TRAFIC SIGN CLASSIFICATION USING DEEP LEARNING

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ABSTRACT

Data mining is extracting information from large sets of databases or data sets. Data mining is the process of discovering correlations, patterns, trends, or relationships by divine through a huge amount of knowledge stored in repositories, corporate databases, and data warehouses. Traffic signs are road facilities that convey, guide, restrict, warn, or instruct information using words or symbols. If the drivers and pedestrians do not notice this information, this may cause the occurrence of traffic accidents. With the increasing demand for the intelligence of vehicles, it is extremely necessary to detect and recognize traffic signs automatically through technology. The difficulty is detecting the traffic signs are as follows: Although an equivalent quite traffic signs has some consistency in color, in outdoor environments the color of the traffic signs is greatly influenced by illumination and lightweight direction. Therefore, the color information is not fully reliable. Traffic signs in some road scenes are often obscured by buildings, trees, and other vehicles, therefore, would have liked to acknowledge the traffic signs with incomplete information. Traffic sign discoloration, traffic sign damage, rain, snow, fog and other problems, also are given as challenges within the process of traffic sign detection and Classification. The various condition dark shade light, blurring, fading, rainy and Foggy.

Key words: Data mining, Traffic signal, Deep learning.

1. INTRODUCTION

The traffic-image dataset is taken from the internet and processed. Figure 1 illustrates the overall workflow. The next stage is either to apply text mining or image mining. The traffic-image dataset is taken, and either text mining or image mining along with some data mining techniques is allowed and the accurate traffic sign is retrieved. For this, the proper data-mining techniques should be adapted [1]. In text mining, Traffic Sign Detection using Centroid Position Identification (TSD-CPI) centroid position of the image is identified, and, with the help of the centroid position, the accuracy of the text is improved. Whereas, in image mining, the image is given as query and the accuracy of the image is acquired by image identification and optimization [2]. The overall performance evaluation is done after applying the proposed techniques.

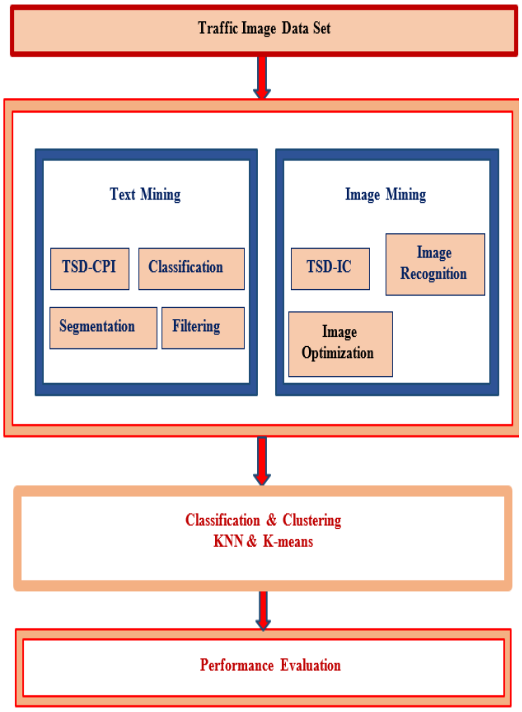

Figure 1: Overall Research Process

The MatLab tool is used in one of the contributions. In the other contributions, WEKA tool is used for computing the data-mining-based techniques, with large amount of data that is to be processed and techniques to compute classification and prediction.

1.1 Data-mining techniques

In this section, the various data extraction techniques that are used for extracting data are discussed.

1.1.1 Classification

Classification is a supervised learning type because the class label is already known. It builds models of data classes. This is built to make prediction about the class labels. It has a two-step process. They are the classification step and the learning step. In the classification step, the class label for particular data is predicted. The performance evaluation is done with the parameter accuracy [3]. Next is the learning step. Here, the data is analysed with the class label, which was given already, and classification is done based on the pre-defined algorithm. To predict functions at the class label, the images in the image dataset will be assigned to the target categories. The classification technique can be applied in banks to detect the loan applicants based on their age.

