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CAR RECOGNITION ON A STATIC IMAGE USING 2D BASIC SHAPE GEOMETRY

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ABSTRACT

In computer vision, object recognition is a technology which able to ease human activity to identify object obtained from digital image. In this research, the identified object is car, and the recognition method is using arrangement of 2 dimensional basic geometric shape that correspond to the simplification of car image. There are some processes that must be performed, such as: pre-processing, image segmentation, object (car parts) extraction, confidence rate measurement, balance point measurement, outline masking, feature and pattern matching. There are three components that detected as main car parts: body, windows and tires, and there is also car shadow as complementary component which help the detection of main component. The result shows we are successfully recognize 95% of car image samples.

Keywords: car part, object recognition, image segmentation, feature matching, image extraction.

1. INTRODUCTION

Object recognition as a part of computer vision field plays role to find and identify object in a digital image. The common application of object recognition such as face recognition which applied in digital cameras, smartphone, and also applied in security aspect; Optical Character Recognition (OCR) which help us to convert image about text so that the scanned image could be edited using word processor software; In robotic technology object recognition could help robot to trace the environment, or recognize the fire pattern. Overall, we can say that object recognition could ease human activities related with the eyesight.

The previous similar research about shape recognition using geometrical shape approach was done to detect and recognize road sign in USA [1]. Another researches about shape, object and image recognition also were done by using fuzzy approach [2], simple string matching method [3], shape masks (segmentation masks) [4], multi features (shape feature and text feature) [5], bottom-up image structures [6], boundary structure segmentation [7]. In this research, we did shape recognition of car parts which extracted from the digital car image. The common composition of basic shapes in every car part and their structure would be the interesting point as the background in this research.

As we know, the types of car based on their dimension or shape are so many, such as: sedan, sport utility vehicle (SUV), truck, van, wagon, etc.; but basically based on their parts and compositions of a common car, they have similarities to each other. Based on the background above, at least there are two major problems will be discussed in this paper (1) How the system will recognize the car object from static image. (2) How significant the result using 2D basic geometry method as a new method in object recognition field.

2. METHODOLOGY

The idea for this research is to simplify the car image and found the particular car components (car parts) as basic 2D geometric shapes then analyze their arrangement whether it is a car object or not. Figure-1 shows the idea in this research. There are 4 main processes in this method which need to be done. The first process is acquiring the input image and reading the colors data.

The second process is segmenting the colors data to simplify and estimate the region of interest for every car parts. This process would simplify image data based on their pixels characteristic into some segments if their characteristic similar with their neighbors. Some aspects that could be considered as characteristics or criteria for image segmentation such as [8]: colors, intensity, and texture.

The third process is extracting the car parts and measuring them as 2D basic shape. The last process is identifying the guessed parts from the data training and matching the arrangement of identified parts with car template.

3. ALGORITHM

More detail algorithm will shows in Figure 2. The initial process (1.) is to obtain the digital image as the input and preparing the data before doing digital image processing. The input could be obtained from different type of image devices, such as webcam, digital camera or directly using digital image file. To reduce computation time, in this research we use QVGA resolution (320 by

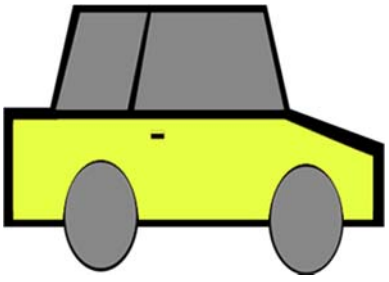


Figure-1. Car in simple 2d geometric shape.

240) digital images file with .jpeg or .jpg file extension. The second process is pre-processing (2.) would read the RGB data from the file in every pixel, the RGB color information of each pixel will be very useful to next steps. Afterwards, the image processing process was performed in order to prepare the extraction process from the input. This process was image segmentation (3.), image segmentation would group the data which have similar characteristic (such as: color) and close to each other [8]. The purpose of this process was to simplify the colors and eliminate the gradients from the input. As the output we would have a color segmented image with simple color composition.

