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Image Based Detection and Recognition of Road Signs

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Abstract

The objective of our work is to develop a noise tolerable threshold based segmentation and detection , which is learnt to the rotation, position and scaling also. Traffic sign analysis can be divided into three main problems: Find location, Detection and Recognition of traffic signs. In existing approaches locating and detection of traffic sign is based on color information and shape based extraction. In this paper, the original traffic image is converted into a grayscale image. The gray scale image was performed into Sobel edge detection algorithm to detect the edges. Filling the interior gaps, which is used to avoid the noise in an image. Smoothen of the object is done using the erosion operations. Segmentation technique is used to remove the unused area of the traffic signs. The clear traffic symbol and fast accessing were obtained from our method. After that the features are extracted from segmented image using histogram technique. SVM classifiers are used in the recognition process to classify and display the processed output image. The advantages of our approach are simple, fast and able to identify a common road sign.

Keywords: *Sobel edge detection algorithm, Morphological operations, segmentation, histogram techniques, SVM.*

1. Introduction

Traffic flow monitoring and traffic analysis are based on computer vision techniques and especially traffic analysis and monitoring in a real-time mode raise precious and complicated demands to computer algorithms.

Road signs are designed for easy detection and recognition by human drivers. They follow clear design principles using color, shape, icons and text. Illumination changes, partial occlusions, rotations, and weather condition further increase the range of variations in visual appearance a classifier has to cope with.

1.1. Image Design

There are various shapes of images used in traffic signs. They are triangular, circular, hexagonal, inverted triangle, square etc. The taken image size is variant. They are designed with specific colors and shapes, with the text or symbol in high contrast to the background.

Fig.1Taffic Symbol - Give Way

1.2 Traffic Signs

A "Traffic Sign" means any object, line, device, or mark on the road whose object is to convey to the road user, or any specified class of road user, restrictions, prohibitions, warnings or information of any description.

Fig.2 Traffic sign

2. Existing Method

In [1] S. Lafunte-Arroy, S. Salcedo-Sanz, S. Maldonado-Bascon et al proposed, a decision support system for automatic keep-clear signs management. The system consists of several modules. A recognition module, which is based on support vector machine (SVM), analyzes each image and decides if there is a keep clear sign on it. The images with keeping clear significantly are included into a Geographical Information System (GIS) database. The data in GIS are compared with the council database in order to decide the actions such as repositioning signs, detection of possible frauds etc. In [2] S. Maldonado-Bascon , J. Acevedo Rodriguez ,

S. Lafuente Arroyo, A. Fernndez Caballero, proposed a Pattern recognition method is used for detection and recognition system where the main objective is to categorize the detected sign. Support vector machine is reported as a good technique to achieve main target due to their ability to provide good accuracy as well as being sparse methods. In [3] Andrzej Ruta, yongmin Li , Xiaohui Liu proposed a Novel image representation and discriminative feature selection algorithms are utilized in a traditional three stage framework involving detection, tracking and recognition.

In [4] Miguel S. Prieto , AlastairR.Allen proposed a Self Organizing Map (SOM) are used for the detection and recognition of traffic signs. It first detects the potential of road signs by analyzing the distribution of red pixels within the image, and then identifies the road signs from the distribution of dark pixels in their pictograms. Additionally a novel hybrid system combining programmable hardware and artificial neural network is embedded machine vision is introduced. In [5] Pedro Gil Jimenez, Saturnino Maldonado Bascon, et al proposed a Detection block is divided into two sub blocks that performs shape classification and localization of road signs. The classification of shape is performed by means of signature of the connected component. Object rotations are tackled with the use of the FFT and normalization of the object eccentricity improves the performance in the presence of projection distortions. In [6] Alan Konear, Holger Janben, SamanHalgamuge, et al proposed a Hierarchical classifiers have a significant advantage over single stage classifiers both in classification accuracy and in complexity of the classification features. A new method for creating the structure of hierarchical classifier using a novel method for determining clusters.

