A Study on Contour Feature Algorithm for Vehicle Type Recognition

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***Abstract*—Vehicle type automatic recognition is of great important today in Intelligent Transportation System. And neural network is often applied to recognize the vehicle type. However, the network can be very complex and therefore difficult to be trained. In order to cope with such issues, a new developed vehicle type recognition method based on contour feature is presented in this study. It is applied to obtain the vehicle type from the geometrical feature of the vehicle. This enables the implementation of the recognition system only in given geometrical size and simplifies the thinning recognize procedure. The contribution of this work is threefold: At first, a novel evolutionary methodology for extracting vehicle feature is presented. Secondly, a vehicle recognition algorithm consisting of four steps is demonstrated. Finally, the performance of the recognition system is evaluated by not only using static vehicle image but also using dynamic vehicle video.**

Keywords- Intelligent Transportation Systemrecognition; contour; vehicel type; geometrical feature; network

I. INTRODUCTION

With continuous development of science technology, the Intelligent Transportation System (ITS) is getting more and more important in the positions of automatic transportation management. It is important that how to carry out the modernization management to highway, city and toll stations for each kind of vehicle and the large parking lot waits. And feature based vehicle recognition algorithm plays an important role in various ITS applications because of its low cost and the ability of providing high-fidelity surrounding vehicle information. Feature extraction is a crucial step in vehicle recognition system, it is to evaluate the information include in the appearance of the vehicle object, and to eliminate unnecessary information causing time losses in recognition of the vehicle object. And vehicle type recognition is an important step in vehicle recognition system too, it is the main factor of the compute complication of the vehicle recognition system, different method can makes different time complication. And neural network is often applied to recognize the vehicle type. However, the network can be very complex and therefore difficult to be trained. In order to cope with such issues, a new developed vehicle type recognition method based on contour feature is presented in this study.

In this work a vehicle type recognition system is presented, that uses the contour size and the proportion of the contour size of the vehicle images to classify the vehicle type directly. And the study shows the readers the basic architecture of the recognition system, the method of the contour feature can be presented, the parameter proportion of the contour size, the range of the proportion value of different vehicle type, the principle of this vehicle type recognition algorithm, the implement of the new recognition approach, and the performance of this new vehicle type recognition system.

The four major components of this contour-feature-based vehicle type recognition system are pre-processing, edge tracing, contour feature extraction, and recognition. Figure 1 illustrates the procedure of this recognition system.

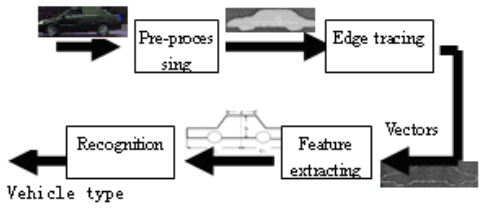

Fig 1 Procedure of the Feature-based Vehicle Recognition

II. EXTRACTING FEATURE

A. Vehicle Categories

In order to classify the types of the vehicles we must define the vehicle categories. Different classification method has different categories. Vehicle categories are defined according to the following international classification in table 1.

TABLE I. INTERNATIONAL VEHICLE CATEGORIES

	Category	Definition
M	M	Motor vehicles with at least four wheels used for the carriage of passengers
	M1	Vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat
	M2	Vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tones
	M3	Vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 tones
N	N	Motor vehicles with at least four wheels used for the carriage of goods
	N1	Vehicles used for the carriage of goods and having a maximum mass not exceeding 3.5 tones
	N2	Vehicles used for the carriage of goods and having a maximum mass exceeding 3.5 tones but not exceeding 12 tones
	N3	Vehicles used for the carriage of goods and having a maximum mass exceeding 12 tones
O	O	Trailers (including semi-trailers)

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	O1	Trailers with a maximum mass not exceeding 0.75 tones
	O2	Trailers with a maximum mass exceeding 0.75 tones but not exceeding 3.5 tones
	O3	Trailers with a maximum mass exceeding 3.5 tones but not exceeding 10 tones
	O4	Trailers with a maximum mass exceeding 10 tones

Vehicle categories are defined according to the industry standard of the turnpike-vehicle in china in table 2.

