Vehicle Classification and Violation Detection on Traffic Light Area using BLOB and Mean-Shift Tracking Method

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***Abstract*—Obeying traffic regulations is an obligation for every driver. Although obeying traffic regulations is mandatory, there are many violations that occur on the road such as breaking through road markings or traffic lights. The police have implemented many innovations to reduce the occurrence of traffic violations, but they are still inefficient in handling traffic violations. In this research, a vision system was built to recognize vehicles (cars and motorcycles) and to recognize violations committed by drivers at road intersections. In this study, a vision system was built to recognize vehicles (cars and motorcycles) and to recognize violations committed by drivers at road intersections. Vehicle violation data is taken from CCTV cameras installed at road junctions. the system works for vehicle detection and traffic violation detection. The process of vehicle detection by searching for vehicle contours uses the BLOB method. Furthermore, in tracking vehicles using the Mean Shift Algorithm. To recognize road marking violations. We create a border as a reference in the CCTV video using image processing. When the traffic light sign stops, and the vehicle does not stop at the reference line, the vehicle is considered a traffic violation. When the vehicle has to turn, or go straight, it must be in the same direction as the reference line, otherwise it is considered a traffic violation. The detection results for motorcycles are 79% and cars are 71%. Meanwhile, the average result of violations on road markings is 58%.**

Keywords—vehicle, traffic violation, BLOB, mean shift algorithm, road markings

I. Introduction

Lack of obeying traffic regulations due to driver selfishness is often the cause of traffic violations. Most traffic violations occur at crossroads in the traffic light area. The number reached 3,285 violators and 1,482 violators were prosecuted. Meanwhile, the second highest number of traffic violations is violating road signs or markings. There are 1,712 violators of road markings and 782 violators have been prosecuted. While the third was violation of the speed limit, 268 people and 113 violators were prosecuted [1]. Research [2] has presented research on vehicle detection using the Convolutional Neural Network method where the success rate in recognizing vehicles is very high, but complex learning parameters are needed to support the neural network. Vehicle detection and classification based on region of interest (ROI) was also carried out [3] so that it was quite successful because the detected area was limited, but this system was only tested to detect the direction of the car on a straight road track. In this research, vehicle detection and vehicle classification using ROI were carried out, where any color change in the video frame was identified as a vehicle. This color is marked as ROI, which has previously been processed into a binary image. The detected ROI will determine the type of vehicle, if the number of pixels of the same color in the ROI is large then it is recognized as a car and if it is small it is recognized as a motor. To detect traffic violations, road junctions are given reference lines for markers. Vehicles crossing the line are considered a traffic violation. This system is successful in detecting and classifying vehicles because it does not need to use training data to identify vehicles.

II. Theori

A. Road markings

A road marking is a sign that is above the road surface which includes signs that form straight lines, transverse lines, dotted lines and other symbols that serve to direct the vehicle to stop, move straight, or turn.

Fig. 1. Road Markings

B. Image Segmentation and Image Substraction

Image segmentation is the separation of objects from other objects in an image. There are 3 types of segmentation:

1. Boundary -based
2. Edge - based: Look for lines in the image and these lines are used to delineate each segment.
3. Region - based: Segmentation based on a set of similarities of pixels (color, texture or grayscale level) from a predetermined point.

Image Subtraction is the process of determining objects in an image by comparing the objects in the image with a background model. The background subtraction procedure consists of 3 stages, namely pre-processing, background modeling, and foreground detection.

C. *Image Thresholding*

Process threshold is a method for determining between objects and the background in an image, which is meant by grayscale. If the color of the image is close to black, the color in the image will be made black (black). If the color of this image is bright then the color of this image is made brighter (white). Black is translated as a value of 0, white is translated into binary as 1. The values of 0 and 1 are the result of the threshold which is realized in the binary image. After the image is successfully separated from the object with the background, it can be marked as masking to cut off the ROI process.

