International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Identification Classification and Monitoring of Traffic Sign Using HOG and Neural Networks

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Abstract: ***When the driving safety is considered, Identification of Traffic sign plays a major role which results in reducing the accidents. The recognition of traffic sign can also be used in Self driving intelligent cars. This paper represents a method to Identify the Traffic sign Patterns using Histogram of Oriented Gradients and Neural Network. Initially a classification of traffic sign is done by using HOG based Support Vector Machine. Secondly the classified data is used to train the Neural Network so that the neural networks are used to recognize the traffic sign patterns. 16 different traffic sign image is taken to classify. To check the robustness of this system it was tested against 2,946 images. It was found that accuracy of recognition was 98% which indicates clearly the high robustness of the system.***

Keywords: Traffic sign, Histogramof Orient Gradient (HOG), Support Vector Machine (SVM), Artificial Neural Network (ANN).

1. Introduction

Traffic sign identification plays a very major role importance in today's world. As the number of accidents is increased, the number of traffic sign is also increased to reduce the accidents. These traffic signs are usually present in either left or right side of the path. None of the traffic sign will be in middle of road, that too in big sizes which makes difficult to identify them easily. The traffic sign identification by the human is very difficult since the driver should give the importance to the vehicles on road, and also to the pedestrians. Some times this makes very difficult to identify the traffic sign. This traffic sign detection system warns the driver to avoid the accidents.

When the traffic sign information given to the driver when he is unaware of the danger in road, the drivers automatically get alerted and a life is saved. The system that supports driver recognizes and detect traffic sign which helps in safety of the driver [1-2].

There is group of prohibitory traffic sign such as stop, No Parking, No standing or stopping are employed to avoid road users accidents which may occur due to vision problems, users mental tension, physical condition. Hence the automatic traffic sign recognition system should be present to recognize these traffic signs so that accidents are avoided and lives are saved [3-4].

The traffic sign identification is developed in two areas[5-9]. First is identifying the traffic sign using image processing and second is detection of traffic sign using artificial NN.

This paper proposes a new approach to Classify speed limit sign and Non- Speed Prohibitory Traffic Sign using Hog and SVM classifier, and detection of these using ANN.

The structure of paper is as follows. Section 2 presents

Related Work as the proposed approach and drawback. Section 3 gives the brief study of traffic sign. The description and proposed algorithm is presented in section 4. In section 5, Result and Analysis is given. Finally in section 6 conclusion is mentioned.

2. Related work

The research on Traffic sign recognition and object detection increasing rapidly due to increase in applications but the challenges that distinguish the performance is efficiency, cost, response time, the number of images trained.

L. Estevez and N. Kehternavaz [4] proposed a system that recognizes to not enter traffic sign which focused on color segmentation, edge detection, edge localization, RGB differencing, and histograph extraction. Here RGB transformed pixels are segmented and sequentially XOR-ed to localized edge areas. Recognition is achieved is based on angular histographic attribute. The procedure is complex and not much accurate.

Recognition system was proposed by C. Y. Fang, C. S. Fuh [8] based on human visual recognition processing. This consists of three major components: Sensory, perceptual, and conceptual analyzer. The sensory extracts the information and its sent to the perceptual analyzer. If there is simulation it's fed to the analyzer to recognize an object. Here if the simulation is continued then only the image sensed is transferred to the analyzer, which takes long time to simulate and to detect the images and was not suitable for distorted images.

Chao- Lin, Kun-Hao, Shang, Hsiu [10] proposed a system that used SVD (Singular Valve Decomposition) and DCT (Discrete Cosine Transform) for feature extraction. The test data set consisted 210 new images where as training data set

contained 1000 set images. Here the precision was 78%. The procedure is complex and not suited for poor weather condition.

Dalal and Triggs [11] who first introduced the important application of HOG for detecting pedestrians. The images were taken from 2 database.One is from MIT pedestrian database and another from INRA pedestrian database. MIT pedestrian database has 509 training images and 200 test images whereas INRA pedestrian database has 1805 images. In order to extract features from these images HOG was used and SVM classifier was used to train and test the inputs. Later they tested for human and other objects in videos.

