law is very severe in Dhaka city by the drivers of transportation sector. The system is intended to detect the traffic rule violating vehicles with minimum cost from the streaming video (Fuad et al., 2015; Hasan et al. 2018, 2019, 2020).

Technological advancement and development in the resent years lead to the inventions various smart, automated and intelligent systems (Uaday et al, 2019; Siddique el al, 2013, 2012; Zaman et al, 2015; Shammi et al, 2018). In case of traffic related works, several innovative ideas employing various techniques has been implemented in order to control and manage traffic related problems (Paul el at, 2017, 2018; Talukder et al, 2017; Osamn et al, 2017; Hossain et al, 2017). Traffic violation in roads and streets in metropolitan has become an important topic of interest and various smart systems have been developed in order to solve the problem (Buch et al, 2011; Özkul and Kapuni, 2018; Bedruz et al., 2018).

This paper presents an automated traffic detection system. Image processing techniques have been utilized in this paper for traffic violation detection.

## 2. Background Study

Object detection based on digital image processing on vehicles is very essential for initiating a monitoring system or a substitute method to gather statistical data to develop a systematic traffic infrastructure. A vehicle detection program based on traffic video feed for the particular type of vehicle using Haar Cascade Classifier is considered as the outcome of this paper (Elkerdawi et al, 2014; Mutsuddy et al., 2019; Karim el at., 2019; Choudhury et al., 2017). At first the optical shape of the vehicle is determined using color-to-grayscale algorithm (Manlangit et al., 2019; Hunes et al, 2016; Jin & Ng, 2015) and later on Haar Cascade Classifier is utilized to make a strong classifier by combining specific classifier into a cascade filter for rapid elimination of the background regions of an image (Noor et al., 2017).

There are many existing implementations of such system. However, this is a new strategy for designing a smart traffic violation detector system with basic security in low budget with real-time visualization. Haar Cascade Classifier proposed by Paul Viola and Michael Jones has been utilized to determine objects (Gemerek et al., 2019). Their system can detect car by monitoring video. This paper works with a total of 1000 vehicle images and 200 negative images where they used OpenCV library as the training procedure (Elkerdawi et al., 2014). Where positive samples were obtained by manually cropping and resizing to 30 x 30 pixels and the testing phase employed 8 videos as real data test of traffic surveillance video. Each video was taken using a 30-50 degree camera position facing down the road as illustrated.

## 3. Methodology

At first, lots of positive and negative photos have been collected using the video camera. Then color-to-grayscale algorithm has been applied followed by cascade classifier to achieve the target (Example Bil File Format, 2020). To keep the cost low, a raspberry pi and camera module are used to do the work more efficiently. After that, we distinguished a basic strategy for the purpose of vehicle and people recognition.

Color images are generally built of different staked color channels and each representing the value levels of that given channel. RGB images comprised of 3 distinct channels. Here, Red, Green and Blue are considered as the primary color sources. In general, 3 algorithms are utilized to convert color image into grayscale image (Junayed et al., 2019).

- The lightness method can be defined as:

$$Lightness\ Method: (Max_{R,G,B} + Min_{R,G,B})/2$$

- The average method is defined as:

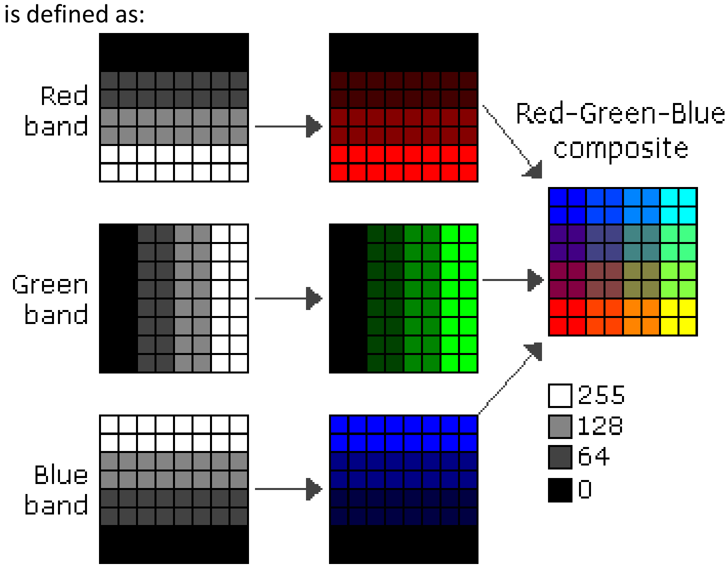



Fig. 1. Color to greyscale conversion.

Fig. 2. List of positive photos.

$$Average\ Value = (R + G + B)/3$$

- The luminosity method can be defined as:

$$Luminosity = 0.21R + 0.72G + 0.07B$$

The lightness method has a tendency to reduce contrast. The average method produces the average result. And the luminosity method overall works best. But sometimes these three methods produce very similar results (Foysal et al., 2019). Fig. 1 represents an example of full RGB color image converting to grayscale image. The right column shows the isolated color channels in natural colors, while at left column there are their grayscale equivalences.

