Real Time Traffic Density Count using Image Processing

Gote Yogita R[1] Prof. Korde A. L[2]
[1]Student [2]Professor
[1,2]Department of Computer Engineering
[1,2]KSIET – Hingoli, India

Abstract— Traffic congestion are very common now a days because of increasing number of vehicles. Traffic jam are also common an insufficient road are also one reason for traffic congestion. There is one solution for traffic problem is to develop intelligent traffic control system which is based on the measurement of traffic density on road using real time video and image processing technique. This paper describe a method of real time area based traffic density estimation using image processing for intelligent traffic control system.in this paper we describe the algorithm to describe the number of vehicles on the road. The algorithm works on the result of comparing the real time frame of live video by the reference image and by searching vehicles only in the region of interest. The main contribution of this research lies in the development of new technique that detect traffic density to the area. This research will be used for the detection of traffic density for intelligent traffic control system.

Key words: Image Processing, Edge Detection, Traffic Congestion Detection, Intelligent Traffic Control System

I. Introduction

The goal of this work is to develop an image based solution for detection, counting and classification by vehicle type of road traffic. There are so many road way sensor are available like radar or inductive loop which provide data only regarding traffic flow but image based technique are differ from that. in this paper a novel algorithm to perform the detection ,counting and classification of vehicles accomplished by using video input from traffic signal cameras that already exists in most of cities .

A. *Problem Definition*

The most common reason of traffic congestion in third world countries is an inefficient traffic signal controlling which affects the traffic flow. For example if one lane has less traffic and the other lane with huge traffic but the duration of green light for both lanes is same then this is the waste of available resources and is inefficient. By considering the above example if the lane with higher traffic density should switch on the green signal light for a longer period than the lane with lesser density. There are lots of techniques proposed to design an intelligent traffic system, for example, fuzzy based controller and morphological edge detection technique. We have proposed an area based technique for the detection of traffic density using image processing for intelligent traffic control system. This technique is based on the measurement of the traffic density by correlating the live traffic image with a reference image. The higher the difference is, higher traffic density is detected. This paper discusses a method for estimating the traffic density on the lane by using image processing. The advantages of this proposed technique is that there is no need to use aerial imagery or complex sensor based systems.

II. Existing System

A lot of techniques are proposed to detect traffic density to control traffic signal. Image processing is one of the most popular techniques.

James Adunya Omina, study on "An intelligent traffic light control system based on fuzzy logic algorithm" that is used for control traffic signals. This study aimed at showing how Fuzzy logic can be used in the development of an intelligent traffic light control system. Traffic light control algorithm plays a vital role in enhancing control of traffic flow in the cities , however despite the fact that traffic lights have been successfully used by many cities, little has been done to establish how fuzzy logic can be used to enhance traffic light control algorithm. Building on sparse literature regarding use of fuzzy logic in traffic light control algorithm, where motorists are allowed to interact collectively and intelligently with the environment, intelligent traffic light algorithm system based on fuzzy logic concept is appropriate and suited for our roads due to its adaptive nature. This research paper has adopted a cross sectional study targeting traffic control in the city of Nairobi Central Business District and its surroundings. The three junctions at Railways, Haile Salessie and General Post Office were used to collect data through observations of traffic behavior at the intersection points. Data was analyzed and presented using descriptive statistics; tables and graphs by using excel 2003. For testing our adaptive traffic light controllers, they developed a simulation system using Qt, C++ software integrated with MATLAB tools. The simulation runs results showed that the adaptive algorithms can strongly reduce average waiting times of cars compared to the conventional traffic controllers [4].