In [7] X.W.Gao, L. Podladchikova, D. Shaposhnikvo, et al proposed a color and shape are basic characteristics of traffic signs which are used both by then drive and to develop artificial traffic sign recognition system. Color appearance model CIECAM97 has been applied to extract color information and to segment and classify traffic sign. In [8] Samuel G .Charlton proposed a study on assessing drive reaction to 16 road hazard warning signs of various formats by projecting life-sized video of road scenes to drivers in a driving simulator. The range of measures worked well as a whole with the two measures of conspicuity and the measure of static comprehension showing the greatest consistency. In [9] Luke Fletcher , Gareth Loy, Nick Barnes, et al proposed a drive assistance system (DAS) should support the drive by monitoring road and vehicle events and presenting relevant and timely information to the driver. In [10] C.Y. Fang, C.S Fuh, P. S. Yen, et al proposed An automatic road signs detection and recognition system that is based on a computational model of human visual recognition processing.

3. Methodology

3.1 Image Acquisition

The traffic images are taken in the form of .jpeg, .bmp, .mpeg, etc. In our work the .JPEG format images are working in our traffic sign Recognition.

3.2 Image Preprocessing

RGB color space is to be converted into a grayscale image. Detection block is divided into two sub blocks that performs shape classification and localization of road signs.

I = 0.2989*R+0.5870*G+0.1140*B;
Where I is an intensity image with integer values ranging from a minimum of zero, Where R,G and B are the red, green, blue components respectively.

3.3 Edge Detection

At this stage all the edges are detected in the given image. Another word of object detection is segmentation. The object to be segmented greatly varies in contrast from the background image. "Sobel" edge detection technique is used to detect the edges with help of applying the threshold (Otsu's) method.

3.3.1 Sobel Edge Detection

The Sobel filter can be used for edge detection. There are two 3*3 mask matrices that convolved with the image data (matrix). The images are grayscale. Mathematically, the operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives - one of horizontal changes, and one for vertical. If we define A as the source image, and $G_x$and $G_y$are two images which at each point contain the horizontal and vertical derivative approximations.

3.3.2 Thresholding

Thresholding based segmentation is method is considered to be core of image processing. Threading is used in most of the methods for determining a threshold value as a criterion to select the required region of interest. The threshold value for an image is selected based on the required region of interest. Different regions are obtained from various threshold values. Popular and commonly used Otsu's thresholding method is adapted for global thresholding in an image. The main aim of Otsu's automatic threshold is to select an optimum threshold value. After thresholding the output produced here is the binary gradient image.

4. Morphological Operations

There are several morphological operations are performed here to get a processed output. The steps involved here are.

4.1 Dilation

The binary gradient mask shows lines of high contrast in the image. The lines do not quite delineate the outline of the object of interest. Sobel image is dilated using the linear structuring elements. The binary gradient mask is dilated using vertical structuring element followed by the horizontal structuring elements.

4.2 Filling the Holes

The dilated gradient mask shows the outline of the image quite nicely, but the holes (noise) in the interior of the images still appear. To avoid this noise we use filling the holes algorithm . The image that has been segmented has found that some objects connected to its region. The connected borders are removed to give a needed portion as an output.

4.3 Smoothen the Object

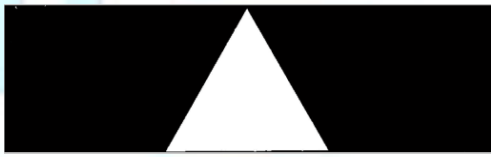
Finally the obtained object is to be smoothen as that the segmented object should look natural as compared with the original image. This can be done eroding the object. Here we create a diamond structuring element for the accuracy of the image. As eroding the image twice we get a cleared image.

