Public Transportation Identification System in Prohibited Areas based on Traffic Signs using Image Processing

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Abstract

Growth in the transportation sector in urban areas was very high. This resulted in an increase in the number of vehicles and congestion on the highway. Public Transportation was a vehicle that causes a lot of traffic jam and made the road feel more crowded. In addition, public transportation also often violated rules such as entering into a residential housing lane to avoid overcrowding of vehicles on the highway. The violation of public transportation was by entering and passing through the residential area which was an area that must be free from the flow of public transportation. In addition, there were also traffic signs to prohibit public transportation from passing. To overcome this problem, this study proposed a system to identify and distinguish types of public transportation from other types of vehicles based on colour images. The system processes were carried out through several stages, including offline video capture, video frame processes, background and foreground separation (background subtraction), morphology (opening), bitwise and, images rectangular crop, HSV colour space conversion and HSV histogram creation. The results of the HSV colour space conversion in the histogram were used for the identification process in determining whether the city transportation existed or not by using Learning Vector Quantization method. The results of the system testing using Learning Vector Quantization method with 30Fps frame rate video test data were capable to recognize 66 images of public transportation and not public transportation from 78 videos of car typed of vehicle, obtained success with a percentage of 84.62%. And 60Fps frame rate video test data was able to recognize 71 images of public transportation and not public transportation from 78 videos of car typed of vehicle, obtained success with a percentage of 91.03%.

Keywords: public transportation, traffic signs, prohibited area, image processing, identification

Received: 15 March 2019

To cite this article:
Yi. Nurhasanah, Ad. Kartika, N. Nur'aini, "Public transportation identification system in prohibited areas based on traffic signs using image processing", in *Electrotehnica, Electronica, Automatica (EEA)*, 2020, vol. 68, no. 2, pp. 73-85, ISSN 1582-5175.

1. Introduction

Growth in the transportation sector in urban areas was very high, but this growth was not in line with the development of adequate infrastructure such as not widening the road [1], [2]. This resulted in a traffic jam on the roadway. The traffic jam on the roadway was caused by several types of vehicles that pass through the road, namely cars, motorbikes, trucks or even buses.

Of the many types of vehicles, City Transportation was a vehicle that causes a lot of transportation congestion and made the road feel more crowded [3]. In addition, city transportation often violated the rules such as stopping carelessly or entering the residential housing lane to avoid overcrowding of vehicles on the roadway.

City Transportation violations by entering and passing through residential areas made congestion in the area which was an area of housing that must be free from the flow of vehicles other than residents of residential areas. In addition, there were traffic signs to prohibit City Transportation type vehicles from crossing the residential area [4], [5].

So, to be able to overcome this congestion, there needed a system that can identify and differentiate types of public transport vehicles compared to other types of vehicles automatically.

Based on these problems, an idea emerged to create a system that could identify public transport vehicles that crossed and passed prohibited areas or routes by utilizing digital image processing using the camera as a monitor in that area [6] [7]. Image processing aimed to improve image quality so that it was easily interpreted by humans or machines (in this case computers). Image processing techniques transformed images into other images. So, the input was the image and output also the image, but the output image had better quality than the input image, included in this field also was image compression [8]. The passing vehicle would go through the stages to be recognized. The system to be created also had the ability to issue a warning [9].

2. Materials and Methods

In order to answer the problem of City Transportation violations that caused the congestion of vehicles by entering and passing through the residential area, there was a need for a system that could alert City Transportation not to pass through residential areas or lanes that must be free from traffic jam [5], [9]. The research conducted was a system to identify public transportation in areas that were prohibited based on traffic signs using image processing by using the Learning Vector Quantization method.

In the research carried out, the scope were as follows:

1. Research objects and warning systems were carried out on public transportation
2. In this system, it was assumed that the camera was stored in traffic signs for public transportation restrictions;
3. The video capture process was carried out:
   - with a camera at a distance of 2 meters from the roadway
   - taken from the direction of the left side of the city transportation object
   - with a camera height of 150 cm
   - on a one-way roadway with a walled background
   - in the morning at 06.30-08.30 a.m. and afternoon at 16.00-17.15 p.m. with the average value of light 10134lx
   - during the day at 09.30 a.m.-14.00 p.m. with the average value of light 198792lx
4. Objects in video frames were not more than one (single object);
5. In this study it was not conducted to recognize the traffic restrictions on public transportation;
6. This study, the object of a public transportation vehicle was distinguished by colour;
7. Traffic signs in prohibited areas were types of prohibited signs issued for special vehicles to pass, namely City Transportation;
8. The feature extraction method in the City Transportation colour used HSV colour feature extraction;
9. The method used to enlarge image data from the results of colour feature extraction was the Learning Vector Quantization method.

2.1. Image Processing

Image processing is a processing process which input is image. The output can be an image or a set of characteristics or parameters related to the image [10]. Image processing has several functions, including:

1. Used as a process of improving image quality so that it is easily interpreted by humans or computers;
2. Used for image processing techniques by transforming images into other images. Example: image compressing as the initial process (pre-processing) of computer vision [11], [12].

2.2. Frame Rate

Frame Rate (expressed in Frame Per Second or FPS) is the frequency at which images (frames) are consecutively displayed. This term applies equally to films, video cameras, graphic compress, and motion capture systems [13]. The smoothness of image movement is determined by the number of different frames per second. To get smooth motion, digital video must be at a minimum value of 25 frames per second. [14], [15] .

2.3. Background Subtraction

Background Subtraction, also known as Foreground Detection, is one of the techniques in the field of image processing and computer vision that aims to detect/ retrieve the foreground from the background for further processing. Generally, the desired foreground is in the form of a human object, car, text, and so on.

Background subtraction is a method commonly used to detect moving objects on video from a stationary camera [16], [17], [8].

2.4. Morphology Operations (Process Opening)

Opening the process begins with the erosion operation followed by a dilation operation. The purpose of the opening process is to remove small and thin objects, break objects at thin points, and generally smooth the boundaries of large objects without significantly preaching the object area. This opening process can be done to reduce noise and improve the edges of the vehicle's image [8], [12], [18]-[22].

2.5. Bitwise AND operator

The bitwise operator functions to manipulate integer or byte data. In context, its use is the same as logical operators, the difference for bitwise operators is used to compare the two values. The process of manipulating the comparison of binary numbers that only recognize numbers 0 and 1 where the output value will display the value of an integer or byte data type. The AND (&) operator is comparing two binary sequences, returning a value of 1 if both are worth 1 in the same position [23], [24].

