MAT JOURNALS

Journal of Image Processing and Artificial Intelligence
eISSN: 2581-3803
Volume 4 Issue 3

Methods for Effective Traffic Control using Image Processing

[1]Sachi D. Agrawal, [2]Dr. Nilesh J. Uke
[1]PG student, Department of Information & Technology,
Pimpri Chinchwad College of Engineering, Pune, Maharashtra, India
[2]Principal, Department of Information & Technology, Trinity Academy of Engineering,
Pune, Maharashtra, India
***Email:** [1]agrawalsachi19@gmail.com, [2]nilesh.uke@gmail.com*
***DOI:** http://doi.org/10.5281/zenodo.1743751*

Abstract

As the issue of urban action blockage spreads, there is a pressing necessity for the introduction of pattern setting advancement and apparatus to upgrade the best in class of development control. Development issues now a days are growing an immediate consequence of the people increases and moreover number of vehicles also augments and the compelled resources given by current structures. The minimum troublesome course to control a development light uses clock for each stage. Another course is to use electronic sensors with the true objective to recognize vehicles, and make hail that cycles. By and by, the best way for movement controlling and watching is using picture getting ready. The structure will perceive vehicles through pictures instead of using electronic sensors introduced in the black-top. A CCTV camera will be presented close by of the action light. It will get picture groupings. The image gathering will then be destitute down using modernized picture dealing with for vehicle acknowledgment, and according to development conditions all over the place movement light can be controlled.

Keywords: *Image Processing, CCTV Camera, Traffic Condition, etc.*

INTRODUCTION

Intelligent traffic

In this day and age there is no proficient activity framework, one method for giving productive movement framework is by controlling movement lights progressively dependent on activity thickness. Likewise there are no crisis administrations accommodated the vehicles like emergency vehicle, fire detachments and so on. Hence, a few administrations other than the typical administrations must be acquainted with these vehicles for more productivity in rush hour gridlock framework. There is an extraordinary need to take care of the issues looked by the subjects for productive administration of movement.

Movement stack is profoundly reliant on ongoing parameters, for example, time, day, season, climate and eccentric circumstances, for example, mischances, extraordinary occasions or development exercises. On the off chance that these parameters are not considered, the movement control framework will make bottlenecks and postponements. A movement control framework that tackles these issues by consistently detecting and checking activity conditions and altering the planning of movement lights as per the real activity stack is called an Intelligent Traffic Control System. This framework will have the capacity to detect the nearness or nonappearance of vehicles and act as needs be. This framework can take care of the issue of movement blockage and aides in clearing a path for the crisis vehicles or crisis correspondence. The fundamental point of the Intelligent Traffic Signal Simulator is to diminish the holding up time of every path of the vehicles.

Image Processing

Image Processing is a strategy to change over a picture into computerized shape and play out a few tasks on it, with the end goal to get an upgraded picture or to remove some valuable data from it. It is a kind of flag benefit in which input is picture, similar to video edge or photo and yield might be picture or qualities related with that picture. Typically Image Processing framework incorporates regarding pictures as two dimensional signs while applying effectively set flag preparing techniques to them. It is among quickly developing advances today, with its applications in different parts of a business. In present times the traffic problem is arise due to the increase in vehicle usage. Traffic flow reason can play a principle role in gathering information about them. This data is used to establish contemptuous flow time periods such as the effect of large vehicle, specific part on vehicular traffic flow and providing a factual record of traffic volume trends.

Traffic congestion gives various negative impacts- including loss of productive time and manpower, waste of fuel, late delivery of goods, pollution, etc. This traffic is regulated in most of the metropolitan cities, but in some semi urban areas the traffic is unregulated. This difference is shown in Fig.1.

Fig: 1. *Regulated and unregulated traffic*

The increasing number of vehicles as well as the increasing density of vehicles during different parts of the day, also the public attitude, and duration of traffic light control system are some of the factors adding to the problem. While these problems don't have a technical solution, a solution can be expected for controlling the duration of traffic signal.