5. Segmentation

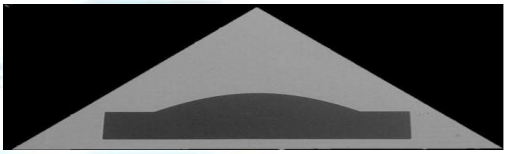
Segmentation is based on pixels relationship with their nearby neighborhood in an image. Basically, segmentation methods are classified based on pixels relationship properties. Here our method of segmentation is by removing the unused row and column to get an image clarity. By removing the unwanted area in the image the traffic sign looks clear and accurate. The output results are shown in fig 3a-3d.

(a)

(b)



(c)



(d)

Fig .3: shows (a) Original image (b) detection of road sign (c) row-wise segmented image (d) segmented image.

6. Feature Extraction for Segmented Image

The task of the feature extraction a selection method is to obtain the most relevant information from the original data and represent that information in a lower dimensional space The gray scale histogram equalized image is split into 64 fixed bins in order to extract more distinct information from it. The frequencies of 256 values of each color planes are split into sixteen (64) bins carrying values each (0~63, 64~127, 128~ 191, 192~255). This is done by turning off the values of the image which do not lie between the particular bins. This provides a

better illustration of image segments and simplifies the computation of features for the distinct portion of the image. The histogram is defined as the frequencies of the pixels in a grayscale image. The quantization is a process in which the histogram is divided into levels or bins. The sharpened filtered image is quantized into 64, 32, 16, 8 and 4 bins. As gray scale image consists of 256 levels, computation cost of the feature extraction in these 256 levels will be high. To reduce the computational cost, the histogram of an image is reduced to different bins. The histogram is then quantized into *L* bins shown in eqn (1).

$$H= \{h(b1), h(b2) \ldots h(bL) \} \quad (1)$$

Where h(bi) is the frequency of pixel values in bin bi and H is the histogram of L bins. Histogram processing is the act of altering an image by modifying its histogram. Common uses of histogram processing include normalization by which one makes the histogram of an image as flat as possible. This is also known as contrast enhancement. Intensity transformation functions based on information extracted from an image such as enhancement, compression, segmentation and description.

Histograms are frequently normalized by the total number of pixels in the image. Histograms are Simple to calculate in software and also lend themselves to economic hardware implementations, thus making them a popular tool for real-time image processing. This method usually increases the global contrast of many images, especially when the usable data of the image are represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. The color Histogram method is applied for feature extraction in classification of traffic sign images.

7. SVM Modelling

The main principle is structural risk minimization. SVM can be used for classifying the obtained data. It is set on a related supervised learning method used for classification and regression. They belong to the family of generalized linear classifiers. For linearly separable data, SVM finds separating hyper plane which separates the data with the data with the largest margin for linearly separable data, it maps the data in the input space into high dimensional space. By choosing a nonlinear mapping. The SVM constructs an optimal separating hyper-plane in this higher dimensional space.

The function k is defined as the kernel function for generating the inner products to construct machine with different types of non-linear decision surfaces in the input spaces. The kernel function may be any of the symmetric functions that satisfy the Mercer's conditions. There are several SVM kernel functions.
The figure 4 shows the separation of data. It is complex in one dimensional array as going further it becomes easier. More formally, a support vector machine constructs a hyper plane of a set of high or infinite dimensional space, which can be used for classification, regression or other tasks. Intuitively, a good separation is achieved by the hyper plane that has the largest distance to the nearest training data points of any class, since in general the larger the margin the lower the generalization error of the classifier. First we have to train all the data's using SVM torch. The data's are trained thoroughly as shown in the figure 4.

