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# A method to search for color segmentation threshold in traffic sign detection

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***Abstract*—Color segmentation is the most commonly used method in traffic sign detection. Therefore we propose a method to search for color segmentation threshold in video. Firstly, we classify every image's pixels into positive samples and negative samples after color segmentation using some experience thresholds. Secondly, all positive samples are assembled into a new collection as "positive-sample-set", and all negative samples are assembled into "negative-sample-set". Thirdly, the difference between positive-sample-set and negative-sample-set both in RGB and HSV color space are gathered statistics. Then better thresholds for color segmentation could be found. Experiments show the color thresholds are more accurate and appropriate to detect traffic signs. And the method could also be used in other color analysis research.**

***Keywords-color segmentation; positive samples; negative samples; threshold search***

## I. INTRODUCTION

Traffic sign recognition system is an important part to driver assistance system. Traffic sign detection is the first step for traffic sign recognition system. It finds traffic signs from the environment as soon as possible, locates them in the image, and then show them on the screen board or store them in order to continue traffic sign recognition research.

Color is one of the most distinct features for traffic sign, so researchers usually use color segmentation for traffic sign detection. Color segmentation is done by choosing suitable thresholds for separate traffic sign from the background. Researchers use different color spaces to get the thresholds. From the resent literature, we can find they usually research in RGB, HSV, LUV color space. In the works of Zadeh [1] and Turan [2], RGB color space is chosen because RGB gives three independent values as red, green, and blue to form different color pixels. Although the colors of traffic signs are fixed, the pixel values in the RGB color space do not stay fixed. Even more, these values change a lot under the different illumination levels in the scene. So researchers who prefer to use RGB color space always focus on the value range of differences between R, G, B, that are R-G, R-B, G-B, for their stability is better. But it is still sensitive to the change of illumination. So some researchers attempt to transform the RGB color space to other color space. HSV is the most popular used one because it is a linear color space [3~7]. In this color space, H represents hue, while S represents saturation and V represents value. Because hue is insensitive to the change of illumination, this color space is usually used for outdoor traffic sign detection research. A few researchers also use LUV color space [8], where L represents light value, U and V both represent hues of red-green and yellow-blue. But due to its irregularity, it can not evaluate colors directly.

Recently years, some methods which used the color classification technique with RGB or HSV or LUV were proposed, combining with computer vision [9] and intelligent algorithms [10] [11], such as Scale Invariant Feature Transform (SIFT) and Neural Network Algorithm. Through lots of trains, those methods also work well. But these methods depend on the choose color space as well. Although these new methods adopt some computer techniques, they have to deal with the color segmentation problem yet.

Above all, researchers have different effects of color segmentation in their own choose color space. The most of all, they just do segmentation work by using threshold but not introduce how to find and choose the threshold in detail. Therefore they cannot objectively analyze and evaluate the results. Meanwhile, they only choose one color space, which has its own disadvantage and limit in applications. Furthermore, they only consider traffic sign's color features while disregard other noises' color features in the images. For deal with these, this paper proposes a method to search for color segmentation threshold. We use this method to analyze the difference between target and background both in RGB and HSV color space, combine the threshold get from both color spaces together to do the color segmentation work. Experiments show that we can separate the target and background totally and get a better segmentation effect than use experience threshold. The method could also give a theoretical analysis and evaluation.

## II. THE METHOD OVERVIEW

The method to search for color segmentation threshold uses some consecutive frames images from video, which includes traffic signs. The process of this method is shown in figure 1.

The process has these steps: getting consecutive frames images from video, rough segmentation using experience threshold and get accurate threshold, segmentation using statistics threshold and traffic signs detection.

(1) Getting consecutive frames images from video. We select 4 seconds' video which contains traffic signs, and there are a hundred consecutive frames. The video shows

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that traffic signs turn up to pass away. During this period traffic signs are more and more clearly. These frames are key images to traffic detection. As shown in figure 2, the 28th, 51st, 73rd frame images are corresponding to (a), (b) and (c).

