Research of Vehicle Type Recognition System Based on Audio Video Interleaved Flow for Toll Station

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***Abstract*—With technology of digital image recognition, the data frames include vehicle's digital image can be detected automatically from an Audio Video Interleaved (AVI) File, and vehicle type will be recognized automatically. The system consists of four modules: Reading AVI file and decomposing it into digital image frames; Motion detection; Vehicle's digital image processing; Module of vehicle type classification. In particularly, algorithm of vehicle recognition through counting number of black pixels included in vehicle body contour is one innovation algorithm. Experiment on actual AVI files shows: the system design is simple and effective.**

***Index Terms*—Vehicle Type Recognition; Background Image Subtraction; Anti-color Processing on image; Threshold Segmentation;**

I. INTRODUCTION

Automatic and real time vehicle type recognition system [1] is an important part of Intelligent Transportation System(ITS) [2][3]. With rapid development of digital image processing and recognition technology, there are more and more research on vehicle type recognition based on video. The primary method [4][5][6] of vehicle type recognition are: radio wave or infrared contour scanning, radar detection, vehicle weight, annular coil[7][8] and laser sensor measurement. Because a wide range application and rich information of image detection, it can be use in road traffic monitoring, vehicle type classification and recognition, automatic license plate recognition, automatic highway toll, intelligent navigation, so the vehicle type recognition using video is a hot research direction.

II. OVERALL SYSTEM DESIGN

A Design Goal

In this system, the passing cars are including Audio Video Interleaved (AVI) files captured by video capture card and camera in a certain toll station, based on AVI files, an algorithm called moving detection runs in order to find moving cars through toll station, then, the moving car's digital image is extracted, by means of digital image, vehicle type feature parameters is computed out for the end classification of vehicle type. Goals of the system are automatic and real time vehicle type recognition, traffic flow and charge statistics.

B Overall System Architecture

Fig. 1 shows this system consists of four main modules: Reading Audio Video Interleaved (AVI) file and decomposing it into digital image frames; Moving vehicles detection; Vehicle digital image processing module and Vehicle type classification module. Audio Video Interleaved (AVI) files are generated by camera, at the same time, real time video is be displayed on screen and digital image frames decomposed by system is be stored into memory for further processing.

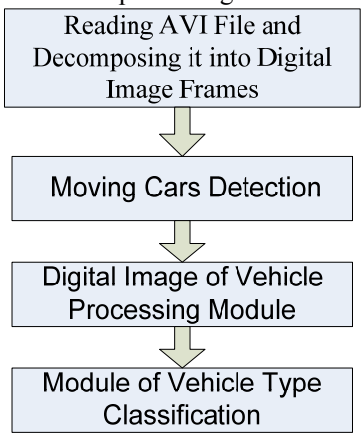

Figure1. System Modules

III. DETAILED DESIGN ON SYSTEM

A Reading Audio Video Interleaved (AVI) File and Decomposing it into Digital Image Frames

1) Structure of AVI File

Fig. 2 shows Audio Video Interleaved (AVI) file's data structure AVI file is one kind of Resource Information

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Format (RIFF) Files. Every AVI file has a header including file's basic information, audio and video information of every AVI file's frame is preserved alternately, for this kind of structure, so one AVI file can be decomposed into some digital image frames.

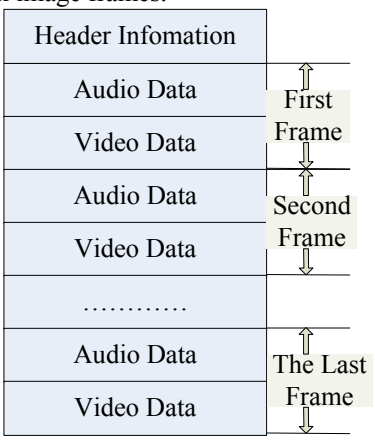

Figure2. Data Structure of AVI File

In Program tool Visual C++, one second development kit (SDK) named vfw.h is provided, using this SDK, a video file can be decomposed into one by one digital image frames, that is so called Decomposing Video into Digital Image Frames[10] which prepares for the next step: module of moving detection.

