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Implementation of Object Recognition Based on Type of Vehicle Entering Main Gate

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Abstract

This project related to develop and implementation of object recognition based on type of vehicle entering the main gate to facilitate the employment data of vehicles entering according to the types of vehicles. Data for the number of vehicles in accordance with the types recorded. In completing this project, there are two algorithms used, the detection algorithm and classification algorithm. Vehicles will be classified by comparison in terms of it front light area and will be stored in three types of vehicles; sedan, multipurpose van or van, and four wheel drive. Wireless camera is mounted with 1.6 meters high on the pipe rod at the guard house as input for the processing algorithm. Vehicle image will be captured by a wireless camera and then processed to identify its type. Data for the type of vehicle and number of vehicles by type is shown through the Graphical User Interface (GUI). Inflow and outflow of vehicles can be monitored via the control unit (GUI) without human monitoring at the entrance.

Keywords: *classification algorithms, detection algorithms, wireless camera, graphical user interface (GUI)*

1. Introduction

Vehicle classification systems are important for traffic management for example, automatic toll collection requires different types of vehicles to determine the different rates. This systems well be applied to traffic management and also in security systems for housing areas. Most of the current housing security systems are using the guard service. Therefore, other than using the guard service, the system can be used discretion to replace the existing system. Continuous monitoring at the main entrance gate is very important to ensure the safety of housing areas is assured. However, most of the main gate monitoring system is controlled by humans. As for the more technology system used, such as the use of CCTV but it only can be recorded inflows vehicle without a clear idea of how much the total number of the incoming vehicles. Still requires the use of CCTV to record the data controller for vehicle entry. Guard on duty will have to guard consistently to avoid errors and to record data or overlooked in some vehicles. In addition, usually there are two main gate of a housing area. Thus, the data records are likely not the same between the two gates. Therefore, a system created to facilitate the acquisition and recording of data.

2. Literature Review

The complex nature and the large number of combinations of all features surrounding the vehicle makes the object detection and recognition are difficult. There are two types of sensor that are widely used including passive sensors such as video camera and actives sensors such as radar. Different types of sensors may be appropriate for different sensing tasks. As example an active sensor are depends on echoes from objects in the field of view. The most important factor is the reflectivity of the object. To detect the conductor such as metal, radar can detect it very well; however it has very poor performance on detecting dielectric such as wood and brick. By using radar, the relative speed and distance between the host vehicle and the preceding object can be determined directly in a single time interval. Objects must be distinguished from the background in the image for the passive sensors such as video camera. It usually used pattern recognition in order to analyzing images and identifying objects. Detailed

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analysis of multiple continuous frames is required for determination of the distance and the closing speed of objects. Image analysis need to be conduct at the object level and not on pixel by pixel basis to detect and recognize the objects. Therefore, passive detection computational cost is higher than the active detection. However, there is advantage of using passive sensor, the objects in the field can be identified and the host vehicle can exactly know what is in the field view.

Vision-based detection has a problem in the identification of objects under strong sunlight, especially the glare of the sun. A shadow created by the intense light is difficult to be recognized by the vision-based sensors, because there is no clear boundary between objects and shadows. That is the lack of vision and needs based on complementary sensors such as radar, laser or infrared sensors. Unfortunately, without a vision-based detection, active detection can meet the challenges in recognizing an object and its moving path. Long-range detection tool are using vision-based detection. Short-range detection is enabled and the security threats object identified. To overcome the lack of vision-based recognition, short-range detection devices such as radar will be called. Compared with other detection approaches, the use of vision-based technologies are more suitable for detecting long-distance because the object can be identified. Detection of short range is to be activated when an imminent danger of being observed by long-range detection to confirm the information. Thus, this proves that the use of short-range sensor with a limited scope can obtain the relative distance and relative speed with respect to the target object.

