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A Survey on Traffic Sign Recognition Techniques

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Abstract: Traffic Sign Detection and recognition (TSDR) is an important feature for autonomous vehicles and driver assistance system, contributing to safety of drivers, pedestrians and vehicles. The TSDR system should be capable of effectively detecting and recognizing road and traffic signs. To classify traffic signs is a crucial task for autonomous driving systems. In today's world, autonomous vehicles together with Advanced Driver Assistance Systems (ADAS) deal with the problem of traffic sign recognition. In this paper a comprehensive study on TSDR system along with several traffic signs and various detection and recognition methods on the basis of various features is highlighted. The major purpose of this paper is to examine, analyze and provide information related to several methods used in TSDR over past years.

***Key Words*:** Traffic sign recognition system, MLP, K-NN, SVM, Random forest, CNN.

1. INTRODUCTION

Road and traffic signs provide significant information for guiding, warning, or regulating the drivers' behavior for the sake of safer and easier driving. The Traffic Sign Recognition is an area of study for applied computer vision research concerned with the automatic recognition and classification of road signs in traffic scene images acquired from a input video. Automatic traffic sign detection and recognition is important in the development of autonomous vehicles, and is expected to provide information on road signs and guide vehicles during driving. Object recognition has numerous applications in various fields. To prevent accidents caused by the traffic sign ignorance it is important to remind the drivers that the traffic signs are ahead using traffic sign recognition system. In this paper, we discuss about Machine learning and deep learning techniques that can classify traffic signs present in the image into different categories. With this proposed model, we will be able to read and understand traffic signs which is one of the most important task for all autonomous vehicles. The proposed model aims to identify a traffic sign from a digital image. This would be useful in an autonomous vehicle application .These ideas and methods could also be used in other areas. A road and traffic sign recognition system be developed as part of an Intelligent Transport Systems (ITS) that continuously monitors the driver, the vehicle, and the road.

2. RELATED WORK

In 2020, Glory Reuben Maxwell et al. proposed an approach to recognize traffic sign [1]. The author have highlighted the challenges that affects the detection and recognition process of traffic signs. These various challenges are Weather Conditions , Color Standards , Obstacles ,Disorientation , Motion blur and interlacing effects , Variable Lighting condition , Fading and blurring effect ,Affected Visibility ,Motion artifacts ,Unavailability of public database. Here, the author have used color-based method and shaped-based method. The major disadvantage of RGB color-based detection method is the illumination as it differs in intensity and color. The shape-based features that are used in detection and recognition of road signs are canny edge detection, Radial symmetry, corner detection, Hough transform, Haar-like feature detection.

Wasif Arman Haquea et al. proposed Deep Thin architecture which is subdivided into 3 modules that are input processing, learning, and prediction. Image resizing is done in pre-processing. Four convolutional layers, two overlapping max-pooling layers preceded by a single fully connected hidden layer is used for learning and analyzing, class prediction with the help of CNN. Because of the light weight architecture it can be utilized on a low-end personal computer even without GPUs. Such network optimization decreases the energy usage criteria for deep learning testing, allowing for environmentally sustainable characteristics in the solution. During the detection process only the color characteristic of the traffic sign is taken into consideration. The authors mainly focused on the RGB and grayscale values of traffic signs [2].

Shijin Songa et al. proposed paper on convolutional neural network for small traffic sign detection focused on issues of small object detection and compared accuracy against R-CNN and Faster R-CNN. This model has been optimized to use minimum GPU memory and decrease computing costs [3].