B Moving Detection Algorithm on Vehicle

1) How to Select Rectangular Detection Area

For finding vehicles in video, the first step is moving detection [1][2][3][11], so some area of a selected image should be compared with corresponding area of current AVI image frame, through the comparing result of change on image pixels in the detection area, there is or no passing vehicle can be find, the area is so called detection area which will directly influence the following image processing algorithm. In this system, an rectangular detection area is be selected. As Fig. 3 shows.

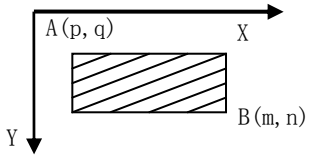

Figure3. Rectangular Detection Area

2) How to Select Background Template

In the system, background image is be selected static: when system is stop, first, an rectangular detection area is selected; second, in the case of insuring there is no vehicle passing, the image data of detection area is be read out from memory as background image template.

3) Algorithm of Judging Weather A Car Goes In or Out the Detection Area

A threshold value is be set when system initializes, such as 5% or 10%, if change ratio in detection area of the image be is more than this threshold value, system thinks there is an moving vehicle in detection area, otherwise, there is no vehicle.

Fig.4 shows a sample how to select rectangular detection area, on the left, an black rectangular is the detection area, on the right there are three little rectangular image: top is detection area image, middle is the background image, bottom is pixels' changing image in detection area. After computing, if pixels' changing ratio in detection area exceeds the value of threshold value, system thinks there is a car in detection area, at the same time, current vehicle image will be stored and be input into module of digital image processing.

Figure4. The Black Rectangle is Detection Area

C Module of Vehicle Digital Image Processing

As Fig. 5 shows, Input of this module is vehicle DIB digital image which is output by moving vehicles detection module [1].

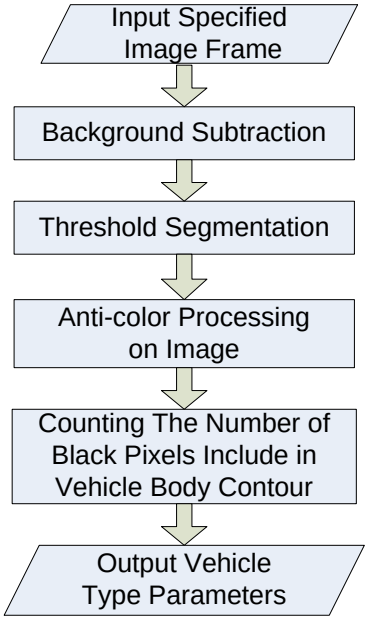

Figure5. Processing Flow of Vehicle Digital Image

1) Background Subtraction

Fig. 6 is image needs processing, Fig. 7 is background and Fig. 8 shows subtraction [4] result of Fig. 6 and Fig.

Figure6. Pending Image

Figure7. Background Image

Figure8. Image after Subtraction with Background

2) Threshold Segmentation:

Algorithm of Threshold segmentation is consisting of two steps:

One is calculating global optimal threshold: RGB Data of every pixel is be read out in order to calculating global optimal threshold using global optimal threshold algorithm.

The other is calculating binarization image through global optimum threshold value: Using value of global optimal threshold, binarization image is be calculated out, as follows:

$$g(x,y)\begin{cases}0, d(x,y) |< Threshold \\ 255, d(x,y) |> Threshold\end{cases}$$

among $g(x,y)$ is result after binarization, Threshold is value of value of global optimal threshold, as long as reasonable threshold value is be selected, useless information can be removed and target marks can be retained. As Fig. 9 shows.

3) Anti-color Processing on Image

Experiment shows that anti-color processing on image can get better intermediate results, popular speaking, anti-color processing is that black and white pixels is be reversed on binarization image. After this process, vehicle body contour image will be get, as Fig. 10 shows.

Figure9. Image after Threshold Segmentation

Figure10. Image after Inverse Color

D Module of Vehicle Type Recognition

Vehicle type characteristic data and algorithm of vehicle type recognition [1] will influence recognition accuracy of vehicle type directly, common algorithm of vehicle type classification are: vehicle recognition based on neural network, models based on support vector machine identification, genetic algorithm based on wavelet decomposition and genetic algorithm (GA). Algorithm mentioned above are complex, in this paper, a simple and effective algorithm of extracting vehicle type parameters based on video and image is designed, that is by counting number of black pixels include in vehicle body contour.

