TRAFFIC SIGN DETECTION USING NEURAL NETWORKS

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by

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Certificate

This is to certify that this report entitled "Twitter Sentiment Analysis on Climate Change Data Set: A Comparative Study of Classifier Algorithms" is a bona fide record of the 30% project presented by ***Mr. Robin CR, Mr. Sanjay MS, Mr. Vidhu Krishnan and Mr. VS Achuthan*** *under our guidance towards the partial fulfilment of the requirements for the award of* ***Bachelor of Technology in Electronics & Communication Engineering*** *of the* ***APJ Abdul Kalam Technological University****.*

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Abstract

Road signs give out a number of messages regarding the road and what you as a driver should expect on the road. They keep the traffic flowing freely by helping drivers reach their destinations and letting them know entry, exit and turn points in advance. Pre-informed drivers will naturally avoid committing mistakes or take abrupt turns causing bottlenecks. Road signs, indicating turns, directions and landmarks, also help to save time and fuel by providing information on the route to be taken to reach a particular destination. Road signs are placed in specific areas to ensure the safety of drivers. These markers let drivers know how fast to drive. They also tell drivers when and where to turn or not to turn. In order to be a terrific driver, you need to have an understanding of what the sign mean. Our project implements a procedure to extract the road sign from a natural complex image, processes it and alerts the driver using voice command. It is implemented in such a way that it acts as a boon to drivers to make easy decisions.

Contents

Chapter 1

Introduction

Traffic signs provide valuable information to drivers and other road users. They represent rules that are in place to keep you safe, and help to communicate messages to drivers and pedestrians that can maintain order and reduce accidents. In order to solve the concerns over road and transportation safety, automatic traffic sign detection and recognition (TSDR) system has been introduced.

An automatic TSDR system can detect and recognise traffic signs from and within images captured by cameras or imaging sensors.In adverse traffic conditions, the driver may not notice traffic signs, which may cause accidents. In such scenarios, the TSDR system comes into action.The main objective of the research on TSDR is to improve the robustness and efficiency of the TSDR system. To develop an automatic TSDR system is a tedious job given the continuous changes in the environment and lighting conditions.

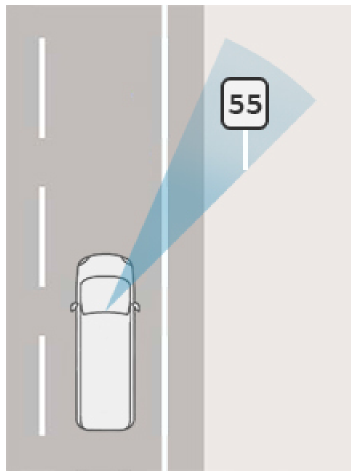

Figure 1.1: *Working of TSDR on road*

Among the other issues that also need to be addressed are partial obscuring, multiple traffic signs appearing at a single time, and blurring and fading of traffic signs, which can also create problem for the detection purpose. For applying the TSDR system in real time environment, a fast algorithm is needed. As well as dealing with these issues, a recognition system should also avoid erroneous recognition of non signs.

Chapter 2

Literature Survey

2.1 Traffic sign recognition by Tesla motors

Tesla motors is accelerating towards a Fully Self Driving (FSD) cars. Tesla's approach to try to achieve FSD is to mimic how a human learns to drive,that is, by training a neural network using the behaviour of hundreds of thousands of Tesla drivers, and (from a sensor perspective), by relying chiefly on visible light cameras supplemented by radar and information from components used for other purposes in the car such as the coarse-grained two-dimensional maps used for navigation; the ultrasonic sensors used for parking, etc.

