# Centroid Distance Shape Recognition for Real Time Low Complexity Traffic Sign Recognition

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**ABSTRACT:**
This paper represents advantages of using Centroid distance function for shape detection in real time traffic sign recognition compared with extracting histogram of oriented gradients (HOG) features and using support vector machine (SVM) classifier. Simulation results of using centroid distance show similar accuracy in compare with HOG SVM while have very low complexity and cost and running with higher speed.

**KEYWORDS:** Traffic Sign Recognition, Advanced Driver Assistance Systems, Centroid Distance, Histogram of Oriented Gradients, HOG, Support Vector Machine, SVM, Shape Recognition, Low-Complexity.

## 1. INTRODUCTION

Traffic sign recognition (TSR) is one of the advanced driver assistant systems (ADAS) subsets. Nowadays, it is serious for intelligent vehicle systems and help drivers for a simpler driving. A traffic sign can display current traffic conditions on the way, represents hazards and obstacles facing the drivers, give them warnings and assist them with their navigation by prepare helpful notifications that causes driving more invulnerable and suitable. Presenting this data to the drivers in a right time can prevent accidents, save peoples, money, enhance driving efficiency and decrease the pollution caused by cars.

Recognition and classification of traffic signs can be achieved by combining the two main traffic sign features: color and shape. This method helps the recognition algorithm to perform in a better way and to reduce the number of false alarms generated by this algorithm. Therefore, the detection and recognition of different signs requires testing the presence of different color combinations in the image together with the presence of the specific shape. Hence, recognition and classification are carried out at two different stages. In the first stage color segmentation is applied. Two rim colors exist for traffic signs, for example red and blue. A traffic sign shape tree is built according to these two colors as depicted in Fig. 1.

Because most of the prohibitory signs and warning signs are red, seeking the red region is very important. Therefore, in this paper we use red color segmentation.

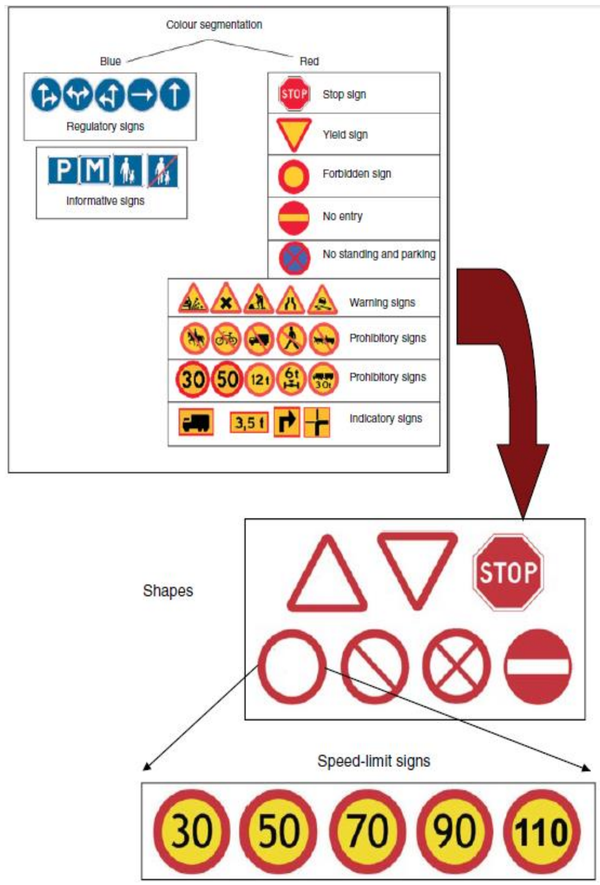


**Fig. 1.** Traffic sign tree based on color and shape information.



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However, the components of the RGB color space are easily affected by light conditions and illumination. It considered from previous researches, as discussed in [1], using Hue, illumination and saturation color space has many benefits for us [2]. Hence, in this paper we implement color-based segmentation in the improved HLS (IHLS) color space. Also we employ a color conversion method using low-cost calculators, such as adder, shifter and comparator [3].

