HIGHWAY VEHICLE ANALYTICS

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CERTIFICATE FOR CORRECTNESS AND APPROVAL

This is to officially state that the thesis work contained in this report "Highway Vehicle Analytics" is carried out by NC Abdul Moiz, PC Sohail Abbas, NC Abdullah Khattak and NC Hamza Khalil under my supervision and that in my judgment, it is fully ample, in scope and excellence, for the degree of Bachelor of Electrical Engineering from Military College of Signals, National University of Sciences and Technology, (NUST). And is original with less than 20% plagiarism.

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DECLARATION

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DEDICATION

In the name of Allah, the Most Merciful, the Most Beneficent To

our Faculty y, without whose unflinching support and cooperation, a

work of this magnitude would not have been possible.

And our Parents for their support.

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TABLE of CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

UAV	Unmanned Aerial Vehicle
NCS	Neural Cornuted Stick
LIDAR	Light Detection and Ranging
CNN	Convolutional Neural Network
MATLAB	Matrix Laboratory

ABSTRACT

Highway Vehicle Analytics plays an important role in intelligent transportation system, especially for traffic management. This project can also be used in areas where high security is needed or just for the purpose of gathering valuable data. Our project proposes the technique for detection and counting of vehicles, which is video-based.

In Pakistan, the security situation has been critical for the past few years. Notwithstanding the circumstances, majority institutions of our country employ manual security y personnel. This apart system from being ultra-expensive is also vulnerable. This project aims to provide a real- time vehicle security and analytics mechanism that will detect all the details of the vehicle that are entering through the gate and then comparing the data with the already y authorized database. Lf the details match, the vehicle will be let through. If not, the vehicle will not be allowed to pass through the security system.

Current services do not work in Pakistan, because all those services available globally are trained on general dataset which has no resemblances with our vehicles. Pakistan has a quite a unique set of vehicles on its roads as compared to rest of the globe.

We have used manual data gathering technique of recording the details of all vehicles entering or leaving manually from various CCTV sources. After

gathering the data, we then applied various techniques to filter the most efficient form of information that would be intern used to train custom models for max efficiency y of the system.

INTRODUCTION

1 INTRODUCTION

Overview

Highway Vehicle Analytics (recognition and counting) system plays an important role in intelligent transportation system, especially for traffic management.Thisprojectcanalsobeusedinareaswherehighsecurityisneeded.Ourpr ojectproposes the technique for detection and counting of vehicles, which is video-based.

1d Problem Statement

In our country y, the security y situation has been critical for the past few years. Notwithstanding the circumstances, majority y institutions of our country employ manual security y personnel. This apart, system from being ultra-expensive is also vulnerable. Until

Now CCTV were just used for only security purposes and it was very difficult to gather data manually on regular bases from a CCTV video feed. Organizations like N LC even tried to make a person sit beside a tool plaza and manually count cars and classify cars as they drove by him and then register it on a notebook. It was soon realized that this method was very difficult to implement and had resulted in lot of errors as humans cannot maintain a constant level of attention for a long period of time. There was a dire need of an intelligent system that could solve all these issues and even provide high efficiency.

Our method of general data gathering that will detect all the details of the vehicles coming through any entrance and then comparing the data with the already developed database.

Current services do not work in Pakistan, because all those services available globally are trained on general dataset which has no resemblances with our vehicles. Pakistan has a quite a unique set of vehicles on its roads as compared to rest of the globe.

1d Approach

This involves following steps which are as follows:

- **Studying of Machine Learning Algorithm (YOLLOV3)**

lt is an algorithm that uses convolutional neural networks for object detection. You only look once, or Y OLO, is one of the faster object detection algorithms out there. Though it is not the most accurate object detection algorithm.

I comparison to recognition algorithms, a detection algorithm does not only predict class labels but detects locations of objects as well. So, it not only classifies the image into category, but it can also detect multiple Objects within an Image. This Algorithm applies single neural network to the Full Image. It means that this network divides the image into regions and predicts bounding boxes and probabilities for each region. These bounding boxes are weighted by the predicted probabilities.

- **Dataset Gathering**

We gathered a lot of data through 2 methods. First method to be extracting images from a **CCTV** footage and organizing them. The second was to search the internet for related datasets. Open image is a great dataset resource powered by Google itself with millions of already annotated images with very high accuracy.