2.6. Character extraction

Feature extraction is the process of indexing an image database with its contents mathematically, each feature extraction is an encode of vector n dimensions called image processing and technical analysis and is used to compare one image with another image [25].

Feature extraction is classified into 3 types, namely low-level, middle-level and high-level. Low-level feature is feature extraction based on visual content such as colour and texture [26], middle-level feature is extraction based on the area of image determined by segmentation, while high-level feature is feature extraction based on semantic information contained in the image [27].

2.7. Colour Space H-S-V

HSV defines colours in terms of Hue, Saturation and Value. The advantage of HSV is that there are colours similar to those captured by the human senses [28], [29], while the colours formed by other models such as RGB are the result of a mixture of primary colours [30].

HSV space has 3 main characteristics, namely Hue, Saturation and Value with the definition as follows [31], [32]:

1. Hue: express true colours, such as red, violet, and yellow and are used to determine redness, greeness, and others.
2. Saturation: often called chroma, is the purity or strength of colour.
3. Value: express the brightness of the colour. The value ranges from 0-100 %. If the value is 0 then the colour will be black, the greater the value, the brighter and new variations emerge from that colour.

The process to get the value of each colour that you want to display through the calculation process by converting the colour space R-G-B (Red, Green, Blue) to the H-S-V colour space (Hue, Saturation, Value) [33], [34]. The way to get each H-S-V value defined by the formula shown in Formula 1 to Formula 6, follows.

Formula 1 is a formula to find the maximum value of the three RGB colour space parameters that will be entered into the max variable [30].

$$max = MAX(R,G,B) \quad (1)$$

where:

- MAX is a function to find the maximum value of several numbers;
- R is a red value;
- G is a green value;
- B is a blue value.

Formula 2 is a formula to find the minimum value of three RGB colour space parameters that will be entered into a variable min.

$$min = MIN(R,G,B) \quad (2)$$

where:

- MIN is a function to find the minimum value of several numbers;
- R is a red value;
- G is a green value;
- B is a blue value.

Formula 3 is a formula to find the difference in the maximum value and the minimum value of the three RGB colour space parameters that will be entered into the variable min.

$$delta = maks - min \quad (3)$$

where:

- max is the result value of the MAX function (R, G, B);
- min is the result of the MIN function (R, G, B).

Formula 4 is a formula to get the value of the HSV colour space parameter from the conversion of three RGB colour space parameters that will be included in variable V.

$$V = \frac{maks}{255} \times 100 \quad (4)$$

where:

- max is the result value of the MAX function (R, G, B).

Formula 5 is a formula to obtain the saturation value of HSV colour space parameters from the conversion of three RGB colour space parameters that will be included in the S variable.

$$S = 0, \text{ if } V=0$$

$$S=\frac{maks-min}{maks} \times 100, \text{ if } V>0 \quad (5)$$

where :

- max is the result value of the MAX function (R, G, B);
- min is the result of the MIN function (R, G, B);
- V is the Value colour value.

Formula 6 is a formula to get the value of the hue HSV colour space parameter from the conversion of three RGB colour space parameters that will be entered into the variable H.

$$H = 0 \text{ , if } S=0$$

$$H=60 \times \frac{G-B}{delta} \text{ , if maks =R}$$

$$H=60 \times \left(2 + \frac{B-R}{delta}\right) \text{ , if maks =G}$$

$$H=60 \times \left(4 + \frac{R-G}{delta}\right) \text{ , if maks =B}$$

$$\text{If } H < 0, \text{ then } H=H+360 \quad (6)$$

where:

- max is the result value of the MAX function (R, G, B);
- delta is the difference between max and min;
- S is the Saturation colour value;
- R is a red value;
- G is a green value;
- B is a blue value.

Formula 1 to Formula 6 were the calculation to get the value of each colour H-S-V and were the most effective method to use if the Saturation value reached was 0 so that the Hue value will be defined. The following was an example of the conversion process of R-G-B colour space to H-S-V [33], [35], [36].

2.8. Learning Vector Quantization (LVQ)

Learning Vector Quantization (LVQ) is a method for training competitive supervised layers. Layers - competitive layers will learn automatically to classify given vector input [37]. If the input vector has very close distances, then the input vectors will be grouped in the same class [35], [36], [38], [39].

The example of the LVQ architecture was X1 … Xn notation which showed the input vector value, while the X - W1 notation … X - Wk showed as a calculation of the distance value of the input vector and weight vector as shown in Figure 1 [37].

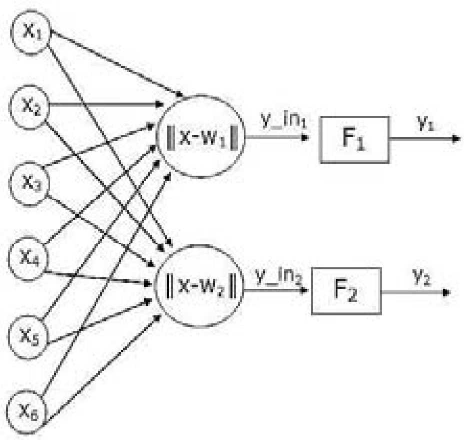


Figure 1. Example architecture LVQ

Figure 1 shows the calculation of the distance between the two points. Calculation of distances between these 2 points can be solved by Euclidean distance using Formula 7.

$$C_j = \sqrt{\sum_{i=1}^{n}(x_i - w_j)^2} \quad (7)$$

where:

- Cj is the value of Euclidean distance;
- xi is the input vector value;
- wj is the weight vector value.

Based on these definitions, steps are taken to solve the LVQ algorithm. The steps are as follows:

1. Initialization: the initial weight of the j-input variable towards the i-class (W), the maximum epoch (MaxEpoch), the expected minimum error (Eps), the Learning rate ().
2. Input:
   a. Data Input: x (m, n); with i = 1,2, ..., n and j = 1,2, ..., m
   b. Targets are classes: T (1, n); with k = 1,2, ..., n
3. Initial condition initialization:
   a. Epoch = 0
   b. Err = 1
4. Performed if: (epoch <MaxEpoch), the minimum error value is reached or the error value = 0 and (α> Eps)
   a. Epoch = Epoch + 1;
   b. done for i = 1 to n
      - Determine the Distance so that || xij-wij || minimum (call Cj)
      - Fix Wj with the following conditions:
        i. If T = Cj then: Wij (new) = wij (old) + α (xij-wij (old)) (3.29)
        ii. If T ≠ Cj then: Wij (new) = wij (old) - α (xij-wij (old)) (3.30)

2.9. City Transportation

City transportation is an urban transportation model that refers to public transportation with a predetermined route. Unlike buses that have stops as designated stops, city transport can stop to raise or drop passengers anywhere.