1.1.2 Bayes Classification

Bayesian Classification comes under classification analysis. It is used to predict the probability of a given tuple which belongs to a particular class. Bayes Classification works on posterior probability and prior probability for the decision- making process. By posterior probability, the hypothesis is made from the given information, that is, the attribute values are known for prior probability, and the hypotheses are given irrespective of the attribute values. It is based on the Bayes theorem, and is the method derived from classification analysis.

1.1.3 Association Analysis

Association analysis will search for interesting associations between the items in database, and it discovers correlation relationship between them and it identifies the pattern. For example, shopping-basket analysis can be taken into account and can find out a customer's shopping preference at a given time. The product may be either paper and pen or fruits and vegetables. This can be found by placing the product on the shelves of the store. The two parameters that are used for finding out the associated items are support and confidence. Support is when two products were purchased at a time, and confidence is when the two products were bought one by one [4].

The threshold value is decided by the domain experts. If a pattern has minimum support and minimum confidence, then the pattern mined is considered as interesting. For example, Pen=>Paper [support=3%, confidence-62%].Here only 3% have bought pen and paper together and 62% of them have bought pen as well as paper. This is known as Market-Basket Analysis. The steps involved in this method are as follows: First, find the frequent item sets that is set of items. Item set containing k items is called k-item set. Next, generate association rules from the frequent item sets. There are many frequent item set-mining methods are in use some methods like Pattern Growth Approach, Apriori Algorithm, and Mining using the Vertical Data Format are in existence.

2. LITERATURE SURVEY

This section reviewed the standard traffic sign detection techniques based on image classification applied to traffic-data sets and the algorithms or methods is used to detect the image.

In [5] explored an optimal binary classifier to distinguish cat and dog images where various architectures and parameters were employed. They considered the architectures with two and three convolutional layers using two input image size when models were trained with and without dropout against an identical dataset. Their results showed that the best performance of binary classification was achieved from a three-layer model with dropout. The accuracy got increased in this work.

In [6], Giuseppe Guido et al. have developed a binary model for predicting the number of vehicles involved in an accident using Neural Networks and the Group Method of Data Handling (GMDH). For that, 775 accident cases were accurately recorded and evaluated from the urban and rural areas of Cosenza in southern Italy and some notable parameters were considered as input data including Daylight, Weekday, Type of accident, Location, Speed limit and Average speed and the number of vehicles involved in an accident was considered as output. And also, 581 cases were selected randomly from the dataset to train, and the rest were used to test the developed binary model. A confusion matrix and a Receiver Operating Characteristic curve were used to investigate the performance of their model. Accuracy for the training and testing dataset has been proven as best for binary classification model.

In [7], Leonardo Bruno et al. proposed an image-analysis technique for automatic traffic-sign detection and classification. It was possible, after proper training, to detect, recognize and classify vertical road signs from video frames acquired on a moving vehicle equipped with cameras, as well as to identify anomalies with respect to road-sign regulations. They showed that this technique allowed one to correctly detect and classify almost all vertical signs and, mainly in extra-urban environment, it was considered as highly reliable, apart from being really versatile and user-friendly for road-inventory and road-maintenance purposes.

In [8] have proposed a system to detect and recognize road signs to assist the driver. The detection phase consists of finding the neon marker, which was placed on the pole of the road sign and finding the Area of Interest (AOI). The recognition phase consists of feature extraction and classification of the road sign using distance-based classification. The proposed system can be integrated in any vehicle and it can serve the purpose of detection and recognition of road sign. Also the proposed method can be used by the drivers to be aware of road conditions.

In [9], Huda Noor Dean and Jabir K.V.T proposed an efficient real-time sign-detection system for Indian traffic signs. Car cameras that capture videos are integrated with an in-vehicle computing device. Traffic-sign detection based on colour and shape was presented. YCbCrcolor space was used for colour segmentationto overcome the illumination-sensitive characteristic of RGB space. Template matching using Euclidean distance approach for correlation was used for the classification of sign based on shape. It shows that YCbCr colour space & Template matching is quite efficient for detection. But the disadvantage here is the recognition rate of training data is not so good.

