Real-Time Traffic Sign Recognition using SURF Descriptor

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Abstract: For road safety, traffic sign is essential for drivers by giving valuable safety and navigation information, pedestrians and even for the development of autonomous driver assistance system. Traffic sign can be classified by two methods can be approached. First approach is color base segmentation which is the region of traffic sign by using HSV color space (Hue, Saturation and Value) and the next approach is shape base segmentation using Hough Circle Detection. In thissystem, we use circle shape base detection for every traffic sign. At first, keypoints descriptor is extracted from each standard traffic sign image in database and then keypoints descriptor is taken from region of traffic sign extracted from Hough circle detection. After that, the nearest distance is matched keypoints descriptor between in each standard traffic sign image in database and extracted traffic sign image.

Index Terms: color segmentation, Hough circle, traffic sign, SURF

1 INTRODUCTION

With the developing number of vehicles over the last few decade, traffic accidents have become an important cause of fatalities. There are many cause of the traffic accident but most of them are due to the human error. We have already known the main difference between the human and computer which have no decision if we are not controlled but better than human in multi-processing. For this purpose, traffic signs play an important role toprovide information about traffic and road conditions which is necessary fora driver to accomplish a collision free driving environment. Road signs are designed to regulate flow of the vehicles, give specific information to the traffic participants, or warn against unexpected road conditions.

Figure1. *Five common types of road signs in category*

The process of automatic traffic sign recognition can be divided into two main steps: the first step is to detect the location of traffic signs within frames and the second step is to identify the traffic signs and convey the information to the driver. For a real time, we can be used efficient sign recognition software. This means that the process of a single video frame has to be done completely, that the received data is keeps up to date. When assigning the specific features, different driving conditions in the scenes should be taken into consideration to achieve robust and fast traffic sign classification. Traffic sign can be detected by shape-based, color-based and machine learning methods. In this system, we use Hough circle transform to achieve the location of the traffic sign. And then it is extracted by using region of interest method. Finally, the candidate of the road sign is recognized by using SURF (Speed Up Robust Feature) algorithm which exhibit highly discriminative performance and achieve robustness in illumination, scale and rotation. Experimental results show that this work attains robust traffic sign recognition in comparison to the state-of-art methods, and achieves a faster processing time, including training time and classification time.

II. DESCRIPTION OF THE PROPOSED METHOD

System Description

The process of traffic sign recognition has three section. The first section is Image acquisition and preprocessing. Image acquisition involves capturing video from thecamera and extracting each frame from video for processing.Step of the procedure are the following.

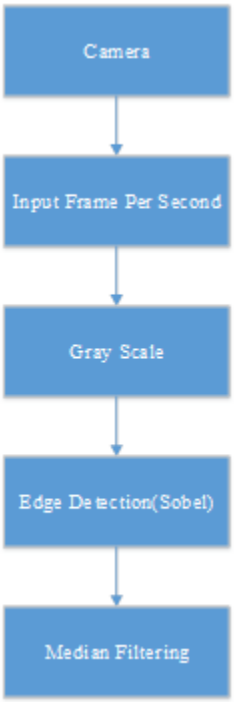

Figure2. *Pre-Processing stage of traffic sign*

Grey-scale Conversion

Pre-processing stage involves resizing of each frame to pre-determined size. It converts RGB image frame to gray-scale image in order to speed up process calculation speed.

Sobel Edge Detection

Sobel edgedetection is used to calculate the gradient of the gray scale image for each pixel position in the frame.

Figure4. *Sobel Edge Detection*

Median Filtering

Median filtering is to reduce salt and pepper noise from edge frame in order to speed up calculation of Hough transform which is highly effective in removing salt-and-pepper noise by replacing the central element with median pixel value in the image.

Road Sign Detection and Extraction

The next section is traffic sign detection and extraction which uses to crop the ROI from the input frame. In our work, road sign is extracted by the following procedure.