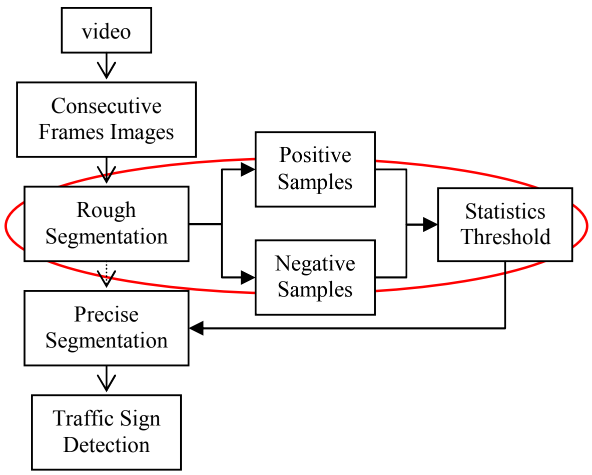



Figure 1. The processing flow of searching color segmentation threshold.

(2) Rough segmentation using experience threshold and get accurate threshold. Using experience threshold roughly segments these consecutive frames images. The task in this part is to take out most of the noise from the environment, such as green trees, brown road, white kiosk, silver car and so on. This step can reduce the complexity in the statistics of samples and simplify the statistics' process. The images after this step is shown in figure 3. To get accurate threshold is the key of the method, which will be introduced in section 3 in detail.

(a) (b) (c)

Figure 2. Consecutive frames images from video: (a) this is 28th frame. (b) this is 51st frame. (c) this is 73rd frame.

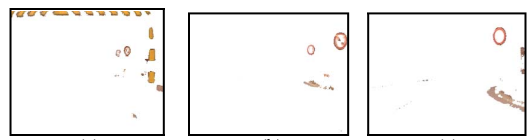
(3) Segmentation using statistics threshold. This step aims to separate target from the background completely. We use the thresholds from statistics to segment traffic signs from the scene. After analysis, the values of R-G and G-B in RGB color space and the value of H in HSV color space are chosen to do this segmentation work. The results are that the noise is totally taken out from the images, only the color of traffic sign remains. The effects of segmentation show this method making progress than the experience threshold.

(4) Traffic sign detection. The method to search for color segmentation threshold shows a good effect in traffic sign' color segmentation. Based on it, we can easily locate the traffic sign's coordinate information and easily take it out of the environment.

## III. CLASSIFY AND REGROUP POSITIVE AND NEGATIVE SAMPLES

After rough segmentation by using experience threshold, every image still has traffic signs' main color information and some noise which is similar to the color of traffic signs. As shown in figure 3, the experience threshold cannot separate them totally. Therefore the experience threshold has a limited application to take part of the noise out. Color segmentation work needs a precise way to find the threshold to separate the traffic sign and background totally if possible. So we propose a way to analyze the color range of traffic signs and noise.

First, positive and negative samples are classified. As shown in figure 3, the traffic sign's annulus is the target while carmine road, yellow and black door frame and little traffic sign's inverted image on the glass are all noise. Here, target pixels are considered as positive samples, and the rest background pixels whose color is similar to the target color are considered as negative samples.



(a) (b) (c)

Figure 3. Segmentation effect by experience threshold: (a) this is 28th frame. (b) this is 51st frame. (c) this is 73rd frame.

Second, the positive and negative samples are separated. Every image has its own positive and negative samples. In this paper, a set of rectangles which have the positive samples are created, which is shown in figure 4.