Data Pre-processing

Data pre-processing is that part of our project where we filter out the data which is either blurry or irrelevant. This step must be done manually as each image has to be analyzed and afterwards a decision is made on whether that image must be kept in the data set or not. We did also used loosely built python scripts to speed up the pre-processing by applying general checks such as to automatically detect if the image in general has a vehicle in it or not. These small techniques saved us a lot hassle and increased the validity of our datasets.

Data Augmentation

The thus formed filtered dataset is then passed through a process known as gmentation. In this step, our dataset is expanded in size using morphological operations. Augmentation is a strategy that enables practitioners to significantly increase the diversity of data available for training the models, without collecting new data. Data augmentation techniques such as cropping, padding, and horizontal flipping are commonly used to train large neutral networks. In order to train a deep learning machine, we require many images per class i.e. minimum 1000 images per class for a decent accuracy y. There are several open-source libraries/packages that are available for this task. The most commonly used ones are imaging and Augrnenter. Our approach employed Augmenter.

Training the ML model

Transfer learning is a research problem in machine learning that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem. For example, knowledge gained while learning to recognize cars could apply when trying to recognize trucks. Transfer learning is popular in deep learning given the enormous resources required to train deep learning models or the large and challenging datasets on which deep learning models are trained. Transfer learning only works in deep learning if the model features learned from the first task are general. In our project we downloaded pre-trained weights of yolox'3 from CiitHub. The new custom model would be trained on our custom dataset but with the same generic weights.

- **Flow chart view of the whole project**

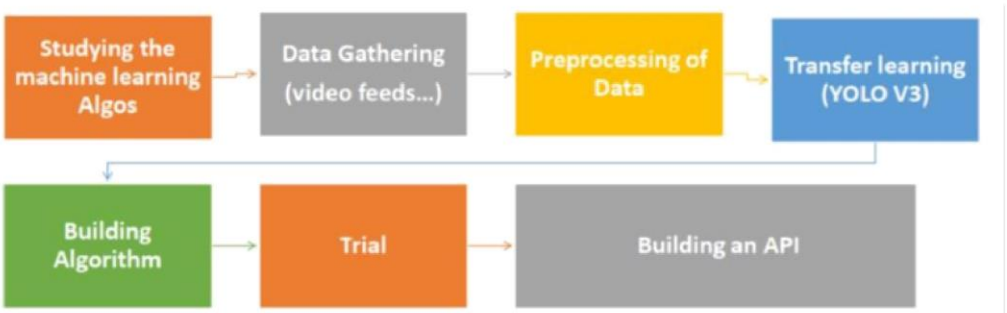

Figure 1

1.4 Scope

The project proposes the technique for detection and counting of vehicles, which is video-based.

. The project finds its scope in the law enforcement departments and all other government bodies working for collecting analyzing data and make decision based on the gathered data. Considering the innovation side of this project, not just the government departments but also the private entities can benefit from it. Some of the institutions that can greatly benefit from this project are:

- NADRA
- N LC(National Logistics Cell)
- N HA(National Highway Authority)
- Urban Development Authorities
- FWO(Fortier Work Organization)
- FBR(Federal bureau of revenue)
- Private companies such Honda Toyota...etc.

1J Aim & objectives

Research Objectives

1. To employ our knowledge and practical skills pertaining to Deep learning models to the best of society.
2. To be confident in the development of databases and their usage.
3. To learn the art of Gkll development along with its integration with backend.

Industrial objectives

To design and develop a smart solution for housing societies and military installations to effectively y:

1. Monitor incoming and outgoing traffic.
2. Determine the authorization of the vehicle to enter.
3. Send live notifications to admin of the system to tackle security breach on spot.

With this project, we wish to integrate our academic knowledge with practicality to achieve further understanding and polish our skills in all the fields as mentioned above.

1J.5 Organization

Our document is distributed into five sections, which includes:

- The first section of the thesis provides the abstract which describes the main details of our research idea, followed by the introduction section which specifies the problem statement, approach, scope, and objectives.

- The second section summarizes the literature about the various resources read online regarding the project and the previous research on the topic.

- The third section emphasizes on the development design part which illustrates the flow figuresofdifferentstepsinvolvedintheprojectaswellasthedescriptionofmainmodules.

- The fourth section is the analysis and evaluation part which gives the detail of results obtained from deep neural network algorithms.