Previously different techniques had been proposed, such as infrared light sensor, induction loop etc. to acquire traffic date which had their fair share of demerits. In recent years, image processing shows potential outcomes in acquiring real time traffic information using CCTV footage installed along the traffic light. Different approaches have been proposed to collect traffic data. Edge detection technique is necessary to extract the required traffic information from the CCTV footage. It can be used to separate the required information from rest of the image. Authors in [8] used unique object detection and tracking system where video segmentation, feature extraction, object detection and tracking are combined perfectly using various features

DIFFERENT TECHNIQUES FOR TRAFFIC CONTROLLING

A.Firmware-based novel technique

In this paper, author focuses on a firmware-based novel technique for vehicle detection. This approach detects the vehicles in the source image, and applies an existing identifier for each of the vehicle. Later it classifies each vehicle on its vehicle-type group and counts them all by individually [1]. The developed approach was implemented in a firmware platform which results is better accuracy, high reliability and less errors.

Pre-processing: Pre-processing is the technique of converting RGB color image to gray color image. It is done by using luminance converter shown in below equation.

$$I_S=0.2896*I_R+0.5870*I_G+0.1140*I_B$$

I_S is the grey level image. I_R, I_G, I_B are the luminance in red, luminance in green and luminance in blue.

Image enhancement: Picture improvement gives the better difference and point by point picture by contrasting picture which is non upgraded one. Some of picture improvement systems are control law change, direct technique and Logarithmic strategy. Among them, control law change strategy is best methodology which has the fundamental equation as demonstrated as follows:

$V = K v\gamma$

Where V and v are I/O gray levels, γ & K is a positive constants (K=1). This method is also called as "Gamma correction method", for attain a Gamma correction, the association between light input and output signals must be taken. This is done by the following equation

S(0)=K.(e)(E) S(0) is output gain and K is the exposure time that is related to intensity and linear vehicles.

Object detection: In protest discovery we can discover the edges of a picture compare to question limits. These edges are only pixels where the adjustment in brilliance may happen and it is computed the conduct of picture work in a neighboring pixel.

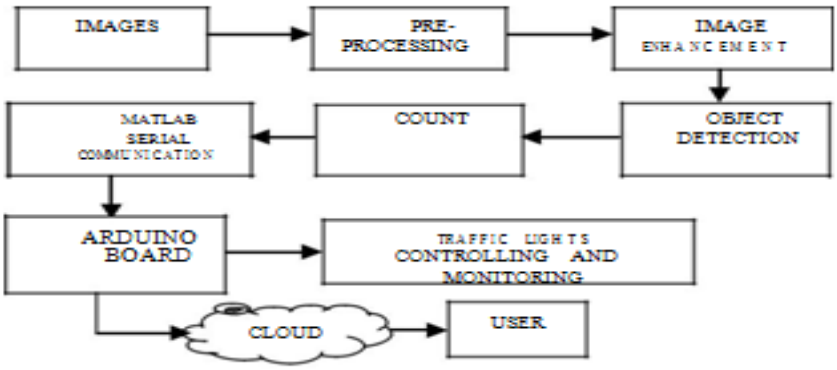

Fig: 2. *Block Diagram*

Count: In order to avoid the problem of traffic we have to know details about number of vehicles and situation. For counting the number of vehicles "bw label function" is used which is inbuilt function in MATLAB.

Serial communication (Matlab to Arduino): By using simple MATLAB m-files to communicate with Arduino board use MATLAB Arduino program for providing communication link between MATLAB and ARDUINO.

Arduino board: In the ARDUINO board the program is dumped from the ARDUINO software. By using the serial communication the data transfers from the MATLAB to the ARDUINO.

Traffic lights controlling and monitoring: Before uploading the Arduino program in to the microcontroller, first the program will saved and compiled. If program is error free then only it will be uploaded. And as per the ARDUINO program the traffic lights will run and the traffic density will be continuously monitored.