Rates charged to passengers vary depending on the distance travelled. Generally, a city transportation is filled by approximately 10 passengers, but it is not uncommon for passengers to be more than 10 people. The operation path of a city transportation can be known through colour or code in the form of letters or numbers in the body of the vehicle. In Bandung city transportation is better known as angkot [40].

3. Results

In designing this system, it took several tools, materials, and supporting application programs, which were grouped into two parts, namely hardware and software. Hardware: 13 Mega Pixel Camera, 18mm EF-M Lens, 1280x70 (HD) Recording Size and Tripod. Software: Netbeans, OpenCV, Xampp and MySQL.

In general, this research was built through several stages. The system built consisted of two sub-systems, namely the introduction of traffic signs prohibiting city transportation and identification of city transportation. However, in this study the introduction of traffic signs was not carried out. The prohibition on crossing city transportation only carried out a research on the identification system of city transportation that was marked by boundering.

The scheme of connected devices on the system made based on boundering that has been marked as follows:

1) City Transportation was used as an input object for conducting research on the identification of city transportation in areas that were prohibited based on traffic signs using image processing.
2) The camera was used to perform image-making process video files on prohibited areas predetermined to capture objects City Transportation.
3) Identification of city transportation was used to carry out processing connected with cameras to identify city transportation in areas that were prohibited based on traffic signs using image processing.

The system identification process for city transportation based on colour images to obtain identification of city transportation which was marked by warning sound. The following is how the whole identification system works :

1. Start the process for identifying city transportation that passes by colour image;
2. Offline city transport video capture process;
3. Video frame sub-process;
4. Background Subtraction MOG Sub-process which was separating the background (background) to black with the foreground (foreground) being white;
5. Opening, bitwise and process contours, contour detection and rectangular crop image;
6. Sub-process of converting RGB colour space into the colour space of the H-S-V image of city transportation;
7. Sub-process of making extracts of features of the colour point histogram H-S-V. Unites the values of H-S-V as many as 1000 pixels into one array;

8. The process of identifying city transportation based on colour images using the LVQ method (Learning Vector Quantization);
9. Sub-process gave a warning;
10. Complete the process of identifying city transportation based on colour images.

Configuring the design of software that would be combined with a camera to make video capture and image processing to identify city transportation automatically and accurately so that a warning would be issued. The interconnection of the system for taking colour images so that the identification of city transportation using image processing could be seen in Figure 2.

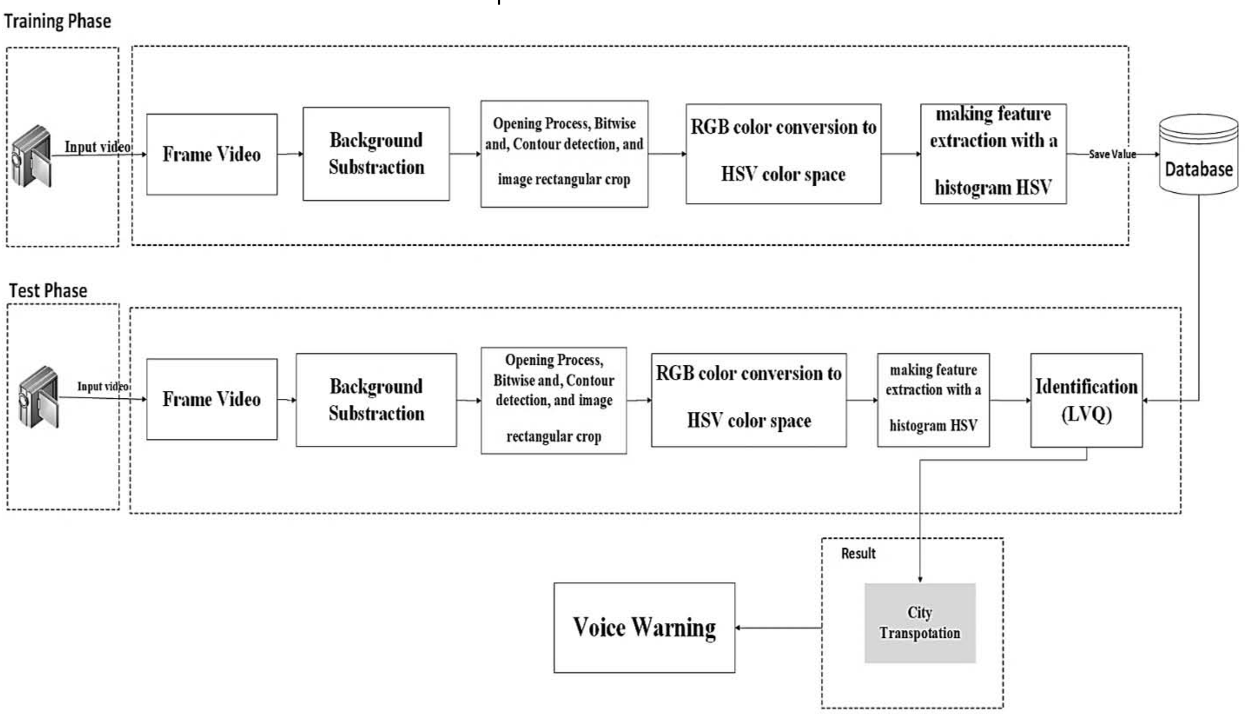


Figure 2. System Workflow

Figure 2 explains the interconnection of the system of identifying urban transport in areas that were prohibited based on traffic signs using image processing made so as to produce a system that could provide warning information on the types of vehicles that were prohibited from crossing as follows:

1. Training Stage:

a) Taking pictures of objects using the camera to be processed at the training stage;
b) Videos were changed to frames;
c) The object was taken, and the training process was carried out by performing stages of colour image processing. Processing the image would pass through the background subtraction stage, which is separating the background from the object, the results would be processed using the opening process followed by the bitwise and rectangular crop images from the detection of the largest contours. The results of the rectangular crop image were obtained by the average RGB colour value that would be converted into the H-S-V colour space, and histogram creation;
d) The value obtained from the histogram would be used to calculate the distance between the two points using the Euclidean distance formula. This distance was a parameter implemented in the Learning Vector Quantization (LVQ) method;
e) The process of implementing the Learning Vector Quantization (LVQ) method would produce weight values to know that there is City Transportation;
f) Weight values that had been obtained would be stored in the training database.

