VIVEKANAND EDUCATION SOCIETY'S
INSTITUTE OF TECHNOLOGY

Department of Computer Engineering

Project Report on

Smart Driver Assistant

In partial fulfillment of the Fourth Year (Semester–VIII), Bachelor of Engineering (B.E.) Degree in Computer Engineering at the University of Mumbai

Academic Year 2017-2018

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(2017-18)

VIVEKANAND EDUCATION SOCIETY’S INSTITUTE OF TECHNOLOGY
Department of Computer Engineering

Certificate

This is to certify that ***Tanmay Rauth, Aditya Krishnan, Sahil Khan, Jyoti Singh*** of Fourth Year Computer Engineering studying under the University of Mumbai have satisfactorily completed the project on “***SMART DRIVER ASSISTANT***” as a part of their coursework of PROJECT-II for Semester-VIII under the guidance of their mentor ***Mrs. Abha Tewari*** in the year 2017-2018.

This project report entitled ***Smart Driver Assistant*** by ***Tanmay Rauth, Aditya Krishnan, Sahil Khan, Jyoti Singh*** is approved for the degree of ***Bachelor of Engineering (B.E.) Degree in Computer Engineering.***

Programme Outcomes	Grade
PO1,PO2,PO3,PO4,PO5,PO6,PO7, PO8, PO9, PO10, PO11, PO12 PSO1, PSO2	

Date:

Project Guide:

Project Report Approval
For
B. E (Computer Engineering)

This project report entitled ***Smart Driver Assistant*** by ***Tanmay Rauth, Aditya Krishnan, Sahil Khan, Jyoti Singh*** is approved for the degree of ***Bachelor of Engineering (B.E.) Degree in Computer Engineering.***

Internal Examiner

External Examiner

Head of the Department

Principal

Date:
Place

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date:

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We are deeply indebted to Head of the Computer Department **Dr.(Mrs.) Nupur Giri and** our Principal **Dr. (Mrs.) J.M. Nair,** for giving us this valuable opportunity to do this project.

We express our hearty thanks to them for their assistance without which it would have been difficult in finishing this project synopsis and project review successfully.

We convey our deep sense of gratitude to all teaching and non-teaching staff for their constant encouragement, support and selfless help throughout the project work. It is great pleasure to acknowledge the help and suggestion, which we received from the Department of Computer Engineering.

We wish to express our profound thanks to all those who helped us in gathering information about the project. Our families too have provided moral support and encouragement at several times.

Computer Engineering Department
COURSE OUTCOMES FOR B.E PROJECT

Learners will be to,

Course Outcome	Description of the Course Outcome
CO 1	Able to apply the relevant engineering concepts, knowledge and skills towards the project.
CO2	Able to identify, formulate and interpret the various relevant research papers and to determine the problem.
CO 3	Able to apply the engineering concepts towards designing solution for the problem.
CO 4	Able to interpret the data and datasets to be utilized.
CO 5	Able to create, select and apply appropriate technologies, techniques, resources and tools for the project.
CO 6	Able to apply ethical, professional policies and principles towards societal, environmental, safety and cultural benefit.
CO 7	Able to function effectively as an individual, and as a member of a team, allocating roles with clear lines of responsibility and accountability.
CO 8	Able to write effective reports, design documents and make effective presentations.
CO 9	Able to apply engineering and management principles to the project as a team member.
CO 10	Able to apply the project domain knowledge to sharpen one’s competency.
CO 11	Able to develop professional, presentational, balanced and structured approach towards project development.
CO 12	Able to adopt skills, languages, environment and platforms for creating innovative solutions for the project.

Abstract

Smart driver assistant that will help drivers avoid accidents during lane departures by providing prompt and quick markings of road lanes. This paper also proposes a novel system for the automatic detection and recognition of traffic signs. It detects candidate regions as maximally stable external regions (MSERs), which offers robustness to variations in lighting conditions. Recognition is based on a cascade of Convolutional Neural Networks that were trained using histogram of oriented gradient (HOG) features. This detection method is significantly insensitive to variations in illumination and lighting conditions. Traffic symbols are recognized using HOG features and a cascade of linear SVM classifiers. A method for the synthetic generation of training data has been proposed, which allows large data sets to be generated from template images, removing the need for hand labeled data sets.

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Chapter 1: Introduction

1.1 Introduction

World Health Organization estimated about 1.35 million death all around the globe due to road traffic which can be approximated to about 1 death in 25 seconds in the year 2016. A majority of these accidents occur due to lack of attentiveness while departing lanes / lane splitting. The purpose of this project is to create a smart driver assistant which will help the driver make rational decisions based on the real-time environment. The system marks lanes in front of the car with image processed highlighting and colored tracking. Along with this, the system will ensure that the driver never misses a traffic sign. The system constantly grabs each and every traffic symbol along the path and makes the information available to the driver through voice assistant.

1.2 Motivation

Lane departure is an unintentional drifting towards the boundary of the driving lane, which usually occurs when the driver is drowsy or fatigued. In the United States, 37.4% of fatal crashes are due to single-vehicle lane departure, which makes it the leading cause of fatalities. Lane departure warning system (LDWS) aim to alert the driver when the lane departure begins and has great potential for vehicle safety. LDW systems can detect or predict lane-departure events and give a warning in an auditory, haptic, or visual form. The challenge is to design a successful Driver Assistant.

1.3 Problem Definition

With 1 billion vehicles dominating the streets of the world, there have been countless yet significant accidents leading to 1.3 million deaths every year; just because of careless / inattentive / reckless driving. Such massive number of deaths is tragic for all. With the emergence of cutting edge technology and real time analysis, driving can be re-imagined. Solution to these problem is to develop a smart driver assistant that will help drivers avoid accidents during lane departures by providing prompt and quick markings of road lanes.

Lane Tracking will be our primary module that will keep the vehicle in check to always maintain a lane so as to avoid jerky lane splitting. Another feature is a Traffic Sign Analyzer that will automatically read road signs and keep the driver informed of the road ahead.

1.4 Relevance of the Project

1.4.1 Autonomous Driving Car

The lane keeping assist system are being achieved in modern driverless vehicle systems using image processing techniques called Hough transform and canny edge detection techniques. These advanced image processing techniques derive lane data from forward facing cameras attached to the front of the vehicle. Advanced lane detection algorithms are also being developed using deep learning and neural network techniques.

1.4.2 Virtual Assistant

A virtual assistant is a software agent that can perform tasks or services for an individual. Virtual assistants use natural language processing (NLP) to match user text or voice input to executable commands. Many continually learn using artificial intelligence techniques including machine learning. Our Traffic Sign Analyzer that will automatically read road signs and keep the driver informed of the road ahead.

1.4.3 Navigation System

A GPS navigation system is a GPS receiver and audio/video (AV) components designed for a specific purpose such as a car-based or hand-held device or a smartphone app.

1.5 Methodology used

Smart driver assistant which comprises of 2 parts, Lane tracking system and Traffic sign analyzer. These both needs to be combined. To create the final integrated model of the various object modeling phases we will make use of Image Processing and Machine learning.

1.5.1 Lane Detection Model

The general method of lane detection is to first take an image of road with the help of a camera fixed in the vehicle. Then the image is converted to a grayscale image in order to minimize the processing time. Secondly, as presence of noise in the image will hinder the correct edge detection. Therefore, filters should be applied to remove noises like bilateral filter, Gabor filter, trilateral filter Then the edge detector is used to produce an edge image by using canny filter with automatic thresholding to obtain the edges. Then edged image is sent to the line detector after detecting the edges which will produces a right and left lane boundary segment. The scan returns a series of points on the right and left side. Finally, pair of hyperbolas is fitted to these data points to represent the lane boundaries. The algorithm undergoes various changes and detection of patterns in the images of roads for detecting the lanes. The filtered image is converted to grayscale image for reducing the processing time. Then this image is segmented to binary image. It is done to locate the lanes in captured image

1.5.2 Road Traffic Sign Detection and Classification

Automatic traffic sign detection and recognition is an important part of an advanced driver assistance system. Traffic symbols have several distinguishing features that may be used for their detection and identification. They are designed in specific colors and shapes, with the text or symbol in high contrast to the background. Because traffic signs are generally oriented upright and facing the camera, the amount of rotational and geometric distortion is limited. Information about traffic symbols, such as shape and color, can be used to place traffic symbols into specific groups; however, there are several factors that can hinder effective detection and recognition of traffic signs. These factors include variations in perspective, variations in illumination (including variations that are caused by changing light levels, twilight, fog, and shadowing), occlusion of signs, motion blur, and weather worn deterioration of signs. Road scenes are also generally very cluttered and contain many strong geometric shapes that could easily be misclassified as road signs. Accuracy is a key consideration, because even one misclassified or undetected sign could have an adverse impact on the driver.

Three tasks: a) road detection; b) obstacle detection; and c) sign recognition. The first two have been studied for many years and with many good results, but traffic sign recognition is a less-studied field. Traffic signs provide drivers with very valuable information about the road, in order to make driving safer and easier. They think that traffic signs must play the same role for autonomous vehicles. They are designed to be easily recognized by human drivers mainly because their color and shapes are very different from natural environments. The algorithm described here has two main parts. The first one, for the detection, uses color thresholding to segment the image and shape analysis to detect the signs. The second one, for the classification, uses a neural network. Some results from natural scenes are shown. On the other hand, the algorithm is valid to detect other kinds of marks that would tell the mobile robot to perform some task at that place.

1.5.3 Image Processing

- **Defining and Conversion of ROI into Grayscale**

  In this step, the captured color image is converted to grayscale to make method faster, less computational, and less sensitive to scene condition. In our proposed method, captured series of images received from a camera on top of a car would be processed.

- **Gaussian Smoothing**

  In image processing, a **Gaussian blur** (also known as **Gaussian smoothing**) is the result of blurring an image by a **Gaussian** function. It is a widely used effect in graphics software, typically to reduce image noise and reduce detail.

- **Focus sub region**

  The camera is adjusted in a way that the vanishing point of road should be placed on the top of ROI Based on camera place adjustment, only part of the bottom of the captured image would be valuable for processing and it causes short time processing and less memory usage. From the whole image only, the focus region of lane is segmented and processed.

- **Canny Edge Detection**

  By applying focus sub region (ROI) in this step, to find lane boundaries in the image we use one of the edge detection methods called Canny Edge Detection. Edge detector most commonly used for step edges due to Optimal, then is corrupted by white noise. The objective is the edges detected must be as close as possible to the true edges the number of local maxima around the true edge should be minimum.

- **Plotting focus lanes**

  In this step we get the pixels of focus lanes, then we keep track of that lane.

1.5.4 OpenCV

OpenCV (*Open Source Computer Vision*) is a library of programming functions mainly aimed at real-time computer vision.

