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RESEARCH ARTICLE

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# SMART TRAFFIC LIGHT CONTROLLING AND VIOLATION DETECTION SYSTEM USING DIGITAL IMAGE PROCESSING

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**ABSTRACT**

In the current days the traffic congestion is becoming a serious issue, especially in developed cities which has a crowded traffic. Many accidents happen because of the traffic jam. Some drivers violate the traffic rule and tries to escape, because there is no system that can detect and report them as a violated drivers. Once the proposed system is implemented the violation of traffic rules will be minimized, because the drivers will be aware of the system that can detect the traffic violations. Currently the traffic lights are working based on time. This system has many drawbacks such as traffic congestion, red light time delays, wastage of time, high cost of transportation, wastage of fuels and air pollution. A smart traffic light system is needed to minimize those problems. The proposed system focuses on how to solve these traffic problems by developing a smart traffic light controlling system. The system proposed to switch the traffic lights based on the density (count) of the vehicles on the road. The lane with the highest density (vehicle count) will have a longer time for a green signal. It also focuses on how to detect traffic violations such as a lane change violation, stop line violation and red light violations using violation detection system that will work simultaneously with the traffic light controlling system.

Keywords – Density count, lane violation, stop line violation, traffic light switching, vehicle count.



## 1. INTRODUCTION

The current traffic control system works based on time to switch the traffic lights. But many researches are conducted to change the current traffic light system into automatic and adaptive system to solve the problems with the traffic congestion. Some researchers used hardware installation such as sensors and Radio Frequency Identification [8] to detect the crowdedness of vehicles, but this is expensive and difficult to implement. Some researchers are also working to solve the problem with the help of image processing using image subtraction method to calculate the density of vehicles [1] - [4]. They have used a fixed image that cannot be changed, as a reference image in image subtraction method. But this method is not efficient in the night-time, because the light condition in the night-time is not same as in daytime. The decision making for switching the traffic light works based on the calculated density. Anurag [1] used an algorithm to determine the approximate density of vehicles on the road with four lanes. Using this algorithm the dynamic system [1] improves 35% over the hard coded system.

Ashwini [2] used a motion detection algorithm to estimate the count of vehicles on the road; the estimated count will then used to control the traffic signal.

In some researches edge detection technique [9] [11] is used to detect the objects and the traffic light durations sets accordingly. But using edge detection method is not efficient in the night-time, because the edge of the vehicles is not visible in night-time. And some vehicles may have similar colors with the road that will be difficult to detect using edge detection method. M. Ashwin and B.K Arvind [3] have used image subtraction using pixel Subtraction using Hole Filling Algorithm. Marcos Paulo Batista [6] proposed an efficient method to detect and estimate the lane using road marker estimation in image processing. Hazim Hamza [10] presents a car recognition system in night-time using HSV color thresholding for segmenting the red regions (tail lights) to classify the different classes of lights for different car models. Elimination method to discriminate the vehicles from the background and used a fuzzy logic to control the traffic light.

Adi Nurhadiyatna [5] improved Gaussian Mixture Model Background Some researches for violation detection are conducted using video processing. Ramesh Marikhu [7] used background subtraction, shadow detection, blob extraction and violation analysis for lane change violation detection. Xiaoling Wang [10] have used a dynamical background update method based on the wavelet transform to detect moving vehicles for violation detection. The problem with this system for violation detection is, a separate camera is needed to capture the image of the traffic lights in order to detect the state of the traffic signal. But in the proposed system there is no need of separate camera for capturing the traffic lights, the system by itself controls the traffic lights.

The proposed method overcomes the limitations in Anurag [1] as it works only in daytime. After Sunset the system [1] doesn't work efficiently because of the low light condition in night-time. In this case the system switches to the hard coded system that is currently working in the traffic light controlling system. The solution for this problem is to install a night vision camera so that the dynamic system will keep working in night-time as it works in day-time. But installing a night vision camera in each side of the road is expensive. The proposed system overcomes this limitation by switching the system in night-time into a system that works in such a way that can detect and count the number of vehicles. Based on this count value the system decides which side of the road will be assigned with a green signal and calculates the amount of time for the green signal.