2. Testing Stage:

a) Recording carried out by the camera in the form of video recordings that will record various types of vehicles that cross the area to be processed at the stage of identification;
b) Videos were converted into frames (video frames);
c) The video was used for the identification process by first carrying out the colour image processing stage. Processing the image will go through the stages of changing the video to frame, background subtraction, opening, bitwise and process, the biggest contour detection and rectangular crop image. The results of the rectangular image were obtained by the average RGB colour value that will be converted to H-S-V, and histogram generation;
d) The value obtained from the histogram will be used to calculate the distance between the two points using the Euclidean distance formula. This distance was a parameter that will be used

during classification by implementing the Learning Vector Quantization (LVQ) method;

e) The process of taking training data in the database;

f) The last process was to adjust the colour value of the processes that had been done before between the value of the training results with the value of the test results. This adjustment would result in the object being tested whether it was included in the type of City Transportation vehicle or not City Transportation which was marked with an initialization of 0 or 1;

g) If the initials were numbers 0 then the object was City Transportation and the system would emit a sound which was a warning. If the initialization was in the number 1, then the object was not City Transportation that was allowed to pass.

3. Video Frame Stages:

The video frame stage aims to extract the video entered into the application into a frame. The frame would be used for the next research phase as shown in Figure 3.

(a) Video frame as background model

(b) Video frames as object

Figure 3. Video Frame

Based on Figure 3, the video frame as object will be compared to the background model. How to compare the two frames using pixel calculation. The difference in pixel values of the two frames is the detected foreground. Then the detected foreground enters the pre-processing stage.

4. Stage of Background Subtraction:

The background subtraction process aimed to separate the background with the foreground with a predefined threshold value. The initial frame in the video was initialized as a background and the last frame was initialized as the foreground. The way this background subtraction works was that it started with reading the first frame of the video that was initialized as the background model. Then the input video frame was then compared to the background model. The difference in the pixel value of the two frames was the detected foreground.

Furthermore, the foreground was detected in the pre-processing stage to improve the foreground quality which improved the quality of object detection.

5. Operation Opening, bitwise and image rectangular crop Stage

This stage aimed to improve the image of city transportation by manipulating image parameters to become better quality images.

a) Opening operation
Performed an opening process to smooth the boundaries of objects without changing the object area and reducing the noise on the object. This opening operation was carried out at the erosion stage and followed by a dilation process.

b) Bitwise AND
Performing a Bitwise AND function process to restore the original transport image from the background subtraction by means of the resulting image dilated in the bitwise and with the final frame in the inserted video, it would get the results.

c) Detect Contour and Image Rectangle Crop
Detect contour to get the largest contour in the object area and perform a rectangular crop image process by comparing the largest contour.

6. Stages of Extraction Feature of HSV Colour Space:

The feature extraction stage aimed to take colour values from an object image of city transportation. This value was obtained from 100x100 pixels in the rectangular crop image and the RBG value was obtained by not counting the 20 pixel grayscale colour. The RGB value was changed to the HSV colour space by using Formula 1 to Formula 6.

7. Classification Method Stages of Learning Vector Quantization:

The Stage of Quantitative Learning Vector method aimed to classify images into two classes, namely the city transportation class and the non-urban transportation class. The values obtained from HSV colour values and processed using equalization histogram to obtain an average value of HSV colour, the average value will be a colour value that represented HSV colour from the image of city transportation which would then be processed at the classification stage using Formula 7 and the final value of the closest distance from the city transportation class and the closest distance not city transportation will be obtained.

8. Sound Warning Stages

The sound warning stage aimed to emit sirens on the system when the results of the classification were included in the category of city transportation classes.

4. Discussion

Based on the design that had been made, obtained a software to identify city transportation using image processing based on colour images can be seen in Figure 4 and Figure 5. Figure 4 shows the results of the implementation of the City Transportation identification system application using image processing.

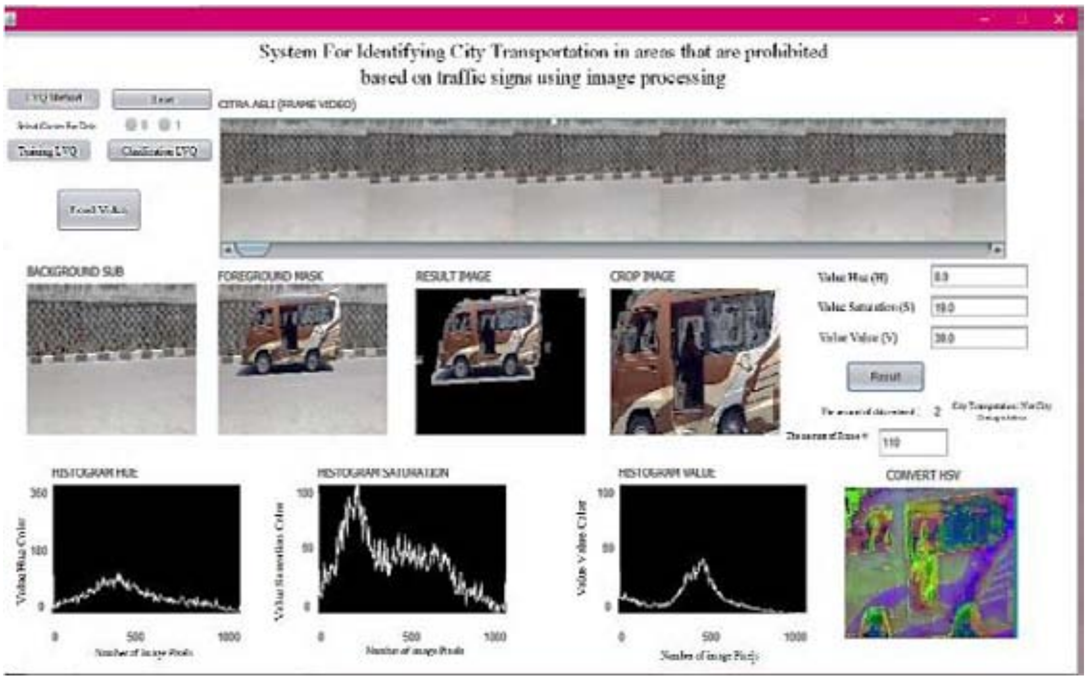


Figure 4. Display of the Initial Form

Based on Figure 4, the functions of the colour image processing stages were found in the initial form with the following paths:

1. The user who ran the application will press the video load button, where the system in the application would display the path location dialog box to select the video entered.
2. Users ran the Learning Vector Quantization method by choosing to conduct training to get the weight of the results of the calculation of city transportation and other types of vehicles with supporting parameters that had been initialized and carried out testing (mapping) to be able to classify images of city transportation and not city transportation.
3. At the training stage the user must enter the target for initializing the city transport image into the city transportation class (0) or the vehicle of the private car into the class instead of city transportation (1). After that the final weight of the training results was stored in the database.
4. At the classification testing stage, the system would display the results of the application of the city transportation test image.
5. Users can press the load image button to enter the video of the vehicle to be tested.
6. The system provided information on the value of Hue, the value of Saturation, Value and the results of the classification.

Figure 5 shows the classification form that was made to be able to group the data that entered into the city transportation class or data that entered the class instead of city transportation.

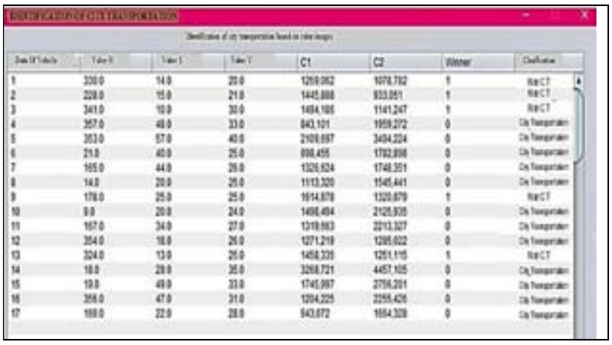


Figure 5. Display of The Classification Form

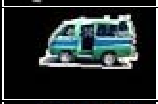
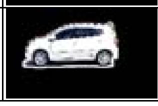
Data grouping was influenced by the results of the training because the training results would guide the data using the LVQ method. The classification process itself was the process of calculating the final Euclidean distance in a database with city transport imagery and not other types of vehicles to be tested.

Based on Figure 5, the classification of vehicles into the class of city transportation and not city transportation is seen from the colour of the image which produces a range of hue (H), saturation (S) and value (V) colours. The system performs a classification process to find the smallest Euclidean distance value. The value of C1 is the closest distance to the category of city transportation class and C2 is the closest distance to the category of non-city transportation class. If the value of C1 is smaller than C2 then the classification of city transportation is 0, if C2 is smaller than C1 then the classification of non-city transportation is 1.

4.1. System Accuracy Testing

The tests applied to the city transportation identification system were by testing the accuracy of the system by comparing the results of the real conditions with the classification of the system. The tests were shown in Table 1.

Table 4. Train Data for City Transportation and not City Transportation

No.	Training image	Camera	Cluster	Real conditions
1.		13MP	0	AK
2.		13MP	0	AK
3.		13MP	0	AK
4.		13MP	0	AK
5.		13MP	0	AK
6.		13MP	0	AK
7.		13MP	0	AK
8.		13MP	0	AK
9.		13MP	0	AK
10.		13MP	0	AK
11.		13MP	0	AK
12.		13MP	0	AK
13.		13MP	0	AK
14.		13MP	0	AK
15.		13MP	0	AK
16.		13MP	0	AK
17.		13MP	0	AK
18.		13MP	0	AK
19.		13MP	0	AK
20.		13MP	0	AK
21.		13MP	0	AK
22.		13MP	1	BAK
23.		13MP	1	BAK
24.		13MP	1	BAK
25.		13MP	1	BAK
26.		13MP	1	BAK
27.		13MP	1	BAK
28.		13MP	1	BAK
29.		13MP	1	BAK
30.		13MP	1	BAK
31.		13MP	1	BAK

In Table 1, there are letter terms as follows:

- AK is a City Transportation object.
- BAK is a Non-City Transportation object.

Table 1 shows the test at the training stage to get the final Euclidean distance value. Training data is captured using a 13 MP camera. Each training data is determined by the cluster value, if the cluster value is 0, then the real condition of the city transportation. If the value of cluster is 1, then the real condition is not city transportation. The tests will then be shown in the classification stages in Table 2 to Table 5.

In tables 2 to 5 there are letter terms as follows:

- H is the value of Hue;
- S is the Saturation value;
- V is the Value;

- C1 is the value of the closest distance to City transportation;
- C2 is the value of the closest distance to not City Transportation;
- KS is a system classification;
- KN is the real condition of the actual image;
- AK is City Transportation;
- BAK is not city transportation;
- C is suitable;
- TC is not suitable

Figure 6 shows a graph of training data contained in Table 1.

Figure 6. Graph of the amount of training data

Figure 6 shows 31 training data consisting of 21 city transportation and 10 non-city transportation.

Figure 7 shows the results of testing 38 data to determine city transportation or not by using a 13 MP 30 fps camera and 13 MP 60 fps camera conducted during the day.

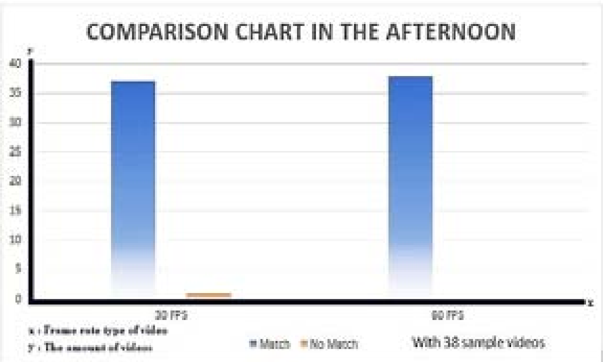


Figure 7. Comparison graph between 30 fps and 60 fps during the day

The graph in Figure 7 is obtained based on Table 2 and Table 3. Figure 7 shows the results of testing data using a 13MP 30Fps camera. There are 37 data that is match and 1 data that is not match. While testing data using a 13MP 60Fps camera obtained 38 data matching.