Cloud: The count of the vehicles or the density is calculated in the MATLAB and are sent to the cloud through Arduino by typing "AT".

User: The user can get traffic information or traffic status over particular area or junction by signing in to the cloud.

B. Fuzzy Inference Technique

In this paper creator means to progressively controlling the activity motion through picture handling and fluffy rationale methods[2]. Brilliant Traffic Controller utilizing Fuzzy Inference System (STCFIS) accepts the movement thickness as contribution to the controller and dependent on the info decides the span of green flag. This value is defuzzified and then sent as a quantitative input to an arduino microcontroller which decides the timing of green signal. Block diagram of STCFIS is shown in Fig.3. There are three blocks- Pre-processing block, Fuzzy Logic based Intelligent Traffic controller block, Computation of duration of green signal block.

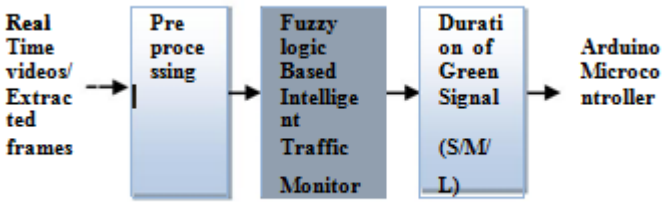

Fig: 3. *Block Diagram: STCFIS*

Feature Detection Method-

Feature detection method, detects pattern or distinct structure found in an image such as edge, corner, point or small image patch. It detects the feature point for each and every object in the image. Two feature detection methods are: SURF and MSER are used in extracting feature points. This method is depicted in Fig.4.

SURF: Speeded Up Robust Feature (SURF) algorithm is implemented to find the blob features. A blob feature is a region of an image in which some properties are approximately constant. This algorithm returns extracted interest points which are known as descriptors.

MSER: Maximally Stable External Region (MSER) algorithm is implemented to detect MSER region. In this method features are actually shape i.e. box features rather than points or corners. By combining MSER region detector with SURF descriptors gives more number of feature points.

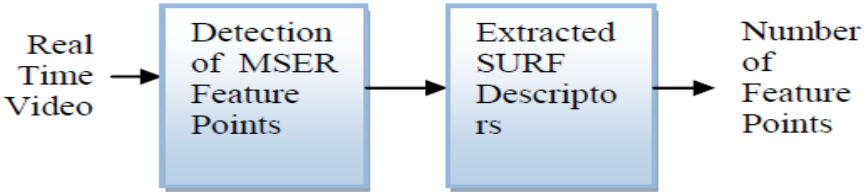

Fig: 4. *Steps in Feature Detection Method*

Image Subtraction Method-

In this method, background image is extracted from the video which has no vehicle or lesser vehicles. This background image is considered as a reference image. Each sample image is subtracted from this

reference image also the video which is divided into frames is subtracted from this reference image. The result of subtraction would be the count of zeros as shown in Fig.5. and this count of zeros gives an indication of vehicular density. If the count of zeros are more than vehicle density is less and vice versa.

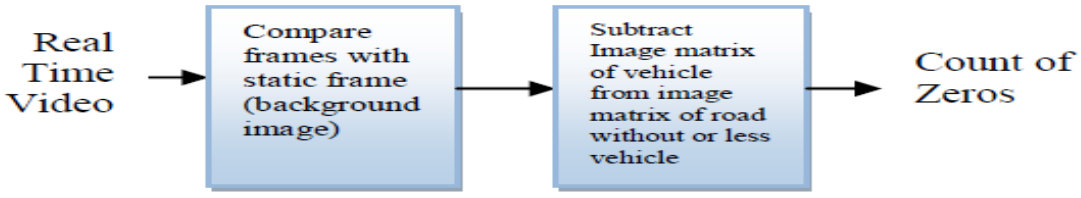

Fig: 5. *Steps in Image Subtraction Method*

Fuzzy Inference System (FIS)-

Fluffy rationale can manage data emerging from computational perception and comprehension, that is dubious, off base, fluffy, halfway obvious, or without sharp limits.