By using Neural Network techniques to detect the traffic sign pattern a system was proposed any Auranuch and Jackrit [12]. Here the images were pre-processed using Canny Edge detection, Fit Eclipse and Contour. The processing time was 37 milliseconds per frame which was tested against 52 test images. the processing time increased as the complexity with the image is increased. This reflected as the major drawback.

3. Prohibitory Traffic Sign

These traffic signs are designed according to the rules of that particular country so that it's different from the surrounding background [13]. A traffic sign usually has different shapes and colors which is different from Nature environment and manmade environment [14].

Traffic sign usually has 3 portions, namely, outer rim, interior and color of picture. Since some country follows interior color as yellow and some as white. Hence in this paper the binary image of traffic sign is considered for feature extraction, training and testing of images. Also one step of converting an image to the binary is reduced thus by saving time.

Some of the traffic signs considered is as shown in the Figure 1. Here the speed limit and prohibitory traffic sign images are considered. Traffic sign considered here has few similarities that is difficult to differentiate each other.

Figure 1: Speed Limit and Prohibitory Traffic Sign

4. System Description

4.1 Proposed system

The block diagram of the proposed system is represented in Figure 2. Initially the noise is removed from the image which is considered and Sobel edge detector is applied to extract edges of all the objects in the image. HOG is applied to extract the feature of an image and its classified using SVM classifier. The result of all images that is the extracted features of all the images is saved. Artificial neural network is created. These ANN is trained with the data, so called extracted features. Finally the ANN is tested to find classified image against test image.

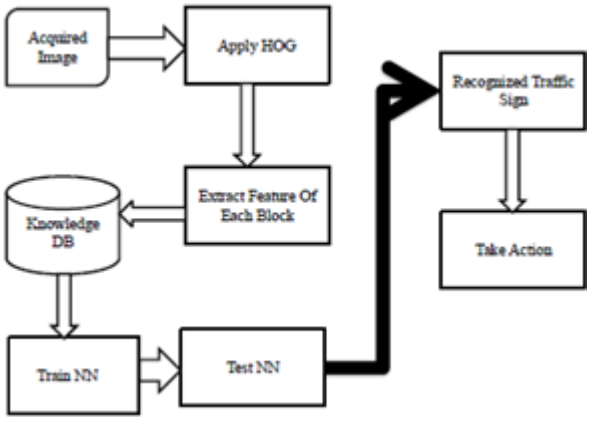


Figure 2: Block diagram of the proposed system

4.2 Circular Object Detection

Usually traffic speed sign and prohibitory sign has different shapes. Especially when it comes to the prohibitory sign some are triangles. Hence to detect the complex objects such as triangles, circles and rectangle, Circular Hough Transform is used instead of regular form. It is described as the transform of the center point (a, b) of a circle in x-y plane to the parameter space (r, θ). The circle equation in Cartesian and parametric format is given below.

$$(x-a)^2 + (y-b)^2 = r^2 \quad (1)$$

$$x = a + r\cos\theta \quad (2)$$

To check weather the circle is present in the given input, votes are accumulated in three dimensional parameter space (a, b, r). the main objective is to find the coordinates (a, b) of the center. The locus of points (a, b) in the parameter space fall on a circle centered at (x, y) of radius r. By using Hough accumulator, the true center point will be common to all parameter circles. This is as shown in Figure 3.

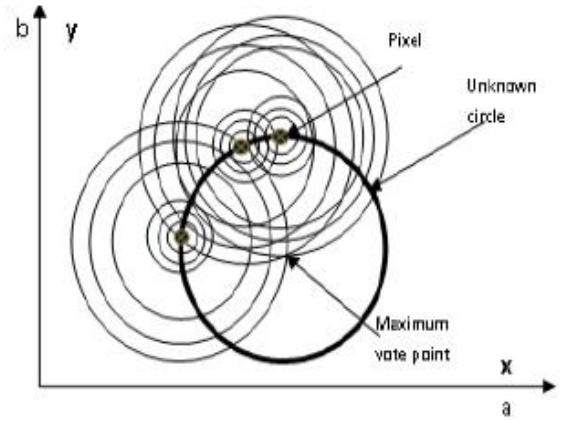


Figure 3: Identification of center point using Hough accumulator array

Hough accumulator array gives the number of votes given to any object in the image, object radius, object location. In many cases traffic sign is detected with noise, imperfection

and presence of other objects. This problem is solved by applying following set of rules.

