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Traffic Signs Detection Using Machine Learning Algorithms

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ABSTRACT

With the rapid advancement and developments in the Automobile industry, that day is not far when each of us would be owning their own Autonomous Vehicle. Although manufacturing of a full proof Autonomous Vehicle has its own fair share of challenges. The main challenge that lies in front of us, is imbibing the latest technologies and advancements into the conventional vehicles we already have. This paper discusses one such technology that we can incorporate in our vehicle, to direct the Conventional Vehicle into becoming an Autonomous Vehicle in future. The user would be able to classify Traffic Signs on Road, which would help him/her to understand what that sign signifies, i.e. what rules the driver must follow while driving on that particular road.

We use Machine Learning Classification Algorithms like k-Nearest Neighbors, Random Forest and Support Vector Machine on our dataset, to compute the best accuracies in the process as well.

KEYWORDS: *Traffic Signs, ML, kNN, Random Forest, SVM*

I. Introduction

Traffic Signs serve as a guide on the roads, thus being familiar with their interpretations is a must. Having proper knowledge of road signs not only helps the driver in better driving, but also the pedestrians as they would be less prone to accidents, therefore maintaining everybody's safety.

Nowadays, strictness regarding driving without license is a much more punishable offense than it used to be. A driver now is expected to learn the traffic rules as well as the interpretations of traffic signs. There are quite a few benefits of learning these traffic signs as listed below [1]:

- It ensures smooth traffic as it informs the driver about the correct lanes to drive in
- Knowing traffic rules reduces the number of accidents by ensuring discipline of the roads
- Provide instructions and information on the road condition ahead
- All information about important curves and junctions, the presence of school and hospitals and speed limits is provided
- The traffic rules and signs inform the driver about entry and exit points and about parking areas
- Provides drivers to follow the traffic rulesand about potential dangers on the road

But we as humans tend to forget the less important and/or less frequently used traffics signs. Therefore, it becomes necessary that a driver has real time intelligence through some medium to abide to the road norms. This is where our classification model comes into play.

We try to make a model which enables the driver to know what a traffic sign means and therefore the driver can easily interpret what is needed to be done.Also, in the future, this will be helpful for Autonomous vehicles to interpret the rules and regulations of the street they are driving on and even act upon it on their own.

Fig 1: The 43 classes of Traffic Signs in our dataset

II. Related Work

The work on automatic Traffic Sign Recognition is dated as back as 1984, in Japan [2]. Since then people have made several attempts to improve the accuracy and effectiveness of the classification model. They implemented various techniques in order to achieve optimal results.A Traffic Sign Detection system includes several stages: preprocessing, detection, mapping, and recognition.

- In the preprocessing stage the visual appearance of images has been enhanced. Different color and shape-based approaches are used to minimize the effect of environment on the test images.
- The goal of traffic sign detection is to identify the region of interest (ROI) in which a traffic sign is supposed to be found and verify the sign after a large-scale search for candidates within an image. Different colour and shape-based approaches are used by the researchers to detect the ROI. The popular colour based detection methods are HSI/HSV Transformation [3, 4], Region Growing [5], Colour Indexing [6], and YCbCr colour space transform [7]. As the colour information can be unreliable due to illumination and weather change, shape-based algorithm is introduced. The popular shape-based approaches are Hough Transformation [8–10], Similarity Detection [11], Distance Transform Matching [12], and Edges with Haar-like features [13, 14].
- The tracking stage is necessary to ensure real-time recognition. In addition, the information provided by the images of the traffic signs will help verify the correct identification and thus detect and follow the object. The most common tracker adapted is the Kalman filter.
- Several methods have been used by the researchers for recognizing traffic sign. Ohara et al. and Torresen et al. used the Template Matching technique, which is a fast and straightforward method. Genetic Algorithm is used by Aoyagi and Asakura and de la Eccalera et al. which is said to be unaffected by the illumination problem. The main advantage of the AdaBosst is its simplicity, feature selection for large dataset, and generalization. Li et al. used Adaboost learning containing five classical Haar wavelets and four HoG (Histogram of Oriented Gradient) features. Greenhalgh and Mirmehdi showed a comparison between SVM, MLP, HOG-based classifiers, and Decision Trees and found that a Decision Tree has the highest accuracy rate and the lowest computational time. Its accuracy is approximately 94.2%, whereas the accuracy of the SVM is 87.8% and that of MLP is 89.2%. Neural Network is flexible, adaptive, and robust. Hechri and Mtibaa used a 3-layer MLP network whereas Sheng et al. used a Probabilistic Neural Network for the recognition process. Support Vector Machine (SVM) is another popular method used by the researchers which is robust against illumination and rotation with a very high accuracy. Yang et al. and García-Garrido et al. used SVM with Gaussian Kernels for the recognition whereas Park and Kim used an advanced SVM technique that improved the computational time and the accuracy rate for gray scale images [15].