1.5.5 Machine Learning for Traffic Sign Detection

- **TensorFlow**

The TensorFlow layers module provides a high-level API that makes it easy to construct a neural network. It provides methods that facilitate the creation of dense (fully connected) layers and convolutional layers, adding activation functions, and applying dropout regularization.

1.5.6 Google Text to Speech API

Google Text-to-Speech is an API in Android operating system. It powers applications to read aloud (speak) the text on the screen which support many languages. This will help to convey results of traffic sign classification to driver.

Chapter 2: Literature Survey

2.1.1 Papers and Books

- **Real time Detection of Lane Markers in Urban Streets (Author: Mohamed Aly)**
  We can get rid of the perspective effect in the image, and so the lane that appears to converge at the horizon line are now vertical and parallel This uses our main assumption that the lanes are parallel (or close to parallel) to the camera. We can focus our attention on only a sub region of the input image, which helps in reducing the run time considerably.

- **Traffic Road Sign Detection and Recognition for Automotive Vehicles (Author: Md. Safaet Hossain, Zakir Hyder)**
  The original image is resized and exposed to a red color threshold. We detect the object using Breadth-First Search (BFS) and cut the possible signboard region. Apply a sobel operator for precise edge detection and then detect the sign in the original RGB image to extract the real signboard.

- **Lane Detection Techniques (Author: Gurveen Kaur, Dinesh Kumar)**
  The general method of lane detection is to first take an image of road with the help of a camera fixed in the vehicle. Then the image is converted to a grayscale image in order to minimize the processing time. as presence of noise in the image will hinder the correct edge detection. Therefore, filters should be applied to remove noises Then the edge detector is used to produce an edge image by using canny filter with automatic thresholding to obtain the edges. Then edged image is sent to the line detector after detecting the edges which will produces a right and left lane boundary segment.

- **Real-Time Detection and Recognition of Road Traffic Signs (Author: Jack Greenhalgh and Majid Mirmehdi)**
  In this paper the proposed method for traffic sign detection and classification consists of the following two stages: Detection is performed using a novel application of maximally stable extremal regions (MSERs) Recognition is performed with histogram of oriented gradient (HOG) features, which are classified using a linear support vector machine.

- **Lane detection and tracking using B-snake (Author: Yue Wanga, Eam Khwang Teoha, Dinggang Shenb)**

  Basically, there are two classes of approaches used in lane detection: the **feature-based technique** and the **model-based technique**. The feature-based technique localizes the lanes in the road images by combining the low-level features. Accordingly, this technique requires the studied road having well-painted lines or strong lane edges, otherwise it will fail. Assuming the shapes of lane can be presented by either straight line or parabolic curve, the processing of detecting lanes is approached as the processing of calculating those model parameters.

- **Traffic Sign Recognition with Multi-Scale Convolutional Networks (Author: Mohamed-Aly)**

  Convolutional Network architecture with state-of-the-art results on the GTSRB traffic sign dataset implemented with the EBLearn open-source library.

2.2 Patent search

Publication number	US82390B5 B2
Publication type	Grant
Application number	US 12/067,477
PCT number	PCT/DE2006/000871
Publication date	7 Aug 2012
Filing date	20 May 2006
Priority date	20 Sep 2005
Inventors	Thomas Fechner, Stefan Heinrich

Table 2.2.1 Patent information

Description:

The invention relates to a method and a device for detecting road lanes. An important component of driver assistance systems which for example are used to regulate interim distance or to keep the vehicle in lane is the prediction of the road lane. Different approaches are offered as solutions in publications. DE 10327869 discloses a navigation system with road lane information in which road map data is stored with road lane information in a storage element and in addition, the road in front of the vehicle is recorded. The data records are compared in order to determine the position and the road lane of the vehicle.

Publication number	US9257045 B2
Publication type	Grant
Application number	US 14/234,485
PCT number	PCT/DE2012/100202
Publication date	9 Feb 2016
Filing date	6 Jul 2012
Priority date	5 Aug 2011
Inventors	Matthias Zobel

Table 2.2.2 Patent Information

Description:

The invention relates to a method for detecting a traffic lane by means of a vehicle camera. A method for traffic lane detection in a driver assistance system of a vehicle, comprising the following steps performed in the driver assistance system: with a camera, acquiring at least one image of surroundings of the vehicle; detecting a driving corridor from the at least one image; performing structure detection in the at least one image while taking the detected driving corridor into consideration to detect a roadway edge and to determine a course of the roadway edge from the at least one image; and based on the determined course of the roadway edge, estimating a position of a traffic lane to perform the traffic lane detection.

Publication number	US6813545 B2
Publication type	Grant
Application number	US 10/615,091
PCT number	---
Publication date	2 Nov 2004
Filing date	7 Jul 2003
Priority date	9 Jul 2002
Inventors	Oyvind Stromme

Table 2.2.3 Patent Information

Description:

The invention concerns a system for reminding a driver of the presence of at least one particular traffic sign, comprising: an imaging unit attached to the vehicle and directed towards the road ahead of the vehicle; a database containing at least one pre-registered shape of traffic sign; an automatic recognition unit for detecting and identifying, in successive images, a traffic sign by searching image areas having a shape contained in said database; and a sound and/or visual indicator of an identified traffic sign.

Chapter 3: Requirements

3.1 Functional Requirements

- **Segregation** between white lines and grey tar road in one of the most important feature of lane detection. Model should be able to distinguish between them in order to track focus lane.
- **Lane tracking** - The continuous plotting of drivable path, i.e. Tracking of the lane on which the car is driven. Model will be tracking the lane on which the driver is driving based on input video capture.
- **Traffic sign detection** - The detection of various traffic symbols among all different objects present beside road. So that whenever there is a traffic symbol present at an image it should be properly classified.
- **Traffic sign analysis** – After detection of traffic symbols classification of those different traffic symbols is an important implementation. Maintaining accuracy in this classification is a major challenge.
- **Voice assistance** - Live updates about the environment and various traffic symbols
- Guiding the driver during lane departure can prevent accidents.
- **Upcoming road** - The angle and type of the road ahead.
- **Off lane detection** - Alert if the vehicle steers out of the allowed path. If the vehicle moves out from the focus lane then the alert system will alert the driver to drive vehicle on focus lane.
- **Signal Detection** - Detecting the status of the traffic signal and informing about the same to the driver

3.2 Non-Functional Requirements

1. **User Interface:** A clean and user-friendly interface should be developed.
2. **Accuracy:** Accuracy in classification of the traffic signs is a major challenge. So that whenever there is a traffic symbol present at an image it should be properly classified.
3. **Real time update:** Real-time update of the environment conditions will be informed to driver.
4. **GPS enabled:** User must have a gps enabled device for navigation support.
5. **Relative distance tracking of vehicles:** The model will track speed of nearby vehicles in order to avoid crash and give warning to driver.
6. **Pothole Alert:** Alerting user regarding the pothole present on roads. The model will alert the driver about the upcoming pothole present on road

3.3 Constraints

1. **Platform constraints**

   These constraints ensure the discussion of the platform dependent and independent parameters of the system. This parameter is specified as per the user requests. Various modifications in the features of platform are possible

2. **Accuracy in classifying the traffic symbols.**
3. **Image capturing while driving fast (>100 kmph).**

   For proper image capturing and classification of traffic symbol and lane detection there is speed limit of vehicle. Above that speed limit the accuracy of detection and classification have bad results.

3.4. Hardware & Software Requirements

3.4.1 Hardware Requirements -

A. Camera: Camera is required in order to capture video of the driving lane. From that the output video is send to model for lane tracking and traffic sign detection.
B. GPS Sensors: These are needed in order to track location of vehicle during navigation.

3.4.2 Software Requirements -

1. OpenCV
2. Anaconda
3. TensorFlow
4. Google Text-to-Speech API

3.5 Selection of the Hardware, Software, Technology and tools

A. Hardware
    a. Camera: 16MP (Everyday use camera with decent FPS)
    b. Machine Learning: Nvidia GTX 1060 6GB, Intel i5 7th generation 7500U, 8GB RAM (The best at hand)
B. Software
    a. Image Processing: OpenCV library for python 3.6 (Best IP library available)
    b. Machine Learning: Tensorflow-gpu using CUDA & cuDNN (Neural Network framework by Google)
C. Technology and tools
    a. Anaconda (Interactive IDE for python)

Chapter 4: Proposed Design

4.1 Block Diagram of the system

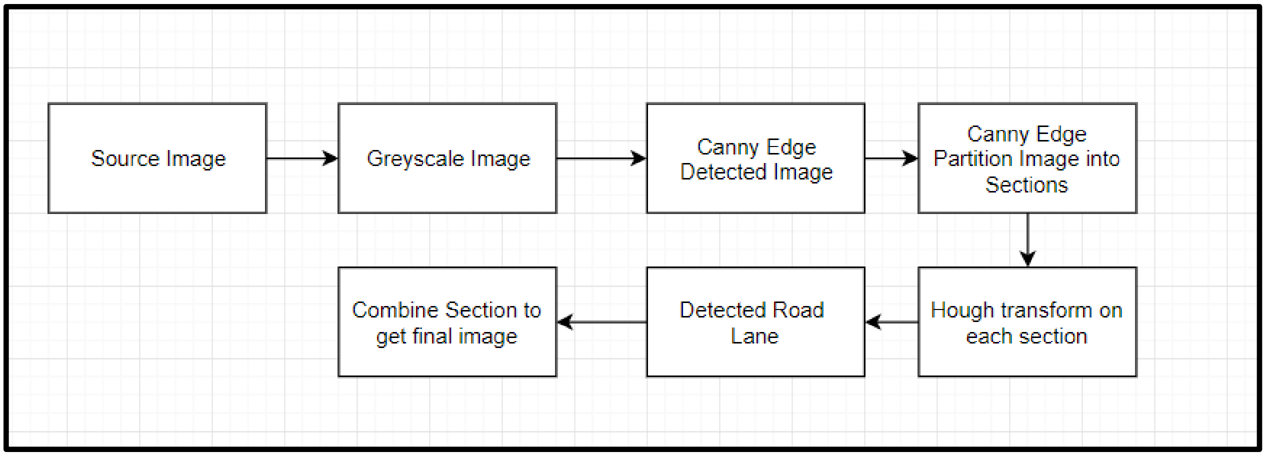

Fig 4.1.1 Block diagram

The following Block diagram represents the lane detection scenario. The video taken as input from the camera consists of many frames. One such frame is given to the input as the source image. The image is converted to the gray-scaled image. Then with the help of canny filters, the edges of the image are extracted. Then the image is segmented into various sections which is then given to the Hough model. Using Hough transform the current lane that is the desired lane is extracted from the image which is then highlighted in the output image.