3. DATASET

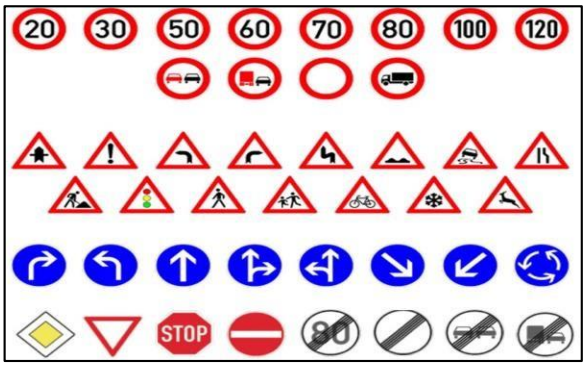

Figure. 1 Images in GTSRB Dataset

The German traffic sign benchmark is a large multicategory classification benchmark. GTSRB that is german traffic sign recognition benchmark is a dataset for classification of images consisting of traffic signs. The images in the dataset can be divided into overall 43 classes. Here the test set consists of 12630 images and training set consists of 39209 images for testing and training of model respectively. The dataset is largely divided into four different categories which consists of Informatory signs, Danger Signs, Mandatory Signs and Prohibitory signs. In GTSRB dataset each image is made up of 3 colour channels which are formatted in RGB. Here, each pixel in the image is saved in as an unsigned integer of 8 bit which gives about 256 possible values. Each photo has 32×32 pixels. A large imbalance in the distribution of the 43 classes from the dataset is shown in the Histogram plot. Some of the classes contains almost 10 times number of samples.

4. ALGORITHMS

4.1 Feature Extraction Methods

4.1.1 Raw Pixels

Raw pixel extraction method takes pixel coordinates of an image into consideration and this data of the obtained pixel coordinates is correlated with the coordinates of the other images.

4.1.2 Color histograms

The depiction of the colors in an image is basically a color histogram.

4.1.3 Histogram of Gradients (HoG)

The process of counting the gradient orientation in the localized part of an image is basically Histogram of gradients.

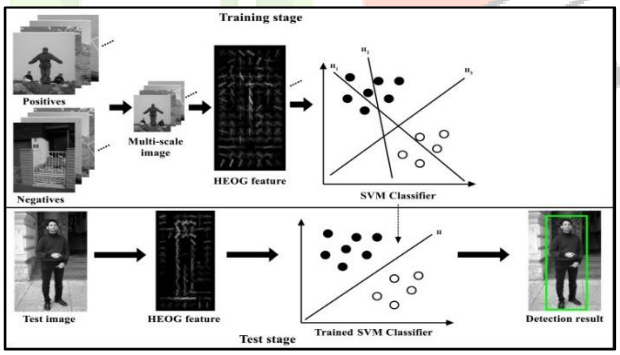

Figure. 2 HOG

4.2 Classification Algorithms

4.2.1 Multi Layer Perceptron(MLP)

A multilayer perceptron(MLP) is one of the class of ANN that is artificial neural network. It contains not less than three layers of neuron. The different types of layers included in MLP are input layers, hidden layers and Output layers. It deals with backpropagation for training which a supervised learning process is.

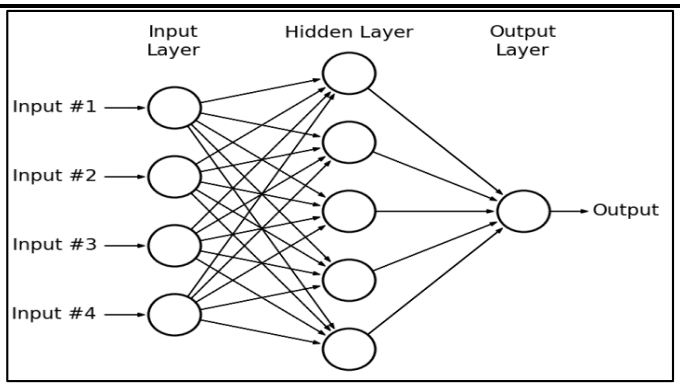

Figure. 3 MLP

4.2.2 K Nearest Neighbors (K-NN)

In KNN algorithm basically relies on its K nearest neighbors and the predicted output is the most common class among its neighbors. KNN is a machine learning technique which consists of the following steps which first starts with loading the dataset and calculate the distance between row of training data and test data .The most widely used technique is Euclidean distance for calculating the distance in the KNN algorithm. Now sort the distance in ascending order and choose K data points .The most frequently occurring class is the predicted output. The Accuracy of KNN over GTSRB dataset is 0.867 [4].