III. Process

The process makes use of technologies like Machine Learning algorithms, to train over the GTSRB - German Traffic Sign Recognition Benchmark dataset[16]. To get a better understanding different Machine Learning algorithm are implemented on the dataset so as to get a comparison between the accuracies obtained. In this case we use KNN classifier, Random Forest and SVM classifier.

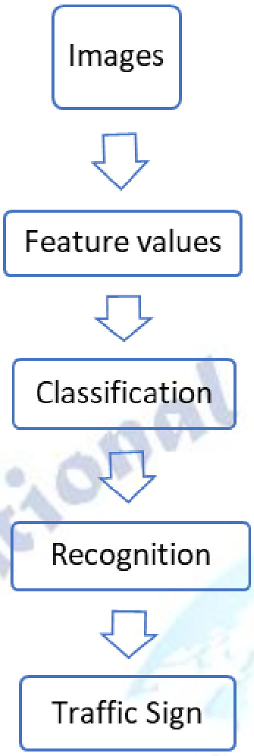

Fig 2: Process Flowchart

The necessary libraries like numpy, pandas and Image are imported, to load the dataset and to read the images from it. The dataset had the following features:

- Single-image, multi-class classification problem
- More than 40 classes
- More than 50,000 images in total
- Large, lifelike database
- Reliable ground-truth data due to semi-automatic annotation
- Physical traffic sign instances are unique within the dataset.

We create different numpy arrays, namely train_x and test_x, to load the images and their respective classes. The train set consists of 39209 sample images whereas the test set consists of 12630 sample images. This completes the first step of loading the dataset.

For better understanding of the dataset, we further explore the data. We try to visualize some random images of a few traffic signs, to ensure that images are correctly loaded in. A statistical chart is also plotted to view the frequency of train images in each class (as shown in fig 3).

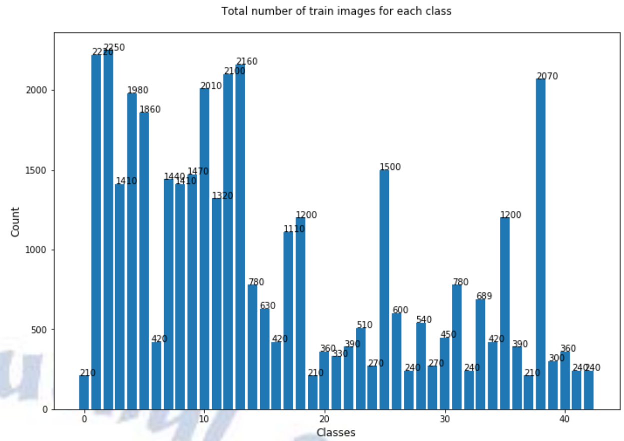

Fig 3: Frequency of training images in each class

The images were then resized so as to fit in accordance to the algorithms used. The data was also normalized using the preprocessing module from 'sklearn' library. After preprocessing, the models were defined, fitted and predictions were carried out.

A.kNN

K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm.

$$Distance = \sqrt{(x-a)^2 + (y-b)^2} \quad (1)$$

We use Euclidean's formula, refer to (1), to find out the distance between any 2 points and further judge which distance is minimum.

B. Random Forest

Random forest, like its name implies, consists of a large number of individual decision trees that operate as an ensemble. Each individual tree in the random forest spits out a class prediction and the class with the most votes becomes our model's prediction.

C. SVM

In the SVM algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiates the two classes very well.

IV.Results

The models were created and predictions were carried out. It was observed that kNN gave the best accuracy out of all 3 classification models we tried.

The following accuracies were obtained:

Algorithm Used	Accuracy
kNN Classifier	0.867
RF classifier	0.7778
SVM classifier	0.8135

Table1: Accuracies obtained for various Algortithms

Further we can say, that this study can be improved by using a more advanced technique and hardware equipment, so as to clearly detect traffic signs at ground level as well as in foggy or rainy weather conditions.

V. Conclusion

The project describes the development of an Assistive device which will turn out to be an innovation in development of Autonomous Vehicles. Even when equipped in a conventional vehicle this technology would help the driver to know better about his/her surroundings, thus help in a better driving experience. It also demonstrates a state-of-the-art implementation of Artificial Intelligence and will show how AI will be leading the revolution in human advancement.

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