In next step for recognition, many shape detection and other methods exist. A common method is extract features by using HOG and classifies them as showed in Fig. 2.

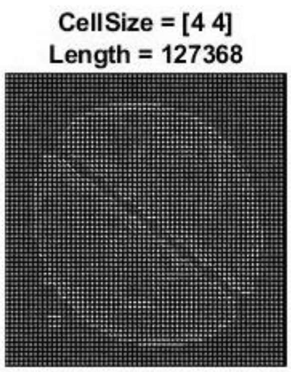


**Fig. 2.** HOG Sample for a given ROI.

These methods firstly used for classify human detection [4] some years ago and shows good results in traffic sign recognition [5]. However, for a simpler system with low complexity of software and hardware and higher speed of test stage we propose using sum of centroid distances of all pixels in a region as a scalar feature.

Then, we can classify shape with two high and low thresholds for each shape. For more simplicity we implement some down sampling method to reduce region of interest (ROI) size.

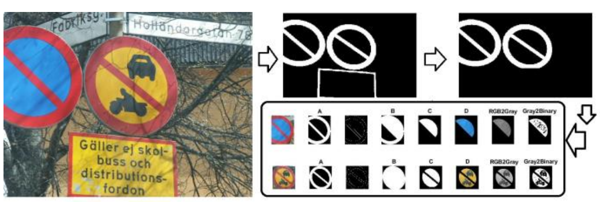


**Fig. 3.** Overview of TSR algorithm.

## 2. ALGORITHM OVERVIEW

As displayed in Fig. 3, there are two major steps: detection and recognition. In preprocessing and detection steps, we find red regions in IHLS color space. Then, by using a connected component algorithm, we have some ROI. Then, we check size and aspect ratio for each of them in order to reduce number of unwanted ROI's feature extraction and recognition process. Therefore, depend on input picture size very small and very big ROI's omitted. After that, we use edge pixel detection technic and calculate centroid distance of each ROI edge pixels. After that, we can find desired TS by comparing sum of centroid distances of edge pixels of each ROIs with some thresholds. In addition, for comparing results of our method with other one, we extract each ROI features by using histogram of oriented gradients (HOG) and classify them by a pre trained model from training set with support vector machine (SVM) results [5] .Block diagram of this method can be found in .Fig 4. By comparing the results, it is shown that our technic obviously has better results and because of very low complexity design is very faster and suitable for low price hardware's.

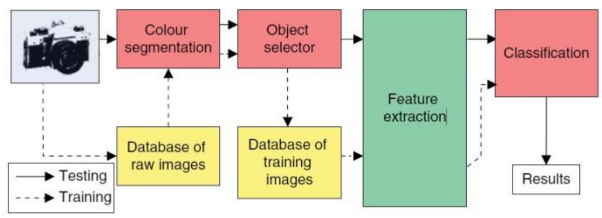


**Fig. 4.** Block diagram of traffic sign recognition system.

### 2.1. Detection

For low complexity purpose from [7] we use (1) and (2) for using IHLS condition of red region straight from RGB values. After that, by using thresholds, we have a binary image that consists of 1 for red pixels in our thresholds and 0 for others. Then, by using label connected components function in binary image, we have some ROIs. Then, as we described before, two filters applied to ROIs. First ones is calculating size of pixels for each ROIs and filter unwanted. Very small and very big ROIs will become zero and deleted. Second filter is aspect ratio filter by calculating remaining ROIs aspect ratios and delete every unwanted ROIs. Aspect ratios of our traffic signs are known. With some assumptions for changes in viewing angels, we can consider aspect ratios between 0.5 and 2 for most traffic signs and situations. This part is same with two methods when using SVM or centroid distance.

$$\left(0.5 * \left(B + \left(R - 1\right)\right) - G\right) \geq 0 \tag{1}$$

$$\left(2 * B - \left(R - 1\right) - G\right) \leq 0 \tag{2}$$

### 2.2. Recognition

In this step we check every received ROI for calculating centroid distance. First, we change all ROI sizes to 50*50 pixels because of reaching more simplicity. After that, we fill the ROIs (sub image A in fig. 3) with white pixels in order to produce (sub image

B). Next, we calculate edge of ROI for calculating centroid distance of each edge pixels to center of ROI.

