Research on Road Traffic Sign Recognition Based on Video Image

J D Zhao[1,2*], Z M Bai[2], H B Chen[1]

[1] National Engineering Laboratory for Surface Transportation Weather Impacts Prevention, Broadvision Engineering Consultants, Kunming, Yunnan 650041

[2]School of Mechanical and Electronic Control Engineering, Beijing Jiaotong University, No.3 Shangyuancun, District, Beijing, P.R. China.

*corresponding author's email: zhaojd@bjtu.edu.cn

***Abstract*-The frequent occurrence of road congestion and traffic accidents has affected people's travel efficiency and travel safety. Traffic sign recognition has become one of the key research objects in intelligent transportation system. This paper studies the identification of road traffic signs based on video images. First of all, collected image will be image preprocessing with image reduction, brightness adjustment, filtering. Secondly, the traffic signs are segmented by means of area filtering and morphological processing based on color and shape features. The method of feature extraction of traffic signs is studied to train traffic sign samples. According to the characteristics of many kinds of traffic signs, select linear kernel function and combine one to one SVM classifier to classify traffic signs. Finally, the traffic signs are identified based on Matlab software. The results show that the traffic signs can be accurately identified.**

Keywords- Road traffic sign; Detection and recognition; Feature extraction; SVM

I. INTRODUCTION

The rapid development of the global economy makes the number of traffic vehicles into the period of rapid growth and the car has become an important way to public travel. However, traffic congestion and traffic accidents also sounded the alarm to the traffic safety trip. In order to make traffic travel more convenient and dredge traffic congestion problems, a large number of experts and scholars have done a lot of work in the field of traffic sign detection, recognition and image processing. In 1999, H X Liu [1] designed and developed an active collision mitigation system consisting of vehicle detection and identification subsystems and traffic sign detection and identification subsystems. Two-layer neural network method was used to identify the vehicle type and establish a parameterized traffic sign model training. Experimental results demonstrated a robust and accurate system in real time object detection and recognition over thousands of image frames. In 2000, a set of recognition systems was designed and developed for speed and direction signs in Osaka University. Speed sign detection rate of 97% or more, the recognition rate of only 46.5% by using template matching and color threshold segmentation algorithm [2]. In 2001, Liu and Ran [3] of the University of Wisconsin in the United States used the HSV color space model to classify the image segmentation landmarks, and finally through the artificial neural network algorithm for classification and recognition. The experimental results show that the accuracy of the road environment image is 95%. In 2013, G Wang, G Ren [4] propose a hierarchical approach to traffic marker classification. The experimental results show that the method achieves 99.52% accuracy on the German traffic sign recognition benchmark (GTSRB), which is superior to the most advanced method. D Wang, X Hou [5] proposed a fast traffic sign detection method based on cascade method, which has significant test and adjacent scale consciousness. The cascade system has only one free parameter, while the multiple thresholds are selected by a data-driven approach. runs 2~7 times as fast as most of the state-of-the-art methods. In July 24, 2014, China Baidu Inc began unmanned vehicle plan, as of December 2015, Baidu driverless car to achieve automatic driving in a variety of mixed roads and complex weather conditions, the maximum speed of up to 100 km / h [6].

Review literature: The improvement of intelligent transportation system requires accurate traffic sign detection and identification. The domestic and foreign research methods of traffic signs is the traffic sign segmentation, recognition of traffic signs and the identification results provide driving and participants, the unmanned vehicle is transferred to the control system identification results. Based on the above, this paper adopts the image processing technology to process the collected traffic sign images, then classifies and identifies the traffic signs through support vector machine (SVM). The results of the final experiment show that the traffic signs can be accurately identified

II. IMAGE PREPROCESSING

Road traffic signs are difficult to be detected easily in complex environment. It is necessary to adjust the image brightness and eliminate noise by preprocessing. The pretreatment process is divided into image reduction, brightness adjustment and image filtering.

A. Image reduction

Image reduction [7] is actually a sampling process. The drop sampling will greatly improve the efficiency of traffic sign recognition. In this paper, the real road image is operated by bilinear interpolation algorithm, the original size is 1920*1080. The size is 384*216 after sampling.

B. Image brightness adjustment

Histogram equalization [8] is a common image brightness adjustment technique in image processing. Algorithm idea: Count the number of times of each gray level in the histogram, then normalize, finally calculate the new gray value.

C. Image filtering

Median filter is widely used in two-dimensional image processing to eliminate the interference of bipolar pulse or unipolar pulse. The details of the image and other information can be well preserved.

978-1-5386-1230-9/17 $31.00 © 2017 IEEE
DOI 10.1109/ICICTA.2017.31

III. COLOR TRAFFIC SIGN SEGMENTATION

A. Color traffic sign segmentation based on HSV color model

The segmentation of color threshold of traffic sign images is a common segmentation method. This paper adopts a new HSV (Hue, Saturation, Value) color model segmentation algorithm [9]. This algorithm transforms the HSV parameters into integers, and the range is shown in Table 1.