### *3.1 Traffic Detection Using Cascading Classifiers*

Cascade classifier is a method using for detecting objects. In this part, we work for detecting the traffic. For doing this, the cascade classifier needs to be trained with a large number of data-set comprising of positive and negative types of images. In case of positive photos, we collect the image of different types of vehicle like Car, Bus, Truck, CNG, Motorcycle, Rickshaw and the images of people which is positive photos. Our target is to detect the positive photos. And for negative photos, we collect lots of roadside photos that do not include the positive photos. A list of positive photos (Fig. 2) and negative photos (Fig. 3) are given.

In fig. 2, we can see different types of vehicle including people too. These types of pictures are considered to be the positive photos. When the video will continue, then the system will detect the vehicles and peoples and identify where the traffic happens and if any car violates the traffic rules it will identify them. The data will save in the database and will be accessible in further use. In Fig. 3 we can see road side images which are negative. The proposed system will avoid identifying these negative photos during detect the traffic.

### *3.2 Traffic Detection Process*

In this section, we will discuss the total vehicle detecting process. In the below flowchart (Fig. 4) at first, the process will start. Then we have to input the video and the video will convert into grayscale. Then it will go to the Haar Cascade Classifier where it will check is it the positive or negative region of interest.

If the input video is not containing the frame of vehicles and peoples then it will not detect but if the video file contains the frame of vehicles and peoples then it will find the region of interest and detect the vehicles and peoples from the input video.

### *3.3 Data Collection Procedure*

To obtain the desired goal, at first, we have to collect lots of data. We collect different sort of images of vehicles, peoples and roadside from many roads with different light and different conditions. To collect the data, we flow some step. I case of software, the OS selected for Raspnerry Pi is Raspbian. In order to train the vehicles and peoples which is the positive image and the roadside image which is negative images into the library we use Haar Cascade Classifier. This classifier creates two different data set. One is for the positive dataset and another one is for the negative dataset.

After classifying the dataset, it will train both the dataset. It takes a few moments to train the dataset. When it finished to train the dataset then we will get our target file which displays in the .xml file. Then it will store the trained dataset into the database.

Fig. 3. List of negative photos.

In the end, utilizing terminals in root mode, the GPIO pins are accessed and ports are initialized. When running the code, the terminal window on the Raspberry Pi is opened and the python code is executed. Then the code runs on the system and it will ready to execute vehicle and people detection.

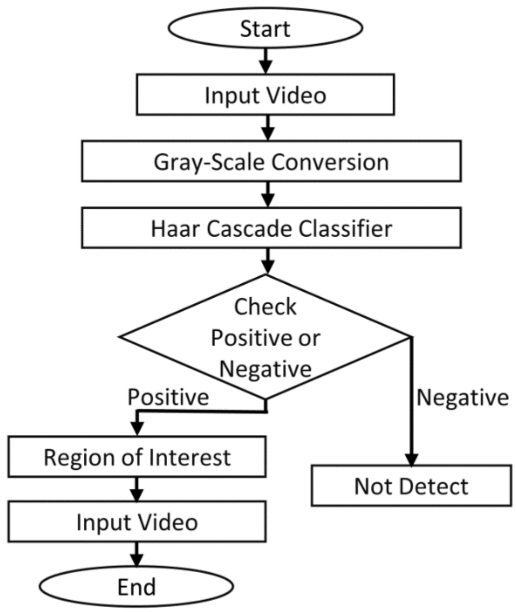



Fig. 4. Traffic detection flowchart.

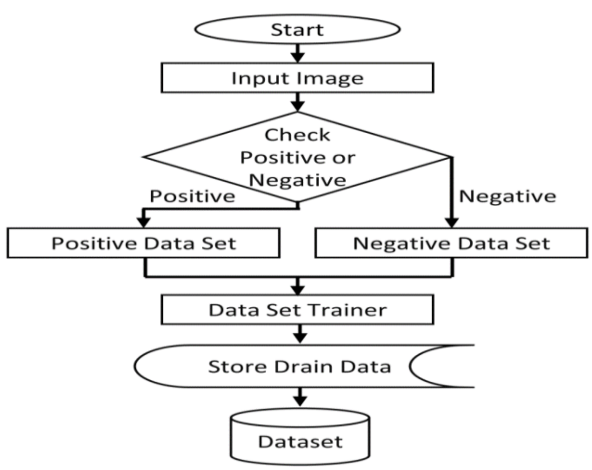
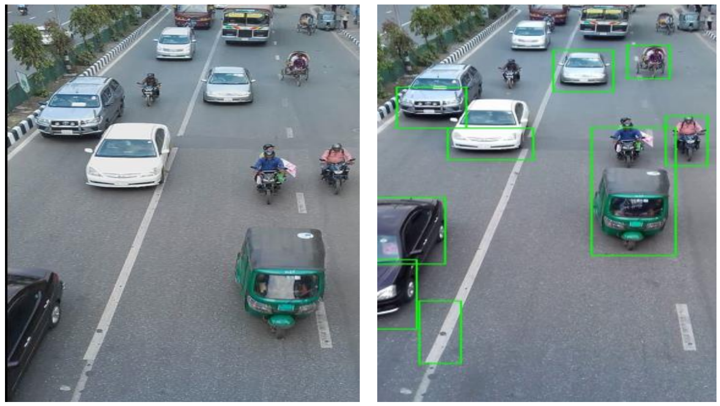



Fig. 5. Data collection procedure.