In this section, the existing models that attempt to detect and recognize objects from image sequences will be discuss. Automatic object recognition from an image is very difficult and unreliable even though the identification of the surface boundaries or the detection of relevant features of the scene is quite natural to human driver. In recent years, there are various approaches have been proposed to perform this task. The vehicles that are occluded and asymmetrical can be detected by the binocular vision [1] for vision based vehicle control, but the computational cost is very expensive. A vision based recognition and tracking system named BVV3 for autonomous vehicle driving [2] by use a multiple parallel processors, a bus for interprocessor communications and a separate video bus for digital data transmission are includes in the system architecture is represented. Image is continuously scanned by an obstacle module to search for a feature that may represent the first sign of possible obstacle like another vehicle. Smaller vehicles like car are detected at a distances at about 350 m while for a larger objects like trucks are detected at very long distances up to 700m. Since the 2-D object models used, the system can reaches good performances in the object detection and tracking task, but yet presents some limitations in the recognition phase.

Sobel Edge detection is used to recognize the type of vehicle [3]. There are three main steps for vehicle classification. Sobel Edge detection used to create minimum number of edges and bring it to a proper shape. Figure 1 shows the designing steps of the vehicle classification algorithm. A series of thresholding in gray scale conversion is applied one after the other on the reference and the current image. Each of pixels of color sample presents the color by three 8-bit numbers. Filter is used to improve present noise on the generated image.

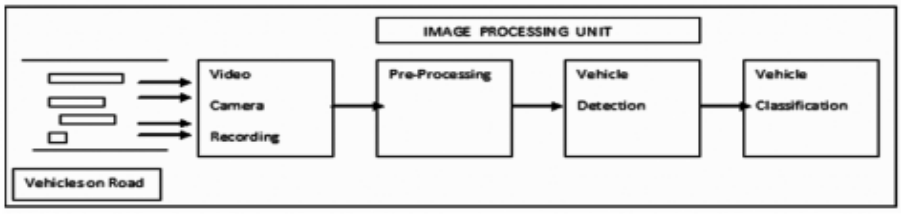


Figure 1. Designing Steps of the Algorithm

A variety of grey scale image sequence taken from a moving vehicle is used in vision-based approach to detect and identify vehicles by taking into the parameters of their motion calculation and track vehicles [4]. Vision-based system consists of four models; object detection model, object recognition model, object information model and object track model. The features

of the object are investigated in order to find the potential object in the object detection model. In recognition model, it consists of a neural network to recognize different vehicles. Next, the information model is used to analyze the relationship between the host vehicle and the object. To track multiple objects, a recursive method is used in the tracking model. Figure 2 shows preprocessing, vehicle detection and classification algorithm.

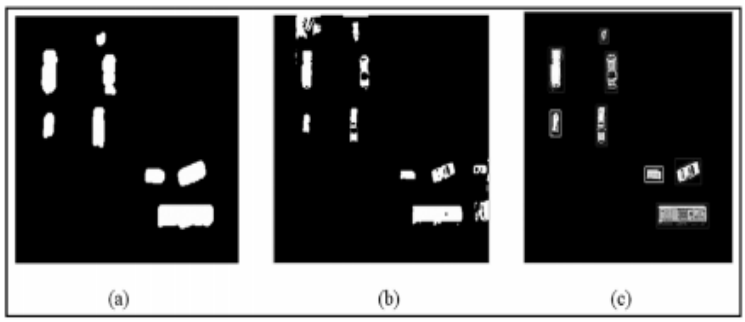


Figure 2. (a) Preprocessing, (b) Vehicle Detection Algorithm, (c) Vehicle Classification

Since vehicles have different colors, rather than traditional methods which use motion features to detect vehicles, a new color transform model method is introduced [5]. A novel detection method is proposed to detect vehicles from still images using colors and edges. It also makes vehicle colors be more compact and sufficiently concentrated on a smaller area. It still owns very nice properties to describe objects even though the color of an object is quite different under different lighting conditions [6, 7]. Results for vehicle color detection both in original image and detection result are shown in Figure 3.