For calculating centroid distance, we have a function that for each pixel in ROI calculate distance to center of ROI by equation (3).

$$\delta = \sqrt{\left((W-c)^2 + (H-c)^2\right)} \tag{3}$$

In this equation $\delta$ is centroid distance of a pixel with height H and width W and C is the center pixel (here it assumed 25). By sum all pixels $\delta$ , we have centroid distance of ROI.

According to distance ranges in table I, Which is obtained experimentally, we can determine the shape and type of traffic sign in ROI and we can classify them in some groups.

**Table 1.** Practical centroid distance ranges.

| Shape | Centroid Distance Ranges of Traffic Signs for 50*50 TS Pixel Size | | |
|---|---|---|---|
| | Traffic Sign | Dist. low | Dist. high |
| Octagon | Stop | 1570 | 1700 |
| Triangle | Yield | 1700 | 2100 |
| Circle | No Entry | 1000 | 1570 |
| Circle | No Parking | 2500 | 3200 |
| Circle | Speed Limit | 2100 | 2500 |
| Circle | No Standing | 3200 | 3700 |

## 3. MATERIAL AND METHODS

We have implemented our algorithm in MATLAB software and worked on Dalarna University traffic sign dataset [8]. Dalarna University in Sweden released a traffic sign dataset which consists of 4338 image collected in Sweden and 330 images collected in other counties. All still images were taken manually when traffic signs were seen by the camera operator. They were collected in different light conditions, in different weather conditions and in different road conditions including different speeds. For all images and without any exception, the camera was set to 640 × 480 pixels. Images in this database are classified into 30 categories depending on weather conditions, type of the sign, sign condition, image condition and light geometry. We choose 284 pictures from it for test set. For training of SVM model we use another image set.

## 4. RESULTS AND DISCUSSION

Accuracy and speed of recognition in two methods is calculated and displayed in Table II. Detection step of both methods is very similar and omitted from calculations of time and accuracy for better comparison.

### 4.1. Accuracy

From simulations, we found that correct detection percent in SVM classifier is about 84.7% and by using centroid distance with very little work on thresholds we reach correct detection ratio about 80.1% for example in Yield and No Entry signs. We can see that accuracy of both methods is approximately same and with doing more work on selecting thresholds we can reach better correctness ratios in future.

### 4.2. Fastness

Unlike accuracy that it was approximately the same in both methods, we have seen that our method is very faster than SVM because of using very little mathematical calculations for same images and sizes of ROIs.

For example we run our algorithm in a corei3 processor and detection of 284 pictures takes 0.0308s while when using SVM classifier it takes 15.293s. Therefore, we reach to a rapid method with about 496 times faster than HOG-SVM while correctness ratio of results is approximately the same and can be better with more practical experiments.

**Table 2.** Centroid distance and SVM classifier results on dataset.

| method | Number of images | Correct | wrong | Correctness Ratio | time |
|---|---|---|---|---|---|
| Centroid Distance | 284 | 226 | 152 | 80.1% | 0.0308 |
| SVM | 284 | 239 | 139 | 84.7% | 15.293 |

## 5. CONCLUSION

As seen before we propose a shape detection method for using in traffic sign recognition that has the same results in compare to SVM but it is very faster than that. This is good when we want to use a cheaper hardware and at the same time expecting real time execution.

## 6. FUTURE WORKS

In the future we can optimize this method and compare it to newer deep learning methods. Also we can compare our model to others while more challenges exist like challenging environments [9]. However, it seems that this method is simplest way to recognize traffic signs with acceptable results.

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