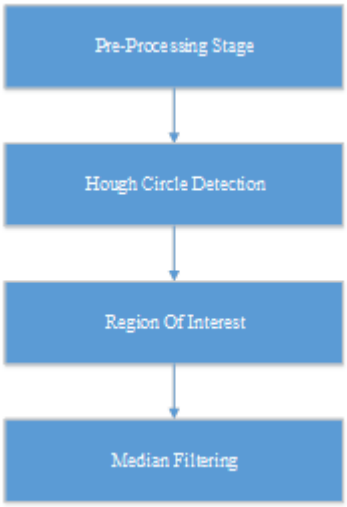

Figure 5: *Flow of the road sign extraction*

Hough Circle Transform

We use Hough circle detection to calculate the circle position from the gradient frame. And then we get the location of traffic sign by using shape base extraction and extract ROI from original input frame.

Region of Interest

To get a rectangle, need top-left corner and bottom-right corner of rectangle. We have (x, y) and radius after Hough circle equation after that crop region of interest from rectangular region.

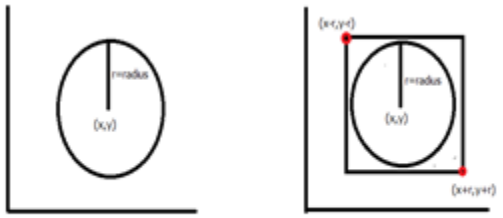

Figure 6. *Region of Interest*

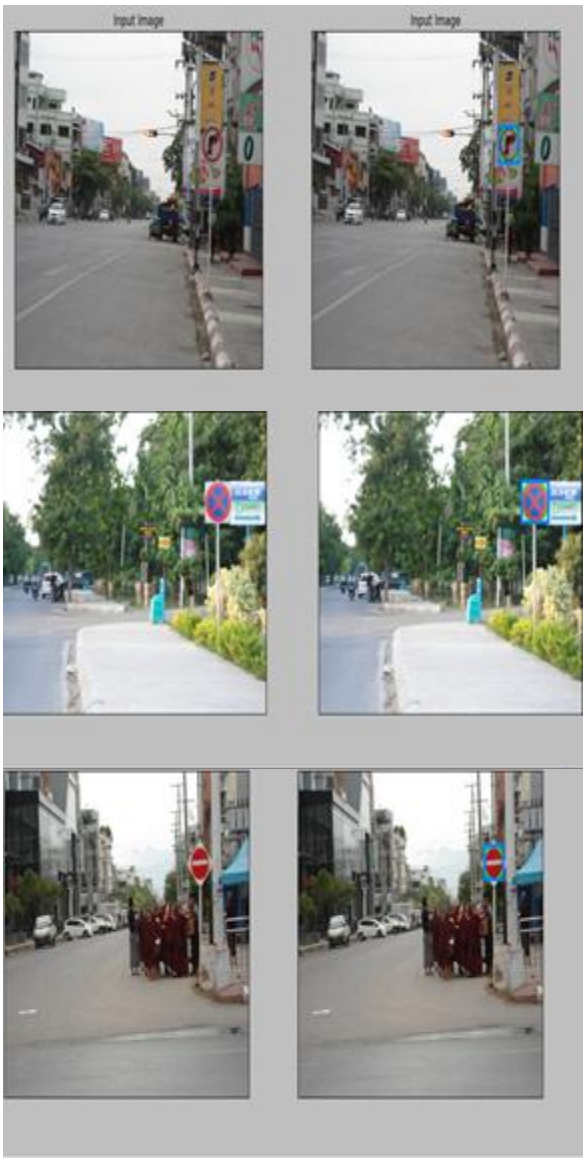

Figure7: *Test Result of Road Sign detection and extraction*

Road Sign Recognition

In recognition method, we first need to train key points from images samples at preprocessing stage and find keypoints and descriptors for each images for matching image from shape base extraction. At this stage, compare each feature on the sample images to all of the features in the crop image and keep the best match for each feature. Keypoints in image can be an edge, a corner, conclusion point, a line or a curve, etc. After that make decision for driver depending upon the most matches keypoints descriptors. Before using key point descriptor in computer vision we need to convert crop image into gray scale image for feature extraction which is more suitable for preprocess stages of SURF keypoints descriptors make fast computation time. Integral image is computed from crop image which is a fast way to compute the intensities for any rectangle within the image and computation time is independent of the size of the filter. SURF uses a blob detector based on the Hessian matrix to find points of interest. The determinant of the matrix is the product of theEigen value and used to the maxima and minima of the function by the second order derivative test on integral image instead of original image. If the determinant of the matrix is positive, both Eigen value are positive or negative and in either case the point is classified as an extreme is referred to as the blob response and provide the interest points for an image LOG(Laplacian of Gaussian)approximations are very close to LOG and one of the advantage of SURF is that convolution with box filter can be easily calculated with the help of integral images. The LOG allows us to vary the amount of smoothing during the convolution stage so that the determinant is calculated at different scales. When the filter size increase, the computation cost also increases significantly for the original Laplacian while the cost for the box filters is independent of size.