4.2 Modular Diagram of the system

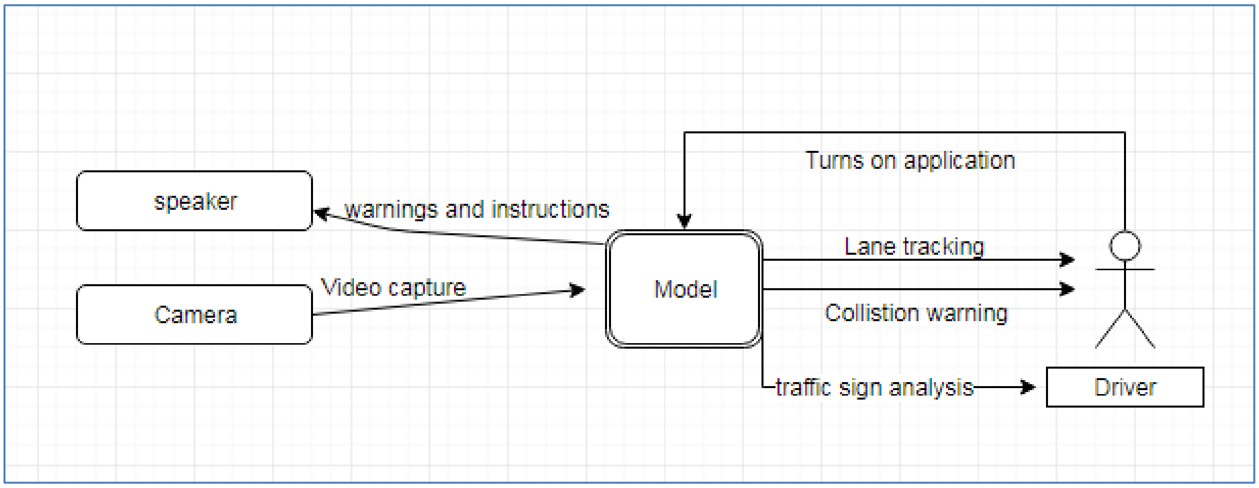

Fig 4.2.1 Modular Diagram

In the above diagram, first when application is started the model is loaded on to memory. There are basically three different model presents in our application: First is Lane detection and tracking model, Collision warning model, Traffic sign detection and analyzer model. The camera takes the video capture which is a series of images then those images are feeded to our model as input. Basically, our models are pre-trained to perform task such as Lane detection and Tracking, Collision warning and Traffic symbol detection and analysis. So, when video capture is feeded to our model as input it will start tracking the current driving lane along with it it will detect the various traffic symbols present beside road and will analyses those symbols with help of our traffic symbol analyzer model. Along with lane detection our model will also keep track of current lane and guide driver during lane departure. The result of the traffic symbol classification or any instruction will be given to driver through speaker using Google text to speech API. Our model will always keep driver alert and active while driving by giving warning, instruction and alert notifications.

4.3 Detailed Diagram

DFD Diagrams

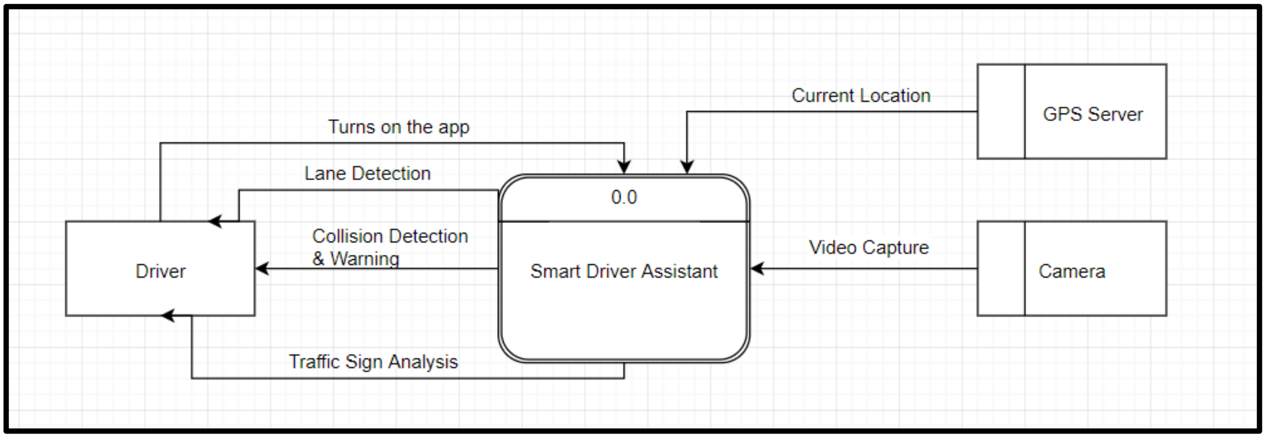

Fig 4.2.1 DFD Level 0

There are basically three models in our system: First is Lane detection and tracking model, Collision warning model, Traffic sign detection and analyzer model. Our Camera acts as an input source whereas speaker is our output device. Various warning or instructions are given to driven by our model using speaker. Lane detection and tracker model basically detects the current driving lane and keeps tracks of it. The collision detection and warning model is based on predictive modelling for predicting collision. Traffic sign analyzer and detection model as the name suggest it gives information of various traffic symbols on road to driver.