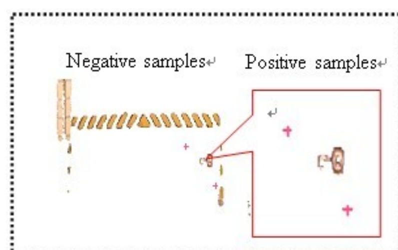
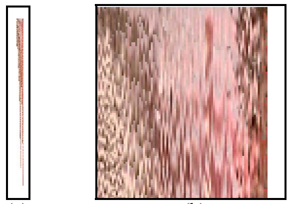


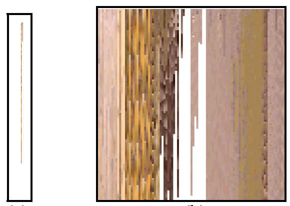

Figure 4. Classify positive and negative samples.

Then, there are a hundred positive samples and a hundred negative samples. As positive sample sub-image is corresponding to a M×N matrix, all the positive samples are regrouped to a new (M×N)×100 positive-sample-set, which is shown in figure 5(a). The part of Figure 5(a) is zoomed in and shown in figure 5(b). A new negative-sample-set can also be gotten in the same way, and is shown in figure 6.



(a) (b)

Figure 5. Positive-sample-set. (a) this is positive-sample-set original image. (b) this is zoomed image of positive-sample-set.



(a) (b)

Figure 6. Negative-sample-set. (a) this is negative-sample-set original image. (b) this is zoomed image of negative-sample-set.

## IV. FIND SEGMENTATION THRESHOLD

Now do a statistics work both in positive-sample-set and negative-sample-set. The threshold parameters can choose R-G, R-B, and G-B in RGB color space and H, S, and V in HSV color space. The reason for choose these two color spaces is as follows:

(1) RGB color space. The color of every pixel is decided by the value of R, G and B. But these values are not stable as they are affected by different hardware and variable lighting conditions. However, the values of R-G, R-B, and G-B have their own regular range. So the values of R-G, R-B, and G-B are chosen as color segmentation's threshold parameters.

(2) HSV color space. Because of RGB color space's sensitive to the light change, this paper also chooses HSV color space to enhance the ability to the variable lighting conditions. In HSV color space, H represents hue which means what color it is, S represents saturation which means one color's different degree. V represents value. So this paper mainly analyzes H as color segmentation's threshold parameters either.

Then the results of the statistics work are shown in figure 7 and figure 8. In figure 7, histogram statistics of positive-sample-set and negative-sample-set's R-G, R-B, and G-B values are shown. The histogram's abscissa represents absolute value of R-G, R-B, and G-B, whose range are all from 0 to 255. The ordinate represents the number of pixels. In the R-G group, the negative samples are only on the left side of red broken line. In the G-B group, the positive samples are on the left side of the red broken line. These mean that the positive samples and negative samples are able to separate from each other through these value features. Accordingly, R-G and G-B's feature values are chosen as threshold values.

In figure 8, histogram statistics of positive-sample-set and negative-sample-set's H, S, and V values are shown. The histogram's abscissa's range is from 0 to 1, and the ordinate represents the number of pixels. In the H group, the positive samples are all on the left side of red broken line. The negative samples are partly on the right of the red broken line. This means that the positive samples and negative samples are able to partly separate from each other through these value features. So, H's feature value is chosen as new threshold value.

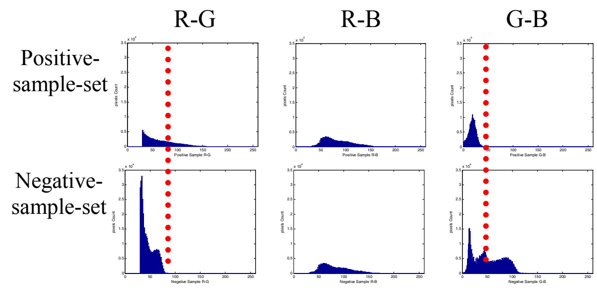



Figure 7. Positive-sample-set and negative-sample-set's R-G, R-B, and G-B histogram statistics.