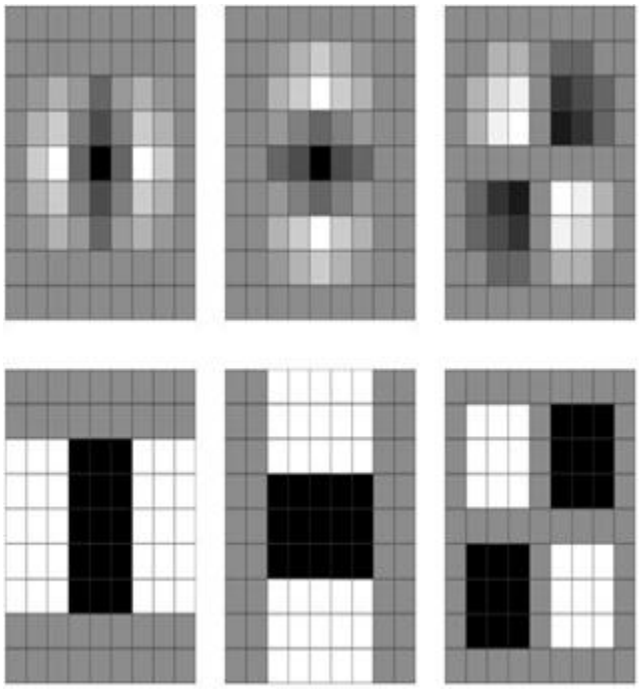

Figure 8: *Laplacian of Gaussian Approximation*

Hessian determinant using the approximated Gaussians:

$$\det(H_{approx}) = D_{xx}D_{yy} - (.9D_{xy})^2$$

Constructing scale space is used to find extrema across all possible scales and typically implements as an image pyramid.So that surf is size invariant and the scale-space can be created by applying kernels of increasing size to the original crop imageand the scale-space is divided into a number of octaves. The task of localizing the scale and rotation invariant interest points in the image include thresholding, a non-maximal suppression and interpolate the interest point to arrive at the correct scale (σ). Haar wavelets is used to find gradients in the x directions and y directions that they give a sense of the direction of the change in intensity. They are resistant to overall luminance changes SURF descriptor is invariant to rotation, scale, brightness and, after reduction to unit length, contrast but rotation invariance is not required for traffic sign recognition and it speeds up the process without orientation. The greater number of matches is the positive result for traffic sign classification. And show information to the driver.

TESTS AND RESULTS

The system search for signs with the help of algorithms for detecting and identifying simultaneously. In our system, we are collected the thirty standard road sign database to match corresponding keypoints between each standard road sign image and the extracted road sign image. The common road signs besides the street were tested using SURF algorithm. All the corresponding keypoints between standard road sign database and the extracted road sign from the whole image are shown by lines. These test images are shown in the following figure.

Figure9: *Test result of no right turn in different background*

Figure10: *Test result of no stopping road sign in database has no corresponding key points with no right turn road sign in original image*

Figur11: *Test result of speed limit road sign. This system work well with partial occlusion. The system should also be able to determine the exact speed limit, if the corresponding sign is classified as such.*

Figure12: *There is no match point if the two road signs are different shape.*

CONCLUSION

All of the above described algorithms are work done with the detailed implementation of a software system. For real-time application, we used the Hough circle transformation method and SURF (Speed Up Robust Feature) feature for road sign classification. The results achieved from the described software prove that our system is applicable for real-time video processing. When used on a video sequence rather than the standard approach of traffic sign detection in static images,moreover, the system has better results. The experimental results have demonstrated the convenience of the system. Examining the publicly available data set in real condition shows that this work achieves fast processing speed and robust traffic sign recognition. Future work of the system should include different kinds of traffic sign shape (for example, triangular) by applying more advanced methods of feature extraction.

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