Table 2 and Table 3 show the test result data for city transportation and non-city transportation that pass the prohibited entry area for city transportation using a 13 MP 30 Fps and 60 Fps camera conducted during the daytime.

Table 5. Daytime 30 Fps Frame Rate Test Data

No	Test Image	H	S	V	C1	C2	S	KN	Result
1.		12	25	29	1720,062	2897,062	AK	AK	C
2.		355	38	43	2799,729	4095,076	AK	AK	C
3.		348	34	43	1590,664	2602,017	AK	AK	C
4.		357	27	35	1208,488	1211,535	AK	AK	C
5.		348	32	40	1712,403	2950,186	AK	AK	C
etc.									
19.		1	11	33	1608,300	1205,560	BAK	AK	TC
etc.									
37		284	2	29	2017,667	1373,557	BAK	BAK	C
38.		154	4	39	2151,081	936,523	BAK	BAK	C

Table 6. Daytime 60 Fps Frame Rate Test Data

No	Test Image	H	S	V	C1	C2	S	N	Result
1.			2	6	038, 67	505, 58	K	K	
2.		51	7	0	149, 80	260, 24	K	K	
3.		50	35	5	756, 01	940, 90	K	K	
4.		57	7	5	205, 80	219, 81	K	K	
5.		48	2	9	765, 49	969, 75	K	K	
etc									
37		08		9	334, 65	379, 95	AK	AK	
38		54		9	494, 86	141, 47	AK	AK	

Based on table 2 and table 3, there are matching results between the test image as the real condition of the actual image (KN) and the classification system (KS) that detects the video frame, so that the results suitable (C). But there is a data that is not suitable (TC), namely in the test image showing city transportation as real condition (KN), but the system (KS) detects non-city transportation because the value of C2 is smaller than C1.

Figure 8 shows the results of testing 40 data to determine city transportation or not by using a 13 MP 30 fps camera and a 13 MP 60 Fps camera conducted in the morning and evening.

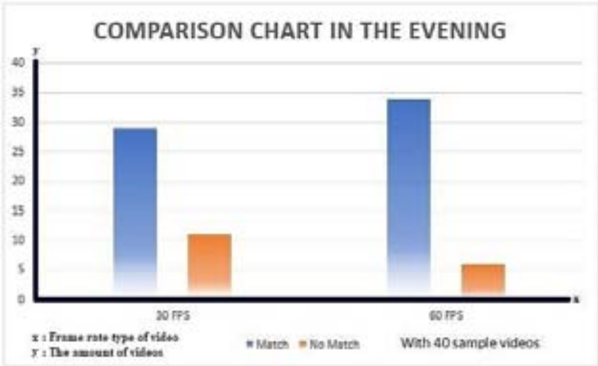


Figure 8. Comparison graph between 30 fps and 60 fps in the morning and evening

The graph in Figure 8 is obtained based on Table 4 and Table 5. Figure 8 shows the results of testing data using a 13 MP 30 Fps camera. There are 29 data that is match and 11 data that is not match. While testing data using a 13 MP 60 Fps camera obtained 33 data matching dan 7 data that is not match. Table 4 and table 5 show the test result data for city transportation and non-city transportation that pass the prohibited entry area for city transportation using a 13 MP 30 Fps and 60 Fps camera conducted in the morning and evening.

Table 7. Frame Rate 30 Fps Morning and Evening Day Test Data

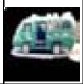
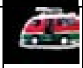
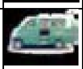
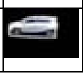
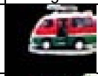
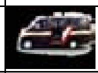
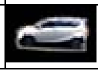
No	Test Image	H	S	V	C1	C2	KS	KN	Result
1.		170	17	30	1582,7 32	1758,714	AK	AK	C
2.		182	19	34	1432,2 95	1891,317	AK	AK	C
3.		348	18	36	1774,4 20	1641,259	BAK	AK	T C
4.		162	22	32	1477,2 20	1894,038	AK	AK	C
5.		169	22	22	1467,1 21	1832,950	AK	AK	C
etc									
38		213	5	30	1878,4 80	665,021	BAK	BAK	C
39		165	1	42	2003,3 54	622,021	BAK	BAK	C
40		213	6	1	1816,1 0	663,984	BAK	BAK	C

Table 8. Frame Rate 60 Fps Morning and Evening Day Test Data

No	Test Image	H	S	V	C1	C2	S	N	Result
1.		170	17	0	1403,301	986,530	K	AK	C
2.		182	19	4	403,301	986,530	K	K	C
3.		346	18	7	739,317	609,118	AK	K	TC
4.		187	33	6	520,893	897,239	K	K	C
5.		348	8	7	489,708	801,385	K	K	C
etc									
9		165	1	2	003,354	22,021	AK	AK	C
0		213	6	1	816,10	63,984	AK	AK	C

Based on Table 4 and Table 5, there are matching results between the test image as the real condition of the actual image (KN) and the classification system (KS) that detects the video frame, so that the results suitable (C). But there is a data that is not suitable (TC), namely in the test image showing city transportation as real condition (KN), but the system (KS) detects non-city transportation because the value of C2 is smaller than C1.

4.2. Results of System Accuracy Measurement

Accuracy measurement results were carried out to determine the performance of the city transportation identification system using image processing that had been made. The measurement is seen from several aspects of the parameter, namely:

1. Comparison of system accuracy with videos taken with a 13 MP 30 Fps camera during the day and morning or evening;
2. Comparison of system accuracy with videos taken with a 13 MP 60 Fps camera during the day and morning or evening;
3. Overall system accuracy.

Based on Table 2 to Table 5 and Figure 7 and Figure 8 which has been shown, it can be analysed the accuracy of the test by using Formula 8. The comparative analysis of accuracy will be shown in Table 6 and Table 7.

$$Level\ of\ accuracy = \frac{\text{Successful data}}{Amount\ of\ data} \times 100\% \qquad (8)$$

where:

- Amount of Data was the amount of input data that the system processes;
- Successful data was a match between system output and real conditions.

Table 6 shows the comparison of system accuracy with video taken with 30 Fps at 06.30 - 08.30 a.m. and 16.00 - 17.15 p.m. and at 09.30 a.m. - 14.00 p.m.