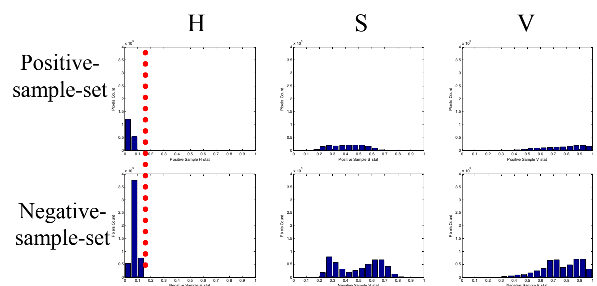
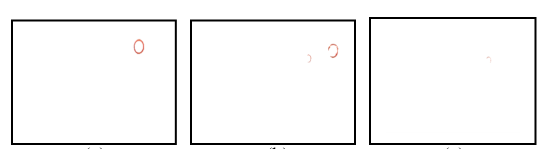



Figure 8. Positive-sample-set and negative-sample-set's H, S, and V histogram statistics.

## V. EXPERIMENT RESULTS

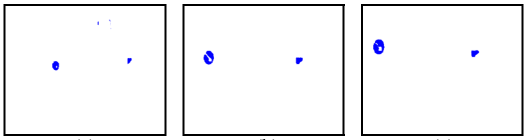
The threshold values were selected by the above process was used in color segmentation experiment.

The results of red color segmentation by using statistics threshold are shown in figure 9. The red traffic sign is separated from background very well. In the 28th frame image, as traffic sign is still far from the camera, the number of color pixels from segmentation is too little to finish the detection work. But it does not affect the detection of this sign. As the vehicle runs near and near to the traffic sign, the sign becomes bigger and bigger. Before the sign pass away, as (c) shows, there is only an integrated annulus without any noise in the image. So the segmentation work is done perfectly. The example for processing the different color--two blue traffic signs, is shown in Figure 10.



(a) (b) (c)

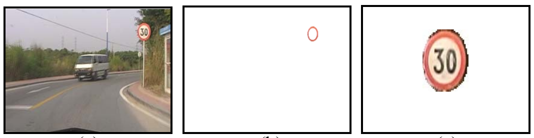
Figure 9. Results of red color segmentation by using statistics threshold. (a) this is the result of $28^{th}$ frame. (b) this is the result of $51^{st}$ frame. (c) this is the result of $73^{rd}$ frame.



(a) (b) (c)

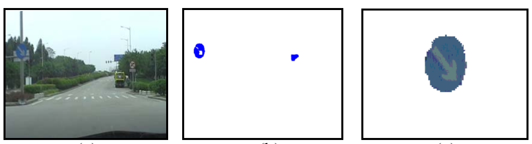
Figure 10. Results of blue color segmentation by using statistics threshold. (a) this is the result of 33rd frame. (b) this is the result of 61st frame. (c) this is the result of 68th frame.

The whole process was cutting traffic signs out from the different scene are shown in figure 11 and figure 12.




(a) (b) (c)

Figure 11. Effect of red color traffic sign detection. (a) this is the original image. (b) this is the result of segmentation. (c) this is the result of traffic sign detection.



(a) (b) (c)

Figure 12. Effect of blue color traffic sign detection. (a) this is the original image. (b) this is the result of segmentation. (c) this is the result of traffic sign detection.

## VI. CONCLUSION

Until now, we have found the method of searching color segmentation threshold in traffic sign detection. The method compares the color difference between target region and background region, and gets some key threshold parameters to finish the color segmentation work. The experiment results show the threshold could identify more details, especially noise whose color similar to the sign's, so traffic signs are separated from background totally. Meanwhile, using both RGB and HSV color spaces' parameters as threshold is better than only one color space, because it combines their advantages. As the method has a precise process, we can make a justifiable analysis and evaluation on the results, and give clearly suggestions for improvement. Lastly, this method can not only use to segment color in traffic sign detection, but also can widely use in other color analysis work.

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