The components of FIS are fuzzifier, rule base which is formulated by the human experts, fuzzy inference engine and defuzzifier.

Design of Fuzzy Inference System (FIS)-

a) Structure of FIS: A fuzzy logic controller designed for computing the density of traffic in junction is a one input and one output controller. The structure of FIS is shown in Fig.6.

Input variable: Density of vehicles on road in terms of count of zeros. Output variable: Timing of green signal which is a number given as an input to arduino microcontroller.

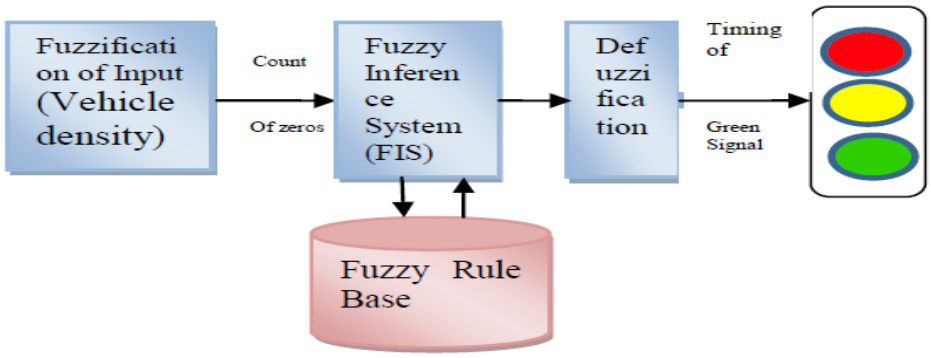

Fig: 6. *Structure of Fuzzy Controller*

b) Fuzzy Rule Base: Fuzzy logic controller is designed with rule base using IF-THEN conditions. There are three fuzzy rules designed for traffic controller as follows;

1. If count of zeros is Less Green Signal will be ON for "Long" Amount of time.
2. If count of zeros is Moderate Green Signal will be ON for "Moderate" Amount of time.
3. If count of zeros is high Green Signal will be ON for "Small" Amount of time.

C. Using Infrared Sensors

An Infrared sensors are installed at either side of the road, makes note of incoming vehicles towards the signal. These signals which have the 'congestion' mark will indicate the Raspberry-Pi processor, which was installed inside the signal [3]. The

Raspberry-Pi instructs the traffic controller to show the appropriate signals of the traffic based on the density. The data signal given to the traffic light will be as: The congested side will be given more 'green light' to the side and vice versa. In case of equal congestion, time distribution of 'green signal' is also equal. The time split is totally depend on the input data from the IR sensors.

The major disadvantage of this algorithm will be the waiting-time of vehicles which are on less congestion side. This problem is overcome by splitting the time, not giving entire time to the side having higher dense. Other factors like sunlight, dust, fog, etc. which can distract the IR sensors and are overcome by using an Image processing mechanism with the help of a Web-Cam employed at the signal.

The **background subtraction algorithm** is used in the image processing to plot out the blockage in the IR-sensors and the blockages are reported to the processing unit. Once the blockages removed the timer is reset and the normal flow of the system is revived to the initial configuration. This can be illustrated as architecture in Fig.7.