Table 9. Measurement of System Accuracy Results on video with 30 Fps

Comparative Aspect	Amount of data	Successful Data	Level of accuracy
City transportation video (09.30 a.m. - 14.00 p.m. with light value of 10134lx)	38`	37	97,37%
Video of City Transportation (06.30 a.m. - 08.30 p.m. and 16.00 - 17.15 WIB with light value 198792lx)	40	29	72,5%
Total	78	66	

Table 7 shows the comparison of system accuracy with video captured with 60 Fps at 06.30 - 08.30 a.m. and 16.00 - 17.15 p.m. and at 09.30 a.m. - 14.00 p.m.

Table 10. Measurement of System Accuracy Results on video with 60 fps

Comparative Aspect	Amount of data	Successful Data	Level of accuracy
City transportation video (09.30 a.m. - 14.00 p.m. with light value of 10134lx)	38`	38	100%
Video of City Transportation (06.30 - 08.30 a.m. and 16.00 - 17.15 p.m. with light value 198792lx)	40	33	82,5%
Total	78	71	

Based on table 6 and table 7, a higher percentage of accuracy value is obtained by detecting video using a 13MP 30 Fps and 60 Fps camera that is done during the day. And for the percentage of accuracy values between 30 Fps and 60 Fps, a 13 MP camera with 60 Fps has a higher accuracy value than a 13 MP 30 Fps camera.

5. Conclusions

Based on the results of the research and system testing, it can be concluded that the level of accuracy of the city transport identification system in areas that are prohibited by traffic signs uses image processing using the Learning Vector Quantization (LVQ) method with 30 Fps frame rate video test data capable of recognizing 66 imagery of city transportation and non-city transportation from 78 videos of vehicles of type cars obtained success with a percentage of 84.62 %, while 60 Fps frame rate video test data is able to recognize 71 images of city transportation and not city transportation from 78 videos of car types obtained success with percentage of 91.03%.

Overall this system has two sub-chapters, namely the introduction of traffic signs and identification of city transportation. However, this research has not been carried out for the process of introducing traffic signs that prohibit crossing city transportation, only carrying out the process of identifying city transportation using image processing.

6. Bibliographic References

[1] Aviasti, A. N. Rukmana and Jamaludin, “Model Penentuan Jumlah Armada Angkutan Kota Yang Optimal di Kota Bandung,” *Ethos (Jurnal Penelitian dan Pengabdian Masyarakat)*, vol. 4, no. 2, e-ISSN 2502-065X, pp. 173-180, 2016.

[2] T. Bahar, O. Z. Tamin, B. S. Kusbiantoro and R. B. Frazila, “Potensi Penggunaan Angkutan Informal di Kota Bandung,” *Jurnal Transportasi*, vol. 11, no. 3, pp. 209-218, 2011.

[3] A. Ilahi, A. I. Waro and P. Sumarsono, “Public Transport Reform in Indonesian Cities,” in *Proceedings of the Eastern Asia Society for Transportation Studies*, Vol.10, 2015.

[4] K. M. Almustafa , “Circular Traffic Signs Recognition Using The Number of Peaks Algorithm,” *International Journal of Image Processing (IJIP)*, vol. 8, no. 6, pp. 514-522, 2014.

[5] M. A. Palupi, “Penumpukkan Angkot di Leuwi Gajah Membuat Macet,” 2017. [Online]. www.Pikiran-rakyat.com. [Accessed 5 Januari 2018].

[6] H. Zhou and S. Zhou, “Scene categorization towards urban tunnel traffic by image quality assessment,” *Journal of Visual Communication and Image Representation*, vol. 65, pp. 1-8, 2019.

[7] T. Ekatamto, A. Hidayatno and Y. Chrityono, “Identifikasi Jenis Mobil Menggunakan Pengolahan Citra Digital Dengan Metode Wavelet,” *TRANSIENT: Jurnal Ilmiah Teknik Elektro*, vol. 4, no. 4, pp. 987-990, 2015.

[8] K. Umam and B. S. Negara, “Deteksi Obyek Manusia Pada Basis Data Video Menggunakan Metode Background Substraction Dan Operasi Morfologi,” *Jurnal CoreIT*, vol. 2, no. 2, ISSN 2460-738X, pp. 31-40, 2016.

[9] F. Zhu, Z. Li, S. Chen and G. Xiong, “Parallel Transportation Management and Control System and Its Applications in Building Smart Cities,” *IEEE Transactions on Intelligent Transportation Systems*, vol. 17, no. 6, pp. 1576-1585, June 2016.

[10] X. Zhang and W. Dahu, “Application of Artificial Intelligence Algorithms in Image Processing,” *Journal of Visual Communication & Image Representation*, vol. 61, pp. 42-49, 2019.

[11] R. K. and A. N. Tompunu, “Pengolahan Citra Digital untuk Mendeteksi Objek Menggunakan Pengolahan warna Model Normalisasi RGB,” in *Seminar Nasional Teknologi Informasi & Komunikasi Terapan (Semantik)*, Semarang, Indonesia, 2011.

[12] S. R. Putra, *Pengukuran Ukuran Tomat Berdasarkan Citra Digital Pada Studi Kasus Pembangunan Sistem Pemilihan Otomatis*, Institut Teknologi Nasional, Bandung, 2017.

[13] Andrew, J. Buliali and A. Wijaya, “Deteksi Kecepatan Kendaraan Berjalan Di Jalan Menggunakan Opencv,” *Jurnal Teknik ITS*, vol. 6, no. 2, ISSN: 2337-3539, pp. A366-A371, 2017.

[14] B. Janzen and R. Teather, “Is 60 FPS better than 30? The impact of frame rate and latency on moving target selection,” in *Conference on Human Factors in Computing Systems - Proceedings*, Canada, 2014.

[15] I. A. Laksmi, N. I. ER and I. M. O. Widyantara, “Frame Rate Minimum Video Dengan Metoda Normalized Frame Difference sebagai Pendeskripsi Intensitas Gerak,” *E-Journal Spektrum*, vol. 2, no. 3, pp. 86-91, 2015.

[16] T. Trnovszky, P. Sykora and R. Hudec, “Comparison of background subtraction methods on near Infra-Red spectrum video sequences,” TRANSCOM 2017: International scientific conference on sustainable, modern and safe transport, *Procedia Engineering* 192, pp. 887-892, 2017.

