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Traffic Sign Detection Using MATLAB

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Abstract: ***The main objective of this paper is to develop an algorithm so that we can automatically recognize traffic signs in digital images. This work uses basic image processing technique for automatically recognizing two different traffic signs- stop sign and yield sign in an image. The proposed method detects the location of the sign in the image, based on its geometrical characteristics and recognizes it using colour information. The image is first thresholded on RGB domain to separate out the regions with red color, which is those traffic signs usually have, then we do region mapping due to which the rest of the parts which are too small or too large are removed since they are unlikely to be a traffic sign. Here we get the signs whose shapes are octagon or triangular thus major axis to minor axis ratio is one. Hence the regions which are very large are eliminated.***

Keywords: MATLAB, image, processing, dilation, RGB, thresholding

1. Introduction

Automatic object recognition has long been an interesting research area in image processing, one specific area with practical importance is automatic traffic sign recognition. A robust traffic sign detection algorithm is an essential part of applications like automatic vehicle control, navigation, etc.

Many researches have been done on this topic and have shown promising results [1-4]. This work tries to get a first taste of this topic using the image processing techniques introduced in the class. Our main objective is to detect two signs namely stop sign and yield sign. By using colour shape and size –being the properties of the sign we can separate them from other part of the image and the filling ratio is used to separate these two sign from each other. I have also used Image dilation to connect the possible fragmented region of the traffic sign after thresholding. We have collected a number of images on stop sign and yield sign and divided them into two groups: a training group of and a testing group. Training group is used to select the proper threshold for the algorithm and the testing group is used to test the effectiveness of the algorithm.[4]

2. Method

A. Data Collection

To recognize the traffic sign, the input image is first passed on to R, G, B domain where thresholding is carried out .This is done to remove all the small and large region which do not represent the traffic sign. These regions are nothing but large axis ratio regions which are eliminated by thresholding.

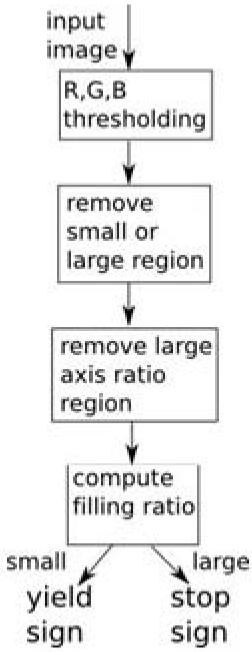


Figure 1: Procedure to recognize stop and yield sign

B. Detail Algorithms

All the procedures performed in this algorithm has been shown in the figue1 and consist of the following steps: first, separate red color region by thresholding in RGB domain, then, remove the regions which will be either too large or too small, remove the images whose stop sign r to minor axis ratio is large,and yield sign is separated by thresholding on their filling ratio[2].Since both stop sign and yield sign are red, they can be separated from background by thresholding in RGB domain using the following scheme

$$G(x; y) = k \quad \begin{cases} Rx \leq Fr(x; y) \leq Ry \\ Gx \leq fg(x; y) \leq Gy \\ Bx \leq fb(x; y) \leq By \end{cases}$$

Where $F_r(x; y)$; $f_g(x; y)$; $f_b(x; y)$ is The components in Red, Green and Blue domain, respectively, and R_x; Ry; G_x; G_y; Bx; B_y is the corresponding lower and upper thresholds in those domains, respectively[6].

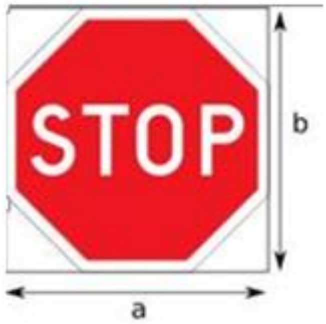


Figure 2: Stop sign and yield sign both have a major/minor axis ratio close to 1

The first phase is to detect the location of the sign in the image which is done by choosing the region of interest.For that we need to find the threshold of the image.However this scheme has a disadvantage which is that the threshold are affected by lightning conditions of the image thus make it difficult to find a universal threshold set which will be applicable on images having varying lightning conditions.Thus we have modified the thresholding scheme used in this work. The thresholding on blue and green components is applied on the ratio of the corresponding component to red component, instead of directly thresholding the blue and green domain[3].