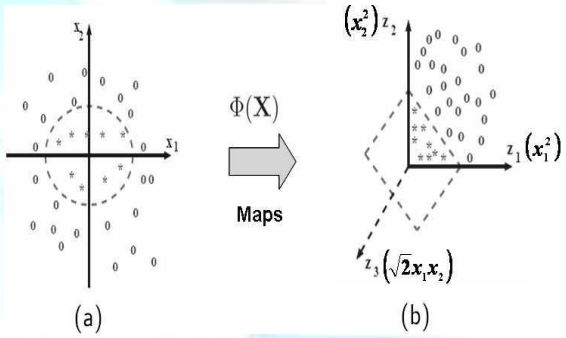


Figure .4: Shows the SVM separation of data

8. Results and Analysis

This section presents the experimental results of the developed automatic traffic sign detection and classification of images. Firstly different traffic sign images with different background are collected and stored in PC. The experimental results show that the system to find out and detect various traffic signs, robust to noise and efficiency of computation. Our method is to increase the precision and the accuracy of traffic sign detection process. Fig 5a-f represents the various inputs taken for processing and their processed output image.

We tested several ways of doing this during the last couple weeks of the project, but could not find a satisfactory method in that short amount of time. One method attempted was to find different characteristics of the blob and compare them to an ideal signs. By this way the proposed work has yielded an efficiency of nearly 70-80%. But our work has been achieved nearly 85-89% of efficiency during the training phase, by which the traffic sign detection technique used has achieved in recognizing the signs accurately.

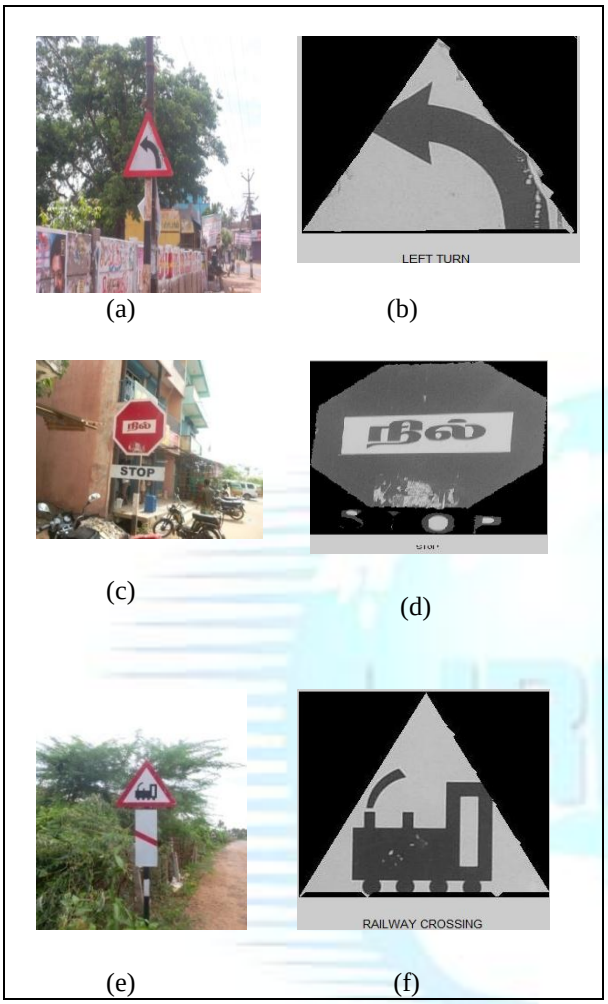


Fig.5 : Shows (a) Left turn original image (b) Recognized left turn image (c) Stop sign original image (d) Recognized stop sign image (e) Railway crossing original image (f) Recognized railway crossing image

9. Conclusion

The process of the proposed system using the detection algorithm has proved an efficient approach for the driver assistance system. Automatic segmentation for this work has successfully yielded an 89% of efficiency which are more helpful for the future work. The feature extraction method called histogram is used for extracting the feature from the segmented images. Support Vector Machine (SVM) is used to recognize the traffic sign image. It is believed that the system is useful for other applications such as maintenance and inventories of traffic sign in highways and our cities.

In future work , our approach extends to the nighttime environment also against various occasions.

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