- The fifth section compromises of the future work, further improvements and points out the additional developments which can be made to enhance the scope of the project.

- In Appendix A we have added the Synopsis document of the project.

- Appendix B contains the code for tree detection.

- And Appendix C contains the code for tree classification.

LITERATURE REVIEW

2 LITERATURE REVIEW

Literature review of Highway Vehicle Analytics consists of comprehensive details of network monitoring

Solutions offered worldwide, their limitations and the novelty of the solutions.

2.1 Project Domain

Our country has been in the middle of the whirlwind of terrorism over the past few decades. Yet almost all the institutions of our country rely on manual security and data gathering mechanism which in most cases proves to be expensive as well as inefficient. This problem has not been addressed on a large scale by the tech industry of Pakistan. This project aims to provide a high-tech solution for the problem.

2J Literature Review

Population of this world is growing rapidly and as a result, the need of automated traffic monitoring systems is growing behind the point where approaches which are manual can be used to check irregularity. To minimize this problem in techniques which are modern to traffic monitoring requires to be checked. Our literature review consists of study of different deep learning techniques to solve our problem. All these techniques will be implemented using Python programming language

2J.1 Deep learning techniques

During the last decade, machine learning has been the focus of interest. Daily we experience the impact of machine learning in industry conferences, various computer science programs and several Wall Street journals. Primarily, machine learning is the technique to use algorithms on raw data to obtain information and then to symbolize it in some form of model. Furthermore, this model is used to conclude other data that has not been explored yet.

The best example of machine learning is the Neuronal network model. This network model is in use for last 50 years. The basic unit is a “node” for neuronal network. This

Node is based in mammalian brain, by the principle of neuron sited. Various associations between neurons are exhibited as models on brains as more connections develop with time and training.

Several vital advancements in architectural structure were designed in neuronal network during 1985 till 1995.However the acceptance and interest decline in neuronal network because it requires huge amount of data and plenty of time. Further in 2000, the computational techniques have extended enormously, and industries experienced the "Cambrian explosion". The computational growth has given birth to Deep learning and this field won various competitions of machine learning. Today, we experience that deep learning has been mentioned in every aspect of machine learning.

Detailed learning is declares as networks which are neutral providing a huge number of layers and parameters in one of these important network architectures:

I. Networks which are unsupervised Pre-Trained

2. Networks of Convolutional Neural

3. Networks of Recurrent Neural

4. Networks of Recursive Neural

The provided techniques can be used to all of these given architectures.

2J.1.1. Back Propagation

This method computes the gradient or panial derivatives of a function that has a function composition. The objective function is the form of composition for a Neuronal Nets. The grant can be computed by 2 ways commonly. First, Analytical differentiation: in this the form of function is known and the derivatives are computed using the chain rule of basic **calculus.** Second, Approximate differentiation using finite difference. This is computationally complicated method because the functional evaluation number can be calculated.

2d.1.2. stochastic gradient Descent

This method is symbolized like the water fall from river from the mountains. Hence if the mountain is shaped without barriers so the river flow is unstoppable till it reaches foothill is the best way we required. Whereas in machine learning; one has to learn minimum or

Optimum solution, which comes from pre-defined point. The pits in the path of river that hinders the flow and traps the water must be removed. The pits are named as local rninirna solution in Machine learning terminology. This local minimum is undesirable.

Therefore, local minima can be a hindrance in gradient decent method. However, when path is designed without barriers, then this algorithm promises to find the optimum. Likewise, subject to the speed at the river flows down, one might reach to the conclusion in a diverse style. These conditions can mark whether one fall into local minima or are capable to evade it.

2d.1.3. Rate of learning decay

Adjusting the learning rate for stochastic gradient, which is an iterative method, best expansion technique could multiply the performance and decreases time of training known as adaptive learning rates or also as learning rate annealing. This technique decreases rate of learning. Although it is best for making much changes at starting level of procedure of training, by using larger learning rate values to decrease learning rate, and small informs of training are constructed to check later. Two commonly used rate of learning decay are:

I. Lessening the rate of learning progressively based on the epoch.

2. Reducing the rate of learning by way of disrupted huge drops at precise epochs.

2J.1.4. Dropout

Detailedneuralnetswithavastamountofparametersarecontrollingmachinelearning systems.Butthisnetworkhasoverfittingproblem.Thesevastnetworksarenotfastto use shaking it tough to treat over fitting by merging the estimates of several different bulkyneuralnetsduringtesttime.Dropoutisamethodforminimizingthatissue.The main notion is to arbitrarily to units along with their connections; from the neural networkintraining.Duringtesttime,itisbettertoapproximatetheeffectofpredictions of all these networks which are thinned by constructing a solo untwined network that hasminimumweights.Thisrelativelydecreasesoverfittingandprovidesbetterincrease over other techniques. Dropout has showed to improve the performance of neural networks on supervised learning tasks invision, speech, classification recognition. It has provided best results on different sets of data.

2d.1.15. Max Pooling

The Sample created discretization model Max Pooling. The objective of maze pooling is to down a sample an input explanation, reducing its dimensionality and letting for assumptions to give rough features contained in the sub-regions not accepted. This is done in different parts, to aid over fitting by giving a short form of the description. Also, it reduces the cost of computation by dropping the quantity of parameters tort and provide conversion invariance to the internal exemplification. By smearing a max filter to frequently non overlapping sub-regions of the early illustration in this way max pooling is performed.

2d.1.6. Batch Normalization

Neural networks counting detailed networks require good tuning of weight initialization and learning parameters. Batch normalization helps in minimizing them a bit.

During the time of back propagation causes interruption to gradients, means the gradients must recompense the outliers, learning the weights to get important required outputs, which results in the sense of extra epochs to get .Batch normalization regularizes the gradients from disruption to outliers and drift to the reciprocated goals within a level of the minibatch.

Learning rate problem: Often, rates of learning are restrained minor, so that a little part of gradients modifies the weights; the reason is that the gradients for outlier activations should not interfere learned activations. By batch normalization model, these outlier activations can be decreased and so higher learning rates can be in use to fast the process of learning.

2d.1.7. A long short-term memory network

lt has primarily three dimensions that discriminate it from a usual neuron in a network of recurrent neural:

I. lt decides that when we provide and give access to input to enter into neuron.

2. This decides when to recollect what was calculated in the earlier time step.

3. lt decides when to give access to output to pass to timestamp.

Attractiveness of that model is that it chooses all this grounded itself on current input.

2d.1.8. Skip Gram Model

Main idea of word fixing models is to know a higher proportions deep illustration for every lexicon terminology in that the resemblance among vectors which are embedded , displays the syntacticorsentic resemblance among the words, which are consistent. This Model is an important model for learning word fixing algorithms. The main idea of this model is that “Two vocabulary expressions are related, if they share related context. Consequently, if two words in numbers recurrently give alike backgrounds in a great quantity, the inserted vectors of those will contains vectors, which are closer.

2d.1.9. Model of Continuous Bag of Words

In that model, the aim is to be capable to utilize the surrounding context a specific word , guess the word, which is precise.

lt can be done by considering many tences and collecting the surrounding word while seeing any word any time. After that we input the context words toward neural network and find the word in the mid of provided context. If one has hundreds of such context words and also the center word, then one has an illustration of a dataset for the neural network. The neural network is trained and lastly the encoded unseen layer output characterizes the inserting for a specific word.

2d.1.10. Transfer learning

Transfer learning is model that takes a trained CN N on one set containing data, cutting the layer, which is present at last; preventing the models last layer on dataset which is not easy. Automatically, we train this model to predict diverse advanced level features. Consequently, training time gets shorter thus transfer learning is a supportive means when one do not have much data or if training is taking much capitals.

Each layer in a detailed CNN gradually increase up advanced level illustrations of features. Last layers incline on whatsoever data one saved onto the model. Whereas the initial layers are majorly generic, majorly pictures share many simplified patterns.

Gene y, for the analysis of visual imager y problems, convolutional neural networks are used. CN Ns are standardized versions of multi-layer perceptron's. Multi-layer perceptron's usually refer to fully connected networks. In a multi-layer perceptron, each neuron in one layer is connected to all neurons in the next layer. The "fully-connectedness" of these networks make them predisposed to over fitting. Typical ways of standardization include adding some sort of scale measurement weights to the loss function. On the other hand, Convolutional Neural Networks take a different approach towards standardization: they take advantage of the patterns in data and amass more complex patterns using smaller and simpler patterns. Therefore, on the scale of connectedness and complexity, CNNs are on the lower extreme. There are several steps that are involved in the implementation of convolutional neural networks. These are further elaborated in software requirements portion of this thesis.