The human brain according to Bradley (2004) is constructed of cells called neurons. Neural networks have been proposed to control traffic lights to solve traffic congestion. Each cell accepts some inputs and then, based on the total value of inputs, the neural decides whether or not to fire an output. In the brain vast numbers of neurons are wired together, sending their outputs to other neurons, and ultimately allowing humans to make complex decisions about things. Neural networks attempts to replicate this process electronically. Neural network follow the same architecture as the brain, except the neurons are represented electronically. In a biological neuron, messages pass from cell to cell over gaps called synapses. Input messages then travel along dendrites. After the cell generates its output, an output message is sent out along an axon. Just as with biological neurons, neuron in a neural network has a set of inputs that it accepts then uses to calculate its outputs. The traffic lights adjust their signaling patterns according to the number of cars waiting in each direction, how long it has been since the light last changed the status of its neighbors. Neural networks provide the traffic lights with brains allowing them to make decisions[4].

Dipti Srinivasan, proposed" Neural Networks for Real-Time Traffic Signal Control", which describe adopts the multiagent system approach to develop distributed unsupervised traffic responsive signal control models, where each agent in the system is a local traffic signal controller for one intersection in the traffic network. The first multiagent system is developed using hybrid computational intelligent techniques. Each agent employs a multistage online learning process to update and adapt its knowledge base and decision-making mechanism. The second multiagent system is developed by integrating the simultaneous perturbation stochastic approximation theorem in fuzzy neural networks (NN). The problem of real-time traffic signal control is especially challenging if the agents are used for an infinite horizon problem, where online learning has to take place continuously once the agent-based traffic signal controllers are implemented into the traffic network. A comprehensive simulation model of a section of the Central Business District of Singapore has been developed using PARAMICS microscopic simulation program. Simulation results show that the hybrid multiagent system provides significant improvement in traffic conditions when evaluated against an existing traffic signal control algorithm as well as the SPSA-NN-based multiagent system as the complexity of the simulation scenario increases. Using the hybrid NN-based multiagent system, the mean delay of each vehicle was reduced by 78% and the mean stoppage time, by 85% compared to the existing traffic signal control algorithm. The promising results demonstrate the efficacy of the hybrid NN-based multiagent system in solving large-scale traffic signal control problems in a distributed manner[5].

Michael L Littman and Csaba Szepesvari, study on the Wiering (2004) explained that there are two types of agents that occupy an infrastructure; vehicles and traffic lights. All agents act autonomously, following some simple rules, and get updated every time-step. Vehicles enter the network at the edge-nodes. Each edge-node has a certain probability of generating a vehicle at each time step. Each vehicle that is generated is assigned a destination, which is one of the other edge-nodes. The distribution of destinations for each edge-node can be adjusted. There are several types of vehicles, defined by their speed, length, and number of passengers. Wiering (2004) further stated that Reinforcement learning is used to learn agent control by letting the agent (for example a car) interact with its environment, learn from the obtained feedback (reward signals).Using a trial and error process, a reinforcement learning (RL) agent is able to learn a policy (or plan) that optimizes the cumulative reward intake of the agent over time. Markov decision problems can be used for modeling the interaction of an agent with its environment. The agent's goal is to select actions that maximize the expected long-term cumulative discounted reinforcement, given arbitrary initial state (SD) using Dynamic programming techniques. Reinforcement learning for traffic light control was studied by Thorpe (1997); Thorpe and Anderson (1996). He used a traffic light based value function, and neural network for the traffic-light based function which predicts the waiting time for all cars standing at the junction. This means that Thorpe's traffic light controller has to deal with a huge number of states, where learning time and variance may be quite large. Furthermore, Thorpe used somewhat other form of RL; SARSA (State-Action, Reward-State Action) with eligibility traces (Sutton, 1996)[6-7].

P.Srinivas, proposed "Image Processing Edge Detection Technique used for Traffic Control Problem", which describe The frequent traffic jams at major junctions call for an efficient traffic management system in place. The resulting wastage of time and increase in pollution levels can be eliminated on a city-wide scale by these systems. The paper proposes to implement an intelligent traffic controller using real time image processing. The image sequences from a camera are analyzed using various edge detection and object counting methods to obtain the most efficient technique. Subsequently, the number of vehicles at the intersection is evaluated and traffic is efficiently managed. The paper also proposes to implement a real-time emergency vehicle detection system. In case an emergency vehicle is detected, the lane is given priority over all the others [8].