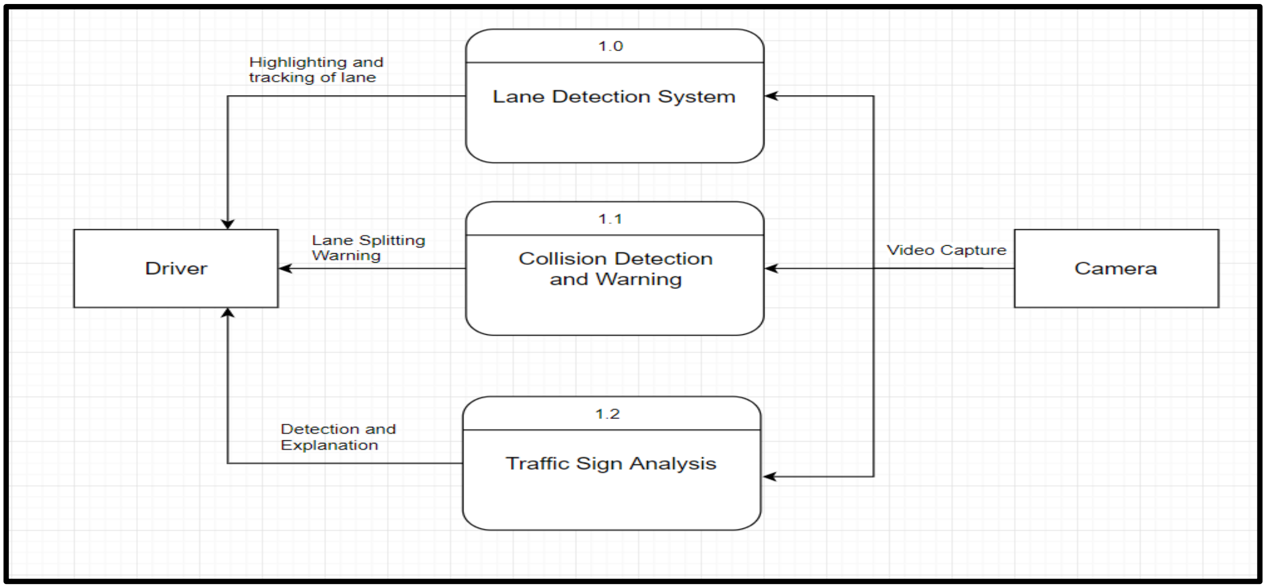

Fig 4.2.2 DFD level 1

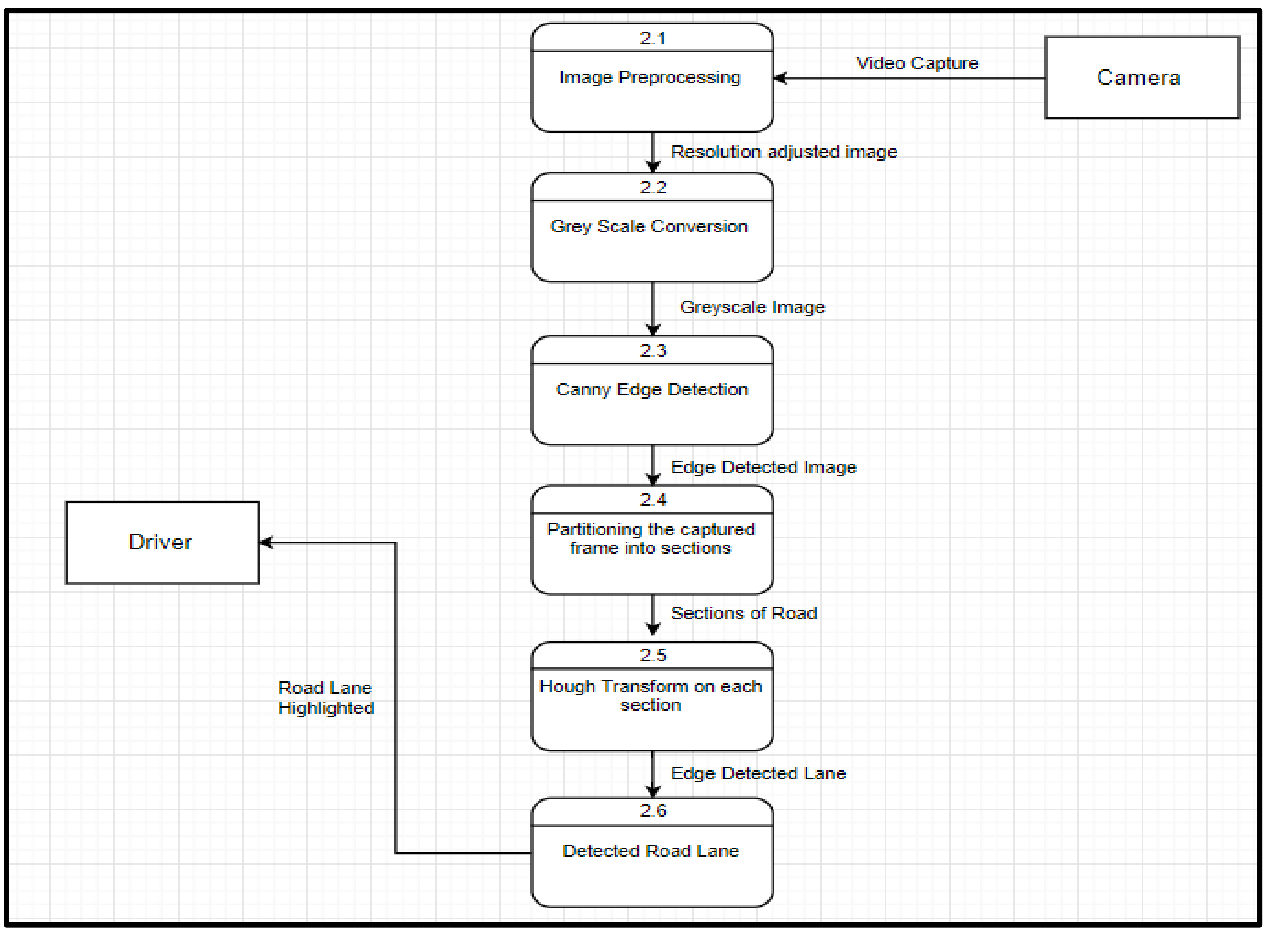

Fig 4.2.3 DFD Level 2

Flow Chart

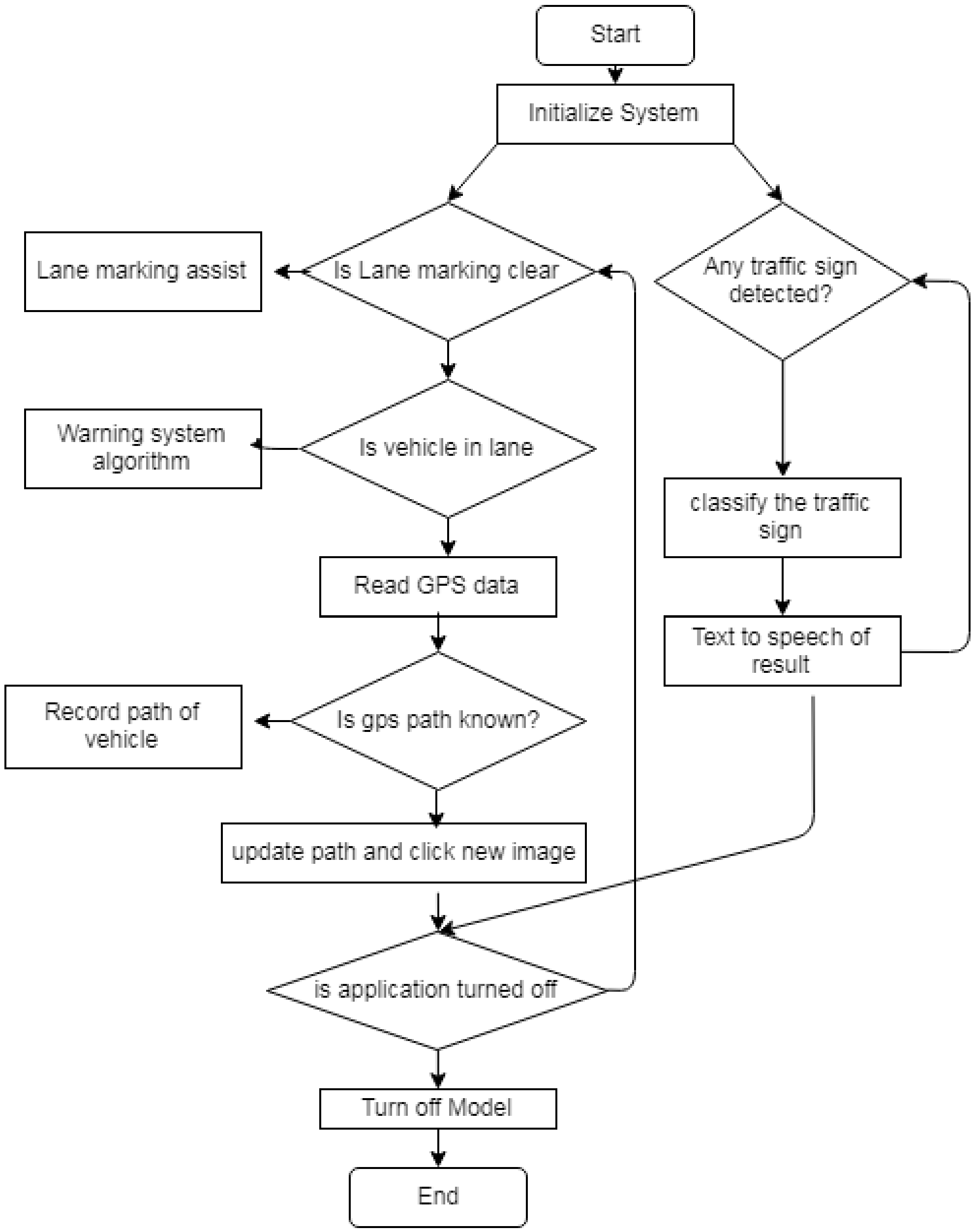

Fig 4.2.4 Flow chart of smart driver assistant

First when application is started the model is loaded into memory. There are basically three different model presents in our application all these three models are loaded into memory: First is Lane detection and tracking model, Collision warning model, Traffic sign detection and analyzer model. Our Camera acts as an input source whereas speaker is our output device. Various warning or instructions are given to driven by our model using speaker. Lane detection and tracker model basically detects the current driving lane and keeps tracks of it. The collision detection and warning model is based on predictive modelling for predicting collision. Traffic sign analyzer and detection model as the name suggest it give information of various traffic symbols on road to driver.

First when model is started all these are model get input from camera (i.e. video capture). From this video capture the lane detection model continuously detect and track the current driving lane. Along with it every time it is check that the vehicle is in current driving lane or not. If the vehicle goes off the current driving lane then the warning system warns the driver.

The Traffic sign analyzer takes input image and detects if there is any traffic symbol present in image. If there is any image present then the specific part of image is segmented then the segmented image is feeded to our Convolution neural network model. After series of convolution neural network layer finally the output of classified traffic symbol is generated using SoftMax function. After we get the result of symbol classification then the instruction on the traffic symbol is conveyed to the driver using Google Text to Speech API. All these goes on for a particular image. After this the next image is loaded and processed by our model and this goes on continuously till our model is turned off.

4.4. Project Scheduling & Tracking using Time line / Gantt Chart

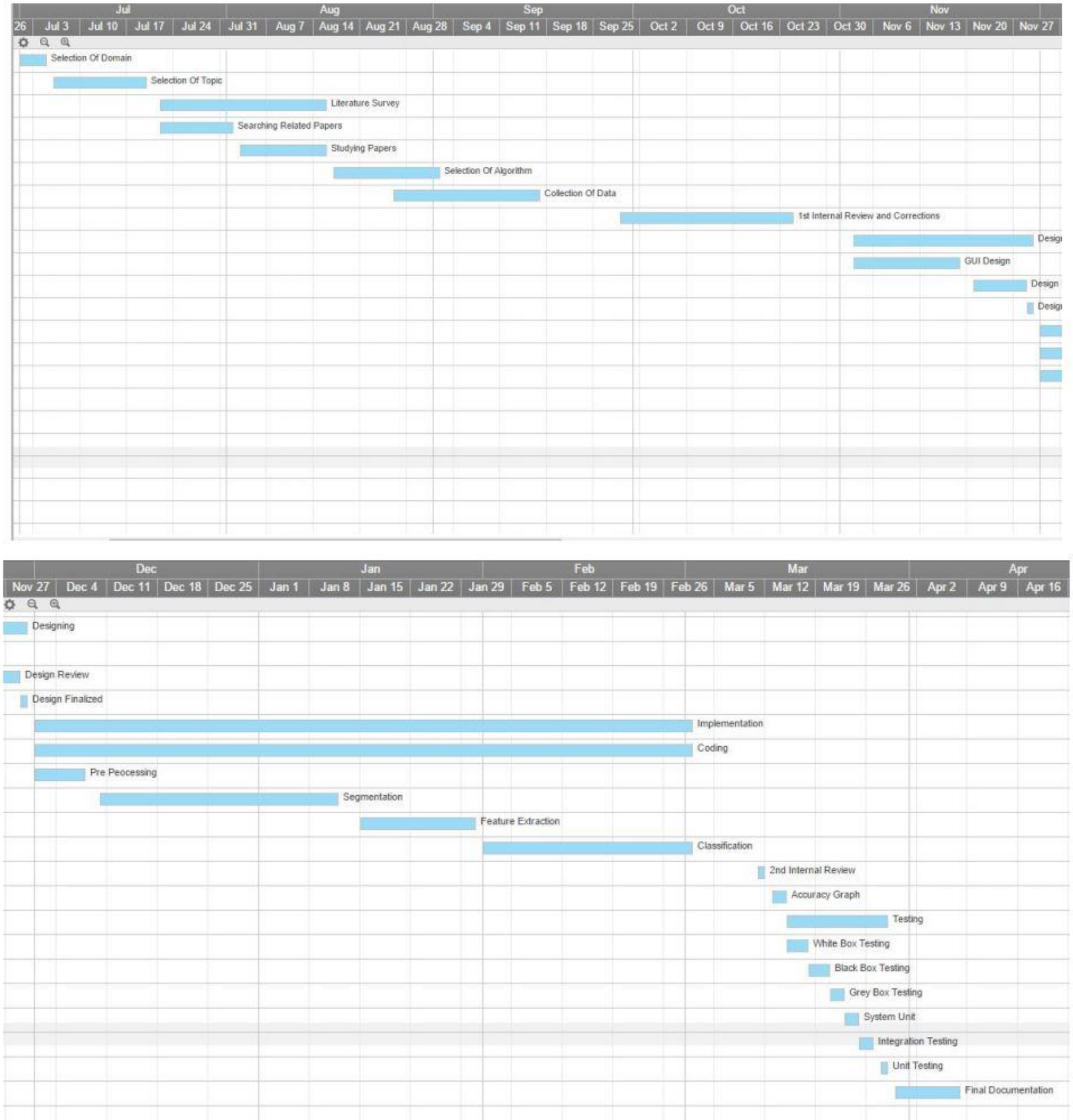

Fig 4.2.5 Gantt Chart

Chapter 5: Implementation Details

5.1. Algorithms for the respective modules developed

Convolutional Neural Networks (CNN)

Convolutional Neural Networks are very similar to ordinary Neural Networks, they are made up of neurons that have learnable weights and biases. Each neuron receives some inputs, performs a dot product and optionally follows it with a non-linearity.
The whole network still expresses a single differentiable score function: from the raw image pixels on one end to class scores at the other. And they still have a loss function (e.g. SVM/SoftMax) on the last (fully-connected) layer and all the tips/tricks we developed for learning regular Neural Networks still apply.
ConvNet architectures make the explicit assumption that the inputs are images, which allows us to encode certain properties into the architecture. These then make the forward function more efficient to implement and vastly reduce the number of parameters in the network.

VGGNet Model

This architecture is from VGG group, Oxford. It makes the improvement over AlexNet by replacing large kernel-sized filters (11 and 5 in the first and second convolutional layer, respectively) with multiple 3X3 kernel-sized filters one after another.
With a given receptive field (the effective area size of input image on which output depends), multiple stacked smaller size kernel is better than the one with a larger size kernel because multiple non-linear layers increases the depth of the network which enables it to learn more complex features, and that too at a lower cost.