The following software are used for the development of this software.

2J.1.11 Anaconda Distribution

Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing, that aims to simplify package management and deployment. Package versions are managed by the package management system conda.

Figure: 2.1: Graphical Installer

2.2.1. I 2Visual studio Code

Visual Studio Code is a source-code editor developed by Microsoft for Windows, Linux and macOS. It includes support for debugging, embedded Git control and GitHub, syntax highlighting, intelligent code completion, snippets, and code refactoring.

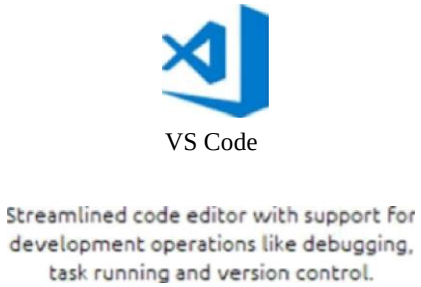

Figure: 2.2: Visual Studio Code

2£ Conclusion

The idea of proposed project is purely unique. Previous projects done in the field of artificial intelligenceatMCShavenotfcicusedonproblemslikex'ehicledetectionandrecognition.Theidea of Highway Vehicle Analytics is exotic since it addresses the basic need of our society which fit both at military as well as enterprise level.

TECHNOLOGICAL REQUIRMENTS

This chapter provides comprehensive details about technical requirements of by Highway Vehicle Analytics i.e. Software and OS requirements. by Highway Vehicle Analytics makes use of an open source software development software (Anaconda). This chapter will also provide readers with details about the software development steps as well as the different mechanisms that were employed along the way.

3.1. Software Requirements

The software required for the implementation of the project includes:

3.1.1 Python 3.6.5

The major software requirement for this project is a python 3.6 installation on your operating system. It can be done by visiting the official website of python.

Figure 3.1: Python Logo

3.1.2Anaconda Distribution

The first step of working with image processing on Python is to install the anaconda distribution from their official website given as

https://www.anaconda.com/

3.1.3. Visual Studio code

After installing the anaconda distribution, launch visual studio code, and wait for its installation.

32. Software Development

3d.1 Deep learning Algorithm development

The main steps that are involved in the development of deep learning models include,

1. Data Acquisition.
2. Data Pre-processing.
3. Data Augmentation.
3. Preparation of machine learning model.
4. Using the model to make predictions.

3. 2. 1. 1 Data Acquisition

Data acquisition for our machine learning model was done by a concept called as web crawling. This took use of a python package /library especially designed to download images from Google in bulk. The name of this package is Google-images-download. The following procedure was carried out for the use of this package.

3 2.1.1.1 Package Installation

This package was installed using the pip command as shown below.

M Anaconda Prompt

Figure 3.2: Installation command.

3 d.1.1d Python script

Amaximumofhundredimagescanbedownloadedusingthefollowingscriptforeachkeyword mentioned. The screenshot for the code is shown below.

Figure 3.3: Automation Script

The code in the above-mentioned screenshot downloads 100 images for each keyword and stores in a download folder, in a sub folder with the name of the keyword.

3 2.1.2 Pre-processing of Data

Pre-processing of data is that part of our project in which we filter out the data which is either blurry or irrelevant. This step must be done manually as each image has to be analyzed and afterwards a decision is made on whether that image has to be kept in the data set or not.

3 d.1.3 Data Augmentation

The thus formed filtered dataset is then passed through a process known as augmentation. In this step, our dataset is expanded in size using morphological operations. In order to train a deep learning model, we require many images per class i.e. minimum 1000 images per class. There are several open-source libraries/packages that are available for this task. The most commonly used ones are imgaug and Augmenter. Our approach employed Augmenter. Following are the steps involved in this process.

3 2.1.3.1 Package installation

The package can be easily installed using pip command as shown below.

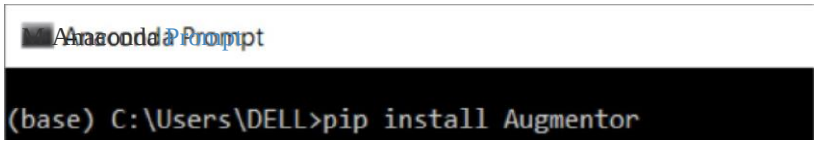

Figure 3.4: Installation command.