FSD is an optional upcoming extension of Autopilot to enable fully autonomous driving. TSDR is a part of their Autopilot mode. They could achieve it with the help of Artificial Intelligence(AI) and Internet of Things(IOT).Tesla's self-driving software is being trained on over 20 billion miles driven by Tesla vehicles as of January 2021. In terms of computing hardware, Tesla designed a self-driving computer chip that has been installed in its cars since March 2019.Since Tesla motors is working for autonomous driving they also research in Lane Detection, Pedestrian Detection, Traffic light Detection, Vehicle detection, Vehicle to Vehicle distance estimation etc. Tesla motors have introduced Traffic sign recognition as a software feature initially in 2019. The model could efficiently detects alot of traffic signs such as speed limit signs, stop sign etc.. After feedback from the drivers they have integrated this model with a GPS based navigation, so now speed limits are monitored based on GPS navigation. Now they are researching on integrating this software with mechanical system of the vehicle, for eg. if a pedestrian crossing sign is detected the vehicle will automatically reduce its speed. Tesla is also having a feature that whenever it detects a speed limit sign, it will automatically set speed limit to that number.

Tesla motors encountered lots of challenges as a part of traffic sign recognition feature. Stop sign which is used as general sign by private firms, is being detected by Tesla cars, which creates a nuisance to the drivers while driving. Traffic sign recognition could not work efficiently when the car moves above a particular speed. Tesla cars need to be connected to a network while driving, if connection is lost, the communication between the sensors is interrupted. So in that case offline mode is activated which is less accurate, in most case the offline model in the car needs to analyse its decision with online server.

2.2 Traffic Sign Recognition by BOSCH

With the advancements in AI and the development of computing capabilities in the 21st century, millions of processes around the globe are being automated like never before. The automobile industry is transforming,and the day isn't far when fully autonomous vehicles would make transportation extremely inexpensive and effective. But to reach this ambitious goal, which aims to change the very foundations of transportation as an industry, we need to first solve a few challenging problems which will help a vehicle make decisions by itself. This is one such problem and solving it would take us one step closer to L5 autonomy.

The developed software package "Analysis.ai" is designed to help an analyst to build datasets for traffic sign recognition, implement wide variety of augmentation and transformation techniques on the dataset with wide flexibility. Furthermore, the package provides user with a latest deep learning model E-DUQ clubbed with an Spatial Transformer Network (STN) to not only make a prediction but also give information regarding noise and confidence level of the prediction. The detailed analysis of the trained model has been done using uncertainty, architecture and augmentative analysis.

2.2.1 STN Model

Spatial transformer networks are a generalization of differentiable attention to any spatial transformation. Spatial transformer networks (STN for short) allow a neural network to learn how to perform spatial transformations on the input image in order to enhance the geometric invariance of the model.

For example, it can crop a region of interest, scale and correct the orientation of an image. It can be a useful mechanism because CNNs are not invariant to rotation and scale and more general affine transformations.

Chapter 3

Traffic Sign Recognition

3.1 Problem

When driving on congested roads, it's sometimes difficult to keep your eyes everywhere at once. Checking the road ahead, oncoming traffic, what's behind you, all while trying to maintain your speed can sometimes become quite distracting. Car firms realise this and are constantly looking to introduce new technologies, which make things easier. With the introduction of Traffic Sign Recognition systems, the chances of not noticing a change in speed limit, or the warning of a potential hazard ahead have been vastly reduced. In the latest of our technical pieces, we explain how this clever system could benefit you.

Figure 3.1: *Output*

3.2 How does it work?

As with most of the best technology, it's a relatively simple principle which has the potential to reduce the hassle for road users. Essentially, the system consists of a forward-facing camera, which scans the road ahead for traffic signs. This camera is connected to character recognition software, which then makes a note of any changes described by the signs, and relaying it onto the car's instrument panel.

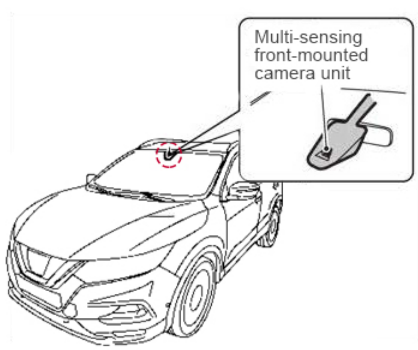

Figure 3.2: *Output*

Chapter 4

Introduction to Neural Networks

4.1 Neural Networks

Neural networks are artificial systems that were inspired by biological neural networks. These systems learn to perform tasks by being exposed to various datasets and examples without any task-specific rules. The idea is that the system generates identifying characteristics from the data they have been passed without being programmed with a pre-programmed understanding of these datasets. Neural networks are based on computational models for threshold logic. Threshold logic is a combination of algorithms and mathematics. Neural networks are based either on the study of the brain or on the application of neural networks to artificial intelligence. The work has led to improvements in finite automata theory.

