Traffic Sign Recognition using Image Processing Techniques

Term Project Report
(Group 5)

Group Members

Soumava Paul (16EE10056)
Anuraag Bhattacharya (16EE30003)
Rajdeep Choudhury (16IE10037)

Methodology

In this project, we have implemented edge detection, contour detection, shape identification and cross-correlation algorithms to successfully detect different traffic signs using the following database of images (Dataset Link). To showcase our work, we have prepared a custom dataset by sampling images of 20 types of traffic signs from the original dataset. Our approach is primarily inspired by the methods discussed in the following paper : **Traffic sign recognition application based on image processing techniques**. We discuss the methods used below:

- To aid in the edge detection process, we first apply Contrast Limited Adaptive Histogram Equalization (CLAHE) on the test RGB image on a per-channel basis and convert it to grayscale.
- The resulting image is thresholded using the lower and upper limits as the mean and maximum of pixel values respectively.
- The image is then blurred using a 3X3 Gaussian kernel.
- The edges are then detected using Canny Edge detection technique.
- We then detect contours in the edge image and isolate the contour have the maximum closed loop area. This is done as a traffic sign almost completely covers any image present in our database.
- Signature of a particular shape of traffic sign is defined as the distance between its centroid and the perimeter. Here we have identified and used signatures of 4 different shapes, namely circle, square, triangle and octagon for comparison with the signature of a detected contour. The signature is normalized to fit its value between 0 and 1, so it can be compared with the normalized signatures of the shape patterns. We sample 100 random points from the detected contour to find its signature. Using this method, irrespective of the size of the object evaluated, its signature will be the same.
- We calculate the absolute differences between the contour and shape signatures and pick the top 2 shapes having minimum difference with the contour signature. This helps us to narrow down our search for the actual traffic sign to a reduced set of potential candidates having those 2 shapes.
- Using the detected contour, we extract the ROI of the image (containing the traffic sign) and compare it with the reduced set of templates using the cross-correlation metric which is defined as follows :

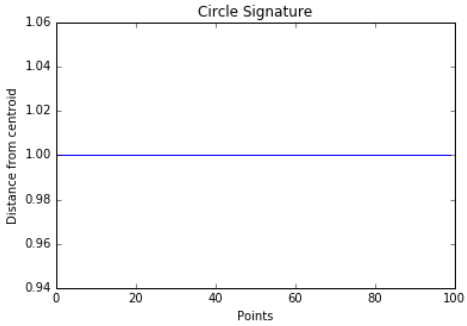
$$R = \frac{\sum_m \sum_n (A_{mn} - A_{mean})(B_{mn} - B_{mean})}{\sqrt{(\sum_m \sum_n (A_{mn} - A_{mean})^2)(\sum_m \sum_n (B_{mn} - B_{mean})^2)}}$$

  where A is the ROI image and B is the template image with which it is being compared, resized to the shape of the ROI image. We blacken the pixels lying outside the contour area in the ROI image so that the background pixels do not interfere with the score.
- The template image having the maximum cross-correlation (R) score with the given image is our detected traffic sign.

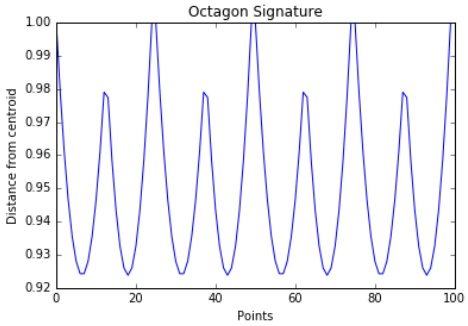
Libraries Used

OpenCV, Numpy, Matplotlib.

