# Interim Project Report

## Project Title

Robust Driver Assistance System based on Computer Vision

## Introduction

Advanced Driver Assistance System (ADAS) are systems developed to enhance vehicle safety and assist the driver in avoiding collisions and accidents by providing alerts and/or warnings whenever necessary. The development of autonomous or self-driving vehicles depends heavily on the development of ADAS. In currently available personal and commercial vehicles, various features are being offered such as adaptive cruise control, automotive navigation which is used in applications like self-parking, driver drowsiness detection, and collision avoidance systems to name a few. Some of the above-mentioned features require more basic computations like traffic sign detection and recognition, lane detection and departure warning, and vehicle proximity warning systems, each of which can be developed using the concepts of Computer Vision in real-time.

Using a front-facing dashboard camera, the project aims at accomplishing the following features of a driver assistant system:

1. A robust lane detection and tracking system, which will identify the lane in which the vehicle is currently traveling by detecting the lane markings and will track it in real-time. By definition, the system would be capable of handling challenging scenarios like worn-out lane markings or other distracting objects like shadows and other vehicles
2. Traffic signs identification and recognition system, which will be trained to detect commonly found traffic signs and alert the driver in advance

## Background

One of the most challenging and innovative problems of the current world is the driverless car. We have built cars that go as fast as 100 miles per hour but we drive them at the same speed as 19th-century horse-drawn carriages. In 2014, we spent 29.6 billion hours in commuting in the US alone[1]. The solution for a long time has been expanding present roads or building more roads, something which is becoming more and more impossible to do due to space restrictions and the ever-growing population.

The concept of a swarm of driverless vehicles that can interact with each other and effortlessly take commuters for point A to point B is something that is extremely interesting and innovative. In an ideal world, this would involve getting into a vehicle and typing in the required destination and the vehicle would perform a few calculations and take you there autonomously. Since every other vehicle would be driverless as well, a smooth operation would be possible leading to dramatically lesser commuting times due to much higher travel speeds and potentially no accidents at the same time. But this is a thing of the future and to achieve these a few important building blocks need to implemented on a smaller scale.

These building blocks include implementing a robust lane detection and tracking system to identify the current lane and follow it as required and traffic signs detection and identification for a safe and accident-free commute. A lot of work has been done already on these topics including but not limited to

**Methodology:**

The methodology that I plan to follow is

1. Identify possible lane markings and develop lane hypotheses based on their calculated confidence
2. Grouping together various lane hypotheses and curve fitting a line through the most probable hypothesis to display the left and right lane boundaries, thus displaying the current lane
3. Similarly, identify possible traffic signs by applying a classifier algorithm on a dataset of images
4. Recognize and display the identified traffic sign as a warning

This will be done by comparing between various detection and tracking algorithms to find the most optimal one based on higher detection rates and lower false-alarm rates on a short video captured from a dashboard camera (dash-cam). I have identified a few datasets of dash-cam videos to be used for training and testing purposes. Links have been provided below

1. <http://ftp.pets.rdg.ac.uk/pub/PETS2001/DATASET5/TESTING/>
2. <http://mi.eng.cam.ac.uk/research/projects/VideoRec/CamVid>
3. <http://gavrila.net/Datasets/Daimler_Pedestrian_Benchmark_D/Daimler_Mono_Ped__Detection_Be/daimler_mono_ped__detection_be.html>

The above-mentioned detection and tracking algorithms will be implemented using OpenCV library functions which are based on C++. The comparison will be done based on higher detection and lower false-alarm rates, which are defined respectively as the number of frames with lane-markings/traffic signs detected per unit time and number of frames with lane-markings/traffic signs detected incorrectly per unit time, on a series of test case scenarios to find the most optimal one.

**References:**

[1] <https://www.ted.com/talks/wanis_kabbaj_what_a_driverless_world_could_look_like>

[2] H. Hattori, "Stereo for 2D visual navigation", Proc. IEEE Intell. Veh. Symp., pp. 31-38, 2000

[3] M. Beauvais, S. Lakshmanan, "Clark: A heterogeneous sensor fusion method for finding lanes and obstacles", Image Vis. Comput., vol. 18, no. 5, pp. 397-413, Apr. 2000

[4] S.-S. Ieng, J.-P. Tarel, R. Labayrade, "On the design of a single lane-markings detectors regardless the on-board camera's position", *Proc. IEEE Intell. Veh. Symp.*, pp. 564-569, 2003

1. X. Miao, S. Li, H. Shen, *On-board lane detection system for intelligent vehicle based on monocular vision*, International Journal on Smart Sensing and Intelligent Systems, vol. 5, no. 4, Dec. 2012

Abstract:

The objective of this research is to develop a monocular vision system that can locate the

positions of the road lane in real time. First, Canny approach is used to obtain edge map from the road image acquired from monocular camera mount on vehicle; Second, a matching process is conducted to normalize the candidates of road line; Third, a searching method is used for reinforce potential road lines while degraded those impossible ones; Forth, a linking condition is used to further enhance the confidence of the potential lane lines, and a K-means cluster algorithm is employed to localize the lane lines; Finally, a on board system is designed for experiment. The proposed system is shown to work well under various conditions on the roadway. Besides, the computation cost is inexpensive and the system's response is almost real-time.

1. Siniša Šegvic, Karla Brkic, Zoran Kalafatic, *Exploiting temporal and spatial constraints in traffic sign detection from a moving vehicle*, Machine Vision and Applications, vol. 25, no. 3, pp 649-655, Apr. 2014

Abstract:

This paper addresses detection, tracking and recognition of traffic signs in video. Previous research has shown that very good detection recalls can be obtained by state-of-the-art detection algorithms. Unfortunately, satisfactory precision and localization accuracy are more difficultly achieved. We follow the intuitive notion that it should be easier to accurately detect an object from an image sequence than from a single image. We propose a novel two-stage technique which achieves improved detection results by applying temporal and spatial constraints to the occurrences of traffic signs in video. The first stage produces well-aligned temporally consistent detection tracks by managing many competing track hypotheses at once. The second stage improves the precision by filtering the detection tracks by a learned discriminative model. The two stages have been evaluated in extensive experiments performed on videos acquired from a moving vehicle. The obtained experimental results clearly confirm the advantages of the proposed technique.