1) The position is bounded by bounding box, if two circular edges are healthy and detected.
2) The position of bounding box is based on detection of inner edge of the sign, if the outer circular edge is destroyed while inner edge is healthy.
3) The position of the bounding box is based on the detection of the outer edge of the sign, if the inner edge of the sign is destroyed and outer edge is healthy.

4.3 HOG Feature

HOG is feature descriptor used for the object detection. It uses gradient orientation in localized potions of an image. The scanning of each image is based on detection window. The window is divided into cells, for each cell accumulating a Histogram of Oriented Gradients over the pixels of each cell. Hence the cell based scanning is approached as shown in Figure 4. For better invariance to illumination, histogram normalization can be done by accumulating a measure of local histogram energy over blocks and using the results to normalize all cells in block.

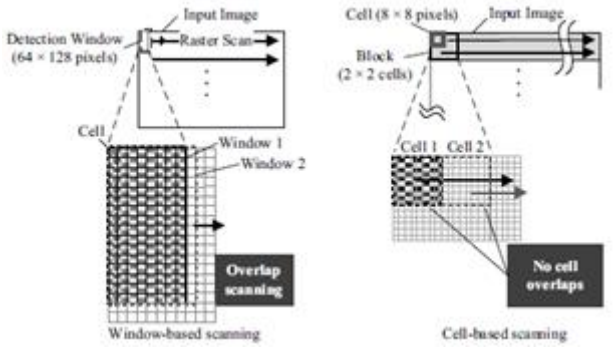


Figure 4: Cell Based scanning method

The flow of how the HOG is applied to detect the object is given in [11]. In order to extract the feature, cropping using bounding box and reshaping of the detected image is done. Following steps are applied for extracting HOG feature in cropped area.

1) Compute the horizontal and vertical gradients.
2) Compute the gradient orientation and magnitude.
3) The image is resized to 100*100
4) Divide the image into 10*10 block with 50% overlapping, then 9*9=81 blocks.
5) Each block consists of 2*2 cells with size 10*10.
6) Quantization the oriented gradients into 20 bins.

4.4 Support Vector Machine

Support vector machines are supervised learning models with associated learning algorithms that analyze data and classify patterns. Given more training examples which has different categories. In addition to the linear classification, SVM's can also perform non-linear classification using Kernel trick [15], which maps inputs into high dimensional feature spaces. SVM calculation for 6 windows and 7 blocks is as shown in Figure 5.

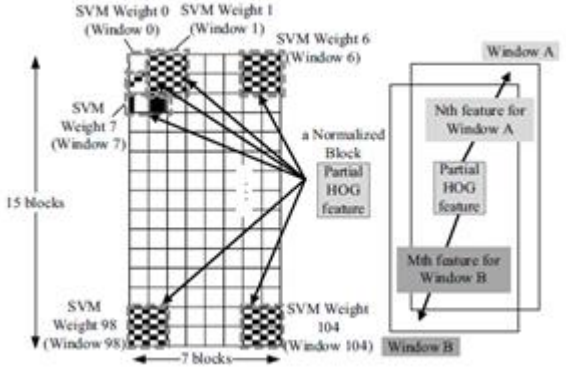
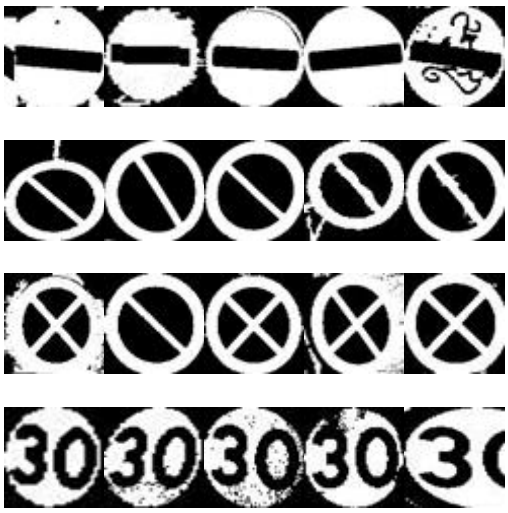