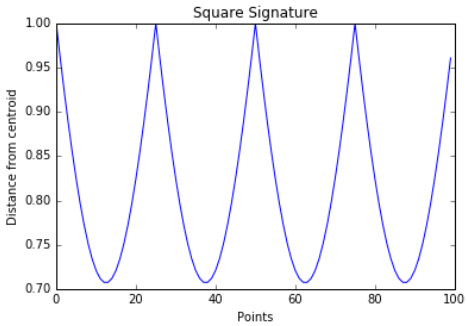
Example Illustrations



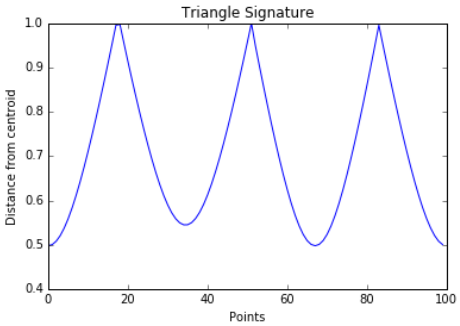
(a) Circle Signature



(b) Octagon Signature



(c) Square Signature



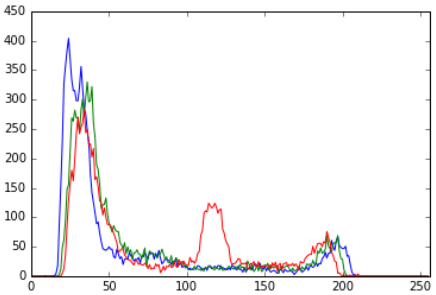
(d) Triangle Signature

Figure 1: Normalized signatures of the shape patterns

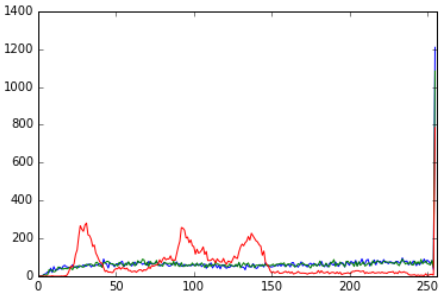
In the following pages, we illustrate the processes involved by showing the intermediate results at each step.