The fourth process (4.) was extracting the car parts from the segmented image. This process would produce some parts based on the color neighborhood and color boundary parameters. In here, the car segmented image may have different color characteristic in some parts or separated from another parts because of color difference. This process will convert the RGB to binary color images for the parts. The purpose of binary color conversion was

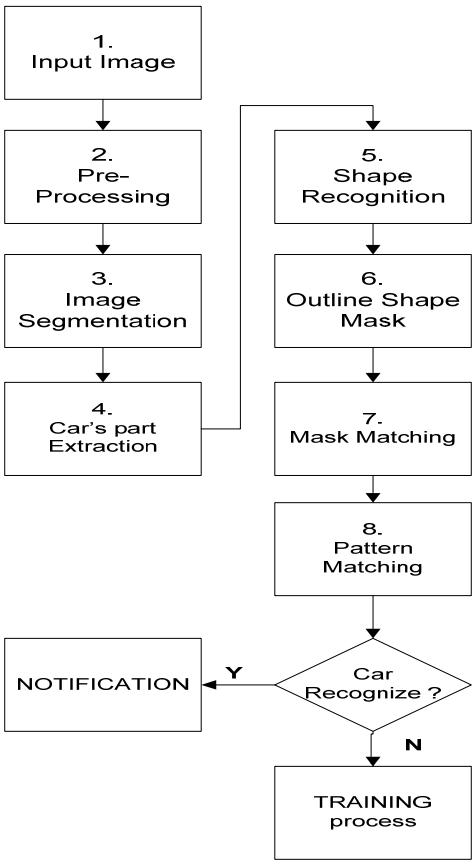


Figure-2. Car recognition algorithm.

to make the shape recognition become efficient. These processes became the initial process of shape recognition (5.); and would be done repeatedly until no distinct segmented region left.

There are two more processes should be done before the shape recognition process. After resulting many extracted car parts from the data samples and giving the identity from the shape recognition result (5.), the sixth process (6.) was making the outline (edge) mask from every car parts as and after that matching the mask with the database of car parts (7.).

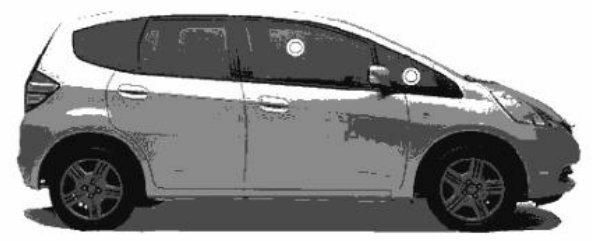
Finally, the car recognition process was performed by using pattern matching method (8.). After obtaining the car feature from previous process, the pattern from the features should be determined whether it would be known as the car pattern or not.

4. RESULT AND DISCUSSIONS

4.1 Process 1-3; Initial process and image segmentation

Two different cars were used is the scheme, they are a city car (as in Figure-3) and a sedan (Figure-4). Those images segmented using 4 colors level of segmentation. The main difference between original image and segmented image was no gradation colors in segmented image, showed at Figure-3b and Figure-4b; therefore this process would ease the object separation process based on color value in every color region and their neighborhood

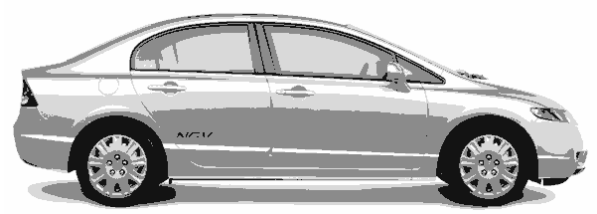
(a) Original image of a city car



(b) Segmented of a city car

Figure-3. City car image pre-processing.

(a) Original image



(b) Segmented image

Figure-4. SUV car's image.

4.2 Process 4 -5; Car parts extraction separation and shape recognition

After segmenting the image, then every part which has color related to another region would be separated. This process was performed along with binary color conversion. The extraction result which categorized in clear condition was done by observing the result and taking the clearest extractions which show the car components, and also taking the big dimension of extracted result as parameters. The unclear condition category was the results which have nearly known as components but only small piece of the components.

The unknown condition category was the results which only consist of little piece of extraction and did not show clue to be a car component. The separation process actually not only gave clear condition objects (Figure-5a), but also parts that not perfectly separated (Figure-5b).

From Figure-5b the separation of segmented sedan image (Figure-4b) showed that there were some possibility that some pixels would not become neighbors with another pixel in which actually those pixels could be in one single partition of a car component, example: car rims.

As continuation of this process, we calculated the extraction of 30 car images without background by not eliminating the unclear condition extractions object we got 339 extracted images in total. The result shown at Table-1. From the Table-1, we decided 3 kind of car parts which become the main features from car: side windows, tires or rims, and car body. At this research we also include the car shadow as complementary part in car recognition.

Table-1. Extraction result of 30 sample images.