Figure 5: SVM Calculation

4.5 Training the Neural Network

In order to get a neural network to successfully learn task, it must be trained first. The training database is divided into training and testing set. The training set is used to train the neural network. Testing set is used to test the neural network. The figure 6 shows (a) training set and (b) testing set. Here the feed forward neural network is used. The number of layers and hidden layers should be identified. In this paper multi-layer perceptron model neural network is used for the verification of the hidden nodes. To find the hidden neurons, in an architecture the dataset is divided into training set $\mathbf{T}_{\mathbf{training}}$ andtesting set $\mathbf{T}_{\mathbf{testing}}$. The test set is used to test the ability of the network [16]. Using Feed-Forward neural Network pattern recognition can be implemented. The general method of training a multi-layer neural network is given [17]. Figure 7 shows how ANN is trained.

The main purpose using the neural network is that the output is given perfectly even though the test data set is not present in the training set.



(a)

(b)

Figure 6: (a) Training set (b) Testing set

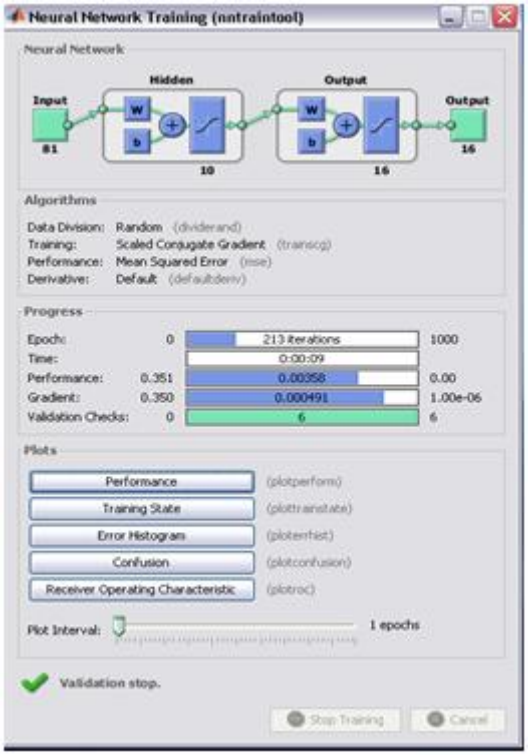


Figure 7: Training the Artificial Neural Network

5. Results and Analysis

This concept of traffic sign identification using HOG and neural neural networks can be used in vehicles where there is a need of identifying the traffic sign more accurately. Here by using HOG and ANN the processing speed is increased, time taken to identify the sign, the number of samples required is reduced. ANN reduces the number of sample required for testing, hence, even though the trained sample is less the quality of recognition is not reduced. Various number of methods are implemented but by using both HOG and ANN result is more optimized to a greater extent as shown in figure 8 and figure 9 and figure 10.