Sobel Filtering

The Sobel operator, sometimes called the Sobel–Feldman operator or Sobel filter, is used in image processing and computer vision, particularly within edge detection algorithms where it creates an image emphasizing edges. The operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives – one for horizontal changes, and one for vertical. If we define A as the source image, and G_x and G_y are two images which at each point contain the horizontal and vertical derivative approximations respectively, the computations are as follows

5.2. Comparative Analysis with the existing algorithms

For Lane Detection System

1. The existing methods provides good accuracy only for high quality images but sometimes provide poor results for poor environmental conditions like fog, haze, noise, dust etc.
2. Most of the existing techniques are best for straight lanes, but they provide poor results for curved roads.
3. Most of the lane detection techniques are based on standard Hough transform, so it can be modified for improving the accuracy further.

Our model for lane detection gives accurate tracking of lanes under poor environmental conditions also. It shows the offset of vehicle w.r.t lane and also track the the radius of curvature of the lane. Our model properly tracks the curved lanes.

The vast majority of existing traffic sign classifier systems consist of classifiers that were trained using hand-labeled real images, which is a repetitive, time-consuming, and error-prone process. Our method avoids collecting and manually labeling training data, because it requires only synthetic graphical representations of signs that were obtained from an online road sign database. Furthermore, although many existing systems report high classification rates, the total number of traffic sign classes recognized is generally very limited and are hence less likely to suffer mismatches against similar signs that were missing from their databases. Our proposed system uses all instances of ideogram-based traffic symbols used in the U.K. and hence performs its matching in this larger set.

5.3. Evaluation of the developed system (accuracy, Effectiveness, Efficiency)

Smart Driver Assistant is an efficient, real time, and robust algorithm for detecting lanes in urban streets. Our algorithm can detect all lanes in still images of urban streets and works at high rates of **50 FPS.** We achieved comparable results to other algorithms that only worked on detecting the current lane boundaries, and good results for detecting all lane boundaries.

For our Traffic sign classifier, the features learned by the classifier relate only to the road signs and not to background information, the classifier was also tested using a data set that comprises synthetically generated images, but with different backgrounds from that in the training set. The accuracy achieved for this experiment was **99.2%** on cross validation dataset. To more thoroughly validate the system, another classifier was trained, with a data set that contains real images and synthetically generated interpolations, created using randomly distorted version of the real images. The total number of images in this data set was **43,509**. This classifier had an overall accuracy of **97%**, which was greater than either the fully synthetic or the fully real data set.

Chapter 6: Testing

The objective of test case design is to derive a set of tests that have the highest likelihood of uncovering errors in the software project. Testing is defined as the process in which defects are identified, isolated, subjected for rectification and ensures that the product is defect-free in order to produce a high-quality product meeting customer expectation.

6.1 TESTING METHODOLOGIES:

- **Black box Testing:**

Is the testing process in which tester can perform testing on an application without having any internal structural knowledge of application. White-box, tests focus on the program control structure. test cases are derived to ensure that all statements in the program have been executed at least once during testing and that all logical conditions have been exercised. Basis path testing, a white-box technique, makes use of program graphs to derive the set of linearly independent tests that will ensure coverage. condition and data flow testing further exercise program logic, and loop testing complements other white-box techniques by providing a procedure for exercising loops of varying degrees of complexity. Usually test Engineers are involved in the black box testing.

- **White box Testing**:

Is the testing process in which tester can perform testing on an application with having internal structural knowledge. Black-box tests are designed to validate functional requirement without regard to the internal working of program. Black-box testing techniques focus on the information domain of the software, deriving test cases by partitioning the input and output domain of a program in a manner that provides thorough tests coverage. Equivalence partitioning, divides the input domain into classes of data that are likely to exercise software function. boundary value analysis probes the program’s ability to handle data at the limits of acceptability. orthogonal array testing provides an efficient, systematic method for testing system will small numbers of input parameters. usually the Developers are involved in white box testing.

- **Gray Box Testing:**

Is the process in which the combination of black box and white box techniques are used.

- **Unit testing:**

In computer programming, unit testing is a software testing method by which individual units of source code, sets of one or more computer program modules together with associated control data, usage procedures, and operating procedures, are tested to determine whether they are fit for use. Intuitively, one can view a unit as the smallest testable part of an application. Ideally, each test case is independent from the others. Unit tests are typically written and run by software developers to ensure that code meets its design and behaves as intended.

- **Integration testing:**

Is the phase in software testing in which individual software modules are combined and tested as a group. It occurs after unit testing and before validation testing. Integration testing takes as its input modules that have been unit tested, groups them in larger aggregates, applies tests defined in an integration test plan to those aggregates, and delivers as its output the integrated system ready for system testing.

- **System testing:**

System testing of software or hardware is testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. System testing falls within the scope of black box testing, and as such, should require no knowledge of the inner design of the code or logic.

Example DATASET Test cases:

Test Cases No.:	Description	Expected Value
1	Check for the labels of each image	Each image should have a proper label
2	Check for the orientation of the image	Each image should be properly oriented

6.1.1 Dataset test cases

Positive Test Cases: ·

- The positive flow of the functionality must be considered ·
- Valid inputs must be used for testing ·
- Must have the positive perception to verify whether the requirements are justified.

Example Positive Test cases:

Test Case No.:	Description	Expected Value
1	Uploading valid image for preprocessing	Each image uploaded should be accepted
2	Check for processed image	The processed image should be proper

6.1.2 Positive test cases

Negative Test Cases:

- Must have negative perception.
- Invalid inputs must be used for test.

Test Case No.:	Description	Expected Value
1	Upload invalid image for pre-processing	It should not accept invalid data
2	Delete the processed image and give it as input to the CNN model	The CNN model should raise an error

6.1.3 Negative test cases

Software testing is more than just error detection.
Testing software is operating the software under controlled conditions,

- To verify that it behaves "as specified".
- To detect errors.
- To validate that what has been specified is what the user actually wanted.

Chapter 7. Result Analysis

7.1 Simulation Model

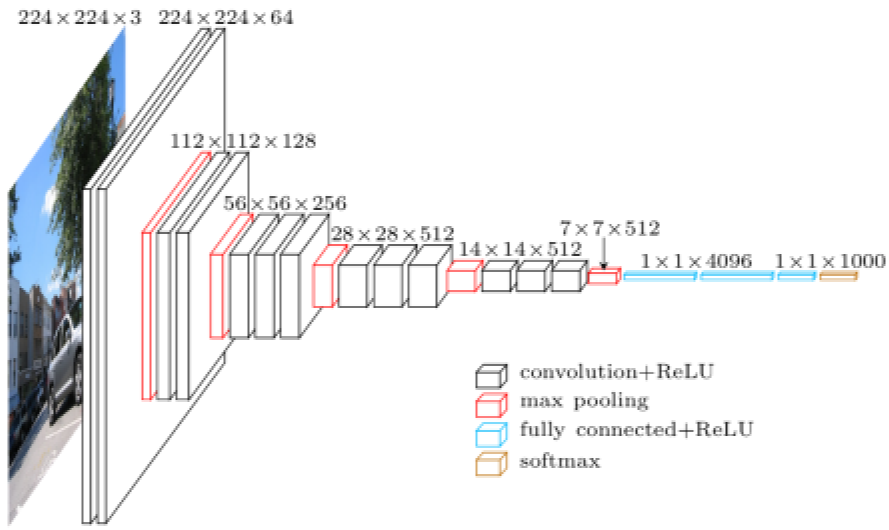

Fig 7.1.1

In our model for traffic sign detection and classification. We decided to use a deep neural network classifier as a model, which was inspired by Yann LeCun paper. It is fairly simple and has 4 layers: **3 convolutional layers** for feature extraction and **one fully connected layer** as a classifier. We used **multi-scale features**, which means that convolutional layers' output is not only forwarded into subsequent layer but is also branched off and fed into classifier (e.g. fully connected layer). That these branched off layers undergo additional max-pooling, so that all convolutions are proportionally subsampled before going into classifier. The idea of using drop outs heavily is to avoid overfitting and force the network to learn multiple models for the same data. The last SoftMax layer is used to compute the log-loss of model prediction. In addition, a l2- regularization cost is included to penalize large model weights.

In our model for Lane detection and tracking we made use of Hough transform. It is used to detect the lane markings. The lane departure method is improved by ROI segmentation technique. By measuring the distance between the lanes and using it to make out decision for left or right departure, the proposed algorithm accurately detects the lanes in short span of time. It is observed that the proposed algorithm has average execution time of 0.053622 second. It has the benefit of less complexity and fast execution.

7.2 Parameters considered

Parameters that we considered for constructing our CNN Model are batch size, number of epochs, learning rate, loss regularization, dropout rate or pooling type.

Having an image at the input, CNN scans it many times to look for certain features. This scanning (convolution) can be set with 2 main parameters: stride and padding type. As we see on below picture, process of the first convolution gives us a set of new frames, shown here in the second column (layer). Each frame contains an information about one feature and its presence in scanned image. Resulting frame will have larger values in places where a feature is strongly visible and lower values where there are no or little such features. A simple, iterative process of finding the best model architecture. After changing one of the model parameters, after running **20 epochs** of the training it was observed that the validation error sets to its minimum level