In [10], Rubén Laguna et al. have described a software application for Traffic-Sign Recognition (TSR). An image pre-processing step and the detection of Regions of Interest (ROIs), with transforming the image to gray-scale and applying edge detection by the Laplacian of Gaussian (LOG) filter was given. The potential traffic-signs detection compared the ROIs with each shape pattern a recognition stage using a cross-correlation algorithm, where each potential traffic sign, if validated, wasclassified according to the data-base of traffic signs. The previous stages were managed and controlled by a graphical user interface. The results obtained showed a good performance of the developed application, taking into account acceptable conditions of size and contrast of the input image.

In [11] have discussed about the object recognition in outdoor environments. The author mentioned that lighting conditions cannot be controlled and predicted, objects can be partially occluded, and their position and orientation was not known a-priori. The chosen type of objects were traffic or road signs, due to their usefulness for sign maintenance, inventory in highways and cities, Driver-Support Systems and Intelligent Autonomous Vehicles. A genetic algorithm was used for the detection step, allowing an invariance localisation to changes in position, scale, rotation, weather conditions, partial occlusion, and the presence of other objects of the same colour. A neural network achieved the classification. The global system not only recognised the traffic sign but also provided information aboutits condition or state.

3. METHODOLOGY

3.1 TSD-BIC: A Proposed Algorithm

The major assignments of traffic sign detection of machine vision in the assisted-driving field are detecting mostly vehicles and pedestrians, which requires training data to meet the special requirements of their missions. The main algorithms belong in five steps. The region of interest is searched in the input image based on yellow colour. R, G, B values for the acceptable yellow band are identified and based on these values the yellow portion of the image marked as white and the rest of the image is marked as black. The image is converted to a binary image. The cropped binary image is denoised by a quantum neural-network algorithm with high convergence rate. Connected components are identified by depth-first search algorithm and bounding box for each connected component is calculated by finding (xmin, ymin) and (xmax, ymax) for each component. Connected components consisting of more than 500 pixels

are selected. Connected components with bounding box and aspect ratio (width / height) less than 0.8 are removed. Selected components are passed to a traffic-sign identification machine which outputs true or false for the corresponding input component. If the connected component is identified as a traffic-sign component, the same component is passed to SVM classifier to identify actual traffic sign. SVM classifier is trained with various images under foggy conditions. The proposal is to improve system performance and accuracy. All binary images consist of noise. The quantum neural-network is used to improve binary-image dataset. The proposed TSD-BIC algorithm process is given is Algorithm 1.

Algorithm 1.

Step1: Input image is converted to a binary image with pixel value 0 to 1. Step2: Each pixel value is multiplied by (pi/2).

Step 3: Binary image is processed in raster scan order with a 3x3 average

convolution filter. For each pixel, the difference with the 8-neighborhood pixels are computed to produce w.

Step 4: w = (pi/2 – difference with one neighbour pixel)

Step 5: w1 = average pixel value for 8-neighborhood pixels for the corresponding pixel Step 6: z is computed with quantum inspired network weight updation formula.

Step 7: z = neighbourhood pixel value * cos (w – w1)

Step 8: z is passed to sigmoidal function with parameter a = 0.5 and c = w1to

compute y. y values for each 8-neighborhood pixels are added to compute the final value for the corresponding pixel.

Each pixel value is multiplied by the corresponding pixel’s weight to calculate the difference among neighbouring pixels. Moreover, each pixel value is calculated with 8 neighbouring pixels to get the maximum weight of the traffic sign images. The final value

(z) is computed with the number of pixel values and difference in the weight to produce a high level of accuracy in the process of training the images.

The new image is considered as the current image. Check for error convergence condition and go back to step 3 if the error is not converged. In this proposal we have used a fixed number of iterations to reduce the running time.

3.2 Experimental Results and Discussion

MATLAB is used to evaluate the performance of the proposed TSD-BIC method. The computed results for SVM, YCbCr, and the proposed TSD-BIC are provided in this section and comparison is also done.

The major assignments of traffic sign

detection of machine vision in the assisted driving fields detect mostly vehicles and pedestrians as shown in Figure 2. It requires training data to meet the special requirements of their missions. The region of interest is searched in the input image based on yellow color. R, G, B values for the acceptable yellow band are identified and based on these values the yellow portion of the image is marked as white and the rest of the image is marked as black. The image is converted to a binary image.