Figure 3. Result of Vehicle Color Detection, (a) Original Image, (b) Detection Result

A vision-based approach to detect and recognize vehicles, calculate their motion parameters, and track multiple vehicles by using a sequence of gray-scale images taken from a moving vehicle are presents [5]. Because the vehicle is the most common objects in the driving environment, so the emphasis is on the vehicle. Several features of a vehicle are investigated, which include symmetrical shape and aspect ratio of a vehicle in order to detect potential objects on the road. Recognition and tracking are accomplished by combining the analysis of single image frame with the analysis of consecutive image frames [8]. In the analysis of single image frame, the system detects potential objects by using their shape features and recognizes the objects [9]. Car-Rec system [10] is an approach to car recognition. It is use to create a real-time car recognition system by building on recent technological advances in object recognition with a strong recognition performance. A smart security camera is stationed at the entrance of an office building parking lot in order to illustrate the usefulness of a car-recognition. It can be used for an employee car database. Car-Rec building consists of three stage; feature descriptor extraction, word quantization and structural matching. Feature descriptor extraction is a Speed-Up Robust Features (SURF) that used to localize interest points in an image and the features as

a vector of value can be described. Word quantization is an effective converter that can convert high-dimensional vectors to single value words [11]. While Structural matching is the top results that returned from the image database search are scored using a structural verification algorithm. As a result, the top matches are returned as a ranked list.

3. Methodology

There are several steps taken in order to completing the object recognition system based on types of vehicle entering main gate.

3.1. Software Development

There are two algorithms used for this project; detection algorithms and classification algorithms. Detection algorithm is used to detect the presence of the vehicle and classification algorithms are used to determine and classify vehicles according to the type specified with the number of vehicles. Figure 4 shows detection algorithm flow chart and Figure 5 shows a flow chart of classification algorithm.

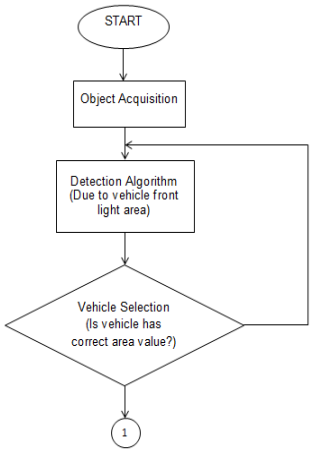


Figure 4. Detection Algorithm Flow Chart

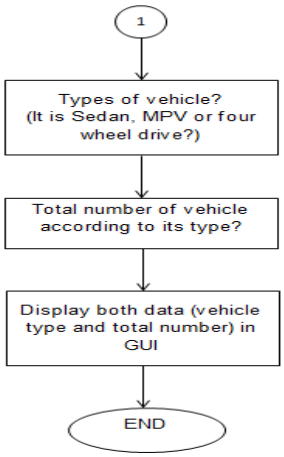


Figure 5. Classification Algorithm Flow Chart

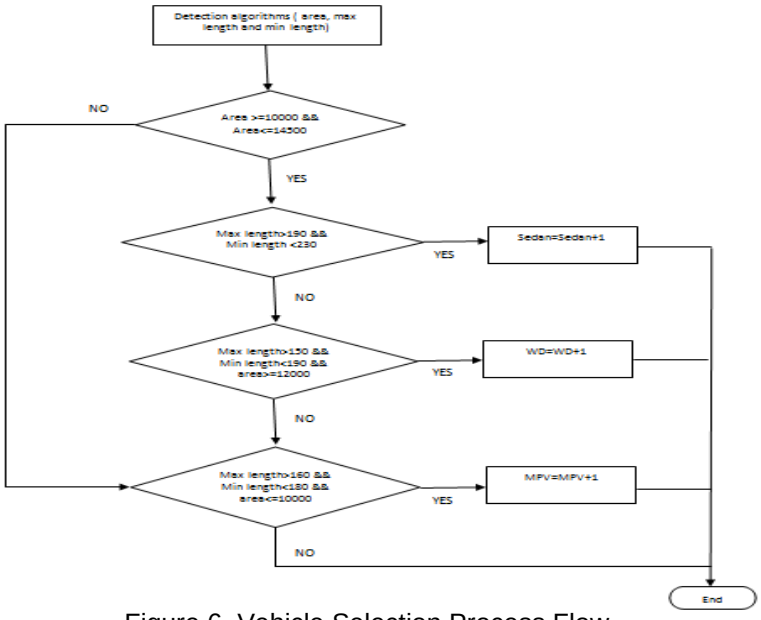


Figure 6. Vehicle Selection Process Flow

3.1.1. Detection Algorithm

Data acquisition is made using a wireless camera. Each vehicle image will be detected by detection algorithm according to the vehicle front light area. After that, the detected vehicle will be selected based on the area value. Vehicles will be classified due to its area value.