Table 1 range of HSV values

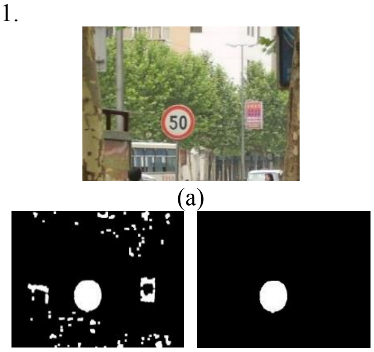
Red sign	yellow sign	blue sign
$240 \le H \le 255$ $0 \le H \le 10$	$18 \le H \le 45$	$120 \le H \le 175$
$S < 40$	$S < 148$	$S < 127.5$
$V < 30$	$V < 66$	$V < 20$
$V \ge 230$	$V \ge 230$	$V \ge 230$

B. Morphological treatment

Morphological basic operations consist of four part: corrosion, expansion, open operation and closed operation [10]. The morphological processing is performed on the binary image with noise after color segmentation.

C. Area filtration

Area filtering requires filling the area of the image. Region filling is based on the morphological operations of the set, as well as the complement and intersection. Filling the image requires removing the non-target item through the area threshold. The filling results are shown in Figure 1.



(a)

(b) (c)

Figure 1. (a)before area filling;(b) after area filling;(c) area filter

IV. SHAPE TRAFFIC SIGN SEGMENTATION

A. Shape feature parameter

Traffic signs have standard fixed shapes, which can be used to segment traffic signs according to the attributes of these shapes. The basic shape is shown in Figure 2.

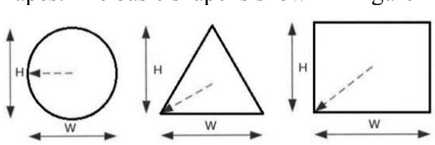


Figure 2. Schematic diagram of the basic shape

Where H denotes the height of the mark, W denotes the width of the mark, and S denotes the area of the mark, L denotes the circumference of the mark. Logo roundness: $C = \frac{4\pi S}{L^2}$; Rectangularity $R = \frac{S}{W \times H}$; Elongation $E = \frac{\min(W,H)}{\max(W,H)}$.

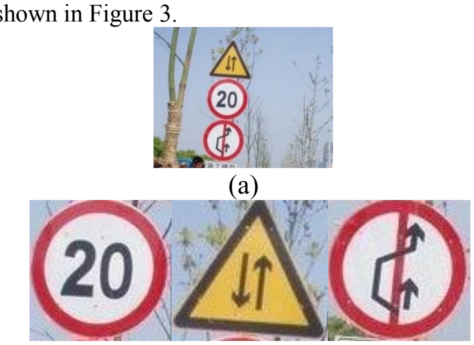
Due to roundness C rectangular R, elongation E need to change according to the actual angle. So these miserable parameters need to be adjusted accordingly. This paper will take the range of Table 2.

Table 2 Shape Feature Attributes Table

	round	triangular	rectangle
C	$C > 0.85$	$0.3 < C < 0.7$	$0.6 < C < 0.85$
R	$R > 0.70$	$0.4 < R < 0.7$	$R > 0.70$
E	$E > 0.85$	$E > 0.8$	$E > 0.8$

B. Sign Segmentation

Traffic signs need to be segmented from the background, then the information contained in the segmented region is assigned to a matrix. The information includes the area, the center of gravity and the smallest rectangle that contains the area. The segmentation results are shown in Figure 3.



(a)

(b) (c) (d)

Figure 3. (a) Image before segmentation; (b)(c)(d) The segmented images, respectively

V. ALGORITHM BASED ON HOG FEATURE EXTRACTION

Histogram of Oriented Gradients (HOG) is a local feature extraction algorithm based on edge feature of image shape [11]. The image size is normalized to 48 * 48 pixel size. Forbidden right turn mark map is divided into 36 area blocks. Extract the HOG feature vector as shown in Figure 4:

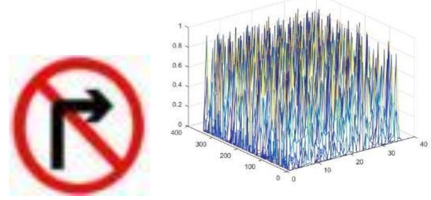


Figure 4 Forbidden right turn sign and its HOG characteristic vector diagram

VI. IDENTIFICATION OF TRAFFIC SIGNS

Traffic sign recognition based on Support Vector Machines. The biggest advantage of the support vector machine is the introduction of kernel functions, which makes the linear indivisible problem transformed into a linear separable problem in high dimensional space [12]. HOG feature is used to extract the feature of traffic signs. Linear kernel function is used to classify the features because of the high dimension of feature. For the multi class problem of support vector machines (SVM), this paper adopts the one to one method with short training time and high training efficiency. The sample training is divided into four steps:

Step 1: Image preprocessing and HOG feature extraction, feature vectors are used to identify the sample library.