3d.1.3d Python script

The script that is used for image Augmentation requires the user to mention all the morphological operations that are to be performed on the dataset. The following can be used as a sample script.

```
Augmentor.py
1  from Augmentor import Pipeline
2
3  p = Pipeline("F:\\Classifiers\\Cars\\training_set\\Honda")
4  p.rotate(probability=0.7, max_left_rotation=10, max_right_rotation=10)
5  p.zoom(probability=0.5, min_factor=1.1, max_factor=1.5)
6  p.set_save_format("auto")
7  p.sample(1000)
```

Figure 3.5: Augmentation Script

Afterwards, the dataset is divided into two parts namely training set and test set. 1n this project, we divided the dataset with a ratio of about 70:3 (e. i.70°/c images were placed in the training set while 30*/e were placed into the test set.

3 2.1.4 Preparation of machine learning model

The library/package that is used in order to build the machine learning model is known as Keras.

3M.4.1 Keras

[1]Keras is an open—source i ce neu i a 1 —ne tz'oi k I the at i• v'i i t ten i n Py t hon. I t c an run on top of Tensoi'ñio , flicrosoft Cogniti'e Toolkit, The«o, or Hl iidMl.
Designed to enable fast experimentation with deep neural networks, it focuses on being user-friendly, modular, and extensible

Figure 3.6: Keraslogo

We are using Keras on top of TensorFlow. Following are some details about procedure of installation andusage.

3 2.1.4.1.1 Package installation

The package can be installed using pip as shown below.

Figure 3.7: Installation command

3d.1, 4Ad Python Script

The python script that is used to train our model is in fact a classical example of a convolutional neural network of sequential type. Our CNN has a total of five hidden layers. The first layer performs convolution in two dimensions. Keras has an in-built function that does convolution for us. The second layer performs maxpooling. Pool size is the only variable that is to be provided to this function. The third layer of this neural network performs flattening. Flattening is the process in which images which are in the form of 2D arrays transformed into lD arrays. The fourth layer of our neural network is the Dense Jr. This dense layer has an output of 128 neurons. The fifth layer is also of dense type. This dense layer also has an output of 4 neurons of different weights. These are used afterwards for prediction on our new images. There is no exact way of figuring out the number and type of the network layers that ought to be used for the best result. Anyway, we can have a good idea about the layers by understanding the mathematical operations that are being performed within each of them.

The output of our training script is a model file stored in h5 format. It could have been stored injsonformataswell.Wechosetheformerasitwasmoreconvenient.Thismodelwhentested onourtrainingsetgaveusanaccuracyofabout77&owhichwasgoodconsidering the scarcity of features that were available for our deep learning problem.

3d.1.4 Using the model to make predictions

This deep learning model thus produced w'ill be used to make predictions on new' data. An example of w'hich is shou'n below'.

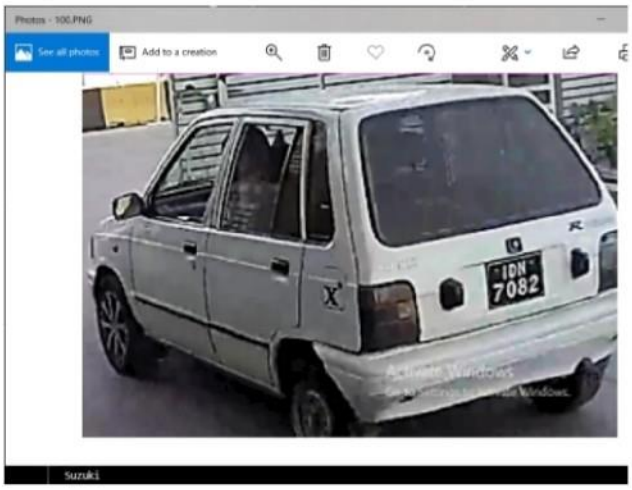

Figure 3.8: Demonstration of model prediction

This feature of our model will be used in our final product w'hile taking frames from a ›'ideo.

3d.2. Vehicle detection algorithm

Then we will do transfer learning using the algorithm named as YOLLO V3. YOLLO V3 s used for classification, realization and recognition.
Then we make our own algorithm on python and compare it with YOLLO V3 algorithm on train set.