[17] A. Pamungkas, “Background Subtraction dengan Metode Pengurangan Citra Grayscale,” 9 Pebruari 2016. [Online]. https://pemrogramanmatlab.com /2016/02/09/background-subtraction-dengan-metode-pengurangan-citra-grayscale/. [Accessed 20 Maret 2018].

[18] G. Amalorpavam, H. Naik T, J. Kumari and S. M, “Analysis Of Digital Images Using Morphological Operations,” *International Journal of Computer Science & Information Technology (IJCSIT)*, vol. 5, no. 1, pp. 145-159, February 2013.

[19] S. Ravi and A. Khan, “Morphological Operations for Image Processing : Understanding and its

Applications," in *NCVSComs-13 Conference Proceedings*, 2013.

[20] S. Sivasakthi , "A STUDY ON MORPHOLOGICAL IMAGE PROCESSING AND ITS OPERATIONS," *Journal of Analysis and Computation (JAC)*, ISSN 0973-2861, 2018.

[21] A. Kleefeld, S. Vorderw•ulbecke and B. Burgeth, "Anomalous diffusion, dilation, and erosion in image processing," *International Journal of Computer Mathematics*, pp. 1-20, January 2018.

[22] F. Virnawati and V. Evania, "Morphological Operation On Binary Image," *Jurnal Informatika*, vol. 4, no. 1, pp. 18-35, 2008.

[23] Fathurrahman , "Belajar Mengenal Operator Bitwise dalam Program Java," 18 Oktober 2017. [Online]. https://www.okedroid.com/2017/10/belajar-mengenal-operator-bitwise-dalam-program-java.html. [Accessed 6 Maret 2018].

[24] V. Seshadri and at al., "Fast Bulk Bitwise AND and OR in DRAM," *IEEE Computer Architecture Letters*, vol. 14, no. 2, pp. 127-131, July-Dec. 2015.

[25] A. AlQaisi, M. AlTarawneh, Z. A. Alqadi and A. A. Sharadqah, "Analysis of colour image features extraction using texture methods," *Telkomnika*, vol. 17, no. 3, pp. 1220-1225, 2019.

[26] J. M. Patel and N. C. Gamit, "A review on feature extraction techniques in Content Based Image Retrieval," in *International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*, Chennai, 2016, pp. 2259-2263.

[27] D. G. Raharja, *Temu Balik Citra Berbasis Konten Dengan Pendekatan Warna, Tekstur, Dan Bentuk Pada Sarung Bermotif*, Institut Teknologi Nasional, Bandung, 2017.

[28] K. Ayuningsih, Y. A. Sari and P. P. Adikara, "Klasifikasi Citra Makanan Menggunakan HSV Colour Moment dan Local Binary Pattern dengan Naïve Bayes Classifier," *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer*, vol. 3, no. 4, e-ISSN: 2548-964X, pp. 3166-3173, 2019.

[29] A. Fauzan, "Ruang Warna Hue Saturation Value (HSV) serta Proses Konversinya.," 03 January 2015. [Online]. https://www.kitainformatika.com/2015/01/ruang-warna-hue-saturation-value-hsv.html. [Accessed 05 Pebruary 2018].

[30] A. N. Hermana, A. Zulkarnain and Y. A. Riadi, "Implementasi Pengolahan Model Warna RGB pada Aplikasi Identifikasi Warna," *Mind Journal*, vol. 3, no. 1, ISSN (e): 2528-0902, pp. 49-60, 2018.

[31] K. B. Shaik, G. P, K. V, S. B.S. and J. J.M.M., "Comparative study of skin colour detection and segmentation in HSV and YCbCr colour space," *Procedia Computer Science*, vol. 57, pp. 41-48, 2015.

[32] B. C, "Hue Saturation Value (HSV) Colour Space for Content based Image Retrieval," *International Journal of Engineering Research & Technology (IJERT)*, vol. 5, no. 4, pp. 119-123, 2016.

[33] V. Chernov, J. Alander and V. Bochko, "Integer-based accurate conversion between RGB and HSV colour spaces," *Computer & Electrical Engineering*, vol. 46, pp. 328-337, 2015.

[34] J. S. Wibowo, "Deteksi dan Klasifikasi Citra Berdasarkan Warna Kulit Menggunakan HSV,"*Jurnal Teknologi Informasi Dinamik*, vol. 16, no. 2, pp. 118-123, 2011.

[35] M. A. Anggriawan, "Pengenalan Tingkat Kematangan Tomat Berdasarkan Citra Warna Pada Studi Kasus Pembangunan Sistem Pemilihan Otomatis," *Jurnal Teknik Informatika dan Sistem Informasi (Jutisi)*, Universitas Maranatha, vol. 3, no. 3, ISSN: 2443-2229, pp. 550-564, 2017.

[36] U. Sudibyo, D. P. Kusumaningrum, E. H. Rachmawanto and C. A. Sari, "Optimasi Algoritma Learning Vector Quantization (LVQ) dalam Pengklasifikasian Citra Daging Sapi dan Daging Babi Berbasis GLCM dan HSV," *Jurnal Simetris*, vol. 9, no. 1, ISSN: 2252-4983, pp. 1-10, 2018.

[37] R. Wulanningrum and B. F. Robby, "Learning Vector Quantization Image for Identification Adenium," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 4, no. 2, pp. 383-389, November 2016.

[38] R. Meliawati, O. Soesanto and D. Kartini, "Penerapan Metode Learning Vector Quantization Pada Prediksi Jurusan di SMA PGRI 1 Banjarbaru," *Kumpulan jurnaL Ilmu Komputer (KLIK)*, vol. 4, no. 1, pp. 11-20, 2016.

[39] E. Budianita and W. Prijodiprodjo, "Penerapan Learning Vector Quantization (LVQ) untuk Klasifikasi Status Gizi Anak," *IJCCS*, vol. 7, no. 2, ISSN: 1978-1520, pp. 155-166, 2013.

[40] T. B. Joewono, D. S. Santoso and Y. O. Susilo, "Paratransit Transport in Indonesia : Characteristics and User Perceptions," *Journal of the Eastern Asia Society for Transportation Studies*, vol. 11, pp. 1346-1361, 2015.

Funding Sources

This work was financially supported by Institut Teknologi Nasional (Itenas) Bandung of Indonesia

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