We have proposed an area based technique for the detection of traffic density using image processing for intelligent traffic control system. This technique can better estimate the traffic density using the area occupied by the edges of vehicles. Area based traffic density estimation will be more effective for controlling traffic lights than the conventional methods for the countries like Bangladesh where different types of vehicles running on the same road. We used here the background substration method that method uptill now no one used here.

III. DETAILED DESCRIPTION OF OUR PROJECT

In this project first different conventional as well as latest algorithms & techniques will be studied and analyzed. . Here we will divided the work is into 4 parts. The first part is to process the video signal and image acquisition from fixed camera using MATLAB. The second part is to select the target area where the vehicles could be present by using image cropping technique. The third part is the object detection which is performed by enhancing features of the image. Finally, the last part is the density counting, where the number of vehicles are being counted. The overall block diagram of the proposed system is illustrated below.

Our system consists the concept of the flow of system will be like below,

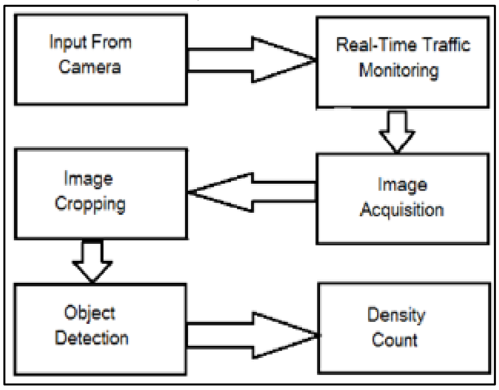

Fig. 1: Block Diagram of the Proposed Model

Our contribution of this research lies in the development of a new techniques that detects traffic density according to the area of the edges of vehicles or connected component by using background subtraction method that we used for clarity purposed in order to count the traffic density due to this we control the traffic signal smartly and avoid the traffic congestion.

A. Image Acquisition

1) Processing of Video Signal and Image Acquisition

The work starts with processing the live video using MATLAB software. The video camera is stationary, which is mounted on the pole near the traffic signal. The next stage is to extract the frames continuously from the real time video coming from the stationary camera. This raw digital data is further processed by converting the images from RGB (Red Green-Blue) to grayscale in order to further process the images. Initially the system captures the image of a vacant road when there is no vehicle present; this image is used as a reference image. Fig 4(a) shows the reference image which is captured from the live video when the road is empty.

Fig. 2: (a) Reference Image taken form live video form[9]

Fig. 2: (b) Defining the region of interest

Fig. 2: (c) Selection of the target area

Generally an image is a two-dimensional function f(x,y)(here x and y are plane coordinates).The amplitude of image at any point say f is called intensity of the image. It is also called the gray level of image at that point. We need to convert these x and y values to finite discrete values to form a digital image. The input image is a fundus taken form stare data base and drive data base. The image of the retina is taken for processing and to check the condition of the person. We need to convert the analog image to digital image to process it through digital computer. Each digital image composed of a finite elements and each finite element is called pixel.

2) Formation of Image

We have some conditions for forming an image f(x,y) as values of image are proportional to energy radiated by a physical source. So f(x,y) must be non-zero and finite. i.e., $0<f(x,y)<\infty$

3) Image pre-processing

a) Image resizing/scaling

Image scaling occurs in all digital photos at some stage whether this be in Bayer demosaicing or in photo enlargement. It happens anytime you resize your image from one pixel grid to another. Image resizing is necessary when you need to increase or decrease the total no. of pixels. Even if the some image resize is performed, the result can vary significantly depending on the algorithm. Image are resized because of the no. of reasons but one of them is very important in our project. Every camera has its resolution, so when a system is designed for some camera specifications it will not run correctly for any other camera depending on specification similarities so it is necessary to make the resolution constant for the application and hence perform image resizing.