**Table 1.** Confusion matrix for matching vehicle and people

| | Positive (%) | Negative (%) |
|---|---|---|
| True | 97 | 80 |
| False | 10 | 70 |



(a) (b)

Fig. 6. Result analysis (a) input image (b) detected image.

**4. Results and Discussion**

After analyzing the data, the calculation of the accuracy of the system is achieved by 97%. To calculate the data more accurately, we use some attributes which are extracted by utilizing confusion matrix. For example, the confusion matrix of Matching vehicles and peoples which is given below (Table 1).

For measuring the performance of the system, we need to define TP, TN, FP and FN.

Where,

- True Positive (TP) = number of cases correctly identified actual class [42].
- False Positive (FP) = number of cases incorrectly identified actual class [42].
- False negative (FN) = number of cases incorrectly identified negative classes [42].
- True negative (TN) = number of cases correctly identified negative classes [42].

To get the best output, first, we have to collect the raw image by Raspberry Pi camera module. We collect almost 5000 positive and negative images of the vehicles, peoples and roadside scenery to make our system more efficient. We take the maximum picture of the object so that the object will look clearer and more intelligible to our program. Since we are working with live video so that we need the clear position of that object. We know live streaming is the moving object so that after taking the images of objects we need to train all image. After train the images, all the data our system will recognize the objects which are in the data set.

**Table 2:** Confusion matrix for detecting vehicle and people.

| | Match | Unknown |
|---|---|---|
| True | Detect | Not Detect |
| False | Not Detect | Detect |

**Table 3:** Confusion matrix for performance analysis.

| | Positive | Negative |
|---|---|---|
| True | TP | TN |
| False | FP | FN |

For experimenting our collecting data firstly, we have to separate the object into four parts which are the Top part, Bottom part, Left side and Right side. Then we need to find matching between object and data set. We use Color to the Grayscale algorithm to convert the color image. This converting process is shown in Fig. 1. After converting in grayscale, the dataset looks like the below format (Fig. 6). In the below image we see both positive dataset and negative dataset are present. And our ultimate target is to detect only the positive dataset which we already trained and it is stored in our database.

After matching the positive dataset with the dataset which is in a .xml file then our next task is to send a General-Purpose

Input/output (GPIO) signal to the raspberry pi. After getting the signal from GPIO, Raspberry Pi check if the image matched with the dataset or not. If it finds the matching positive dataset then it will detect the vehicle and people. Otherwise, it will not detect the other object. The matching part is shown in (Fig. 7) below:
The system we create gives the final output which is almost satisfying to our expected output. We find analyzing our image matching accuracy, sensitivity, specificity, precision from table 3.

### *4.1 Accuracy*
We find the accuracy of this system is 69%. To determine the accuracy, we need the actual class and negative classes correctly. To find the final accuracy mathematically, this can be stated as:
Accuracy = $(TP+TN) / (TP+TN+FP+FN)$×100%

### *4.2 Sensitivity*
We find the sensitivity of this system is 58%. To determine the sensitivity correctly we need actual classes correctly. To find the final sensitivity mathematically, this can be stated as:
Sensitivity = $TP/(TP+FN)$×100%

### *4.3 Specificity*
We find the specificity of this system is 89%. To determine the specificity of this system we need to determine the negative cases correctly. To find the final specificity mathematically, this can be stated as:
Specificity = $TN / (FP+TN)$×100%

### *4.4 Traffic Detection Using Cascading Classifiers*
We find the precision of this system is 91%. To determine the precision, we need the number of relevant classes among all the positive cases. To find the final precision mathematically, this can be stated as:
Precision = TP / (TP +$FP$)×100%
The increase in the number of vehicles and poor traffic management system is the reason behind the huge traffic problem in our country. But when we establish an automatic traffic detecting system then we can easily handle the traffic. Because of our experimental result has achieved almost 95% accuracy, satisfying to our expected result. Our traffic detection technique is more viable than others.

## 5. Conclusion
In this research, an image processing-based traffic detection and live surveillance system has been developed. It is a web-based system. Since it works on live streaming video, it can detect instantly provide information on traffic. The data obtained from the traffic detections system in this work can be further accessed and used for traffic violation detection by the law enforcing team. The streaming is stored in a database and can be accessed from anywhere anytime. In future, addition of Convolutional Neural Networks [13] can being in some intelligent insights on the output of the project

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