7.3 Screenshots of User Interface (UI)

Fig 7.3.1

Fig 7.3.2

7.4 Graphical outputs

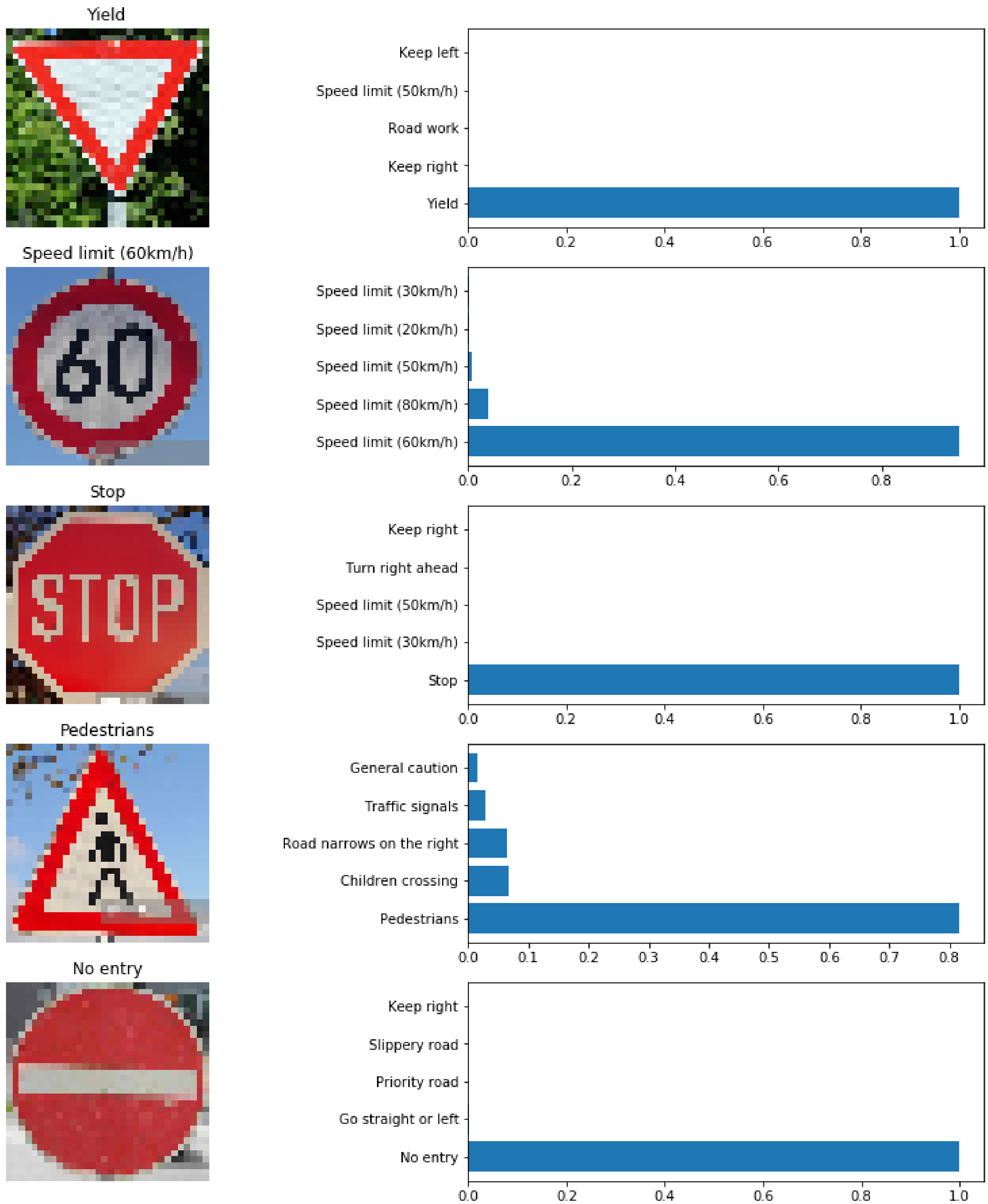

Fig 7.4.1

7.5 Reports generated / Tables obtained

1	Total Training Samples	**43,509**
2	Cross Validation Set Accuracy	**99.2%**
3	Training Set Accuracy	**97%**
4	Accuracy on real time images	**99.3%**
5	Test Set Accuracy	**98.7%**
6	Processing Speed	**50 FPS**
7	Train - Test Split	**8:2**

Chapter 8. Conclusion

8.1 Limitations

Our project faces limitations such as the lane detection does not properly work on the roads that have unmarked white lanes. The classification model is susceptible to weather conditions like Fog, Rain and low light conditions as the traffic sign detection is unable to put a bounding box on the traffic sign which is then cropped and dent to the classifier.

8.2 Conclusion

We have proposed a novel real-time system for the automatic detection and recognition of traffic symbols. Candidate regions are detected as MSERs. This detection method is significantly insensitive to variations in illumination and lighting conditions. Traffic symbols are recognized using HOG features and a cascade of linear SVM classifiers. A method for the synthetic generation of training data has been proposed, which allows large data sets to be generated from template images, removing the need for hand labeled data sets. Our system can identify signs from the whole range of ideographic traffic symbols currently in use in the U.K. which form the basis of our training data. The system retains a high accuracy at a variety of vehicle speeds.

8.3 Future Scope

The lane detection techniques play a significant role in intelligent transport systems. In this, lane detection methods have been studied. Most of them resulted in inaccurate results. Therefore, further improvements can be done to enhance the results. In the near future, one can modify the existing Hough Transformation so that it can measure both the curved and straight roads. Various steps should be taken to improve the results in different environmental conditions like sunny day, foggy day, rainy day etc.

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- http://www.vision.caltech.edu/malaa/publications/aly08realtime.pdf
- https://docs.opencv.org/
- https://www.tensorflow.org/api_docs/

Appendix

Paper Publications:

1. Paper - I:

Smart Driver Assistant

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***Abstract* - This paper proposes a smart driver assistant system that will help drivers avoid accidents during lane departures by providing prompt and quick markings of road lanes. This paper also proposes a novel system for the automatic detection and recognition of traffic signs. It detects the blobs using MSER i.e. Maximally Stable Extremal Regions which provides similar results under different lighting conditions. Recognition is based on a cascade of Convolutional Neural Networks (CNN) that were trained using histogram of oriented gradient (HOG) features.**

Keywords - Maximally Stable Extremal Region, Convoluted Neural Networks, Histogram of Oriented Gradient

I. INTRODUCTION

With the advent of smartphones, Android has become the dominating mobile OS functioning on over 1.2 million devices worldwide [1]. Android provides an efficient SDK which when used with Android Studio IDE can help make applications reasonably fast and easily. World Health Organization estimated about 1.35 million death all around the globe due to road traffic which can be approximated to about 1 death in 25 seconds in the year 2016. A majority of these accidents occur due to lack of attentiveness while departing lanes / lane splitting. The purpose of this paper is to create a smart driver assistant which will help the driver make rational decisions based on the real-time environment. The system marks lanes in front of the car with image processed highlighting and colored tracking. Along with this, the system will ensure that the driver never misses a traffic sign. The system constantly grabs each and every traffic symbol along the path and makes the information available to the driver through voice assistant. The following sections provides sufficient background and insight into our objective to develop the Smart Driver Assistant

II. RELATED WORK

A) Real time Detection of Pavement Markers in Streets[2]

Getting rid of the perspective of the image, one can observe that the lanes appear to converge at the horizon line and these lanes are now vertical and parallel. The main assumption here is that the lanes are parallel or almost parallel to the camera. This focusses the attention on only a sub region of the input image, which helps in reducing the run time considerably.

B) Detection and Recognition of Road Traffic Signs [3]

Detection is performed using a novel application of Maximally Stable Extremal Regions (MSERs). Recognition is performed with histogram of oriented gradient (HOG) features, which are classified using a linear support vector machine (SVM).

C) Traffic Road Sign Detection and Recognition for Automotive Vehicles [4]

The original image is resized and exposed to a red colour threshold. The object is detected using Breadth-First Search (BFS) and the possible signboard region is cut. A sobel operator for precise edge detection is applied and then the sign in the original RGB image is extracted to real signboard.

D) Lane Detection Techniques [5]

The process of lane detection starts by taking the image of the road with the help of a camera. The coloured image is converted into its grayscale image to minimize the objective of processing the image. Then basic filtering techniques are used to remove the noise presented in the grayscaled image as it can affect the efficiency of detection. Then these filtered images are sent to the canny edge detectors which uses automatic thresholding techniques for edge detection. After the process of edge detection this intermediate processed image is fed to the line detectors which provides us the right and left boundary segments[6] the image is then superimposed over the original image to get final image.

Figure 1 : Proposed output of lane detection system

E) Lane detection and tracking using B-snake[7]

In real world there are generally two methods taken into consideration for lane detection , they are feature-based technique and model based technique. The feature-based technique localizes the lanes in the road images by combining the low-level features, such as painted lines or lane edges, etc. lane segments that are detected by traditional image segmentation. Accordingly, this technique requires the studied road having well-painted lines or strong lane edges, otherwise it will fail[8]. On the other hand, the model-based technique just uses a few parameters to represent the lanes. Assuming that lane shape can be represented by line or a curved line like hyperbole , the process can be done by taking into considerations these model parameters. Using these techniques, the system gives satisfactory results even in varying conditions of noises , shadows and illumination that are there in the images that are captured by the camera. this system is applicable to both marked and unmarked lane.

III. SMART DRIVER ASSISTANT SYSTEM

The system actively tracks the road lane and identifies traffic symbols. For this, the in-built camera of the smartphone will be used. This camera will constantly capture a video sequence at a suitable frame rate which will then be used to identify and mark lanes and traffic signs.

Beginning with lane detection and tracking, the general method of lane detection is to first take an image of road with the help of a camera in the vehicle. Conversion of image to grayscale image image is important to reduce the processing time. Noise present in the image affects the accuracy of the system hence it becomes important to eliminate these noise components from the image.For this purpose lateral filters like bilateral filters, trilateral filters and gabor filters are used. To obtain the edges in an image using automatic thresholding , the edge detector makes use of a canny filter. To obtain the boundaries on both side of the image , the resultant image from the above step is further segmented using the line detectors. The lane boundary scan mainly consists of Hough transform. It uses the information of the edge detected image returned by the Hough transform to perform the scan. The scan results in a an array of points towards the left and right side of the line. The final step in this process is to properly fit a curved/straight line according to the need to get the resultant image.

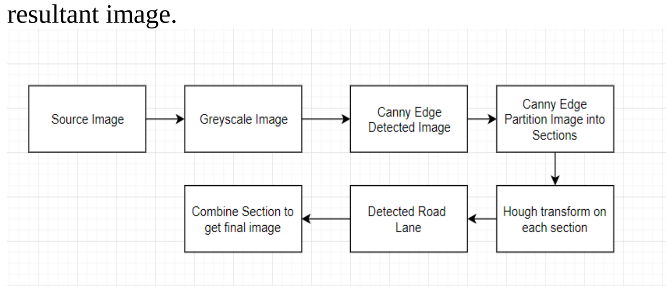

Figure 2 : Lane detection basic flow diagram

The sign which is placed at the side of roads to impart information to road users is known as road signs or traffic signs. There are four types of traffic signs that are shown in the traffic code: a) warning; b) prohibition; c) obligation; and d) informative[9]. These traffic signs are given different geometrical shapes based on features like form and colour. The warning signs are triangular in shape with the vertex at the top. These signs consists of a white or blue background and are bordered in red. If the signs are located in an area where there's public work taking place , then the signs are given a yellow background. If the traffic sign has to portray a sense of obligation or information , then the signs are given a circular shape with blue background[10]. In order to detect the location of the traffic sign in an image , two main properties are to be considered , the colour of the traffic sign as well as the shape of the traffic sign.