3. 2. 2. 1 Installing Packages

Python has its own libraries known as pre kage s. for i n s tal I i ng thos e I i brar ies, t here are severalmay s. conda. All of the below

The main command being pip and coxand shoudbe

i n t he anac onda proopt of t he

➢

Installing TensnrFlow

Using command "conda install TensorFlow", the library is easily installed in the conda distribution.

Installing OpenC V

Using command pip install “OpenCV-python”, the library is installed in the distribution.

Installing darknet

Using “pip install darknet”, we can easily install this library as well.

Installing dark flow

Dark flow library should be downloaded and then installed locally. The library can be installed from the following link .https://qithu b.coin/thtrieu /darkflow

Afterwards, from the command prompt, we reach the library where the library is locally downloaded. Afterwards, run the command “python setup.py build Ext —inplace”

The library will be installed.

Downloading weights

Weights of the yolov2 code can be easily downloaded from the following link:

https //oireddie com/darknet/volo/

Uo nT oak the \ ono› 2. Rei ght s f i T e.

The Bin Folder

Blake a bi n fo I rler in t he mark fl o —ma s t er fo I her anrl pu t t he rlo»n I oadeh

eights in it.

The eagi e words

After doing that, run the following command.

”Q ’t OR # OH ——MO/P# C#@/\O O.O#@——#O0/ il/\O O\’2. ?Pi@ tS——UPTO

camera1.mp4 --gpu 1.0 - saveVideo” .

Your video by the name of camera1.mp4 will be opened and all the recognizable objects will be made clear by making a rectangle around them and labelling them.

32.3 C’.UI (C’.raphical **User Interface)development**

This portion of the chapter provides a guide to the GUI we developed, and the packages used and installed. The standard package in python that is used for GUI development is known as tkinter. It is generally in-built with every python installation.

The browse button in the video can be used to browse to the video on which we want to deploy our software. We can also grasp the live feed of a camera if needed.

3.2.3.1 Database maintenance

In this portion, we will discuss the development of the database in which our data will be finally stored and maintained. We are employing a framework call as MySQL. It is a database management system that makes working with SQL (Structured Query Language) easy.

Figure 3.11: MySQL Logo

The first step that we perform is that we download the MySQL-installer from their web page. Afterwards, we run its setup and get the MySQL workbench on our system. This means that we can access the MySQL server without requiring to write any kind of code. Afterwards, you can create a database in the

server in a number of ways. The most commonly used is to create the database and corresponding tables with the help of python programming language. For this to be done, we need to first install the MySQLconnectorwithpython.Thefollowingcommandisusedtoinstallthatconnector.

Figure 3.12: Connector Installation Command.

the corresponding editor to

w.

```
Real-GUi.py    yolo12.py
3  import numpy as np
4  import time
5  from keras.preprocessing import image
6  from keras.models import load_model
7  #import csv
8  import tkinter
9  import os
10 import datetime
11 import mysql.connector
12
13 mydb = mysql.connector.connect(
14   host="localhost",
15   user="root",
16   passwd="Pak@Watan231"
17 )
18
19 mycursor = mydb.cursor()
20
21 mycursor.execute("CREATE DATABASE mydatabase")
22
```

of

Figure 3.13: Database initiation

his

```
79          val = (prediction,dateTimeObj.strftime("%d-%b-%Y (%H:%M:%S.%f)"))
80          sql = "INSERT INTO Vehicles(name,time) VALUES (%s, %s)"
81          mycursor = mydb.cursor()
82          mycursor.execute(sql, val)
83          mydb.commit()
```

Figure 3.14: Database initiation Script

Ihis database can be w i nta i ned and seen us i ng t he IlySQL vorkbenc h.

Fe4

Figure 3.15: Database visualization

3d.4 Software integration

So far, we have discussed the development of the machine learning model, the working of YOLOV3,andthedevelopmentofourgraphicaluserinterface.Inthisportion,wewilldiscuss the integration of these parts were madepossible.

The firststep of software integration was to be able to write a piece of code in which we can down1oad our video and isolate the frames. If they pass each frame through the object detection algorithms and then select Chich frame to pass to the deep 1earning model. The deep learning model afterwards gives us a prediction on Chich riake, and type of vehicle is passing through the video. The prediction thus made vi 11 then be saved in ourSQL database a long time a the vehicle is passing through the gateway. It is acquired as the hours and on the device the software is working on.