Through repeated experiments shows that the greater vehicle type the more black pixels include in vehicle body contour after anti-color processing, so the black pixels' total number include in vehicle body contour is be used as vehicle type characteristic data. The Fig.11 is vehicle classification algorithm which includes two parts: algorithm of extracting vehicle type characteristic data and algorithm of vehicle type classification.

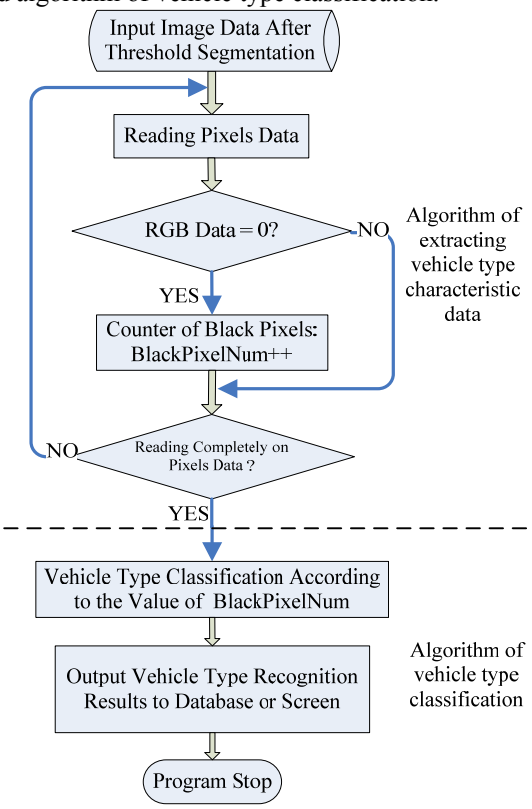

Figure11. Algorithm of Vehicle Type Recognition

V. Result of System Test

A Test on Non-motor Vehicle

Fig. 12 shows when one person goes into monitor area, system has not recognized the person as a car, system flag of vehicle in and out has not be changed, which shows that setting of the rectangular image detection region are reasonable and effective.

Figure12. Test on Non-motor Vehicle

B System Test on Cars Fleet

As shows in Fig. 13, if there is a cars fleet , system has not response timely, cars in fleet has not be separated

timely by system which leads to recognition error. More effective algorithm need be designed to solve this difficult recognition problem, at the same time ,it is a key question in the future research.

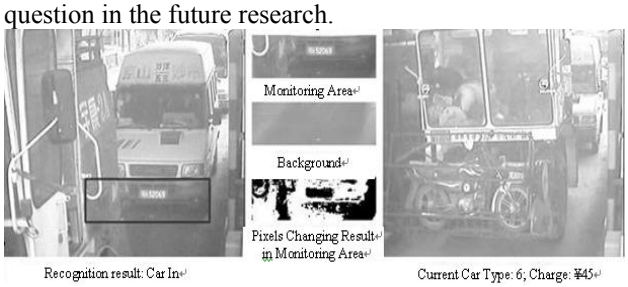

Figure13. System Test on Cars Fleet

C System Test on Cars in Different Color

When testing, often, recognition result on a dark color car is less than that of a light color car although they are the same vehicle type, as shows in Fig. 14, the left is a white Elysee, the right is a black Passat, the right result is less than the left, but actually, result should be the same one. For this problem, solution will be proposed in the future.

(a) Recognition Result: Type 2
Charge: ¥10
The result is accurate.

(b) Recognition Result: Type 1,
Charge:¥ 5
The Result is inaccuracy

Figure14. System Test on Cars in Different Color

VI. CONCLUSIONS

Technology of vehicle type recognition can be widely used on automatic statistics of traffic and toll. System test shows: system design is simple and effective, there are two innovations:

A Algorithm of vehicle image processing

Algorithm of vehicle image processing in the system is simpler than that of reference, there are only 3 steps: first is background image subtraction, second is threshold segmentation, the last is anti-color processing on image, a large number of experiments show that the algorithm of vehicle image processing in this system is simple to achieve and the effect is good.

B Algorithm of extracting vehicle type characteristic data

Especially to say: compared with complex algorithm of vehicle type recognition in reference, algorithm of counting the number of black pixels included in vehicle body contour is another innovative approach.

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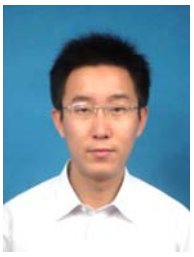

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