The proposed system is to develop a smart traffic light switching with the techniques of image processing that can switch the traffic signals in different ways for day-time and night-time. In the day-time the system measures the density of the vehicles on the road and in the night-time the system counts the number of vehicles on the road using the vehicle's headlight, based on these measurements the traffic light will be switched. Apart from that the proposed system will improve the functionalities of the previous works, such that it can detect the traffic violations such as a red light violation, stop line and lane violations. Each of the lights will have their own additional features, such that the red light detects a stop line and red light violations, and the green light will also detect the lane violation. In the proposed system some filtering techniques, image enhancement and segmentation will be used to remove a noise and improve the quality of the captured image so that the accuracy and efficiency of the system will be improved accordingly.

**2. Design and Methodology**

The system will use image subtraction method to calculate the amount pixels occupied by vehicles on the road. The proposed system uses two different methods in day-time and night-time. Density of vehicles will be calculated in day-time, because the vehicles are more visible in the day-time than in the night-time. So it is effective to use density count rather than vehicle count in day-time. Counting the number of vehicles in the daytime may lead to a false result because two very close vehicles may be counted as a one vehicle. But the system calculates the number of vehicles in the night-time using headlight because the headlight is more visible at night. At night-time; Counting the number of headlight is effective than calculating the density of vehicles because the vehicles are not visible at night-time with a very low condition. The system will be developed using image processing techniques in Matlab programming.

The proposed algorithm checks the time, whether it is a day or night in order to switch the system accordingly. The decision module receives density count (number of vehicles) in green signal and red signals (2) (3). Based on these values the decision module calculates the amount of time for the green signal (TDi and TNi) and decide which side of the road will be assigned with a green signal.

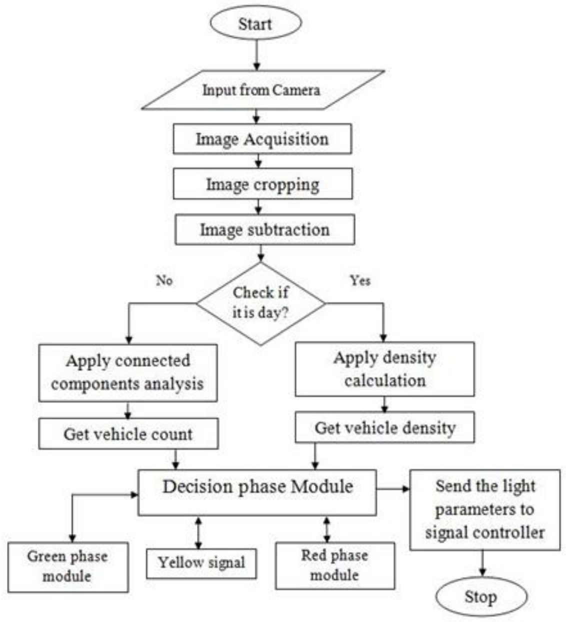


Fig. 1 Flowchart of the proposed system

### 2.1 Density count in day-time

The following steps are needed to calculate the density of vehicles.

- Image acquisition: The proposed system will start by recording a live real time video using a stationary video camera.
- Initially the system captures the image of an empty road with no vehicles which is used as a reference image (RI).
- The system captures a continuous sequence image frames from the live video per one second, which is used as a current image (CI).
- Only the interested target area of the road will be cropped for both reference and current images, so that the unnecessary parts will be eliminated.
- Background subtraction will be applied in each sequence of image frames to separate the foreground objects (vehicles) from the background, then the result image (I) will be obtained.
- The subtracted image will be processed by converting from RGB (Red Green Blue) to Grayscale for further processing.
- In each step of the image acquisition process a noise may be introduced, Image filtering techniques will be applied to remove any kind of noises, here median filtering will be used to remove salt and pepper noises and generate a filtered image.
- In the filtered result image there may be some non vehicles detected as foreground objects that are needed to be removed to improve the quality of the result image. So that thresholding will be applied to differentiate the objects (white) and non object (black). Dilation morphological technique will also be used to fill the holes inside vehicle objects; dilation is used for examining and expanding the shapes of the image to extend the border and regions of the objects. This results the final black and white image (Ibw) which is used to calculate the density count.