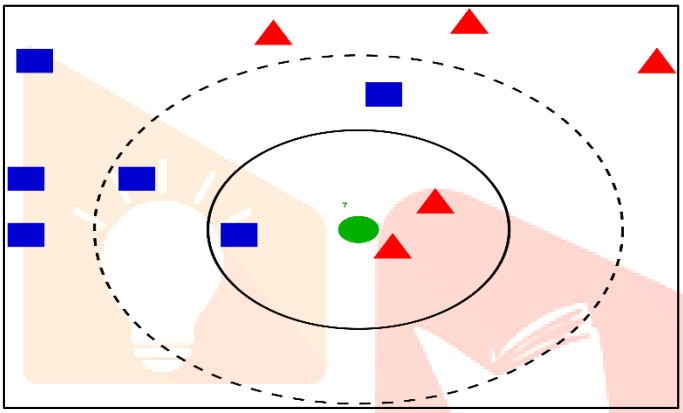

Figure. 4 K-NN

4.2.3 Support Vector Machines (SVM)

The SVM algorithm builds set of hyperplanes in a high dimensional space that has the highest distance to the closest training data point of any class which produces a good separation. The main goal of the Support Vector machine is to search a hyperplane in an N-dimensional space that is used for classification of data points. Number of features present indicates the dimension of the respective hyperplane .The Accuracy of SVM classifier over GTSRB dataset is 0.8135 [4].

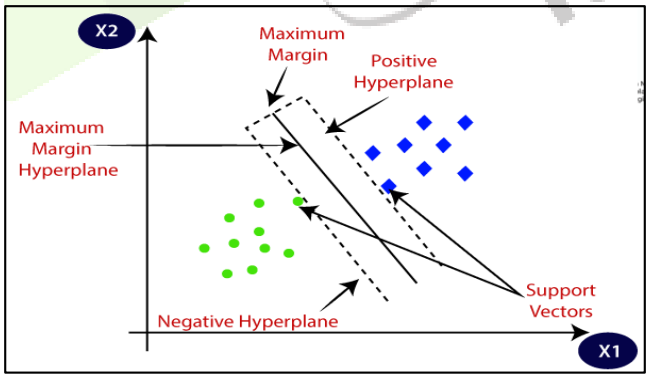

Figure. 5 SVM

4.2.4 Random Forest

Random Forest is a combination of multiple decision trees at the time of training and it predicts the class as a output which has the mode of the individual trees. It is a classifier which basically groups many decision trees on various subsets of the GTSRB dataset and takes the average of all of them and thus used to maximize the accuracy of the algorithm. Instead of considering only one decision tree it takes into consideration the output of many and predicts on the basis of majority of outputs. More the number of decision trees higher will be the accuracy of the model and this also prevents the issue of overfitting. The accuracy of Random Forest classifier over GTSRB dataset is 0.778[4].

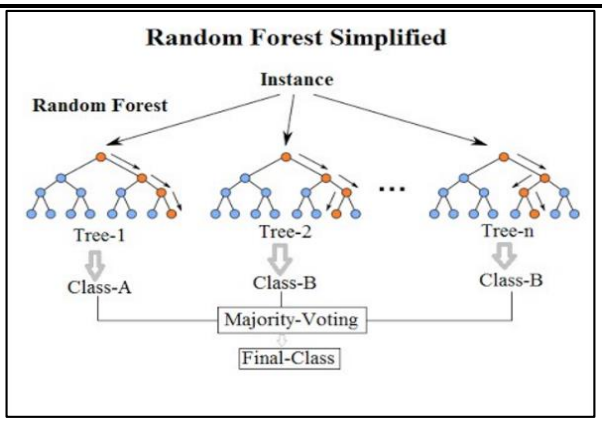

Figure. 6 Random forest

4.2.5 Convolutional Neural Networks (CNN):LeNet

A feed forward deep artificial neural networks in which hidden layers includes four different layers that is convolutional layers, pooling layers ,fully connected and normalization layers is called convolutional neural networks. The Architecture of this algorithm consists of the following different Convolutional Layer, Pooling Layer , Activation Function , Flattening Layer and Fully Connected Layer and thus helps in increasing the accuracy of the model as the learning is automatic that is we do not need to handcodedly provide the important features as in machine learning deep learning models learns the features automatically by using activation functions and different hidden layers .The Accuracy of CNN (Convolutional Neural Networks) over GTSRB dataset is 0.99 [5].