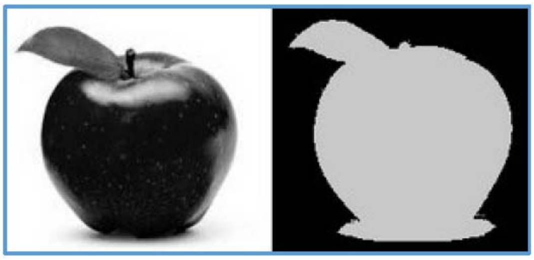


Fig. 2. Binary Image

D. *Convex Hull*

Convex hull method is a classic problem in computational geometry, the problem is simply described in two-dimensional space (plane) to find a subset of the set of points on that plane so that if these points are made into polygon they will form convex polygons. A polygon is said to be convex. If a line connecting a point is drawn, no line intersects the line that becomes the outer boundary of the polygon. Another definition of convex hull is polygons which are arranged from a subset of points so that there is no point from the initial set that is outside the polygon. This process is used so that excessive threshold results are not considered objects. The object in this research is the vehicle.

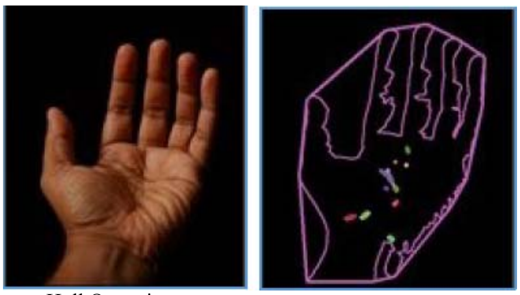


Fig. 3. Convex Hull Operation

E. *Binary Large Object (BLOB)*

BLOB (Binary Large Object) is a collection of pixels connected together in an image that has the same property (color, texture or grayscale level). The main use of this BLOB is to detect objects that have been processed by Convex Hull so that it is considered as a vehicle. BLOB has features to detect objects including:

1. Based on color: To detect objects between dark and light this feature can be used.
2. By size: To detect the size of the object this feature can be used.
3. By shape: To detect shapes you can use this feature (circle, convexity and inertia ratio).

III. Methodology

This section represents the design and implementation of systems used for vehicle detection and violation detection systems. All the process stuff is explained in the block diagram of Figure 4.

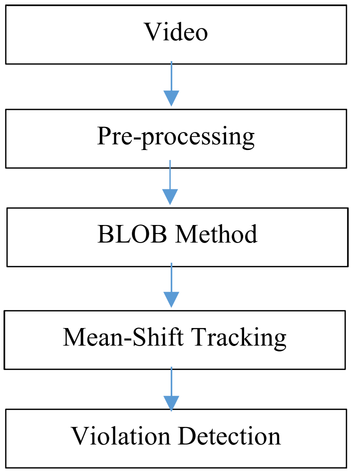


Fig. 4. Diagram system

A. *Preprocessing until BLOB Method*

Before creating a BLOB that automatically detects vehicles, pre-processing is necessary. Detect moving objects and not objects (noise)

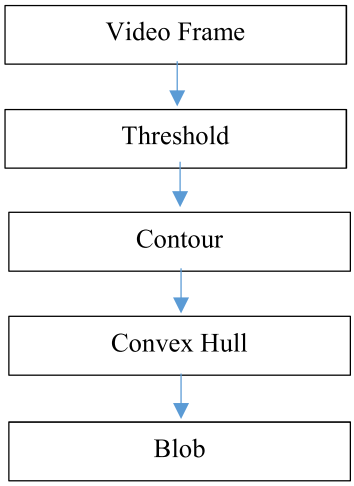


Fig. 5. Flowchart of pre-processing

Input comes from CCTV cameras which are divided into 3 times namely night, morning and noon. Figure 6 shows video input from various times.

(a) (b) (c)

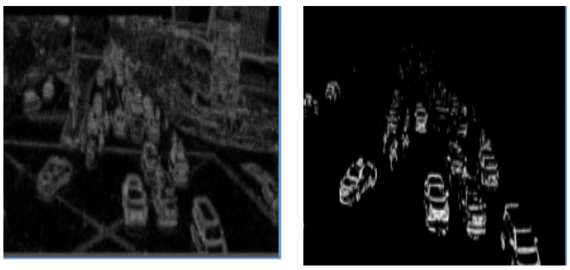
Fig. 6. CCTV camera (a) night (b) morning (c) noon

Image subtraction or image difference is used for detect moving objects. In this study is to see Changes from frames are subtracted from frames that have been added Gaussian Blur. So, we get foreground moving objects only. The result obtained is grayscale because of the two frame operands has gone through the grayscale process before.