  Here if the pixel value (pv) is not zero, which is considered as an object (vehicle). But if pv is zero, which is considered as a background (non object) that needs to be eliminated.

$$I_{bw} = \begin{cases} 1 & \text{if } pv \geq 1 \\ 0 & \text{else} \end{cases} \quad \textbf{(1)}$$

- Finally the density of vehicles on the road will be calculated (not number of vehicles). The value of vehicle density determines the amount for which portion of the road is occupied by vehicles [4].

$$D = \sum_{i=1}^{n} \sum_{j=1}^{m} \mathrm{I_{bw}} \qquad (2)$$

Here n is number of rows and m is number of columns. Only the white pixel values in all rows and columns will be added to density (D).

(a)

(b)

(c)

(d)

(e)

**Fig. 2** background subtraction method for density count, (a) Reference image (RI), (b) Cropped image, (c) Current image (CI), (d) Subtracted image (I), (e) $I_{bw}$ image

**2.2 Vehicle count in night-time**

- In the night-time unlike the day-time there is no need to calculate the total number of pixel values; here we need only to calculate the total number of connected white colors in the given image.
- After all the above techniques applied to the input image an enhanced black and white image (Ibw) will be produced, and it will be used for vehicle count in the night-time.
- Since the front light of the vehicles is more visible at night, only the light of the vehicle remains white and the rest part of the image remains black, if it is not exactly black the thresholding techniques will be applied to change the colors to black.
- The number of connected white color objects (N) will be calculated in Ibw using NumObjects function in Matlab, which is used to calculate the number of connected components (objects) in black and white images.
- Some cars can have four headlights, but the system assumes two headlights per car. Apply the Dilation morphological technique to extend the border of the regions until both headlights are connected, so that both lights will be considered as a single object and the count will become one.

- Mark all the detected headlights with BoundingBox.

Finally the number of objects will be divided by two to get the total number of vehicles on the road.

C=N/2 (3)

C is the count of vehicles in a particular lane and N is the total number of connected white objects in Ibw. Here the total number of objects is divided by the constant number (2) to estimate the total number of vehicles in a particular lane which affects the same way in all the lanes. The effect of two vehicles with only one headlight such as motorcycle is considered as the same as one vehicle with two headlight.

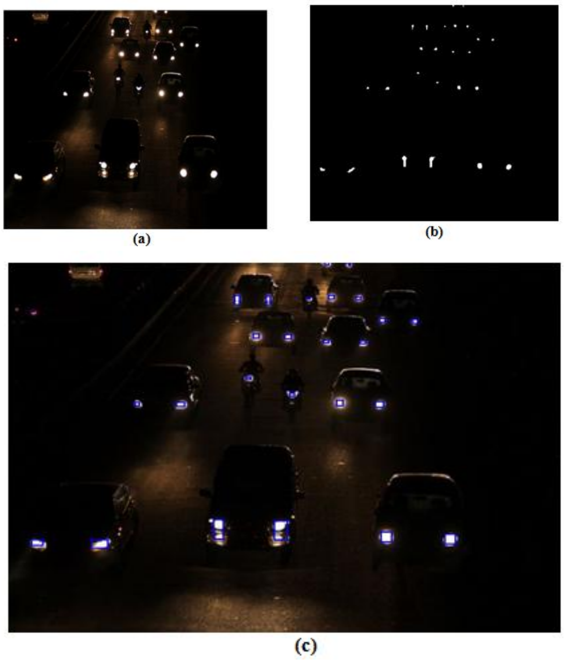


Fig. 3 Mark and count headlight in night-time, (a) Input image frame, (b) Headlight detection, (c) Mark and count headlights

**How the signal will be switched**

The density (count) for all the vehicles in all sides of the road will be determined and used as input parameters to switch the signals.

The time for green signal is calculated using density (count) of vehicles in one road per the total density (vehicle count) in all sides of the intersection road.