4.2 Evolution

In 1943, Warren McCulloch and Walter Pitts laid the first brick in the foundation of an advanced future of artificial neural networks. Warren McCulloch and Walter Pitts developed a mathematical model of an artificial neural network using threshold logic to mimic how a neuron works in a human brain. Thereafter, Frank Rosenblatt created the “Perceptron” model, which was the first of its kind to perform pattern recognition, in 1958. But, Marvin Minsky and Seymour Papert found multiple problems with the Perceptron model, which were later solved by Paul Werbos in 1975 using Back Propagation. Between 2009 and 2012, recurrent neural networks and deep feedforward neural networks were created by Jürgen Schmidhuber’s research group, which won eight international competitions in pattern recognition and machine learning.

4.3 Limitations

The neural network is for a supervised model. It does not handle unsupervised machine learning and does not cluster and associate data. It also lacks a level of accuracy that will be found in more computationally expensive neural network.

The next steps would be to create an unsupervised neural network and to increase computational power for the supervised model with more iterations and threading.

4.4 Types of Neural Networks

4.4.1 Artificial Neural Networks(ANN)

ANN is a group of multiple perceptrons or neurons at each layer. ANN is also known as a Feed-Forward Neural network because inputs are processed only in the forward direction. This type of neural networks are one of the simplest variants of neural networks. They pass information in one direction, through various input nodes, until it makes it to the output node. The network may or may not have hidden node layers, making their functioning more interpretable. ANN learning is robust to errors in the training data and has been successfully applied for learning real-valued, discrete-valued, and vector-valued functions containing problems such as interpreting visual scenes, speech recognition, and learning robot control strategies. The study of artificial neural networks (ANNs) has been inspired in part by the observation that biological learning systems are built of very complex webs of interconnected neurons in brains.

Advantages

- Storing information on the entire network.
- Ability to work with incomplete knowledge.
- Having fault tolerance.
- Having a distributed memory.

Disadvantages

- Hardware dependence.
- Unexplained behavior of the network.
- Determination of proper network structure.

4.4.2 Convolutional Neural Network (CNN)

A convolutional neural network is a specific kind of neural network with multiple layers. It processes data that has a grid-like arrangement then extracts important features. One huge advantage of using CNNs is that you don't need to do a lot of pre-processing on images.With most algorithms that handle image processing, the filters are typically created by an engineer based on heuristics. CNNs can learn what characteristics in the filters are the most important. That saves a lot of time and trial and error work since we don't need as many parameters. A convolution is used instead of matrix multiplication in at least one layer of the CNN. Convolutions take to two functions and return a function.

CNNs work by applying filters to your input data. What makes them so special is that CNNs are able to tune the filters as training happens. That way the results are fine-tuned in real time, even when you have huge data sets, like with images.

Convolution Neural Networks or covnets are neural networks that share their parameters.A covnets is a sequence of layers, and every layer transforms one volume to another through differentiable function.

Layers used to build ConvNets

Convolution Layer: This layer computes the output volume by computing dot product between all filters and image patch.
Activation Function Layer: This layer will apply element wise activation function to the output of convolution layer. Some common activation functions are RELU: max(0, x), Sigmoid, Tanh, Leaky RELU, etc.
Pool Layer: This layer is periodically inserted in the covnets and its main function is to reduce the size of volume which makes the computation fast reduces memory and also prevents from overfitting. Two common types of pooling layers are max pooling and average pooling.
Fully-Connected Layer: This layer is regular neural network layer which takes input from the previous layer and computes the class scores and outputs the 1-D array of size equal to the number of classes.

Training in CNN

Training a neural network typically consists of two phases:

- A forward phase, where the input is passed completely through the network.During the forward phase, each layer will cache any data (like inputs, intermediate values, etc) it'll need for the backward phase. This means that any backward phase must be preceded by a corresponding forward phase.