(a) (b)

Fig. 7. Video (a) input (b) image subtraction (grayscale)

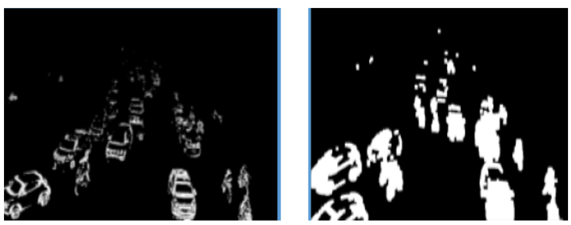
After the image subtraction process, the next process is the threshold (the value range is 0-255), the video is given the same threshold that is 30 and 225, the number explains that the lower limit of color is 30 and a maximum of 225 if more than that it will not be considered.



(a) (b)

Fig. 8. Image preprocessing (a) grayscale (b) binary thresholding

In this process the image of the threshold results will be formed again to make it more dense by adding morphology operations through dilation and erosion. For this process the value given can vary using 3x3, 5x5 or 7x7 as needed, so that the image formed looks clear.



(a) (b)

Fig. 9. Image preprocessing (a) binary threshold (b)contours

The use of Convex Hull Operation here is to form an image so that no part is separated from a contours.

(a) (b)

Fig. 10. Image (a) convex hull (b) BLOB

BLOB (Binary Large Object) is a process used to form objects that have the same value, because BLOB only processes the resulting contours, then objects that have the same contour will be put together. Then to remove noise, a decision will be taken which will determine whether the measure includes a vehicle or not. For contours that are recognized as vehicles, they will be immediately tracked otherwise they will not be considered. To determine how much the size of the vehicle can be determined by the user using a slider by increasing the lowest limit for motorcycles and the lowest limit for cars.

B. *Mean Shift Algorithm*

In this step the detected BLOB must be tracked so that when a collision occurs it does not reduce the level of accuracy. Collisions themselves are caused due to collisions when BLOB is formed or collisions that occur after BLOB is formed. For collisions when BLOB is formed it is unavoidable, while for collisions when BLOB is formed, tracking can be done for each BLOB. By using this prediction a collision will be avoided even if it is only a collision when a BLOB is formed.

$$\Delta x = \frac{\sum a.K(a-x)w(a)(a-x)}{\sum a.K(a-x)w(a)} \quad (1)$$

$$\Delta y = \frac{\sum a.K(a-y)w(a)(a-y)}{\sum a.K(a-y)w(a)} \quad (2)$$

The tracking phase will predict the position of the BLOB center using the mean shift method, by looking at the BLOB center values up to 5 previous frames and then looking for the total value changes (x, y) in the video frame. Figure 11 is the result of tracking using mean shift.

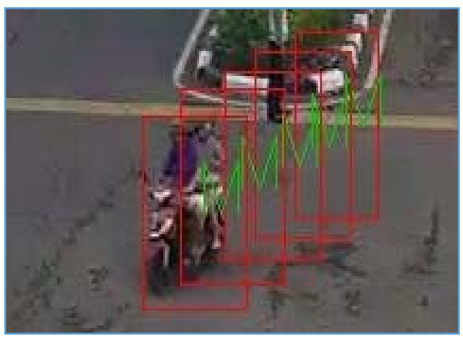


Fig. 11. Object tracking

C. *Vehicle Classification*

In this paper classification will be classified by 2 kind of vehicle that is motorcycle and car. By using BLOB feature by the size for classify the vehicle, ROI will be needed (in Fig. 12 will using line as a ROI so all vehicle that not pass it will not be classified yet) so all vehicle will have the same view and make them have near size so the classification logically can be done.

Fig. 12. Red box is a detected vehicle

D. Violation Detection

This stage will identify every change in the path, but from observations made in order to get the most appropriate data then mark violations will be counted as half or all Vehicle parts have crossed the line.