TABLE II. CHINA INDUSTRY STANDARD

Type	Vehicle Type and Specification	
	Bus	Truck
1	Seats<=7	Weight>=2tonne
2	8<=Seats<=19	2tonne<Weight<=5tonne
3	20<=seats<=39	5tonne<weight<=10tonne
4	Seats>=40	10tonne<weight<=15tonne
5		Weight>15tonne

The second classification approach in table 2 is used in the following experiments. Figure 2 shows some contours of different vehicle categories in table 2.

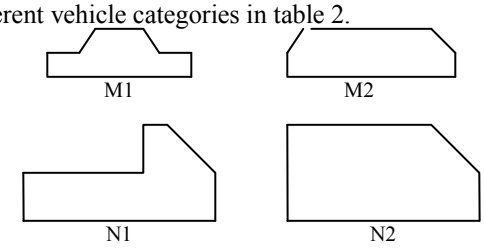

Fig 2 Contours of Different Vehicles Categories

B. Vehicle Characters

There exist many different parameters of the vehicle contour character for classing the vehicle type and in this paper are classified into the following categories:

- Edged-based character parameters. This category includes the following parameters which are shown in Figure 3(a): the width of the vehicle top d1, the width of the vehicle bottom d2, and the height of the vehicle h. The type of big and small is classified through recognizes from these character parameters.
- Ratio-based character parameters. It includes the following parameters:
  - ✧ Top-Length Ratio (*TLR*). It is computed as the ratio between the top edge and the bottom edge. And the express of the *TLR* is:

$$TLR = \frac{d_1}{d_2} \qquad (1)$$

  - ✧ Width-Height Ratio (*WHR*). It is computed as the ratio between the width of the vehicle contour and the height of the vehicle contour. the express of the *WHR* is:

$$WHR = \frac{d_2}{h} \qquad (2)$$

  - ✧ Bottom-Center Ratio (*BCR*). This is computed as the ratio between the distance from the poison of the left-bottom boundary and right-bottom boundary to the top boundary center which are shown in Figure 3(b). the express of the *BCR* is:

$$BCR = \frac{C_1}{C_2} \qquad (3)$$

- Assistant character parameters. It includes the following parameters:
  - ✧ The main assistant parameter is the number of the axle, figure 3(c) shows the axles of different vehicle type.
  - ✧ The other assistant parameter is the distance of the vehicle axles which are shown in Figure 3(c).

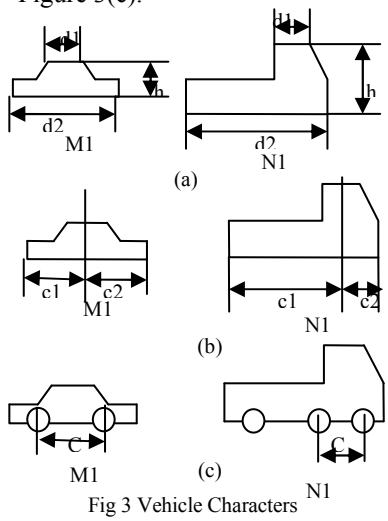

Fig 3 Vehicle Characters

C. Statistic of Vehicle Character Parameter

In order to recognize the vehicle categories, it is importing to collect the technology parameters of different vehicle categories. Table 3 shows some statistical ranges of different character parameters introduced above.

TABLE III. STATISTICL OF VEHICLE CONTOUR PARAMETERS

	d1(m)	d2(m)	H(m)	TLR	WHR	BCR	Axle number
passenger car	3-6	1.2 — 2	1.1-2.5	0.2-0.6	0.8 — 1.4	1-3	2
mini car	3~3.5		1.35~1.57				
subcompact car	3.5~4		1.4~1.7				
compact car	4~6		1.4~2.2				
bus	7 — 10	6.5 — 10		0.9-1	2.5 — 3.2	1-1.5	
minibus	3.5-6		1.5-3	0.7-1			2
medium bus	6~9						
large bus	9-13		3-5				2-3
truck	6-15	1.2 — 2.3	2-3.5	0.1-0.3	0.46 — 0.76	0.1-0.5	2-4

III. VEHICLE TYPE RECOGNITION ALGORITHM

A. Standardization of Image Size

In order to obtain the real parameter value form the vehicle image, standardizing the size of the vehicle image must be used to this system. The express is:

$$RS = k * TS \qquad (4)$$

Where *RS* is the real value of the vehicle parameter, *k* is the ratio coefficient of the whole vehicle image, and *TS* is the value measured form the vehicle image.

B. Principle of Vehicle Type Recognition

According to the character described above, the vehicle type should be recognized by the following approach.