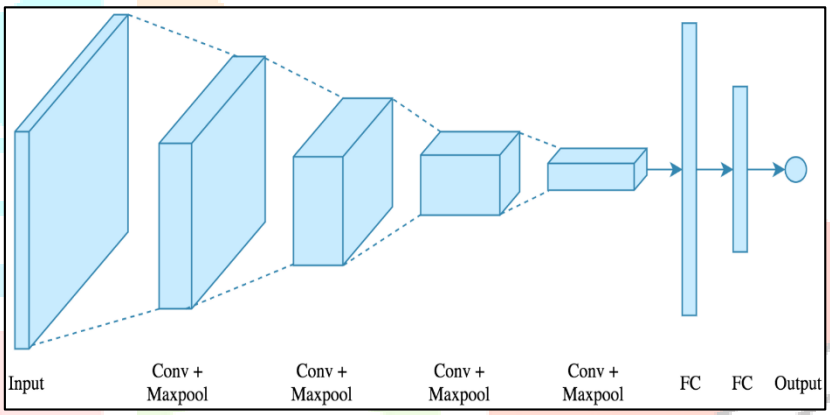

Figure. 7 CNN

5. Comparison Between Classification Algorithms

Table 1: Comparison table

Algorithms	Features	Limitations
KNN	1. Specifically this algorithm can be used for non linear data as there is no assumption of data in this algorithm. 2.It can be used for classification purpose and regression as well 3.Used for achieving higher accuracy	1.It stores training data and thus the computational cost is high. 2.More memory storage is required by this algorithm as compared to other machine learning techniques. 3.The algorithm is relatively slow with increasing K value.
SVM	1.More efficient when the value of n is more in n dimensional hyperplane. 2.Is used subsets of training points and hence it is more efficient. 3.The decision functions can consists of different kernel function and can have custom kernels as well.	1.SVM algorithm does not work well with large datasets. 2.The performance of the algorithm is not good when the target classes are overlapping. 3.The performance decreases in the cases where features of data point are more than the number training samples.
Random forest	1.Prediction accuracy is relatively higher with respect to other machine learning techniques. 2.It works well with particularly large datasets 3.Prevents the problem of overfitting. 4.The combination of decision trees made can be saved and reused.	1.It requires more time for training. 2.Due to combination of decision trees the computational cost is relatively high. 3.It is not able to determine the significance of each variable due to ensemble learning procedure.
CNN	1.It has greater ability of generalization and discrimination than handcrafted features.	1.The main drawback of CNN is overfitting.

	2.It has ability of hierarchical learning. 3.It learns multiple features and classifies it in joint fashion.	2.If the Neural Network is not provided with enough features from the training images then it would be difficult for the model to generalize and create an accurate model.

6. PROPOSED SYSTEM

The System basically is a combination of feature extraction methods and a Classification algorithm. Overall By comparing Different Classification Algorithms in machine learning and deep learning we concluded that the CNN that is Convolutional neural Networks specifically LENET-5 Architecture of CNN will give the most accurate results on the GTSRB Dataset. So the Proposed System consists of a model which is basically CNN LENET-5 model which will help to give more accurate results as compared to Support Vector Machines and K nearest Neighbors.

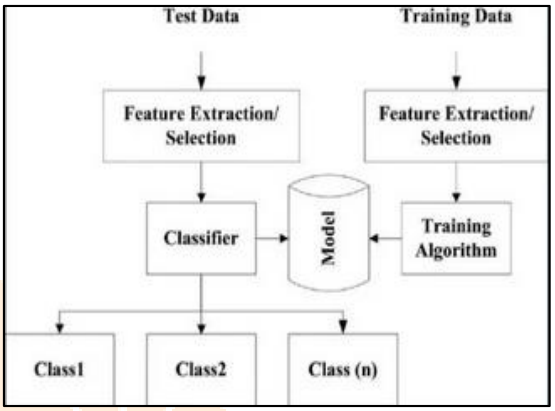

Figure. 8 Proposed system

7. CONCLUSIONS

The Project focuses on building an assistance device for autonomous vehicles. After rigorous survey over TSDR Systems we concluded that the accuracy of the CNN algorithm which basically comes under deep learning is highest the Study particularly focuses in the accuracy over standard GTSRB dataset containing about 5000 images. CNN will give real time accuracy For TSDR Systems if improved further. Overall the conclusion of the paper is that the best classification Algorithm for TSDR systems is CNN.

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