The proposed method use the formula in [4] to calculate the time for green signal, that produces three outputs from the input parameters; weighted time (WD, WN) and traffic cycle (Tc). Tc is the total amount of time for one complete cycle of the traffic lights. WDi is a weight factor (the relative density) at a particular road in the intersection road and calculated as:

$$WD_i = \frac{D_i}{\sum_{j=1}^{n} D_j} \quad (4)$$

WNi is a weight factor (the relative vehicle count) at a particular road in the intersection road and calculated as:

$$WN_i = \frac{C_i}{\sum_{j=1}^{n} C_j} \quad (5)$$

Where WDi is a weight factor of ith road in day-time, WNi is a weight factor of ith road at night-time, D is density calculated in day-time, C is vehicle count calculated in night-time, and n is the total number of road in the intersection,. The time (TDi) of green light at ith road in the day-time is calculated by:

$$TD_i = T_c \times WD_i \quad (6)$$

The time (TNi) for green light that will be assigned to ith road in the night-time is calculated by:

$$TN_i = T_c \times WN_i \quad (7)$$

Finally, this value will be sent to signal controller to switch the signals accordingly based on the decision phase module. The minimum amount of green light provided to a lane must be 15 Sec and maximum is 60 sec.

### 2.4 Traffic violation detection

The system proposed to detect violations such as stop line violation, red light violation and lane violation to improve the smartness of the traffic light system. If any of these violations happened the system automatically captures an image of the violated vehicle. Lane violation is a violation of traffic law committed by the driver by changing lanes illegally when turning or failing to stay in the assigned lane. Stop line or red light violation is crossing the stop line while the red signal is ON.

The lines of the lane and stop line will be cropped and the system calculates density (2) in the cropped line image. If any vehicle crosses the lane line or stop line, the density in that line will be changed from the threshold density (calculated with no vehicle). In this condition the system detects the vehicle as a violated vehicle if the vehicle tries to cross the lane lines or stop lines.

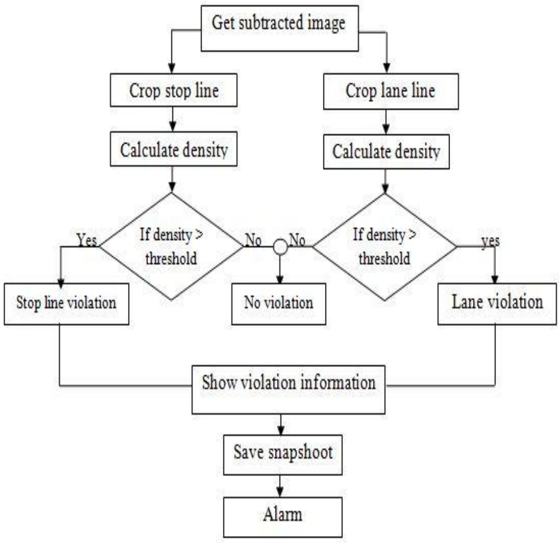


Fig. 4 Flowchart for violation detection

When a green light is switched ON then the system starts to detect lane change violation, because the vehicles starts to move when the green light is ON and this is the condition in which most probably the violation for lane change can happen. When the red light is ON then the system starts to detect stop line violation or red light violation and lane change violation, because the vehicles supposed to stop when the red light is ON. If the system detects any vehicle in the stop line region when the red light is switched ON then the vehicle will be detected as a violated vehicle and the system automatically takes a snapshot and make an alarm.

**3. Experimental Results**

In dynamic algorithm for switching traffic light by Anurag [1] the system doesn't work up to expectations in the night time. The proposed system overcomes this limitation by counting the head light of vehicles at night time by applying connected component analysis method. This method counts the total number of connected white pixels. The following figure shows the implementation on how to detect, mark and count headlights using connected component analysis method.

Table 1 shows real time image frames of vehicles in the night time as input. The total vehicles represent the number of actual vehicles in real time, and counted vehicles represent the number of vehicles counted by the system. In some image frames there may be some non vehicle objects counted as vehicles so that the counted vehicles become more than the actual total number of vehicles. And some vehicles may not be detected so that the counted vehicles become less than the actual total number of vehicles. The system generates a good Experimental result for 40 random image frames. Most of the vehicles are detected with high accuracy. The success percentage for detecting vehicles in night-time from Table1 is:

%success = (3753/4000)*100%=93.8%

So the success percentage to detect vehicles in night-time is approximately 93.8%, which can improve the dynamic algorithm for switching traffic light [4].

Table 2 shows the vehicle count and the time assigned to a green signal in night time. In this experiment there are four lanes and the time assigned to each lane is different according to the vehicle count. The lane with a large number of vehicles assigned with a longer time for a green signal and the lane with less number of vehicles have short time for a green signal. The minimum time assigned for a lane is 15 Sec and maximum is 60 Sec.