Step 2: Since traffic signs have more training samples and higher feature dimension, linear kernel function is adopted to ensure real-time identification.

Step 3: The sample set is divided into n parts for each model (for $i=1,2\cdots n$). All data other than i are used as training sets to obtain training parameters. Test the first i data and get the test error data $E(\mathrm{i})$. The n error is averaged to obtain the estimated generalization error of the model, that is, the optimal model. Re training all samples to obtain the required parameter model.

Step 4: Classification is performed using the svmpridict function. Through the data model to predict the input data classification, that is, the corresponding specific traffic signs of the category. We only need to send the flag image HOG feature data of the test identification into our designed one to one support vector machine classifier, then we can complete the specific traffic sign category judgment.

VII. EXPERIMENTAL RESULTS AND VERIFICATION ANALYSIS

A. Sample database

There is no uniform sample database of road traffic signs in China at present. Therefore, the traffic signs are rotated at a certain angle to simulate the effect of the actual shooting process. Then sort it into a database. This paper chooses the common 91 kinds of traffic signs, including 42 kinds of yellow warning signs, 23 kinds of prohibition signs, 26 kinds of blue indicator. In addition, each mark is rotated by the standard mark to obtain 21 samples, interception of real shooting logo images 182, a total of 2093 training samples. Each mark is reduced to 48 * 48 pixels. Some of the training samples are shown in figure 5.

Figure 5 part of training samples

B. Experimental results

The experimental results of block partitioning in different regions are shown in Table 3.

Table 3 experimental results of classification of blocks in different regions

Features	Area block size	Number of region blocks	Characteristic dimension	Recognition accuracy (%)	Recognition time (s)
HOG	12×12	4×4	512	92.45	0.073
	8×8	6×6	1152	98.53	0.085
	6×6	8×8	2048	93.45	0.089

VIII. CONCLUSIONS

Traffic signs is identified by using Matlab based on video image processing technology. A set of traffic sign samples is set up and a SVM classifier based on a one-to-one classification algorithm is designed. The appropriate size partitioning HOG area block is selected. The experiment is carried out to verify the effectiveness of the proposed method. The experimental results show that SVM classifier based on one-to-one classification algorithm can realize the identification of traffic signs more accurately.

ACKNOWLEDGMENTS

This work is supported by "Open Research Foundation of National Engineering Laboratory for Surface Transportation Weather Impacts Prevention(NELJA201601)".

REFERENCES

[1] Liu H X. "Vision-based object detection and recognition system for intelligent vehicles". Proceedings of SPIE - The International Society for Optical Engineering, 1999, vol.3525, no.7, pp.1119-1126.

[2] Miura J, Kanda T, Shirai Y. "An active vision system for real-time traffic sign recognition". Intelligent Transportation Systems, 2000. Proceedings. IEEE, 2002, pp.52-57.

[3] Liu H, Ran B. "Vision-Based Stop Sign Detection and Recognition System for Intelligent Vehicles". Transportation Research Record Journal of the Transportation Research Board, 2001, vol.1748, no.1, pp.161-166.

[4] Wang G, Ren G, Wu Z, et al. "A hierarchical method for traffic sign classification with support vector machines". 2013, pp.1-6.

[5] Wang D, Hou X, Xu J, et al. "Traffic Sign Detection Using a Cascade Method With Fast Feature Extraction and Saliency Test". IEEE Transactions on Intelligent Transportation Systems, 2017, no.99, pp.1-13.

[6] Wen siao, Li zhimin and Hao yuting. "Review of traffic sign detection". 2016, vol.19, pp.34-36.

[7] Yu wanbo, "Image Processing Based on". Tsinghua University Press. 2008.

[8] Liu X, Wang G, Liao J, et al. "Detection of geometric shape for traffic lane and mark". International Conference on Information and Automation. IEEE, 2012, pp.395-399.

[9] Peng yuejun, "Research on Road Traffic Sign Detection and Recognition Technology". Guangzhou: South China University of Technology, 2013.

[10] RafaelC.Gonzalez, RichardE.Woods, StevenL.Eddins, etc. "Digital Image Processing (MATLAB)". Electronic Industry Press.2013.

[11] Dalal N, Triggs B. "Histograms of Oriented Gradients for Human Detection". Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on. IEEE, 2005, pp.886-893.

[12] Zhang Y, Li B, Lu H, et al. "Sample-Specific SVM Learning for Person Re-identification". IEEE Conference on Computer Vision and Pattern Recognition. IEEE, 2016, pp.1278-1287.