This scheme turns out to be less affected by lighting condition than original scheme and provide good segmentation results.After thresholding, we then remove those red regions which are not from a traffic sign, which might come from a car, building or other objects that have similar colors. To do this, we first remove the region that is too small, which might come from noise or small random object[7]. As a result, the traffic sign won't be detected if it is too far away from the observer.Too large regions are then removed.This step is in participation of some extreme cases such as the image has a large red background. Image dilation is used after this step to connect together the possible fragmented parts of the traffic sign after thresholding[5]. Since both signs has a major to minor axis ratio of close to 1 (as shown in Figure 2), thus those regions having larger ratiowill be eliminated[1]. After the above steps, ideally, the remained regions will be either a yield sign or a stop sign, next the filling ratio is used to separate these two signs[2]. A stop sign is an octagon and tend to have a higher filling ratio than that of a yield sign which is triangle and have an empty triangle center, as shown in Figure 3.

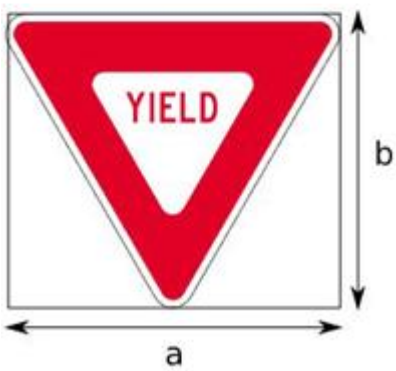


Figure 3: Stop sign tend to have a larger filling ratio that yield sign

In this area (Fr(x; y), and in Equation 2)

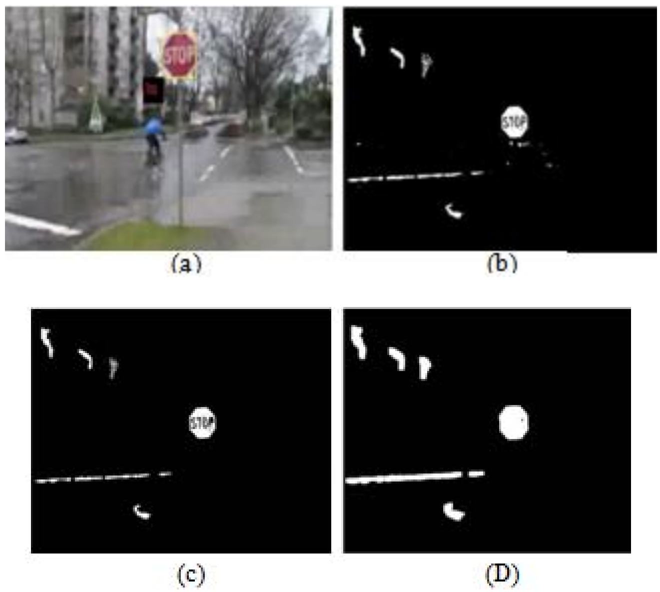
3. Results

All the thresholds have been chosen depending upon the performance of training images. For each of the image in the testing group, a small area in the traffic sign is manually selected and its red component and the ratio of green to red, and blue to red Computed. The thresholds for size limit and that for filling ratio are chosen based on trial-and-error. The results have been shown in Fig 4 and Fig 5.In Fig 4a, the stop sign has been detected, the image after thresholding is shown in fig 4b.After the removal of small region in the image, it has been dilated and then we have eliminated the axis ratio which is too large in the image .The same implementation has been applied for the yield sign and all the images have been shown in Fig5.