- A backward phase, where gradients are backpropagated and weights are updated.During the backward phase, each layer will receive a gradient and also return a gradient. It will receive the gradient of loss with respect to its outputs and return the gradient of loss with respect to its inputs.

Advantages

- Very High accuracy in image recognition problems.
- Automatically detects the important features without any human supervision.
- Weight sharing.

Disadvantages

- CNN do not encode the position and orientation of object.
- Lack of ability to be spatially invariant to the input data.
- Lots of training data is required.

Chapter 5

System Design

5.1 Block Diagram

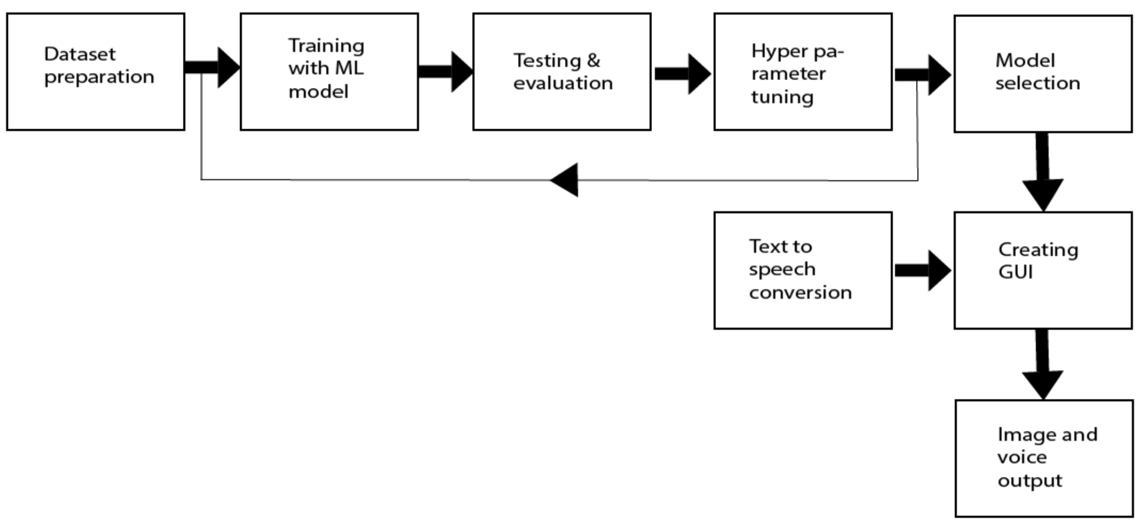

Figure 5.1: *Output*

5.2 Dataset Preparation

5.2.1 Collecting data

Collecting the images of these traffic signs is the most time consuming process. In our project we have used a German traffic sign dataset from the site kaggle.com. The signs which are common among german and indian signs are

filtered. There were around 35 signs which are common. After thorough research we have selected 12 signs, that if the driver didn't notice any of these sign boards the chances of getting to accident is very high. The signs are selected based on the collision accident rates in India.

5.2.2 Data Augmentation

During dataset preparation we encountered a problem called class skew. It arises when there is wide variation in training images among different classes. In our project we have around 500 images for "hump" sign but only 40 images for "no parking" signal. So the solution is data augmentation.Data augmentation in data analysis are techniques used to increase the amount of data by adding slightly modi

ed copies of already existing data or newly created synthetic data from existing data. It will create new images by changing the properties such as orientation, size etc.., so that there is enough data for each class.

5.3 Training

The model for traffic sign detecion is implemented with the help of Convolutional Neural Network (CNN).The observations in the training set form the experience that the algorithm uses to learn.

5.4 Voice assisted message

If a particular sign is detected a voice message is given according to the sign. Suppose "School Ahead" traffic sign is detected, then a voice message "School is Ahead, so please control your speed" is given by the system. This is implemented with the help of Google Text to Speech library.

Chapter 6

Work Done

Till date, we have completed 30% our project which includes collecting the Twitter dataset, preprocessing the tweets and tokenising. These steps were implemented using Python programming language and the Natural Language Toolkit Library.

