Traffic signs recognition for driving assistance

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Abstract. In the current circumstances with the innovative headway, we must be able to provide assistance to the driving in recognising the traffic signs on the roads. At present time, many reviews are being directed moving in the direction of the usage of keen Traffic Systems. One field of this exploration is driving support systems, and many reviews are being directed to create frameworks which distinguish and perceive street signs in front of the vehicle, and afterward utilize the data to advise the driver or to even control the vehicle by implementing this system on self-driving vehicles. In this paper we propose a method to detect the traffic sign board in a frame using HAAR cascading and then identifying the sign on it. The output may be either given out in voice or can be displayed as per the driver’s convenience. Each of the Traffic Sign is recognised using a database of images of symbols used to train the KNN classifier using open CV libraries.

1. Introduction

Traffic sign recognition is important for autonomous vehicles and also for manual drivers to avoid accidents. Traffic sign boards on the road sides become hard to look for the drivers and the driver may now and then miss the sign boards on the road. These boards may indicate Humps ahead or No parking or even accident zone etc. Many times as a result of the close traffic movement or the street condition driver may not read anything and regardless of the possibility that he tries to peruse it with a wide eye there is a shot for the driver to lose focus on the road. It is mostly important for the autonomous vehicles to recognize the traffic signs. There is no complication of adding extra sign boards for this system to detect them. All existing traffic sign boards can be detected using image-processing techniques and open CV libraries alone. The system is trained with a set of positive and negative images to Detect the required ROI and then the features are extracted for the sign detection using an object classifier. The response returned from the classifier is thus used to decide the output. The extent of this system is wide and with the assistance from this system we can guarantee the driver advantageously gets the help without any diversion while concentrating on the driving. This paper comprises of seven segments: area II talks about the related work in this topic in the previous years. Area III talks about the proposed technique and the work done with a specific end goal to accomplish feasible outcomes. Area IV shows the outcomes found throughout our exploration. Segment V talks
about the conclusions. Area VI talks about the future applications and conceivable augmentations to the Traffic sign acknowledgment framework. Area VII points out the references.

![System Functional Diagram](image)

**Figure. 1.** The system functional diagram.

### 1.1 Related work

A considerable measure of past work has been done on the field of object detection and classification for over 15 years now. However a large portion of the work was on increasing accuracy by using various classifier methods for text extraction [14], face features matching etc using various classifiers and matchers. In 2001 Paul Viola and Michael Jones [1] have demonstrated Haar cascade classifier concept using integral image, Adaboost algorithm and cascading concepts. In 2010 Yuanxing Zhao, Jing Gu, Chui Liu, Shumin Han, Yong Gao1, Qingmao Hu[2] proposed number plate recognition using Haar-like cascade classifier which guides the sample preparation for object detection. Also real time face detection by Jian-qing Zhu, Can-hui Cai[3] in 2012 using Gentle Adaboost algorithm guides the reduction of the number of weak classifiers, increasing the detection speed detection accuracy as well. Besides, numerous procedures have been used for recognizing street signs, for instance, Pacheco et al.[4] utilized exceptional colour barcode under street sign boards for distinguishing street signs in vision-based framework. Our paper includes the success of each of the prior works, we employ the K-NN method on the detected sign board to recognise the sign using OpenCV libraries.

### 2. Methodology

**HAAR Cascade Training**

Haar feature-based cascade classifier is powerful object recognition technique and it is a machine learning based approach.

Training Steps to Create a Haar-like Classifier are:
1) Collect the positive and negative training images.
2) Mark the positive images using objectmarker or ImageClipper tools and thus creating an annotations file.
3) Create a .vec (vector) file based on positive marked images using opencv_createsamples tool as shown in fig.5.
4) Using opencv_traincascade application
XML file is formed as shown in fig.6.

What unquestionably does make a difference is the width \( w \) and the height \( h \) arguments you passed to create samples and train cascade. Only the objects littler than the measurements passed are detected.

**Figure 2.** Haarcascade –Viola Jones Algorithm.

Now our own XML file for the traffic sign board detection is obtained. This classifier is pointed by setting the path from the source code and detection is done by `detectMultiScale();` an openCV method.

```java
String TSR_cascade_name = "../../TrafficSign.xml";
CascadeClassifier TSR_cascade;
if( !TSR_cascade.load( TSR_cascade_name ) )
{ printf("(!)Error loading\n"); return -1; };
```

Viola-Jones algorithm uses the Integral images and rectangular boxes as building blocks to detect features. An object’s features are the differences in pixel intensities between various parts of the pictures. The only thing that matters is just the relative darkness between the parts of the images. Thus
the algorithm works irrespective of the colour of our images or objects. The positive images are the images containing the target object whereas the negative images are any random pictures strictly not containing the target object defining the background for our detection target object being our foreground.