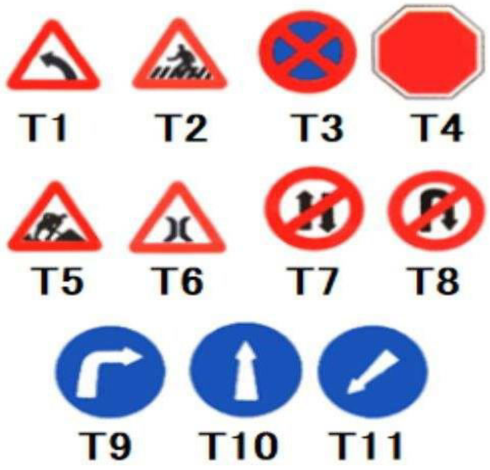

Figure 2: Selected Traffic Sign for TSD-BIC

The cropped binary image is denoised by a quantum neural-network algorithm with high convergence rate. Connected components are identified by depth-first search algorithm and bounding box for each connected component is calculated by finding (xmin, ymin) and (xmax, ymax) for each component. Connected components consisting of more than 500 pixels are selected. Connected components with bounding box aspect ratio (width / height) less than 0.8 are removed. Selected components are passed to traffic-sign identification machine which outputs true or false for the corresponding input component. If the connected component is identified as a traffic sign component, the same component is passed to the SVM classifier to identify the actual traffic sign. SVM classifier is trained with various images under foggy conditions. The proposal improves the system performance and accuracy. The proposed method TSD-BIC and performance improvement points that the system can be further improved for real time traffic-sign detection for ITS system implementation.

4. PERFORMANCE ANALYSIS:

The dataset used to categorise the various traffic sign classifications is available here. There are approximately 58 classes, each with about 120 photos. The related information about each traffic sign class is in .csv file. Changes to these classID assignments with descriptions are possible. The fundamental CNN model is capable of producing respectable val accuracy. Approximately two thousand files are available for testing.

Table. Traffic Sign Attributes

ClassId	Name
0	Speed limit (5km/h)
1	Speed limit (15km/h)
2	Speed limit (30km/h)
3	Speed limit (40km/h)
4	Speed limit (50km/h)
5	Speed limit (60km/h)
6	Speed limit (70km/h)
7	speed limit (80km/h)
8	Dont Go straight or left
9	Dont Go straight or Right
10	Dont Go straight
11	Dont Go Left
12	Dont Go Left or Right
13	Dont Go Right
14	Dont overtake from Left

15	No Uturn
16	No Car
17	No horn
18	Speed limit (40km/h)
19	Speed limit (50km/h)
20	Go straight or right
21	Go straight
22	Go Left
23	Go Left or right
24	Go Right
25	keep Left
26	keep Right
27	Roundabout mandatory
28	watch out for cars
29	Horn
30	Bicycles crossing
31	Uturn
32	Road Divider
33	Traffic signals
34	Danger Ahead
35	Zebra Crossing
36	Bicycles crossing
37	Children crossing
38	Dangerous curve to the left
39	Dangerous curve to the right
40	Unknown1
41	Unknown2
42	Unknown3
43	Go right or straight
44	Go left or straight
45	Unknown4
46	ZigZag Curve
47	Train Crossing
48	Under Construction
49	Unknown5
50	Fences
51	Heavy Vehicle Accidents
52	Unknown6
53	Give Way
54	No stopping
55	No entry
56	Unknown7
57	Unknown8

```
Downloading traffic-sign-dataset-classification, 199059936 bytes compressed
[==================================================] 199059936 bytes downloaded
Downloaded and uncompressed: traffic-sign-dataset-classification
Data source import complete.
```

Figure. Traffic Sign Datasets

In the figure, list of packages being upload in CNN in terms of Conv2D, MaxPool2D, Dense, Flatten, Dropout.

```
import pandas as pd
import numpy as np
import tensorflow as tf
from PIL import Image
import os
from sklearn.model_selection import train_test_split
from keras.models import Sequential
from keras.layers import Conv2D, MaxPool2D, Dense, Flatten, Dropout
import matplotlib.pyplot as plt
import plotly.express as px
import random
```

Then based on the datasets for traffic sign classification, all 58 number of classes are loaded. Then the feature extraction is performed based on the datasets of feature labels and data labels as (2793, 90, 90); (2793, 1). By using the image displayer ( ) function, data_features, data_labels_act, data_labels_pred are defined as it specifies the random variable function in terms of row and column.