(a) Original Image 1

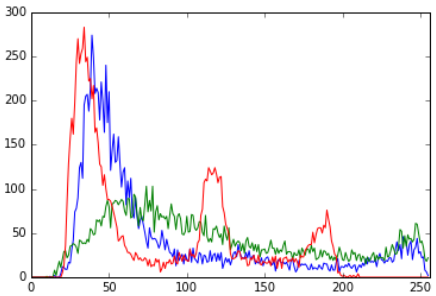
(b) Original Image 2



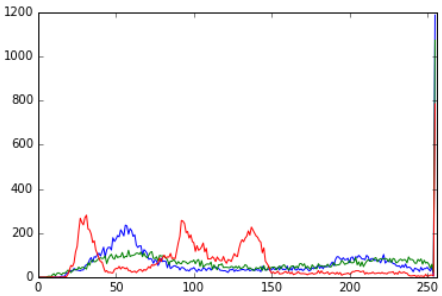
(c) Histogram of Original Image 1



(d) Histogram of Original Image 2



(e) Histogram of CLAHE equalised Image 1



(f) Histogram of CLAHE equalised Image 2

(g) Grayscale Image 1

(h) Grayscale Image 2

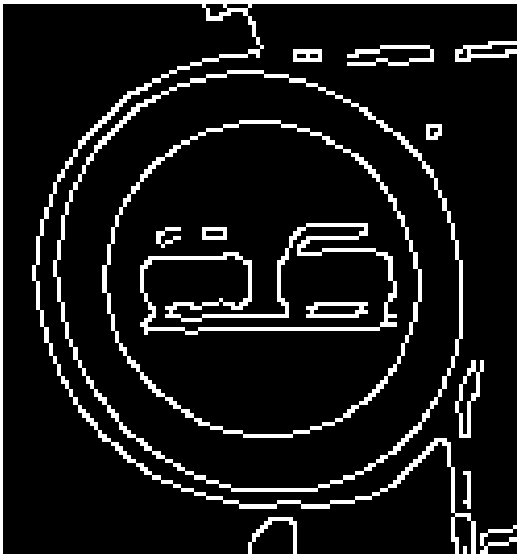
(a) Thresholded Image 1

(b) Thresholded Image 2

(c) Gaussian Blurred Image 1

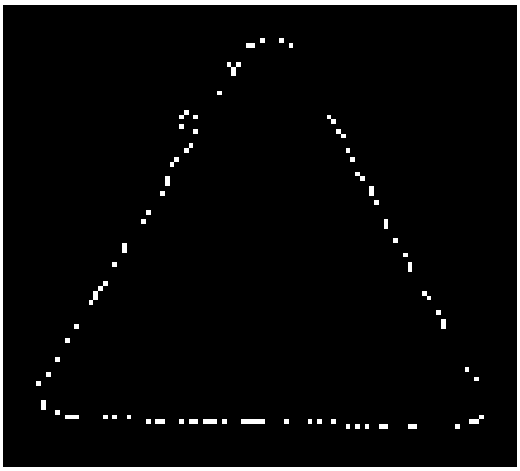
(d) Gaussian Blurred Image 2

(e) Edge Detected Image 1

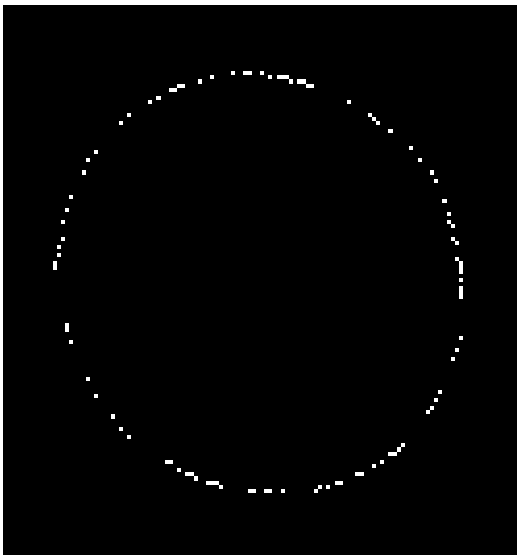


(f) Edge Detected Image 2

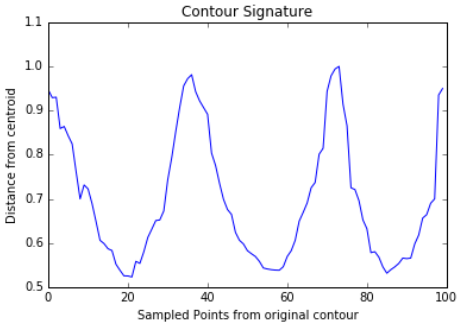
Figure 3: Normalized signatures of the shape patterns



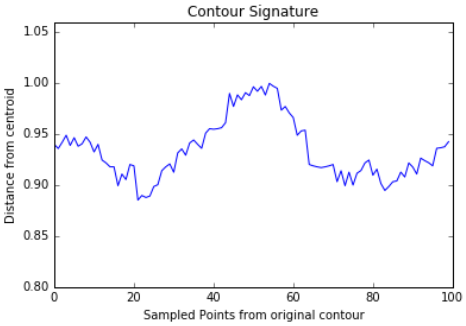
(a) Sampled Contour Image 1



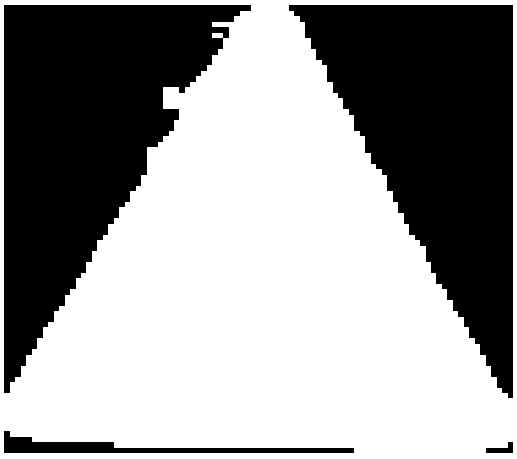
(b) Sampled Contour Image 2



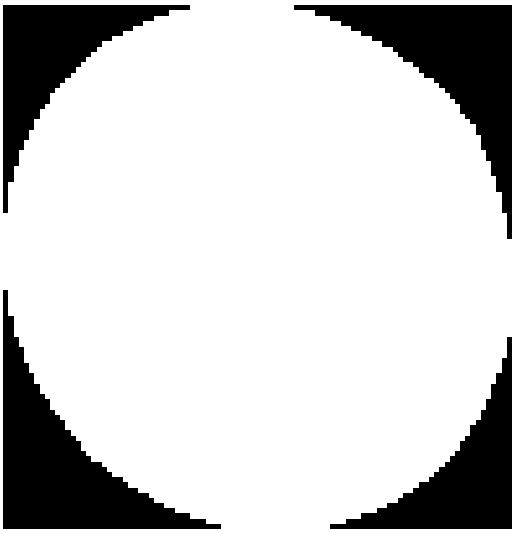
(c) Signature of Detected Shape 1



(d) Signature of Detected Shape 2



(e) Image with Bounding Box 1



(f) Image with Bounding Box 2

(a) ROI of Original Image 1

(b) ROI of Original Image 2

(c) Detected Traffic Sign 1

(d) Detected Traffic Sign 2