Table 3 shows the density of vehicles and the time assigned for a green signal. The lane with a high density will have a longer time for a green signal and a lane with less density will have a short time for a green signal.

Table 1: Statistical analysis of counting vehicles in night-time

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Actual vehicles | 6 | 4 | 9 | 7 | 7 | 11 | 11 | 7 | 11 | 10 | 10 | 8 | 7 | 9 | 10 | 8 | 10 | 7 | 9 | 11 |
| Counted vehicles | 6 | 4 | 7 | 7 | 8 | 11 | 10 | 6 | 10 | 10 | 12 | 9 | 7 | 9 | 10 | 8 | 9 | 8 | 9 | 10 |
| % success | 100 | 100 | 77 | 100 | 87 | 100 | 91 | 85 | 91 | 100 | 83 | 89 | 100 | 100 | 100 | 100 | 90 | 87 | 100 | 91 |
| Actual vehicles | 13 | 7 | 11 | 10 | 5 | 4 | 4 | 7 | 6 | 5 | 7 | 5 | 10 | 8 | 6 | 11 | 9 | 10 | 10 | 11 |
| Counted vehicles | 13 | 7 | 12 | 9 | 4 | 4 | 4 | 8 | 6 | 5 | 9 | 5 | 11 | 8 | 6 | 13 | 9 | 9 | 10 | 10 |
| % success | 100 | 100 | 91 | 90 | 80 | 100 | 100 | 87 | 100 | 100 | 77 | 100 | 91 | 100 | 100 | 85 | 100 | 90 | 100 | 91 |

Table 2 : Vehicle Count(C) and Time (Tn) for a green signal of each lane in the night-time

| Traffic cycle | Lane 1 | | Lane 2 | | Lane 3 | | Lane 4 | |
|---|---|---|---|---|---|---|---|---|
| | V.Count(C1) | Time (Tn1) sec | V.Count(C2) | Time (Tn2) sec | V.Count(C3) | Time (Tn3) sec | V.Count(C4) | Time (Tn4) sec |
| 1st | 13 | 60 | 5 | 25 | 8 | 40 | 4 | 20 |
| 2nd | 9 | 47 | 6 | 31 | 11 | 57 | 3 | 16 |
| 3rd | 7 | 37 | 8 | 39 | 13 | 60 | 3 | 15 |
| 4th | 4 | 22 | 11 | 60 | 8 | 44 | 4 | 22 |
| 5th | 5 | 28 | 7 | 39 | 4 | 22 | 11 | 60 |

Table 3: Density (D) and Time (Td) for a green signal of each lane in the day-time

| **Traffic cycle** | **Lane 1** | | **Lane 2** | | **Lane 3** | | **Lane 4** | |
|---|---|---|---|---|---|---|---|---|
| | Density ($D_1$) | Time ($Td_1$) Sec | Density ($D_2$) | Time ($Td_2$) Sec | Density ($D_3$) | Time ($Td_3$) Sec | Density ($D_4$) | Time ($Td_4$) Sec |
| **1st** | 609 | 21 | 1428 | 48 | 1663 | 56 | 756 | 25 |
| **2nd** | 1851 | 60 | 488 | 19 | 299 | 15 | 1310 | 50 |
| **3rd** | 1273 | 43 | 975 | 33 | 388 | 15 | 1846 | 60 |
| **4th** | 408 | 15 | 1797 | 60 | 636 | 23 | 1373 | 49 |
| **5th** | 1437 | 46 | 830 | 27 | 397 | 15 | 2031 | 60 |