b) RGB to GRAY Conversion

Humans perceive colour through wavelength-sensitive sensory cells called cones. There are three different varieties of cones, each has a different sensitivity to electromagnetic radiation (light) of different wavelength. One cone is mainly sensitive to green light, one to red light, and one to blue light. By emitting a restricted combination of these three colours (red, green and blue), and hence stimulate the three types of cones at will, we are able to generate almost any detectable colour. This is the reason behind why colour images are often stored as three separate image matrices; one storing the amount of red(R) in each pixel, one the amount of green(G) and one the amount of blue(B).

We call such colour images as stored in an RGB format. In grayscale images, however, we do not differentiate how much we emit of different colours, we emit the same amount in every channel. We will be able to differentiate the total amount of emitted light for each pixel; little light give dark pixels and much light is perceived as bright pixels. When converting an RGB image to grayscale, we have to consider the RGB values for each pixel and make as output a single value reflecting the brightness of that pixel.

One of the approaches is to take the average of the contribution form each channe. (R+B+C)/3. However, since the perceived brightness is often dominated by the green component a different, more "Human-oriented", method is to consider a weighted average, eg.,0.3R+0.59+0.11B.

B. Image Cropping

The second step is to select the targeted area by designing image cropping algorithms in MATLAB. The purpose of cropping is to identify the road region where the vehicles are present and exclude the unnecessary background information. This unnecessary information is fixed in every frame of the live video because the camera is stationary. To crop the required area, reference image has been used, Fig. 4(a), which has no road traffic. First, a binary image of having the same dimensions is created, as in the reference image, then the road area has been shaded white, and the leftover region as black, as shown in Fig. 4(b). Finally, the multiplication of the reference image with the cropping black and white image results in the final desired target area which is illustrated in Fig 4 (c). The next part explains the procedure of object detection.

C. Object Detection

The third step is the object or vehicle detection in order to identify and count the vehicles which are present in the targeted area shown in Fig. 4(c). To perform the object detection, first the frame from the real time video sequence is extracted as illustrated in Fig 5(a).

The next step is to convert both images; the reference image and the real time image into grayscale and then the absolute difference of two images will be determined. Since the dimensions of the road are fixed therefore the difference image only highlights the presence of vehicles in the desired target area. The difference image is illustrated in Fig. 5(b).

Fig. 3: (a) Real-time image extracted form the live video taken form[9]

Fig. 3: (b) Difference of reference and real time image

Fig. 4: (a) binarization of the difference Image

Fig. 4: (b) Image highlighting the presence of vehicles in the targeted area

Fig. 4(b) shows the presence of vehicles in the desired target area but the visibility of the vehicles is not much clearer in that image. In order to improve the visibility of the vehicles, the difference image is converted to a binary image based on a threshold value. The resulting binary image is shown in Fig. 2(a), where the presence of any object is more improved. In order to determine only vehicles in the desired area, multiplication of the cropped image, Fig. 2(b), with the enhanced version of the difference image, Fig. 4(a), is carried out. The product image is illustrated in Fig. 4(b). In Fig. 4(b), the unnecessary information is filtered out and it only highlights the presence of vehicles in the desired area.

1) Edge Detection

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more technically, has discontinuities or noise. The points at which image brightness alters sharply are typically organized into a set of curved line segments termed edges. The same problem of detecting discontinuities over time is known as change detection. Edge detection is a basic tool in image processing, machine vision and computer envisage, particularly in the areas of feature reveal and feature extraction.

a) Edge Detection Techniques

Different colours has different brightness values of particular colour. Green image has more bright than red and blue image or blue image is blurred image and red image is the high noise image.

Following are list of various edge-detection methods:

- Sobel Edge Detection technique
- Perwitt Edge Detection Technique
- Zerocross Threshold Edge Detection technique
- Canny Edge Detection technique.