Feature	Minimum	Maximum
Width	14	100
Height	14	110
MSER/boundin	0.3	1.2

g box perimeter		
MSER/boundin g box area	0.4	1

Table 1 : Properties used to sort connected components

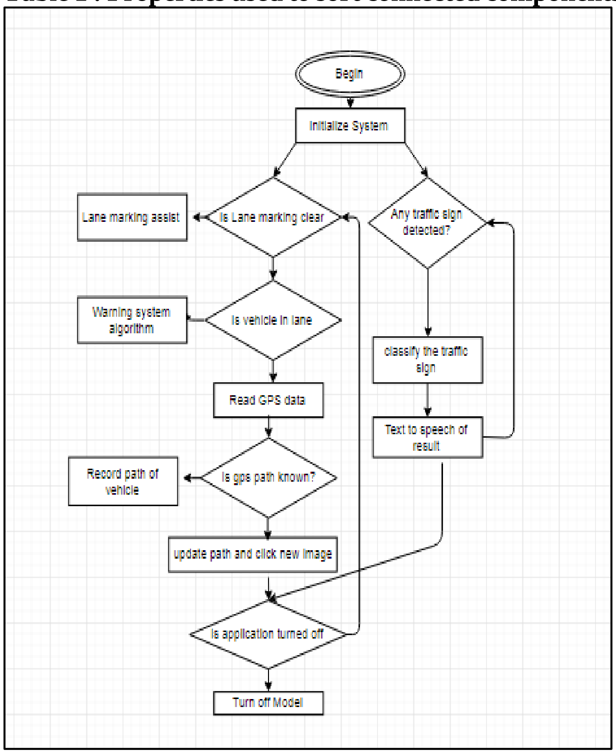

Figure 3 : Combined flow diagram of Lane detection and warning system

White background traffic signs can be detected with the help of MSERs of the grayscaled image. The video is nothing but a series of frame. Each frame of the video are binarized using a variety of threshold levels. Using this , the connected components at each thresholded level are found. MSERs are selected for the components that are connected and retain their shape at different threshold levels. This property of the MSERs ensures stability of the image irrespective of the lighting and contrast conditions which in turn increases the efficiency of the system[11].Some other advantages of using MSERs include reducing the number of candidate regions with the help of connected components and several other features.

The features mentioned above include the geometrical height and width of the sign , aspect ratio of the image , region perimeter , area as well perimeter and area using bounding box method. The process of eliminating the unnecessary connected components i.e the components that does not fit the criteria facilitates in enhancing the speed of the process and also its accuracy. The following Table 1 depicts the parameters that are used as restrictions for the features that were determined using empirical methods[12].

Figure 4 : Traffic sign detection

The detection of the red and blue backgrounded traffic signs are performed in a contrasting manner as compared to the traffic signs having white backgrounds. Instead of finding out the MSERs of the image that is grayscaled , the frame is converted into normalised red/blue image from the original RGB image. The normalised red/blue of an image is calculated such that for each pixel in the original image , the value of the pixel is replaced with the maximum of the ratio of the blue channel to the sum of all the channels and the ratio of the red channel to the sum of all the channels.This ensures that the value of the pixel replacing the original pixel has higher values for red and blue components as compared to other coloured components[13]. For this normalised red/blue image , the MSERs are calculated in the same way as the traffic sign with white background.

The next step in the process is the recognition stage. The recognition stage uses the candidate region found above as a traffic sign and helps to allocate the exact type of sign to it. HOG features are used for proper characterisation of the candidate region. The HOG feature helps to represent the gradient orientation of the image. This process is repeated for every detected candidate region. For finding out the magnitude and orientation of each of the pixel , a sobel filter is used which operates by calculating the horizontal and vertical derivatives in an image[14]. The HOG application for recognition of traffic symbols are extremely convenient as the traffic symbols consists of well founded geometric shapes and varying contrast edges that encircles a spectrum of orientations. In this process , there is no need for rotational invariance since the traffic signs are positioned in a location where they are fairly visible and are mostly upright and facing the camera which limits rotational and geometrical distortions. A cascade of multilayer Convolutional Neural Networks are then used for the classification of the traffic sign.

Taking the inspiration of the biological nervous system such as the human brain , an information processing paradigm was developed which is known as the Artificial Neural Network (ANN). The unique structure of the information processing system is the primary element of this paradigm.The difference between the normal neural networks and the convolutional neural network is that the neurons in the CNNs have learnable biases and weights. The function of each neuron is to receive some input at the beginning , then calculate a dot product and at one's discretion perform it with nonlinearity. Taking raw input image at one end of the network and to classify the scores at the other end is the single differentiable function of the whole network. Despite this , CNN still has a loss function on the last layer.

Three convolutional layers will be used for feature extraction and one fully connected layer as a classifier. Multiscale features will be used in contrast to the general feed forward CNNS which will result the output to be forwarded to subsequent layers and also the output will be branched off and it will be fed to the classifier.All the output layers that are branched off has to undergo max pooling so that the convolutions are subsampled proportionally.

IV. Tools and Technologies

The smart driver assistant being a combination of two components i.e. lane tracking and traffic symbol analysis, we would be needing two major technologies viz Image Processing and Machine Learning. Following libraries and frameworks provide a comprehensive aid in the production of the system.

- **OpenCV** (*Open Source Computer Vision*) is a library of programming functions mainly aimed at real-time computer vision.
- TensorFlow layers module provides a high-level API that makes it easy to construct a neural network. It provides methods that facilitate the creation of dense (fully connected) layers and convolutional layers, adding activation functions, and applying dropout regularization.
- **Android Studio** provides the fastest tools for building apps on every type of Android device. We will make use of android studio to make our android application of smart driver assistant.
- **Google Text to Speech API** is an API in Android operating system. It powers applications to read aloud (speak) the text on the screen which support many languages. This will help to convey results of traffic sign classification to driver.

V. Datasets

German Traffic Dataset :
It's a set of 51,839 labeled images of 43 different German traffic signs. It comes in two separate sets. A set of 39,209 images for training and another set of 12,630 in order to test the accuracy of our trained network. Each image is a 32×32×3 array of pixel intensities, represented as [0, 255] integer values in RGB color space. Class of each image is encoded as an integer in a 0 to 42 range. Dataset is very unbalanced, and some classes are represented way better than the others. The images also differ significantly in terms of contrast and brightness, so we will need to apply some kind of histogram equalization, this should noticeably improve feature extraction.For the classification process, the german traffic sign dataset has been chosen as it is the most comprehensive dataset available and has a 90% similarity to Indian road symbols.Before the main implementation takes place , the image is preprocessed which usually involves changing the scale of the pixel to [0,1]. the image is then characterised using labels where they are hot encoded and shuffled. The general preprocessing also involves a step of histogram equalisation to increase the overall contrast of the image and it proves to be useful in most of the cases. We chose to work with grayscale images instead of colour ones as using color images didn't seem to improve the results.The amount of data we had was not sufficient for a model to generalise well. It was also fairly unbalanced, and some classes were represented to significantly lower extent than the others. So to extend our dataset, we applied a variety of flips, rotations and inverts on our available images as we can use data of these classes to extend their counterparts. This simple trick extended our dataset from almost 40,000 to nearly 65,000.

The following regularization techniques to minimize overfitting of data are used. Dropout drastically improved the generalization of our model. We applied dropout only to fully connected layers, as shared weights in convolutional layers are good regularizers themselves. Lambda=0.0001 seemed to perform best in L2 Regularization. We used early stopping with a patience of 100 epochs to capture the last best-performing weights and roll back when model starts overfitting training data. We used validation set cross entropy loss as an early stopping metric, intuition behind using it instead of accuracy is that it generalizes better.

VI. Discussion

The smart driver assistant system provides useful tips to the user. The lane detection and tracker will guide the driver to stay in his own designated path. This will prevent rash lane splittings as well as wandering off from the lane due to inattentive driving or drowsiness. The system will warn the driver of inattentive swaying away from the lane. Also, if the the car in front of the driver gets too close too fast then the system will also present a warning signal. In addition, the system will consist of a fail safe system that will still detect lane even in the absence of white lane markers which will be based on the b-snake algorithm.

We get excellent results in clear conditions, however we get some false positives due to stop lines at cross streets, at cross
walks, near passing cars. False positives are mostly found when driving on the right lane of the street with no right lane boundary, and we detect the curb as the right lane boundary , and that's the reason for the high false positive rate in clip.However, this is not a real problem, as the curb is really a lane boundary, but not painted as such, and this won't affect the objectives of the algorithm to detect lane boundaries. In the current algorithm, we only work on the red channel, which gives us better images for white and yellow lanes than converting it to grayscale. However, there is plenty to be done to further improve this algorithm. We plan on using the color information to classify different lane boundaries: white solid lines, double yellow lines, ..etc. This will also allow us to remove the false positives due to curbs being detected as lanes, as well as confusing writings on the streets, which are usually in yellow and can be filtered out.

The traffic sign analysis information will be conveyed to the driver with the help of voice assistant and also it will be displayed on the screen of the mobile device. The driver can use voice commands to gain additional information about the traffic sign. Also, the sign analysis will be integrated with the environment of the car such as the speed. Thus, if the speed limit is detected as 60 kmph on the traffic symbol then the system will alert the driver if the car is moving at a speed much greater than the speed threshold.

VII. CONCLUSION

The lane detection techniques play a significant role in intelligent transport systems. In this paper various lane detection methods have been studied. Most of them resulted in inaccurate results. Therefore, further improvements can be done to enhance the results. In the near future, one can modify the existing Hough Transformation so that it can measure both the curved and straight roads.

In this paper , we proposed an automatic traffic sign detection and recognition system that works in real time. The region where the traffic signs are located are identified as candidate region and is calculated through the process of MSERs. We have chosen MSERs as the candidate regions because these regions can be calculated irrespective of the sensitivity of the lighting conditions and the illumination in the image.Recognition of the traffic signs are based on HOG feature which are classified using a cascade of CNNs and SVMs. We have also generated synthetic datasets so as to increase the number of images in the overall datasets which will increase the accuracy of the system and the model will be trained better. Our system can identify signs from the whole range of ideographic traffic symbols currently in use in the U.K. which form the basis of our training data. The system retains a high accuracy at a variety of vehicle speeds.

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Abstract - This paper proposes a smart driver assistant system that will help drivers avoid accidents during lane departures by providing prompt and quick markings of road lanes. This paper also proposes a novel system for the automatic detection and recognition of traffic signs. It detects the blobs using MSER i.e. Maximally Stable Extremal Regions which provides similar results under different lighting conditions. Recognition is based on a cascade of Convolutional Neural Networks (CNN) that were trained using histogram of oriented gradient (HOG) features.

Keywords - Maximally Stable Extremal Region, Convoluted Neural Networks, Histogram of Oriented Gradient

Introduction

With the advent of smartphones, Android has become the dominating mobile OS functioning on over 1.2 million devices worldwide [1]. Android provides an efficient SDK which when used with Android Studio IDE can help create applications quickly and easily. World Health Organization estimated about 1.35 million death all around the globe due to road traffic which can be approximated to about 1 death in 25 seconds in the year 2016. A majority of these accidents occur due to lack of attentiveness while departing lanes / lane splitting. The purpose of this paper is to create a smart driver assistant which will help the driver make rational decisions based on the real-time environment. The system marks lanes in front of the car with image processed highlighting and colored tracking. Along with this, the system will ensure that the driver never misses a traffic sign. The system constantly grabs each and every traffic symbol along the path and makes the information available to the driver through voice assistant. The following sections provides sufficient background and insight into our objective to develop the Smart Driver Assistant

Related Work

To get rid of the perspective of the image, one can observe that the lanes appear to converge at the horizon line and these lanes are now vertical and parallel. The paper Real Time Detection of Pavement Markers in Streets [2] gives an insight to find the pavement markers. The main assumption here is that the lanes are parallel or almost parallel to the camera. This focuses the attention on only a sub region of the input image reducing the run time considerably.