3.1.2. Classification Algorithm

After the vehicle has been identified, the model (type of) the vehicle will be determined by this algorithm. Other than the type, number of vehicles for each type of vehicle will also be recorded. Next, both the saved data will be displayed through the GUI. The GUI is implemented and developed to display the results or data obtained from the hardware and algorithms. Figure 6 shows process flow for vehicle classification. The vehicles are classified as sedan if the area of vehicle front light is between 10000 and 14500 while maximum length greater than 190 and minimum length less than 230. If the area of front light vehicle is between 12000 and 14500 while its maximum length is greater than 150 and minimum length is less than 190 than it will be classified as four wheel drive. Meanwhile if the vehicle front light area is less than 10000 with the value of maximum area is greater than 160 and minimum area is less than 180 then the vehicle will be classified as MPV.

3.2. Material

Wireless camera is used as an input to capture the image or video. Table 1 shows specification list for wireless camera and its receiver and Figure 7 shows the device model. The specification list for USB DVR (audio/video) capture show in Table 2 and its model shows in Figure 8.

Table 1. Wireless Camera and Receiver Specification

Specification	Explanation
Power Supply	1. Camera: 9V DC 2. Receiver: 9V DC
Image Sensor	1/3 1/4 inch CMOS
Signal System	PAL/CCIR NTSC/EIA
Horizontal Resolution	380 TV lines
Scan Frequency	PAL/CCIR:50HZ NTSC/EIA:60Hz
Transmission Power	50mW
Receiving Frequency	1.2G/2.4G
Antenna	50ohm SMA

Figure 7. Wireless Camera and Receiver Model

Figure 8. USB DVR (video/audio) Capture

The wireless camera was mounted with 1.6 feet height as shown in Figure 9. This wireless camera are placed 7.5metres from the vehicles stopping point. The wireless camera was used to capture some images of vehicle with a Jusco AEON entrance as a background for testing the vehicles detection algorithm. The background used is shown in Figure 10.

Table 2. USB DVR (video/audio) Capture

Specification	Explanation
Video Input	One RCA composite, One S-Video
Support	NTSC, PAL, Video Format
Audio Input	Stereo Audio (RCA)mm
Dimension	(L)88mmx(W)28mmx(H)18mm
Performance	• NTSC: 720x480 @30fps • PAL: 720x576 @25fps
Power Source	USB Bus Power

Figure 9. Wireless camera Setup

Figure 10. Area used for Background of the Images

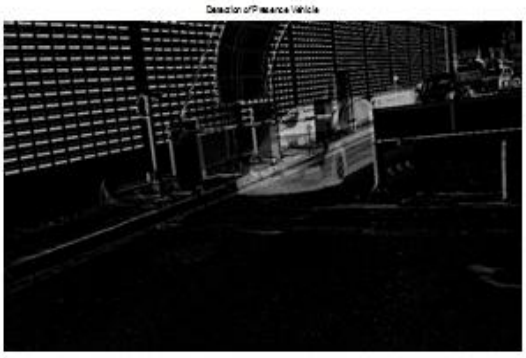


Figure 11. Detection of Presence Vehicle

4. Results and Analysis

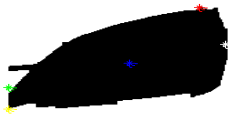
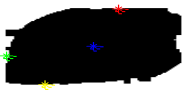
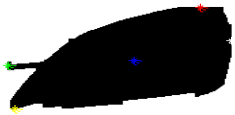
4.1. Vehicles Detection

Figure 11 shows the detection of presence vehicle. In order to get the image of presence vehicles, first need to get a picture that there is no vehicles as a background. Then another image with the presence of vehicles is inserted. In this detection, subtraction method is used. The images need to be converted to grayscale image.Then subtraction method will subtract between the images.