**Table 4:** Comparison between hard coded and dynamic coded algorithm in night-time.

| S.No | Time | Algorithm | Lane 1 | | Lane 2 | | Lane 3 | | Lane 4 | | Total cars | Percentage improvement |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Car passed | Time for Greenlight | Car passed | Time for Greenlight | Car passed | Time for Greenlight | Car passed | Time for Greenlight | | |
| 1 | 0-150 | Hard | 44 | 60 | 68 | 60 | 52 | 30 | 0 | 0 | 164 | 36 |
| | | Dynamic | 32 | 22 | 50 | 36 | 102 | 59 | 40 | 33 | 224 | |
| 2 | 151 - 300 | Hard | 62 | 60 | 0 | 0 | 50 | 30 | 58 | 60 | 170 | 37 |
| | | Dynamic | 54 | 31 | 56 | 35 | 92 | 56 | 31 | 28 | 233 | |
| 3 | 301 - 450 | Hard | 0 | 0 | 75 | 60 | 78 | 60 | 42 | 30 | 195 | 14 |
| | | Dynamic | 52 | 25 | 60 | 40 | 59 | 45 | 52 | 37 | 223 | |
| 4 | 451-600 | Hard | 58 | 60 | 80 | 60 | 0 | 0 | 46 | 30 | 184 | 23 |
| | | Dynamic | 51 | 33 | 53 | 37 | 72 | 43 | 51 | 37 | 227 | |
| 5 | 601-750 | Hard | 36 | 30 | 0 | 0 | 101 | 60 | 48 | 60 | 185 | 13 |
| | | Dynamic | 36 | 31 | 50 | 34 | 88 | 48 | 36 | 38 | 210 | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 751-900 | Hard | 40 | 30 | 84 | 60 | 97 | 60 | 0 | 0 | 221 | 10 |
| | | Dynamic | 49 | 35 | 65 | 38 | 82 | 48 | 48 | 29 | 244 | |
| 7 | 901-1050 | Hard | 55 | 60 | 42 | 30 | 0 | 0 | 68 | 60 | 165 | 42 |
| | | Dynamic | 49 | 34 | 47 | 33 | 95 | 52 | 44 | 31 | 235 | |
| 8 | 1051-1200 | Hard | 0 | 0 | 54 | 30 | 109 | 60 | 42 | 60 | 205 | 12 |
| | | Dynamic | 33 | 27 | 69 | 39 | 98 | 53 | 30 | 31 | 230 | |
| 9 | 1201-1350 | Hard | 32 | 60 | 71 | 60 | 57 | 30 | 0 | 0 | 160 | 25 |
| | | Dynamic | 18 | 26 | 52 | 35 | 86 | 53 | 45 | 37 | 201 | |
| 10 | 1351-1500 | Hard | 38 | 60 | 0 | 0 | 49 | 30 | 75 | 60 | 162 | 34 |
| | | Dynamic | 24 | 20 | 50 | 34 | 96 | 60 | 47 | 32 | 217 | |

- Hard coded: In the conventional traffic light every lane gets a fixed duration of time for green light and for red light. Here we take a scenario of intersection road with four lanes. Each lane assigned with 60 seconds of green light and 180 seconds of red light per one traffic cycle.
- Dynamic coded: In the proposed algorithm a lane with the highest number of vehicles gets a longer time for a green
- light and a lane with less number of vehicles gets a short time for a green light. In table IV we have taken a different number of vehicles that can pass in each lane, and compare both algorithms by running each algorithm for 1500 seconds on the same interval of 150 seconds. More number of vehicles can pass in dynamic coded than in hard coded.
- The average of the improvement is approximately 24%.

**Table 5:** Violation detection using Density threshold

| | Input image frames | Targeted area (Cropped stop line) | Subtracted image of the target area ($I_{bw}$) | Density (D) In the cropped area | Check violation |
|---|---|---|---|---|---|
| Reference image(RI) |  | | | D=0, Threshold=20 | |
| Current image with no violation |  | | | D=0 | D<Threshold No violation detected |
| Current image with violation |  | | | D=244 | D>Threshold, Violation detected |

Table 5 shows violation detection using density threshold. Let the density threshold is 20, because there may be some none vehicle objects detected in the violation target area with a density less than 20. But if any object detected with density greater than threshold (20) in the target area, then the object will be considered as a violated vehicle.

The rate of capturing image frames from the video affects the accuracy for violation detection. The system captures 30 image frames per second from the video. The accuracy for detecting the state of the traffic light signal is 100%, because the system by itself is switching the lights. So that the system starts to detect stop line and lane violation when the red light is ON, and the system starts to detect lane change violation when the green light is ON.