6.1 Collecting data

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6.4 Hardware

Real time detection of traffic signs is done with the help of Raspberry pi. The basic installation of linux os in Raspberry pi is done and it is interfaced with a web cam module. In real time detection a print out of traffic sign is kept infront of the webcam module.

Chapter 7

Result

The German Traffic sign dataset containing over 12 traffic signs were pre-processed and trained using CNN algorithm.

The CNN algorithm shows a least accuracy of 0.6716 and highest accuracy of 0.9978.

```
In [1]: runfile('C:/Users/Robin/Desktop/project/30%/code/archive/2.py', wdir='C:/Users/Rol
archive')
(3570, 30, 30, 3) (3570,)
(2856, 30, 30, 3) (714, 30, 30, 3) (2856,) (714,)
Epoch 1/5
90/90 [==============================] - 12s 127ms/step - loss: 4.1128 - accuracy: 0.6716
val_accuracy: 0.9944
Epoch 2/5
90/90 [==============================] - 7s 79ms/step - loss: 0.1117 - accuracy: 0.9713 -
val_accuracy: 1.0000
Epoch 3/5
90/90 [==============================] - 7s 80ms/step - loss: 0.0230 - accuracy: 0.9955 -
val_accuracy: 1.0000
Epoch 4/5
90/90 [==============================] - 7s 82ms/step - loss: 0.0190 - accuracy: 0.9952 -
val_accuracy: 1.0000
Epoch 5/5
90/90 [==============================] - 7s 80ms/step - loss: 0.0062 - accuracy: 0.9978 -
val_accuracy: 1.0000
```

Figure 7.1: *Output*

Chapter 8

Conclusion

Traffic sign detection is achieved through Convolutional Neural Network(CNN) algorithm. 12 traffic signs from German Traffic sign dataset is trained and achieved an accuracy of 0.9. Implementing the prototype, configuration of raspberry pi micro controller is done. Raspberry pi is interfaced with web-cam module. The live camera recording is working smoothly.

Chapter 9

Future Work

9.1 Real time detection

The trained image recognition model will be tested real time, with the help of a webcam. A new set of images will be used for testing.

9.2 Testing with other algorithms

The current model is implemented in Convolutional Neural Network (CNN). The model will be tested with other algorithms such as Artifical Neural Network (ANN), Recurrent Neural Network (RNN) etc... in order to compare the performance.

9.3 Hardware Implementation

After comparing the performance of different neural network algorithms, the one with more accuracy or better performance will be selected to create a model. This program will be loaded to raspberry pi and will be using for trial and test run.

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[1] [2] [3] [4] [5]

Chapter 10

Appendix

1. What are the challenges to Traffic Sign Detection and Recognition?

   In TSDR moving camera needs to detect stationary objects, so if the speed of camera increases beyond a threshold value noise adds to the image. So in that case TSDR system will not detect the signs. Secondly signs from private firms are mistakenly detected which creates a problem to the driver.

2. Define Neural Networks?

   A neural network is a series of algorithms that endeavors to recognize underlying relationships in a set of data through a process that mimics the way the human brain operates. In this sense, neural networks refer to systems of neurons, either organic or artificial in nature. Neural networks can adapt to changing input; so the network generates the best possible result without needing to redesign the output criteria.

3. What is class skew?

Skewed classes basically refer to a dataset, wherein the number of training example belonging to one class out-numbers heavily the number of training examples belonging to the other. for example in our project we have around 500 images for ”Hump” traffic sign but only 200 images for ”railway cross”.

4. What is convolution in convolution neural networks(CNN)?

   Convolution is a specialized kind of linear operation. Convnets are simply neural networks that use convolution in place of general matrix multiplication in at least one of their layers.Convolution between two functions in mathematics produces a third function expressing how the shape of one function is modified by other.

5. Differentiate training data and testing data?

   Training Data : The observations in the training set form the experience that the algorithm uses to learn. In supervised learning problems, each observation consists of an observed output variable and one or more observed input variables.

   Test Data : The test set is a set of observations used to evaluate the performance of the model using some performance metric. It is important that no observations from the training set are included in the test set. If the test set does contain examples from the training set, it will be difficult to assess whether the algorithm has learned to generalize from the training set or has simply memorized it.