4.2. Filtering Results

Figure 12 shows image result using different types of filtering. Figure 12 (a) shows the resulting image by using binary gradient mask. Binary gradient mask is used to dilate image vertically and then horizontally. Figure 12 (b) shows the resulting image for dilated gradient mask. This filter will outline the image cell quite nicely but there are still holes in the interior of cell. This hole will be filling by using binary image with filled holes. The resulting image for binary image with filled holes is shown in Figure 12 (c). By using this filter, the image is smoother. Meanwhile, Figure 12 (d) shows the resulting image for outlined original image filter.

Table 3. Data for Area of Vehicle's Front Light

Type of Vehicle	Data
Sedan1  ROI:(651:807,1831:2090)	Area: 11198 Centroid: [124.2045 75.1846] MajorAxisLength: 235.7445 MinorAxisLength: 68.7123
Sedan2:  ROI:(597:901,1776:1987)	Area: 12028 Centroid: [89.8229 65.6085] MajorAxisLength: 176.2268 MinorAxisLength: 90.5785
Sedan3:  ROI: (700:775,1875:1980)	Area: 6462 Centroid: [54.0929 37.3279] MajorAxisLength: 114.1962 MinorAxisLength: 73.6928
Sedan4:  ROI: (775:888,1962:2120)	Area: 10166 Centroid: [80.0646 53.8070] MajorAxisLength: 165.3146 MinorAxisLength: 82.1182
Avanza1(MPV 2):  ROI: (737:839,1863:2019)	Area: 8777 Centroid: [73.7775 41.0458] MajorAxisLength: 157.3408 MinorAxisLength: 74.6223
Avanza2 (MPV 1):  ROI: (737:839,1863:2019)	Area: 9555 Centroid: [78.0583 55.7174] MajorAxisLength: 165.3958 MinorAxisLength: 77.8753
4wheeldrive:  ROI: (603:720,1861:2027)	Area: 12034 Centroid: [94.7192 58.2461] MajorAxisLength: 177.6170 MinorAxisLength: 90.0896

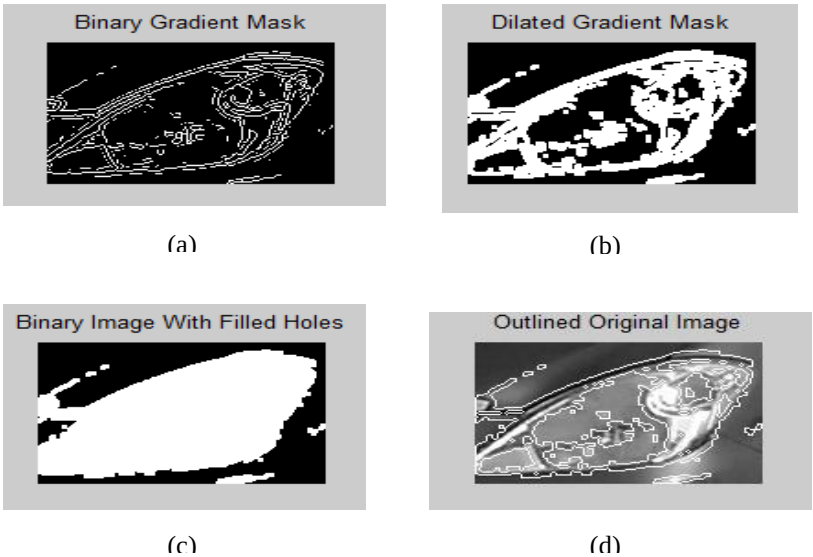


Figure 12. Filtering Results

Figure 13. Offline Test

Figure 14. Results for Online Test

4.3. Area of Vehicle's Front Light

Firstly there have a vehicle pictures will be capture by camera to get the front light area for each vehicle as references. Several types of vehicles which are four Sedan, two MPV and one four wheel drive are chosen in order to get the data for area of vehicle's front light. Due to the shape and size of sedan are different, so range of the area of front light are quite large. Which is its area is from 6000-12100. The smaller area is for Kelisa while the largest area is for Nissan car. While for MPV, the range of area is about from 8000 to 10000. Since only used one four wheel drive car, the area of front light is about over than 12000.