- Firstly, the vehicles can be classified into car, bus and truck by following parameters: *TLR, HER,* and *BCR*.
- Secondly, based on the above procedure, the vehicles can be classified into the following sub-vehicle-types by the contour-size of the vehicle include the vehicle top d1, the vehicle bottom d2, and the vehicle height h: mini vehicle, medium vehicle and lager vehicle.
- Lastly, the vehicles which could not be classified by above procedure can be classified through the assistant parameter Axle number and *C*.

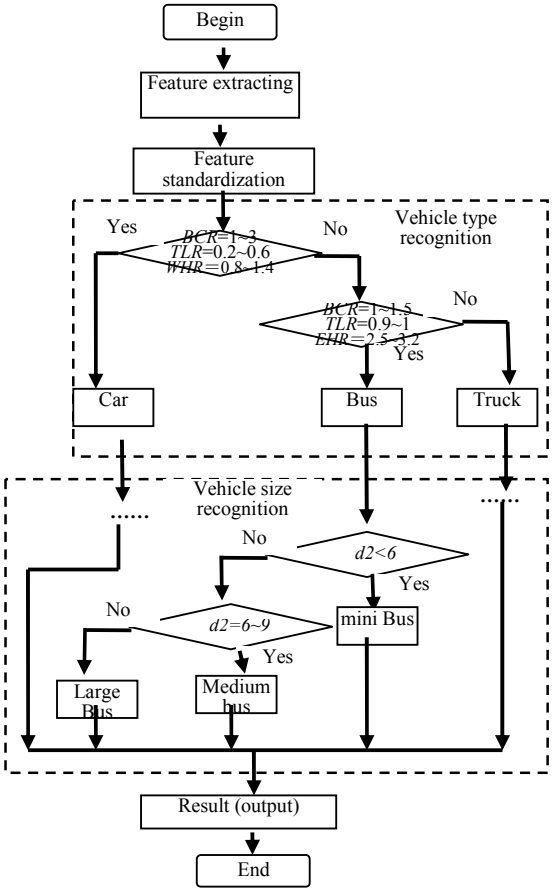

Fig 4 Procedure of proposed recognition algorithm

C. Recognition Algorithm

The proposed recognition algorithm consists of the following basic steps:

- Feature extracting processing.
- Feature parameters standardization step.
- Vehicle type recognition.
- Vehicle size recognition.
- The result obtained step:

Figure 4 illustrates the procedure of this recognition algorithm.

IV. Experiment and Results

For testing the right performance of the proposed algorithm in this paper, I've examined 5common types of vehicles in China, that include of ShangTaLa 2000, ChangAn ZhiXing, etc.. The total vehicle images are obtained from an video acquired by a modest speed of monitor.

In this experiment, to gain feature vector from the vehicle images of the video, the ratio coefficient *k* decided by the distance between the monitor and the vehicles must be known firstly.

Figure 5 shows the recognition process of the new method.

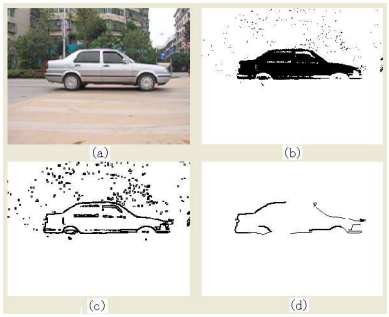

Fig 5 Recognition Process

Figure 5(a) is the color image described by RGB. Figure 5(b) is the binary image of the figure 7(a) . Figure 5(c) is object boundary image obtained by the emluator in this paper by using Sobel operator. Figure 5(d) is the contour feature obtained by the emluator in this paper by using the above algorithm.

The performance about the above new vehicle type recognition algorithm recognized by different vehicle images is shown in table 4.

TABLE IV. Performance of the new algorithm

	Recognition Rate
Car	81.2%
Bus	82.5%
Truck	81.3%

V. Conclusion and Future Work

A simple vehicle recognition algorithm based on contour feature was presented here. Instead of recognizing the vehicle type by BP neural networks, with this new method, only the recognition step can be used directly, and the training step can not be used, thus getting the result in shorter times. In addition, the implement of this method is simpler, and it is easy to modify the number of vehicle types. The disadvantage of this method is: not to be able to recognize some complex vehicles and special vehicle types. Keystones for my future works are: Optimize the new algorithm and resolve the above problem.

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