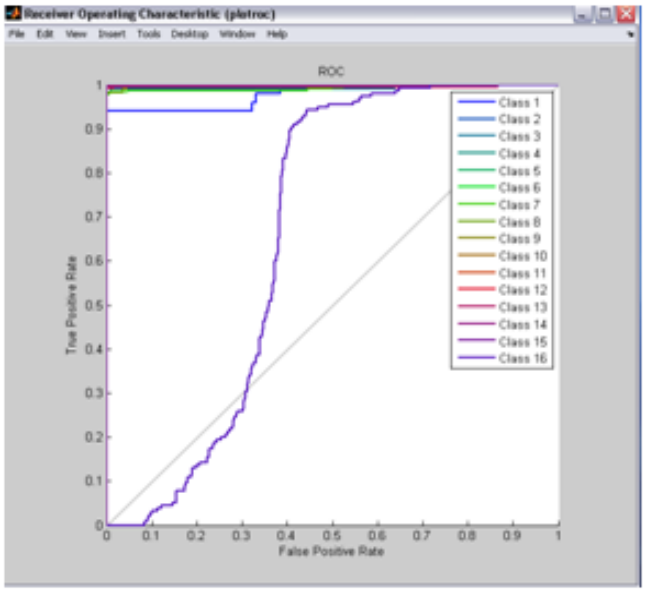


Figure 8: Region of convergence for all 16 classes

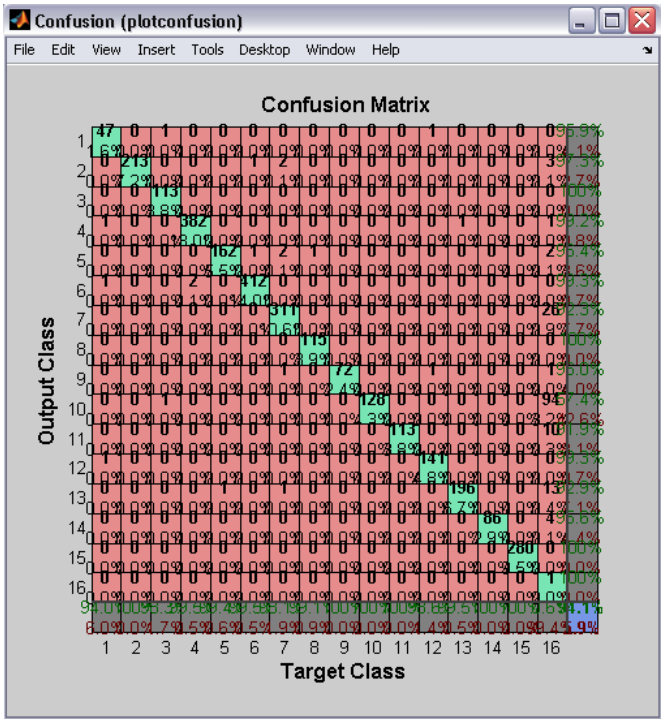


Figure 9: Confusion Matrix for all 16 Classes of image

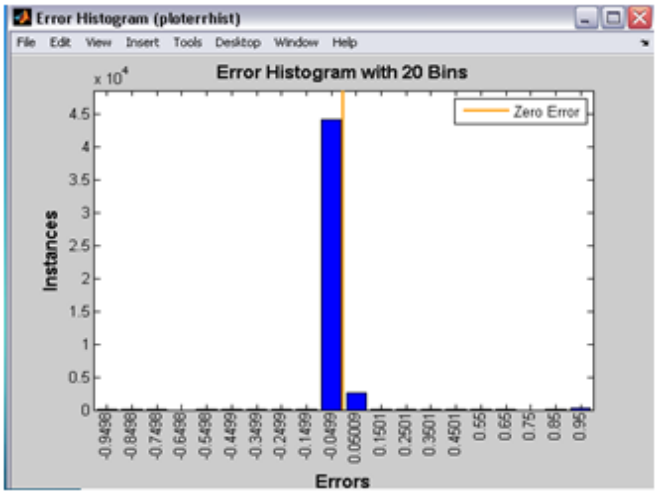


Figure 10: Error Histogram with 20 bins

6. Conclusion

In this work, 16 different traffic sign is considered, where each sign is considered as one class. Therefore there will sixteen classes. Each class will be having many assumed distortions. All the possible distortion data is collected and then the feature of each distorted image is extracted through HOG using MATLAB. Once the feature is extracted then it's time for creating, training and testing the neural networks, which we call as ANN. This Neural Network is also created, trained and tested using MATLAB. Feature extraction takes more time since it has to take every pixel data of assumed distorted image of 16 classes. Then the result of feature extraction is stored in Excel sheet. It takes only few seconds for training the neural network to test the images.

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