**Conclusion**

In this paper, it is proposed to develop a smart traffic light controlling system that can switch the traffic lights automatically and detects traffic violation such as lane violation, stop line violation and red light violation. The proposed system works 24 hours; in the day-time the system calculates the density of the vehicles and in the night-time the system calculates the number of vehicles. Based on the crowdedness of the vehicles the traffic signals will be switched. The road with the highest value of density (vehicle count) will have a longer time for a green signal. The system is proposed to improve the functionality, accuracy and efficiency of the previous works in automatic traffic light controlling system by applying different image enhancement techniques, thresholding, noise filtering, morphological techniques. The proposed system can be extended using neural network and fuzzy logic to control the traffic lights and predict urban traffic congestion.

References

[1]. Anurag Kanungo, Ayush Sharma, Chetan Singla, Smart Traffic Lights Switching and Traffic Density Calculation using Video Processing, Proceedings of 2014 RAECS UIET Panjab University Chandigarh, 06 – 08 March, 2014, 978-1-4799-2291-8/14/$31.00 ©2014 IEEE

[2]. Ashwini D. Bharade, Surabhi S. Gaopande, Robust and Adaptive Traffic Surveillance System for Urban Intersections on Embedded Platform, 2014 Annual IEEE India Conference (INDICON), 978-1-4799-5364-6/14/$31.00 ©2014 IEEE

[3]. M. Ashwin, B.K Arvind, R. Barath Kumar, S. Arun Karthik, Pixel Detection and Elimination Algorithm to Control Traffic Congestion Aided by Fuzzy Logic, 2013 Fifth International Conference on Advanced Computing (ICoAC), 978-1-4799-3448-5/13/$31.00 ©2013 IEEE

[4]. Md. Munir Hasan, Gobinda Saha, Aminul Hoque, Md. Badruddoja Majumder, Smart Traffic Control System with Application of Image Processing Techniques, 3rd international conference on informatics, electronics & vision 2014, 978-1-4799-6711-7/14 $31.00 © 2014 IEEE

[5]. Adi Nurhadiyatna, Wisnu Jatmiko, Benny Hardjono Ari Wibisono1, Ibnu Sina, Petrus Mursanto, Background Subtraction Using Gaussian Mixture Model Enhanced by Hole Filling Algorithm (GMMHF), 2013 IEEE International Conference on Systems, Man, and Cybernetics, 978-1-4799-0652-9/13 $31.00 © 2013 IEEE

[6]. [6]. Marcos Paulo Batista, Patrick Y. Shinzato, Denis F. Wolf and Diego Gomes, Lane Detection and Estimation using Perspective Image, 2014 Joint Conference on Robotics: SBR-LARS Robotics Symposium and Robocontrol. 978-1-4799-5180-2/14/$31.00 ©2014 IEEE

[7]. Ramesh Marikhu, Jednipat Moonrinta, Mongkol Ekpanyapong and Matthew Dailey, Supakorn Siddhichai, Police Eyes: Real World Automated Detection of Traffic Violations, 978-1-4799-0545-4/13/$31.00 c 2013 IEEE

[8]. Harpal Singh, Satinder Jeet Singh, Ravinder Pal Si, Red Light Violation Detection Using RFID, Proceedings of 'I-Society 2012' at GKU, Talwandi Sabo Bathinda (Punjab)

[9]. Chandrasekhar. M, Saikrishna. C, Chakradhar. B, Phaneendra Kumar. P & Sasanka. C, Traffic Control using Digital Image Processing, ISSN (Print): 2278-8948, Volume-2, Issue-5, 2013

[10]. Hazim Hamza, Prof. Paul Whelan, Night Time Car Recognition Using MATLAB, M-Eng in Electronic Systems 2013

[11]. kzavya P Walad, Jyothi Shetty, Traffic Light Control System Using Image Processing, Vol.2, Special Issue 5, October 2014

[12]. Xiaoling Wang, Li-Min Meng, Biaobiao Zhang, Junjie Lu, K,-L. Ju, A video-based traffic violation detection system, 978-1-4799-2565-0/13/$31.00 ©2013 IEEE

[13]. Waing, Dr. Nyein Aye, On the Automatic Detection System of Stop Line Violation for Myanmar Vehicles (Car), Volume 1 - Issue 4 November 2013

[14]. Md. Rifat Rayhan, Faysal, Mohammad , Md. Taslim Reza, Improvement of a Traffic System using Image and Video Processing, Volume 2, Issue 3 (May. – Jun. 2013),