Examples:

While threshold choosing, it is noted that all the thresholds are chosen based on their performanceon provided training data. For each of the image in the testing group, a small area in the traffic sign is manually selected and its red component and the ratio of green to red, and blue to red. One example to identify stop sign is shown in Figure 4. In this example, after thresholding in rgb domain, the stop sign region is segmented out, but the other red areas such as the red strip in the flag, red road pavement and some other small red regions which are also selected (Figure 4 (b)). By removing small region, a number of red regions are gone, then by checking their axis ratio, all other red region is removed and only the stop sign region remains (Figure 4)[1]. Then by computing its filling ratio, we can correctly identify it as a stop sign since its filling ratio is 0.82, which is greater than the 0.7 threshold[8].

One more example is shown in Figure 5, which shows the procedures to segment out the red region and to remove foreign regions are similar to the first example and the yield sign is identified by its filling ratio of 0.60 (<0.7)[8].

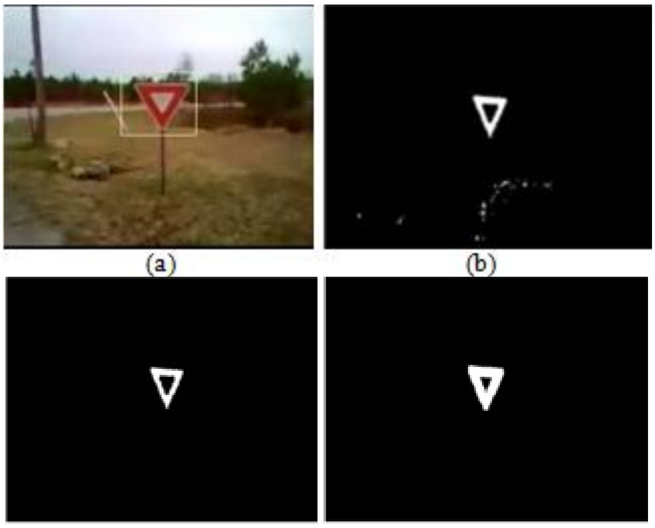


(e)

Figure 4: (a) Original image, (b) image after rgb thresholding, (c) after removing small region, (d) after dilation, (e) after removing region whose axis ratio is too large

4. Limitations

Overall, the algorithm works fine on both the training and testing images, however, there are some cases that the algorithm either fail to correctly single out the sign region or falsely remove the sign region[4]. Two examples that thealgorithm doesn't work well are shown in Figure 6. In one case (Figure 6 (a)),Since the major to minor axis ratio is large the stop sign will falsely be removed; in the other example (Figure 6 (b)) the stop sign is not picked up because it is dark. Hence these examples show a clear room for improvement. Also, we think that the complexity of traffic sign detection. Systems will diminish in the future, as technology advances[6].With the advancement of technology, high quality sensors will become cheaper and more available in mass production. If in the future every car is equipped with a high resolution color camera, an infrared camera and other sensors, the problem of traffic sign detection will be simple then it is now.



(a) (b) (c) (d)

Figure 5: (a) Original image, (b) image after rgb thresholding, (c) after removing small region, (d) after dilation and removing region whose axis ratio is too large

(a) (b)

Figure 6: (a) Stop sign is not correctly identified as it was connected with a red pole, (b) stop sign is not detected since it is too dark

5. Future Scope

In the future, we hope to delve into the possibilities of Neural Networks and Machine Learning in these fields. If the system is able to learn different stop signs, through Neural Networks, you could hope to see almost 100% accuracy after a given period of use.

6. Conclusion

This project is trying to develop an image processing algorithm to recognize stop sign and yield sign in any given image. The processing methods used in this algorithm include rgb domain thresholding, dilation of image, mapping of region and thresholding based on region properties and the like. This algorithm has an accuracy of over 80%. We believe that with implementation neural networks and machine learning will significantly improve the accuracy.

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