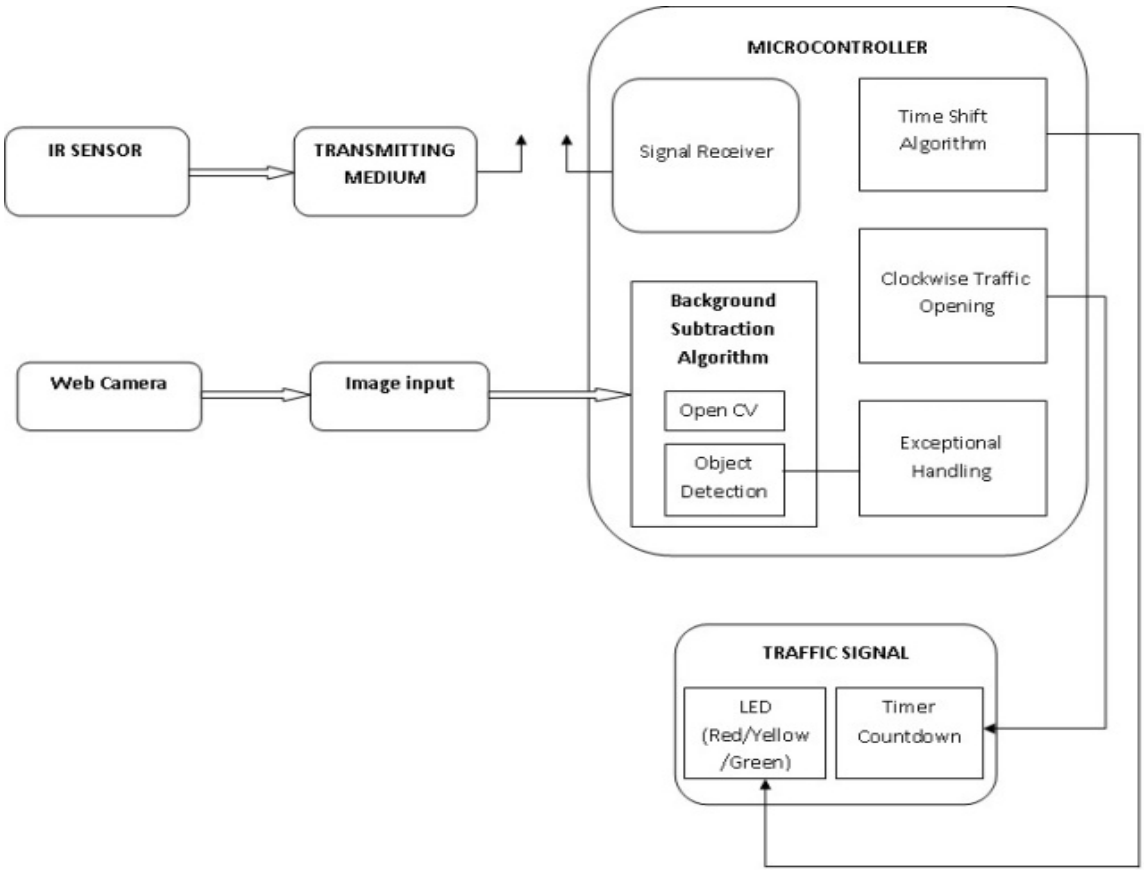

Fig: 7. *Architecture*

D. Canny Edge detection technique

A framework in which thickness of activity is estimated by contrasting caught picture and ongoing movement data against the picture of the vacant street as reference picture is proposed. Fig.8. demonstrates the square outline for proposed activity control strategy [4].