RESULTS & OUTCOME

This chapter describes about the detailed results and outcomes of V DRS.

22

4.1 Deep learning algorithm

After the development of the deep learning algorithm, the accuracy on the test set came out to be 80°/c i.e. about 80*/c of vehicles from the test set we're recognized correctly. Afterwards, the algorithm was also tested manually on new' unseen data. An example is shown below'.

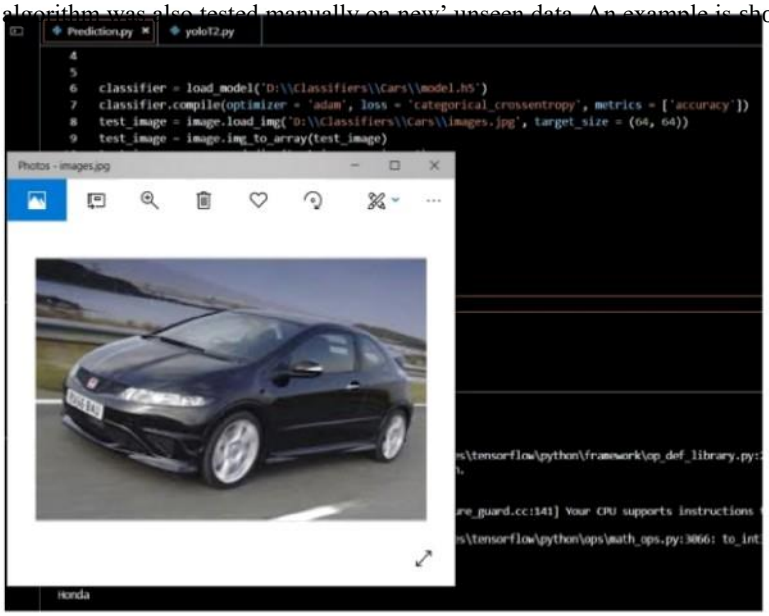

Figure 4.1: Working algorithm demonstration

As we can observe in the screenshot that the vehicle is of Honda type and the deep learning algorithm also predicted the same.

4d Software Testing

After integration of software, the testing process begins. While testing, the following results are found:

I. The problem of induction: The dataset used for the development of the deep learning algorithm has a total of about 2000 images per class. Thus V DRS cannot be claimed to be a universal system.

2. The deep learning algorithm has an accuracy of 50*/c on the test set.

3. The frame rate of our software is about I frame per second. The software can be made real time by employing other processing resources in the form of GPU s.

ENHANCMENT &FUTURE WORK

This chapter states the future work and possible enhancements of the VDRS. This chapter also tells about the enhancements already done in VDRS and those which can further can make. This would provide a clear picture to the reader its future status.

5.1 Mobile Application

To make Highway Vehicle Analytics user friendly and all-time accessible, a cross-platform appcanalsobedev'elopedsothattheadmincaneasilygettheupdatedstatusof the types and number of vehicles that are entering and leaving the facility i.e. our database. Generally, java programming language is used for android development and its learning resources are readily available, both online as well as offline.

5d Adding computational resources

As it is mentioned in the section 4.2, the software developed so far does not function in real time on an i7 processor that has 4 physical and 8 logical cores. Thus, computational resources such as GPUs can be introduced to make it real time. Some technical difficulties will be the development of the software with libraries that are GPU enabled.

Fortunately, GPU enabled Keras and TensorFlow are readily available and can be installed using the following command.

```
To ills clit T| is| cckclc e \vit| cool((1t:
 conda install -c anaconda keras-gpu
```

Figure 5.1: Installation instructions.

Apart from this, the GPU should have the computational capabilit y to make this software real time. According to our estimations, the software will require a minimum of about 800 cuda cores for real time functionality.

8 Deliverables

Research paper

User-friendly

GUI

Python(.exe)

Detection and classification

9 Application / End Level Objectives

To count the care based on their categories and share that data with the administrative cell of a certain toll plaza or any entrance.

The betterment of security state in our country by providing a solution of encroachment of private space by unwanted vehicles.

Minimizing internal and external threats to sensitive installations as well as high ranked Organizations.

Provide for traffic congestion solutions.

thesis

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