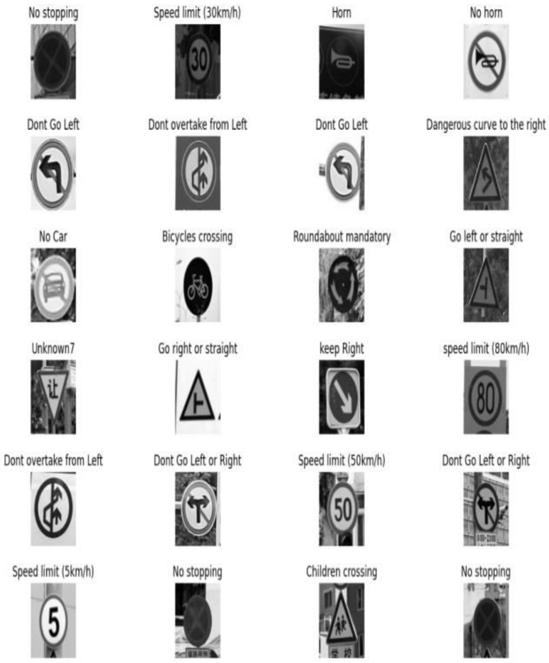

Figure 3. data features and labels

After defining the data features and labels shown in figure , CNN is applied on sequential function as it uses conv2D; Maxpool2D; Dense layer as it defines padding, input shape, activation function as it represents Relu and softmax function.

epochs = 12

batchSize = 14

cnnModel = convolutionModel()

```
(2793, 90, 90, 16)
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 90, 90, 16)        160

 max_pooling2d (MaxPooling2  (None, 45, 45, 16)        0
 D)

 conv2d_1 (Conv2D)           (None, 45, 45, 32)        4640

 max_pooling2d_1 (MaxPoolin  (None, 23, 23, 32)        0
 g2D)

 conv2d_2 (Conv2D)           (None, 23, 23, 64)        51264

 max_pooling2d_2 (MaxPoolin  (None, 12, 12, 64)        0
 g2D)

 conv2d_3 (Conv2D)           (None, 12, 12, 128)       401536

 max_pooling2d_3 (MaxPoolin  (None, 6, 6, 128)         0
 g2D)

 flatten (Flatten)           (None, 4608)              0

 dense (Dense)               (None, 232)               1069288

 dense_1 (Dense)             (None, 116)               27028

 dense_2 (Dense)             (None, 58)                6786

=================================================================
Total params: 1560702 (5.95 MB)
Trainable params: 1560702 (5.95 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

Then the data training is performed as it specifies the data shape, data label shapes. (2793, 90, 90) (2793, 1). The CNN model is analyzed based on the adam optimizer and Sparse Categorical Cross entropy to evaluate the accuracy metrics.

CONCLUSION:

If the drivers and pedestrians do not notice this information, this may cause the occurrence of traffic accidents. With the increasing demand for the intelligence of vehicles, it is extremely necessary to detect and recognize traffic signs automatically through technology. Research in this area began in 1980s, to unravel this problem. To make them easy for drivers to read and recognize traffic signs are often designed to be of a specific shape and color with a robust number “50”.These features also are important information for traffic sign recognition systems. However, traffic sign recognition is not a simple task, because there are many adverse factors, like inclemency, viewpoint variation, physical damage, etc. The difficulty is detecting the traffic signs are as follows: Although an equivalent quite traffic signs has some consistency in color, in outdoor environments the color of the traffic signs is greatly influenced by illumination and lightweight direction. Therefore, the color information is not fully reliable. Traffic signs in some road scenes are often obscured by buildings, trees, and other vehicles, therefore, would have liked to acknowledge the traffic signs with incomplete information. Traffic sign discoloration, traffic sign damage, rain, snow, fog and other problems, also are given as challenges within the process of traffic sign detection and Classification. The various condition dark shade light, blurring, fading, rainy and Foggy.

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