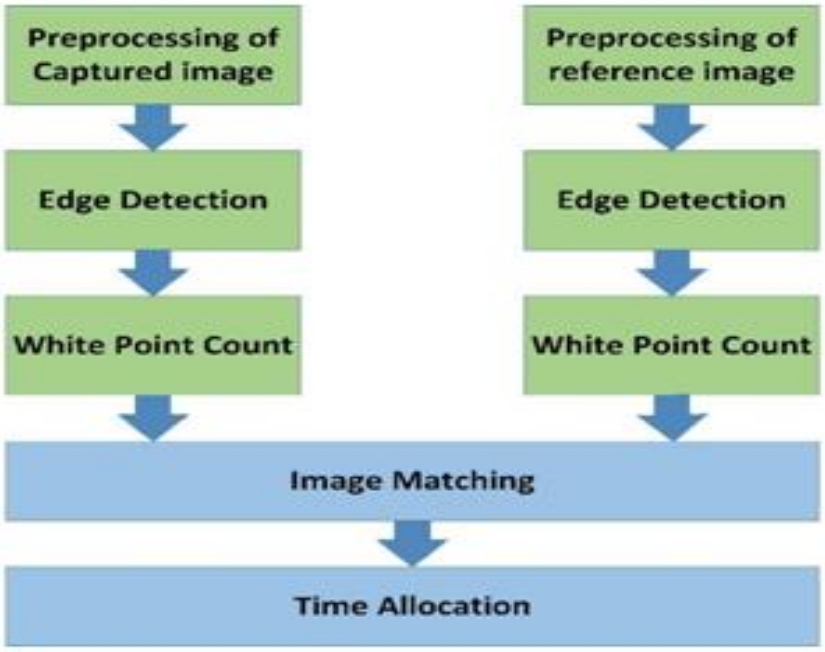

Fig: 8. *Block diagram of density based smart traffic control system*

Each lane will have a minimum amount of green signal duration allocated. According to the percentage of matching allocated traffic light duration can be controlled. The entire image processing before edge detection i.e. image acquisition, image resizing, image pre-processing and noise reduction is done. Canny edge detection operation and white point count are depicted. Canny edge detector operator is selected because of its greater overall performance. This paper completely serves the purpose of indicating the limitations of current traffic control techniques and the solution of this limitation with detailed explanation.

Edge detection and white point count:

Edge detection technique is used to identify different types of shapes and isolating different shapes of vehicles from rest of the image. After comparing different edge detectors, canny edge detector is found suitable for this experiment. After edge detection, the resultant images are binary image with only black and white pixels i.e. values 0 and 1. The value '0' denotes black points while value '1' denotes white points. The white pixels essentially represent the detected edges. So, images with different traffic conditions will have different white point counts. Since the reference image has least number of vehicles, it would have the least number of white pixels among these five images. Therefore, this image is used as a reference image to measure the traffic density. Total number of white pixels are calculated for each individual image intended for matching purpose.

Percentage matching and time allocation:

Since reference image is basically an image of the empty road, the less similarity between sample image and reference image, the more vehicles are present on the road. As irrelevant edges detected in sample images such as edges of footpaths, islands etc. are also exist in reference image, their effects are nullified when comparing them with reference image. The percentage of matching is calculated using the following formula,

$$\%match = \frac{Total\ number\ of\ white\ points\ in\ reference\ image}{Total\ number\ of\ white\ points\ in\ sample\ image} * 100$$

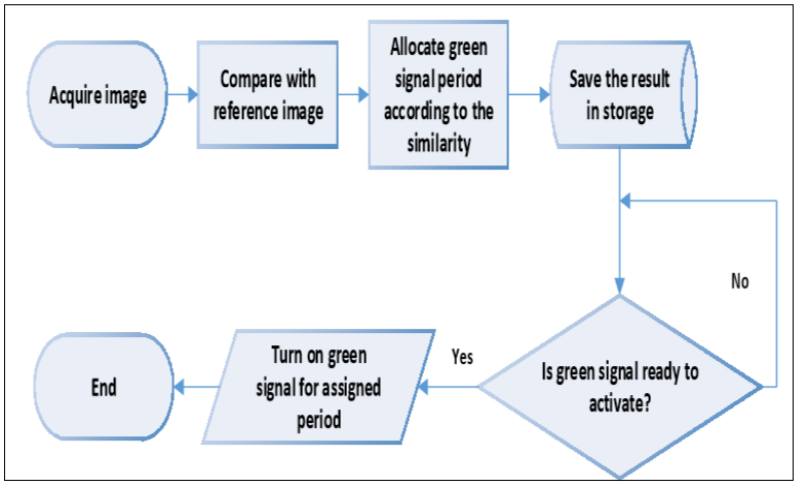

Fig: 9. *Time allocation algorithm for autonomous traffic control system*

Time allocation to green signal is decided by the percentage of matching of consecutive lanes. The proposed time allocation is based on assumption and contemporary time allocation may depend on various factors; for instance, number of vehicles, traffic condition on neighboring intersections etc. For example, if the vehicle queue is larger than average, it would require longer time to clear. Additionally, it would be malicious if other vehicles from neighboring intersections make worse the traffic congestion of adjacent intersections.