All of this area are depends on the value of region of interest that had been set earlier. Different vehicles have different value of region of interest. This region of interest value is as a mark point to get the centroid, right, left, bottom and top point. From these five points, then the area will be calculated. Eventhough the range areas of cars are also included the range area of MPV but it can still be differentiate between them by using the value of major axis. Table 3 shows the data of vehicle's front light area.

4.4. Offline Test (image.capture)

In offline test, static image is used and all data will be shown through Graphical User Interface (GUI). Figure 13 (a) – (e) shows five different vehicles which is successfully test and data had been displayed in GUI. This test made to ensure whether the type of vehicle can be differentiate or not. The value of region of interest that have been used for all five of vehicles image is (575:790, 1850:2099). The range area of Sedan's front light is between 10000 and 12000 with the maximum length greater than 190 and minimum length less than 230; the range area for four wheel drive front light is between 12000 and 14000 with its maximum length is greater than 150 and minimum length is less than 190. Meanwhile the range area of MPV is less than 10000 the value of maximum area is greater than 160 and minimum area is less than 180. So the results shows it have three Sedan, one MPV and one four wheel drive. All results are shown in Graphical User Interface (GUI).

4.5. Online Test (video.capture)

The online test are using video which is the image are still moving. Wireless camera is used to capture the video. Due to the pixel value of wireless camera is not good, so the video quality also not good. Because of this factors, need to set new value of region of interest. The value of region of interest for all vehicles is same. The value that been chooses are suit for all types of vehicles that need to be test. Since the value of region of interest is change, so the area value for front light vehicle also change.

The value of region of interest that has been used for all of vehicles image is (239:274,300:342). The range area of Sedan's front light is between 300 and 1000 with the maximum length less than 50 and minimum length less than 40; the range area for four wheel drive front light is greater than 1000 with its maximum length is greater than 150 and minimum length is less than 190. Meanwhile the range area of MPV is less than 1000 with the value of maximum length is less than 60 and minimum length is less than 30. So the results shows it have four Sedan and one MPV since there are no four wheel drive entered when the video was capture. All results are shown in Graphical User Interface (GUI). Figure 14 shows the result for online test.

5. Discussion

The object to be segmented differs greatly in contrast from the background image. Changes in contrast can be detected by operators that calculate the gradient of an image. The gradient image can be calculated and a threshold can be applied to create a binary mask containing the segmented cell. Firstly, the edge and the Prewitt operator are used to calculate the threshold value. Then the threshold value is tune by using edge a gain to obtain a binary that contains the segmented cell. Images that need to be process and then classified are image of vehicle. Images of vehicle that have been captured by camera will be process in order to classify the vehicles due to its types. There are three types of vehicles that have been set to be detected which are car, MPV and four wheel drive.

To detect the types of vehicle using static image is easier compare to detect the types of vehicle using live image. It is because, by using live image difficult to set the region of

interest. Since the image still moving, need to be set certain value of frame so system would capture until it get exact image that match to the setting area. In static image, since the vehicles did not stop at the same point, so the image would not uniformly capture. This factor cause needs to be declared different value of region of interest for each vehicles image. Image also needed to be converted from RGB to Grayscale image. It quite easier to detect image nicely by using Grayscale image compared to RGB image. Area of front light vehicle to differentiate the types of vehicle, maximum and minimum length also needs to be considered. It is because some of Sedan and MPV car have same value of front light area. In order to differentiate these two types of vehicles, the other value can be considered which are the maximum and minimum lengths of front light area each cars. Eventhough the area value for Sedan and MPV are same but the value for maximum and minimum length for both are different. There are several ways to get the image references. In this project, the area of front light vehicle will be choosen. It is because by using this front light area, it quite easier compared to choose the other part of vehicle.

6. Conclusion

As conclusion, this project has two algorithm; classification algorithm and detection algorithm. The vehicle will be classified using the value of front light which is the area, maximum and minimum length. The types of vehicle only focus on sedan, MPV and four wheel drive with the range of value of front light. Graphical User Interface is used in order to display the data for type of vehicles. The camera position needs to setup correctly to get the car image directly without any obstacle involved. Since this project done at outside weather surrounding should be considered. If sunny day, it will difficult to classify the vehicle is white or silver colour. Silver and white colour will reflect to the sunlight and difficult to get the value of region of interest.

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