In our project we use: “Canny Edge Detection Technique” because of its various advantages over other edge detection techniques.

b) Canny edge detector

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. It was developed by John F. Canny in 1986. Canny also produced a computational theory of edge detection explaining why the technique works.

c) Development of the Canny algorithm

Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. The general criteria for edge detection includes:

- Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible
- The edge point detected from the operator should accurately localize on the center of the edge.
- A given edge in the image should only be marked once, and where possible, image noise should not create false edges.

Among the edge detection methods developed so far, Canny edge detection algorithm is one of the most strictly defined methods that provides good and reliable detection. Owing to its optimality to meet with the three criteria for edge detection and the simplicity of process for implementation, it became one of the most popular algorithms for edge detection.

d) Process of Canny edge detection algorithm

The Process of Canny edge detection algorithm can be broken down to 5 different steps:

- Apply Gaussian filter to smooth the image in order to remove the noise
- Find the intensity gradients of the image
- Apply non-maximum suppression to get rid of spurious response to edge detection
- Apply double threshold to determine potential edges
- Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

Every step will be described in details as following. The introduction of procedure below is developed based on Prof Thomas Moeslund's lecture note for digital image processing in Indian Institute of Technology [5].

e) Background Subtraction Method

1) Vision.OpticalFlow

Optical flow Vision.OpticalFlow return an optical flow system objects, optical flow. This object estimates the direction and speed of object motion form one image to another or from one video frame to another.

2) MedianFilter :

This objects performs two-dimensional median filtering of an input matrix. Image filtering is used to remove noise, sharpen contrast, highlight contours, detect edges etc.

IV. Conclusion and Future Work

This paper discuss a simple way of counting object in the image and determine the correct value of density has been implemented. The number of object and density value are determined and vehicle counting application. The problem of counting density automatically as well as determining accurate value of density has been solved. In future the same algorithm can be extended which identifies the presence of emergency vehicle and by giving preference to those emergency vehicles.

References

[1] Naeem Abbas," Real Time Traffic Density Count using Image Processing", International Journal of Computer Applications (0975 – 8887) Volume 83 – No 9, December 2013, page no-16.

[2] Mohammad Shahab Uddin," Real-time Area Based Traffic Density Estimation by Image Processing for Traffic Signal Control System: Bangladesh Perspective", 2nd Int'l Conf. on Electrical Engineering and Information & Communication Technology (ICEEICT) 2015 Jahangirnagar University, Dhaka-1342, Bangladesh, 21-23 May 2015, 978-1-4673-6676-2/15/$31.00 ©20 15 IEEE.

[3] S.Sri Harsha," Real Time Traffic Density And Vehicle Count Using Image Processing Technique", International Journal of Research in Computer and Communication Technology, Vol 4, Issue 8 , August - 2015, Page no - 596.

[4] James Adunya Omina," an intelligent traffic light control system based on fuzzy logic algorithm", International Academic Journal of Information Systems and Technology | Volume 1, Issue 5, pp. 1-17, October 2015.

[5] Dipti Srinivasan," Neural Networks for Real-Time Traffic Signal Control", IEEE Transactions on intelligent transportation systems, vol. 7, no. 3, september 2006,Page no - 261.

[6] Michael L Littman,and Csaba Szepesvari,"A generalized reinforcement learning model:convergence and applications," in 13th International Conference Machine Learning,pp.310-318,1996 .

[7] Zhenjiang Li,Feng He,Qingming Yao,and Fei-Vue Wang," signal controller design for agent-based traffic control system,"in IEEE International Conference on Networking,Sensing and Control,pp.199-204,April 2007.

[8] P.Srinivas," Image Processing Edge Detection Technique used for Traffic Control Problem", (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 4 (1) , 2013,Page no – 17.

[9] Live Video of CCTV Camera for Traffic Monitoring in Stockholm, available at http://www.trafiken.nu/sv/Stockholm/trafiklaget/Kamer o r/Roslagsvagen/Albano/