E. Contour finding technique

This paper mainly focuses on controlling and monitoring of the traffic using image processing with CCTV camera. The traffic congestion investigating system by Image Processing from CCTV Camera is separated in three main parts in an overview Fig.10.

1) Image categorization by background subtraction and vehicle detection techniques.

2) Traffic density computing from a traffic image.

3) Collection and representation of a traffic condition.

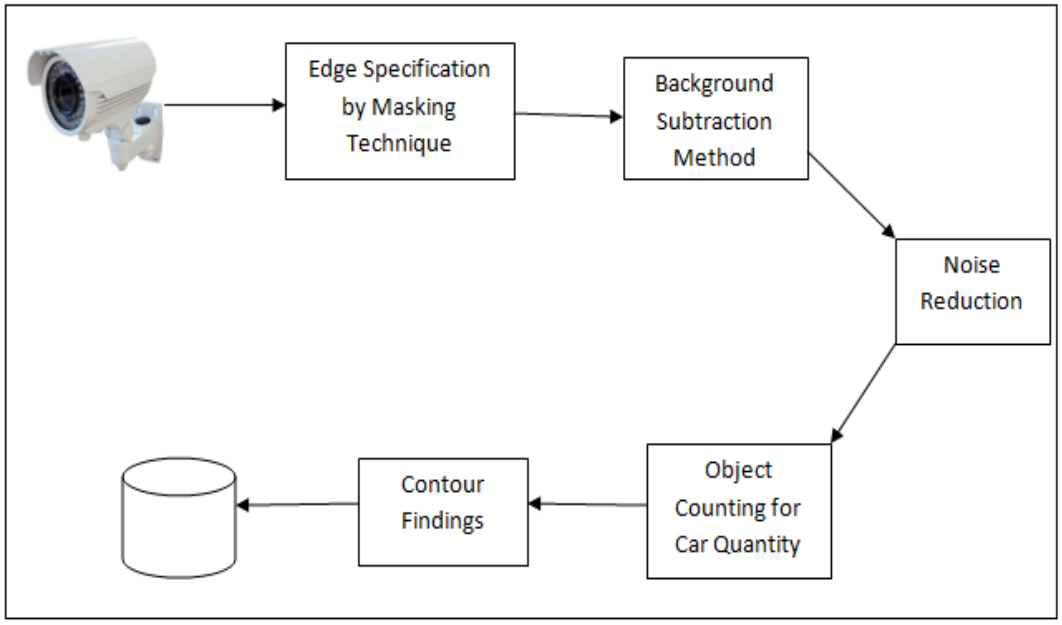

Fig: 10. *Processes of the Traffic Congestion Investigating System*

Step 1: Masking technique is used to delete unnecessary parts out for the system computing from CCTV camera images in each frame. Those examples of unnecessary parts are an opposite site of the road or a sidewalk, footpaths, etc.

Step 2: Convert an image into a form of gray scale for finding threshold.


Step 3: Find the objects or cars on the road by using background subtraction technique.


Step 4: Use an erosion technique for noise reduction and connect object pixels together with a dilation method.

Step 5: Use a contour technique in order to find out an edge in each object from an image.