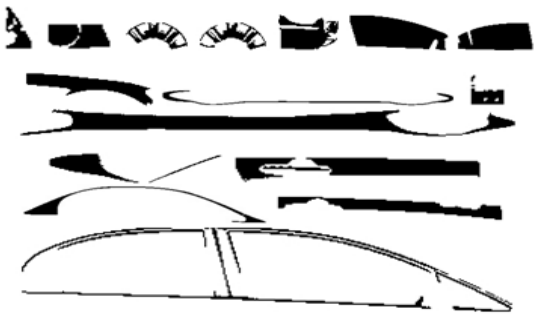
No.	Car parts	Total
1	Side Windows	51
2	Tires and Rims	55
3	Car Body	11
4	Unknown (unclear) extractions	222
	Total Extracted Images	339

Outline mask along with the shape identity is a set of information (knowledge) from a car part. The outline (edge) mask had binary value as the data and had 8×8 matrix form as the size for every size of car part image. At the training process (feature storing), the binary data and shape identity was stored into the database along with the identity of the part. In the opposite process (feature searching) the binary data and shape identity become the parameter that needed to search the car part. The masking is made by 8x8 regions, and one part is identifying by one mask. As example we identify three different parts, body, side windows and tires. Table-2 shows the process, from the image to outline masking.

4.3 Process 6-8; Outline mask shape - template matching

After finding the features, the last process was checking the car pattern based on the location of the features (template matching [10]). We use 20 random car images with background objects and different point of view in two different conditions, car without shadow and car with the shadow.

(a) Clear Extraction Region



(b) Unclear region

Figure-5. Segmented region.

The first trial was successfully recognize 15 car images (75%) without using car shadow (Figure-6a). There is a problem when acquiring car tires when using the complex image (with background). The tires were the main car parts that should be found before any other parts. In order to fix this problem, we use the complementary part (car shadow) to help the tires acquiring process. By using the shadow part (Figure-6b), the recognition success rate become 95% (19 car images were recognized). The car shadow components were shown at Figure-7.

(a) without shadow part

(b)With shadow part

Figure-6. Car recognition with different method.

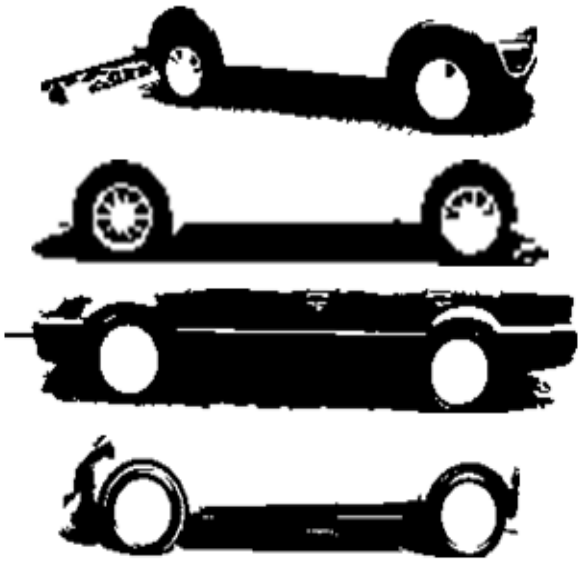


Figure-7. Car's segmented with the shadow.

5. CONCLUSIONS

The process of car components extraction mainly consist of 4 processes: obtaining image and data (image pre-processing), image segmentation, component extraction, and confidence measurement. Image pre-processing was the initial process that prepared the image data. Image segmentation would simplify the color from the original image in order to ease the extraction process, the complexity of colors and level of gradient from the image may result various segmented colors as color regions after segmentation process. The component extraction would separate every parts of image which has same color in their neighbors (region) after segmentation result. The more color regions the image had, the more extracted regions at this process were resulted. This complexity could be obstacle in component extraction method because it probably produced more unclear regions which became residue for component recognition process.

Object recognition using the basic 2D geometric shape arrangement approch gave significant result (95%) to recognize car image. This result prove that the new method could be promising to be developed to recognize another common objects which have particular features.

Table-2. Process of making mask outline.

No.	Car parts	Image extraction	Outline	Mask outline (8×8)
1	Body			01000 01001000 10000100 10000010 10000001 10000001 10000001 01111111
2	Side Window			11111000 10000100 10000100 10000100 10000010 11100010 00011101 00000010
3	Tire			00011100 01100010 10000001 10000001 10000001 10000001 01000001 00111110

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