Figure. 3. Positive images and their annotation file.

Figure 4. Negative images and the batch file.
Figure 5. Marking ROI in positive images using object-maker.

Figure 6. Creating Traffic sign boards Haar XML file.
2.1 Image Processing

The video capture from the camera is used to retrieve the frames from the camera.

```cpp
VideoCapture capture(0);
if(!capture.isOpened())
    return -1;

while(1)
{
    capture>> frame;
    if( frame1.empty() )
    {
        cout<< "Error in Video capturing..." <<endl;
        break;
    }
    DetectROI(frame, TSR_cascade);
}
```

The frame is then converted to grayscale and histogram equalization is done for sharp detection.

```cpp
DetectROI(Mat frame, CascadeClassifier& TSR_cascade ){
    vector<Rect> Speedtext;
    Mat frame_gray;
cvtColor( frame, frame_gray, CV_BGR2GRAY );
equalizeHist(frame_gray, frame_gray );
    TSR_cascade.detectMultiScale( frame_gray,
                        Speedtext, 1.1, 2, 0|CASCADE_SCALE_IMAGE,   Size(30, 30));
    Rect rect;
    rect = Speedtext[i];
    Mat roi(frame,rect);
}
```

Thus the Region of Interest that is the traffic sign board region is cropped out from the frame. This ROI is sent for further processing. Thresholding to eliminate boundary colour followed by MORPH_RECT dilation filters out the content inside the sign board. This image is compared in the database and the Nearest Neighbour is found out. Gaussian blur is applied for smoothening and adaptive thresholding to remove noises.

Before feeding to the KNN classifier the image to be identified and the images in the database are pre-processed and resized to same size.

```cpp
voidPreProcessImage(Mat *inImage, Mat *outImage,intsizex, intsizey)
{
    cvtColor(*inImage,grayImage,COLOR_BGR2GRAY);
    GaussianBlur(grayImage, blurredImage, Size(5, 5), 2, 2);
    adaptiveThreshold(blurredImage, thresholdImage, 255, 1, 1, 11, 2);
    thresholdImage.copyTo(contourImage);  vector<vector<Point>> contours;
    findContours(contourImage,contours,CV_RETR_EXTERNAL, CV_CHAIN_APPROX_SIMPLE);
    intidx = 0; size_t area = 0;
    for (size_ti = 0; i<contours.size(); i++)
    {
        if (area < contours[i].size() )
        {  idx = i;
            area = contours[i].size();}
    }
```
Rect rec = boundingRect(contours[idx]); regionOfInterest = thresholdImage(rec); resize(regionOfInterest,*outImage, Size(sizex, sizey)); 
}

Thus the texts or symbols alone in the images are cropped out. These are now fed to KNN classifier learning.

costintssizez = 20;
costintssizey = 30;
costintImageSize = sizex * sizey;
CvMattrainData,TrainClasses;
CvMat* sample = cvCreateMat(1, ImageSize, CV_32FC1);
KNearestknearest(trainData, trainClasses);

The trainData is trained from the images in the database and trainClasses are the responses for the each image in the database.

for (int n = 0; n <ImageSize; n++)
{trainData->data.fl[i * ImageSize + n] = outfile.data[n]; } trainClasses->data.fl[i] = i;
knearest.train(trainData,trainClasses);
for (int n = 0; n <ImageSize; n++)
{sample->data.fl[n]= targetImage.data[n];}

CvMatSample stores the pixel to pixel information of the target ROI after pre-processing the traffic sign board region in the frame.

The nearest neighbour is found out by using find_nearest method and the response is thus stored to identify the sign that has been detected.

Floatresult = knearest.find_nearest(sample, 1);

2.2 Finding the Traffic Sign

The x,y positions and the response through the KNN classifier of the each symbol in the traffic sign board are stored in an object.

structResultStruct{
 intX_Point;
 intY_Point;
 intResultedNum;
}Result[5];

The symbols and responses are swapped based on their x-positions to properly read which symbol falls where from left to right.
3. Results
For the traffic sign boards with single contour, the nearest neighbour is found and the output is obtained from the response returned by the classifier. For the traffic sign boards with multiple contours, the respective nearest neighbours are found and the responses returned by the classifier are sorted based on their x-positions.
Figure 9. Output from single contour containing Signboards.