Step 6: Analyze an object from a distance with a CCTV camera. If an object is near from a camera or in a lower part of an image, that object will be big. In an opposite way, if an object is far from a camera or in an upper part of an image, that object will be small. From that point onward, the analysts investigate if there should be an occurrence of a size of a question does not identify with a separation from a CCTV camera. For instance, a too little question possibly isn't a vehicle likewise a too enormous protest is in excess of one vehicle particularly when activity is congestive. In outcome, there is a cover between every vehicle in rush hour gridlock. At that point, there is an expected an incentive for a vehicle amount that staying together. Here is a computation for that estimation.

1. For (first pixel in y axis) to (last pixel in y axis) do.
2. An estimating formula is, Number of Cars in This Range = Contours Size / Size of One Car in This Range.
3. Increase output by adding number of cars in this range.
4. Adjust y axis pixel to another range. A pixel in y axis represents a distance from a CCTV camera. A contours size represents how large for contours in an image.

Step 7: This progression is an execution for an activity blockage notice as stream, substantial, or stuck. In the wake of getting a yield as a generally vehicle amount, the framework registers that yield with a past picture casing to discover for a normal esteem and complete a proportion count with a whole zone in the wake of utilizing a covering procedure. As a result,

1. If a ratio value is similar to 1, it means that traffic is jammed.
2. If a ratio value is between 0.4 and 0.7, it means that traffic is heavy.
3. If a ratio value is less than 0.4, it means that traffic is flow.

Step 8: Transfer a traffic congestion data to a database of the system for a traffic planning.

COMPARATIVE STUDY OF FIVE PAPERS

Here we studied 5 papers about their datasets, algorithms, noise reduction techniques, hardware used also their traffic

type and environment. Following table shows comparative study of different five papers. So by comparing this papers we can judge accuracy of each paper and finds how each techniques will accurate for application.

Table: 1. *Comparison of Papers*

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
Hardware used	Arduino board, camera, Mobile device	Video camera, Arduino, microcontroller, LED's	IR sensors, Wi-Fi transmitter, Raspberry Picontroller	CCTV, LED's, Arduino board	CCTV, LED's
Data Sets	Captured Images	Real time traffic videos (Vile Parle, Bandra, santacruz)	Real time traffic images	Real time traffic images	Traffic images
Traffic Type	Normal, Heavy	Moderate, Heavy	Congested	Congested, Minor, Moderate	Flow, Heavy, Jammed
Environment	Day time	Morning, Afternoon, Evening	-	-	Day time
Algorithm	Power law transformation	Feature detection, Image subtraction	Background subtraction	Canny edge detection	Contour based thinning
Noise Reduction Technique	Median filter	-	-	Gaussian filter	Erosion technique

APPLICATIONS

Reduce Accidents - By considering necessary constraints required for traffic controlling, can reduce the accidents.

1. **Emergency Transport** - Traffic controlling is beneficial for emergency transport. By informing drivers about traffic conditions, they can change the route in case of any emergencies.
2. **Creation of Green Corridor** - During medical emergency, Ambulance can get the easy way.
3. **Vehicle Detection** - For searching the particular vehicle during any crime or accidents.
4. **Vehicle Counting** - If we want to calculate the number of vehicles of specific brand.
5. **Finding thieves and offenders** – In case of any crime investigation, finding thieves and offenders will be easy because of CCTV.

CONCLUSION

Contemplated different strategies to control the activity like utilizing Arduino Board, utilizing Fuzzy interface framework, utilizing Infrared and IOT, utilizing Canny Edge recognition calculation, utilizing picture preparing with CCTV camera. Taken in the points of interest and inconveniences of different strategies for movement controlling. Endless supply of different edge location calculations, it is inferred that Canny Edge Detection procedure is productive one. The utilization of this method evacuates the requirement for additional equipment, for example, sound sensors.

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Cite this article as: Sachi D. Agrawal, & Dr. Nilesh J. Uke. (2018). Methods for Effective Traffic Control using Image Processing. Journal of Image Processing and Artificial Intelligence, 4(3), 26–36. http://doi.org/10.5281/zenodo.1743751