Fig. 13. Road Markings

IV. Result

Table 1 is the result of vehicle detection at night, morning and noon. Each time taken 3 times the test.

TABLE I. Result of Vehicle Detection

Data	Length (sec)	*Real counter vehicle*	*Counter vehicle*	%
Night-1	17	4	3	75
Night -2	19	5	6	93
Night -3	32	8	14	57
Morning-1	21	38	30	78
Morning-2	23	29	27	93
Morning-3	36	43	37	86
Noon-1	21	102	65	63
Noon-2	17	63	53	83
Noon-3	19	42	48	87
% Average				85

From table 1, this method got average 85% detected the vehicle, the best results when vehicle detection is early morning. During the day the vehicle detection results are not very accurate because of traffic jams on the road so the means of shifting is not too optimal to take every 5 frames.

Fig. 14. Vehicle Counter ROI Result

Because the light bounces off the asphalt road, so it is considered a vehicle. For vehicle density will cause an error when covering each other.

TABLE II. Result of Car Classification

Data	Real car	Not car detected	Car detected	%
Night-1	1	2	1	33
Night -2	1	0	1	100
Night -3	4	2	2	75
Morning-1	6	3	4	85
Morning-2	10	-	7	70
Morning-3	26	9	15	92
Noon-1	59	17	40	96
Noon-2	50	8	26	68
Noon-3	36	14	21	97
% Average				71

If white pixels are collected in large numbers, they are recognized as car vehicles, if white pixels are collected in small numbers, they are recognized as motorcycles.

Fig. 15. Car and motorcycle classification

Table 3 is the classification results for motorcycle type vehicles.

TABLE III. Result of Motor Classification

Data	Real motor	Not motor detected	Motor detected	%
Night-1	2	0	2	99
Night -2	4	1	4	80
Night -3	4	2	3	80
morning-1	33	5	30	94
morning-2	19	0	19	99
morning-3	16	1	11	70
Noon-1	42	24	25	85
Noon-2	15	9	10	93
Noon-3	15	9	10	93
% Average				79

The detection of vehicle classification is lower because if several motors are located close to each other, then the white binary threshold results will be even greater, so it will be considered a car. Next is the result of violating vehicles when the traffic lights are green and red.

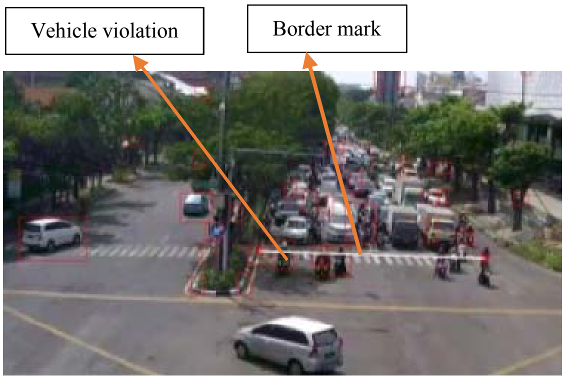


Fig. 16. Vehicle violation (red traffic lights)

Table 4 presents the number of vehicles detected that violated the mark (outside the boundary line) at the time of the red traffic lights.

TABLE IV. RESULT OF RED-TRAFFIC LIGHTS VIOLATION

Data	Length	Real Violation	Violation Detected	%
Morning-1	02:51	2	2	100
Morning-2	02:33	4	1	25
Morning-3	01:46	6	5	83
Morning-4	01:26	3	15	20
Morning-5	02:03	9	33	28
Noon- 1	00:56	8	8	100
Noon- 2	02:31	9	9	100
Noon- 3	00:41	8	35	25
Noon- 4	01:15	11	29	37
Noon- 5	01:15	16	34	47
			% Average	58

In table 4 its contains the result of violation detection in red light and green light. The average for violation detection is 58%.

V. CONCLUSION

From this research, it can be concluded that the BLOB method and the shift-tracking algorithm can classify vehicles and get an average of 79% for motor detection and 71% for car detection. Detecting vehicle catches only gets an average of 58% while in the marker line. The successful classification of vehicle types and complicated results from thresholds at the beginning of the system. If the threshold is good, the vehicle will be detected properly.

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