Figure 10. Output from multiple contour containing Signboards.
4. Future Applications

This traffic sign recognition can be used by the autonomous vehicles to keep control of their speed from the speed limit boards or even to go slow at school zones or pedestrian crossing zones etc. By using the depth reading sensors such as LIDAR (Light Detection and Ranging) and Stereo-Vision the depth can be learnt and the vehicle can know well in advance the distance from which it should start responding. For the manually driven vehicles the response from the system can be given out through voice announcement in any language including Tamil, English or Hindi etc. for better assistance to the driver. This system can be linked to the Traffic security systems to track the vehicles which exceed the speed limits or disobey the traffic rules on the roads. The detection accuracy can be increased using neural networks[15] using GPU to increase the training speed of the neural networks.

Acknowledgments
We would like to thank Dr. Renuga Devi, for her support and inspiration for this project. We would like to extend our appreciation to our guide Dr. Jasmine Peemena Priyadarsini M towards understanding our fantasies and supporting us in this project from the beginning. We are fortunate to be a part of our families for supporting us without whom this review would not have been finished successfully.
References

[1] P Viola and M Jones 2001 Rapid Object Detection Using a Boosted Cascade of Simple Features Proc. IEEE Conf. Comput. Vis. Pattern Reco. 51

[2] Yuanxing Zhao, Jing Gu, Chui Liu, Shumin Han, Yong Gao1 Qingmao Hu 2010 License Plate Location Based on Haar-like Cascade Classifiers and Edges Proc. of IEEE Second WRI Global Congress on Intelligent Systems. 3 102

[3] Jian-qing Zhu, Can-hui Cai 2012 Real-Time Face Detection Using Gentle AdaBoost Algorithm and Nesting Cascade Structure Proc. of IEEE International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS 2012) 978

[4] L Pacheco, J Batlle, X. Cufi 1994 A new approach to real time traffic sign recognition based on colour information Proc. of e Intelligent Vehicles Symposium 339

[5] H Fleyeh, and M Dougherty Road And Traffic Sign Detection And Recognition Proc. of 16th Mini - EURO Conference and 10th Meeting of EWGT 644

[6] S Kang, N C Griswold, and N Kehtarnavaz 1994 An Invariant Traffic Sign Recognition System Based on Sequential Color Processing and Geometrical Transformation Proc. of the IEEE Southwest Symposium on Image Analysis and Interpretation 12 88

[7] C Bahlman 2005, A system for traffic sign detection, tracking, and recognition using colour, shape, and motion information Proc. of IEEE Intelligent Vehicles Symposium 255

[8] S Maldonado-Bascon 2007, Road sign detection and recognition based on support vector machines, Proc. of IEEE International Conference on Intelligent Transportation Systems 8 264

[9] F Ren, J. Huang, R. Jiang, and R. Klette 2009 General traffic sign recognition by feature matching Proc. 24th Int. Conf. IVCNZ 409

[10] E Krsak, S Toth Traffic sign recognition and localization for databases of traffic signs ACTA Electrotechnica Et Informatica, 11 431.

[11] F Chang, C J Chen, and C J Lu 2004 A linear-time component labelling algorithm using contour tracing technique Computer Vision and Image Understanding 93 206

[12] G Loy 2004 Fast shape-based road sign detection for a driver assistance system, Proc. of 2004 IEEE/RSJ International Conference on Intelligent Robots and Systems, 1 70

[13] Y Fang, C S Fuh, P S Yen, S. Cherrg, and S W Chen 2004 An Automatic Road Sign Recognition System based on a Computational Model of Human Recognition Processing Computer Vision and Image Understanding 96 237

[14] U Pal and P P Roy 2004 Multi-oriented and curved text lines extraction from Indian documents IEEE Trans on system, Man and Cybernetics-Part B 34 1667

[15] R Vicen-Bueno, R Gil-Pita, M P Jarabo-Amores and F L opezFerreras 2005 Complexity Reduction in Neural Networks Applied to Traffic Sign Recognition Proc. of 13th European Signal Processing Conference 1