In Detection and Recognition of Road Traffic Signs [3] the Detection is performed using a novel application of Maximally Stable Extremal Regions (MSERs) and Recognition is performed with histogram of oriented gradient (HOG) features, which are classified using a linear support vector machine (SVM).

The paper Traffic Road Sign Detection and Recognition for Automotive Vehicles [4] gives a

intuition on the algorithms that are used to detect and recognize the traffic signs. According to this paper the original image is resized and exposed to a red colour threshold. The object is detected using Breadth-First Search (BFS) and the possible signboard region is cut. A sobel operator for precise edge detection is applied and then the sign in the original RGB image is extracted to real signboard.

The paper Lane Detection Techniques [5] describes various limitations in the existing lane detection models and gives a basic understanding of the solutions that can be used to eliminate these limitations. The process of lane detection starts by taking the image of the road with the help of a camera. The coloured image is converted into its grayscale image to minimize the objective of processing the image. Then the basic filtering techniques are used to remove the noise presented in the grayscale image as it can affect the efficiency of detection. Then these filtered images are sent to the canny edge detectors which uses automatic thresholding techniques for edge detection. After the process of edge detection this intermediate processed image is fed to the line detectors which provides us the right and left boundary segments [6] the image is then superimposed over the original image to get final image. The paper Lane detection and tracking using B-snake [7] gives solution to the problem of identifying the lane when the pavement markers are not clear or absent. In real world there are generally two methods taken into consideration for lane detection, they are feature-based technique and model-based technique. Accordingly, this technique requires the studied road having well-painted lines or strong lane edges, otherwise it will fail [8]. Assuming that lane shape can be represented by line or a curved line like hyperbole, the process can be done by taking into considerations these model parameters. Using these techniques, the system gives satisfactory results even in varying conditions of noises, shadows and illumination that are there in the images that are captured by the camera. This system is applicable to both marked and unmarked lane.

Smart Driver Assistant System

The system actively tracks the road lane and identifies traffic symbols. For this, the in-built camera of the smartphone will be used. This camera will constantly capture a video sequence at a suitable frame rate which will then be used to identify and mark lanes and traffic signs. The sign which is placed at the side of roads to impart information to road users is known as road signs or traffic signs. There are four types of traffic signs that are shown in the traffic code: a) warning b) prohibition c) obligation and d) informative [9]. These traffic signs are given different geometrical shapes based on features like form and colour. The warning signs are triangular in shape with the vertex at the top. These signs consist of a white or blue background and are bordered in red. If the signs are located in an area where there's public work taking place, then the signs are given a yellow background. If the traffic sign has to portray a sense of obligation or information, then the signs are given a circular shape with blue background [10]. In order to detect the location of the traffic sign in an image, two main properties are to be considered, the colour of the traffic sign as well as the shape of the traffic sign. White background traffic signs can be detected with the help of MSERs of the grayscaled image. The video is nothing but a series of frame. Each frame of the video is binarized using a variety of threshold levels. Using this, the connected components at each thresholder level are found. MSERs are selected for the components that are connected and retain their shape at different threshold levels. This property of the MSERs ensures stability of the image irrespective of the lighting and contrast conditions which in turn increases the efficiency of the system [11]. Some other advantages of using MSERs include reducing the number of candidate regions with the help of connected components and several other features.

The features mentioned above include the geometrical height and width of the sign, aspect ratio of the image, region perimeter, area as well perimeter and area using bounding box method. The process of eliminating the unnecessary connected components i.e. the components that does not fit the criteria facilitates in enhancing the speed of the process and also its accuracy. The following Table 1 depicts the parameters that are used as restrictions for the features that were determined using empirical methods [12].

The detection of the red and blue backgrounded traffic signs are performed in a contrasting manner as compared to the traffic signs having white backgrounds. Instead of finding out the MSERs of the image that is grayscaled, the frame is converted into normalized red/blue image from the original RGB image. The normalized red/blue of an image is calculated such that for each pixel in the original image, the value of the pixel is replaced with the maximum of the ratio of the blue channel to the sum of all the channels and the ratio of the red channel to the sum of all the channels. This ensures that the value of the pixel replacing the original pixel has higher values for red and blue components as compared to other coloured components [13]. For this normalized red/blue image, the MSERs are calculated in the same way as the traffic sign with white background.

The next step in the process is the recognition stage. The recognition stage uses the candidate region found above as a traffic sign and helps to allocate the exact type of sign to it. HOG features are used for proper characterization of the candidate region. The HOG feature helps to represent the gradient orientation of the image. This process is repeated for every detected candidate region. For finding out the magnitude and orientation of each of the pixel, a sobel filter is used which operates by calculating the horizontal and vertical derivatives in an image [14]. The HOG application for recognition of traffic symbols are extremely convenient as the traffic symbols consists of well-founded geometric shapes and varying contrast edges that encircles a spectrum of orientations. In this process, there is no need for rotational invariance since the traffic signs are positioned in a location where they are fairly visible and are mostly upright and facing the camera which limits rotational and geometrical distortions. A cascade of multilayer Convolutional Neural Networks is then used for the classification of the traffic sign.

Taking the inspiration of the biological nervous system such as the human brain, an information processing paradigm was developed which is known as the Artificial Neural Network (ANN). The unique structure of the information processing system is the primary element of this paradigm. The difference between the normal neural networks and the convolutional neural network is that the neurons in the CNNs have learnable biases and weights. The function of each neuron is to receive some input at the beginning, then calculate a dot product and at one’s discretion perform it with nonlinearity. Taking raw input image at one end of the network and to classify the scores at the other end is the single differentiable function of the whole network. Despite this, CNN still has a loss function on the last layer.

Three convolutional layers will be used for feature extraction and one fully connected layer as a classifier. Multiscale features will be used in contrast to the general feed forward CNNs which will result the output to be forwarded to subsequent layers and also the output will be branched off and it will be fed to the classifier. All the output layers that are branched off has to undergo max pooling so that the convolutions are subsampled proportionally.

Tools and Technologies

The smart driver assistant being a combination of two components i.e. lane tracking and traffic symbol analysis, we would be needing two major technologies viz Image Processing and Machine Learning. Following libraries and frameworks provide a comprehensive aid in the production of the system.

OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision.

TensorFlow layers module provides a high-level API that makes it easy to construct a neural network. It provides methods that facilitate the creation of dense (fully connected) layers and convolutional layers, adding activation functions, and applying dropout regularization.

Datasets

German Traffic Dataset is a set of 51,839 labeled images of 43 different German traffic signs. It comes in two separate sets. A set of 39,209 images for training and another set of 12,630 images in order to test the accuracy of our trained network. Each image is a 32×32×3 array of pixel intensities, represented as [0, 255] integer values in RGB color space. Class of each image is encoded as an integer in a 0 to 42 range. Dataset is very unbalanced, and some classes are represented way better than the others. The images also differ significantly in terms of contrast and brightness; hence some kind of histogram equalization is necessary to be applied, this should noticeably improve feature extraction. For the classification process, the German traffic sign dataset has been chosen as it is the most comprehensive dataset available and has a 90% similarity to Indian road symbols. Before the main implementation takes place, the image is preprocessed which usually involves changing the scale of the pixel to [0,1]. The image is then characterized using labels where they are hot encoded and shuffled. The general preprocessing also involves a step of histogram equalization to increase the overall contrast of the image and it proves to be useful in most of the cases. It is necessary to work with grayscale images instead of colour ones as using color images doesn’t improve the results. The amount of data mentioned above is not sufficient for a model to generalize well. It is also fairly unbalanced, and some classes were represented to significantly lower extent than the others. So, to extend the dataset, a variety of flips, rotations and inverts on the available images needs to be applied to extend the counterparts of the classes. This simple trick extends the dataset from almost 40,000 to nearly 65,000. As a result of the above process the dropout drastically improved the generalization of the model. The dropout was applied only to fully connected layers, as shared weights in convolutional layers are good regularizes themselves. Lambda=0.0001 seemed to perform best in L2 Regularization. Early stopping with a patience of 100 epochs can be used to capture the last best-performing weights and roll back when model starts overfitting training data. Validation set cross entropy loss is used as an early stopping metric, intuition behind using it instead of accuracy is that it generalizes better.

Discussion

The smart driver assistant system provides useful tips to the user. The lane detection and tracker will guide the driver to stay in his own designated path. This will prevent rash lane splitting as well as wandering off from the lane due to inattentive driving or drowsiness. The system will warn the driver of inattentive swaying away from the lane. Also, if the the car in front of the driver gets too close too fast then the system will also present a warning signal. In addition, the system will consist of a failsafe that will still detect lane even in the absence of white lane markers which will be based on the B-snake algorithm.

Excellent results are obtained in clear conditions; however, some false positives occur due to stop lines at cross streets, at crosswalks, near passing cars. False positives are mostly found when driving on the right lane of the street with no right lane boundary, and we detect the curb as the right lane boundary, and that's the reason for the high false positive rate. However, this is not a real problem as the curb is really a lane boundary, but not painted as such and this won't affect the objectives of the algorithm to detect lane boundaries. In the current algorithm, the work is done only on the red channel which gives us better images for white and yellow lanes than converting it to grayscale. However, there is plenty to be done to further improve this algorithm. The plan is to use the color information to classify different lane boundaries, white solid lines, double yellow lines, etc. This will also allow to remove the false positives due to curbs being detected as lanes, as well as confusing writings on the streets, which are usually in yellow and can be filtered out.

The traffic sign analysis information will be conveyed to the driver with the help of voice assistant and also it will be displayed on the screen of the mobile device. The driver can use voice commands to gain additional information about the traffic sign. Also, the sign analysis will be integrated with the environment of the car such as the speed. Thus, if the speed limit is detected as 60 kmph on the traffic symbol then the system will alert the driver if the car is moving at a speed much greater than the speed threshold.

Conclusion

The lane detection techniques play a significant role in intelligent transport systems. In this paper various lane detection methods have been studied. However, further improvements can be done to enhance the results. In the near future, one can modify the existing Hough Transformation so that it can measure both the curved and straight roads.

In this paper, an automatic traffic sign detection and recognition system is visualized that works in real time. The region where the traffic signs are located are identified as candidate region and is calculated through the process of MSERs. MSERs are chosen as the candidate regions because these regions can be calculated irrespective of the sensitivity of the lighting conditions and the illumination in the image.

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