# 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. 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 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 the topic of lane detection including but not limited to [2], [3], [4], [5] using a lot of various algorithms including fixed-width line pairs, spline-ribbon trajectories and a deformable template model for the representation of the path, Hough transform, probabilistic fitting and Kalman filtering for the detection and tracking, as well as stereo and monocular modalities [6].

Similarly, a lot of research has been done on the topic of traffic signs recognition. The challenges faced are the surroundings, partial occlusion and insufficient lighting conditions and the fact that the position and orientation are not known beforehand as explained in [7], [8], [9].

## Methodology

The methodology that I plan to follow is loosely based on that implemented by X. Miao et al [10] and Siniša Šegvic et al [11] which has been summarized below:

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 series of images obtained from a dashboard camera. A few online sources have been identified for these images which could be used for training purposes [12], [13], [14].

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 accurately 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 detector regardless the onboard camera's position", *Proc. IEEE Intell. Veh. Symp.*, pp. 564-569, 2003

[5] Y. Zhou, R. Xu, X. Hu, Q. Ye, "A robust lane detection and tracking method based on computer vision", *Meas. Sci. Technol.*, vol. 17, no. 4, pp. 736-745, Apr. 2006

[6] Z. Kim, “Robust Lane Detection and Tracking in Challenging Scenarios”, *IEEE Transactions on Intelligent Transportation Systems*, vol. 9, no. 1, Mar 2008

[7] A. de la Escalera, J.Ma Armingol, M. Mata, “Traffic sign recognition and analysis for intelligent vehicles”, *Image and Vision Computing*, vol. 21, no. 3, pp. 247-258, Mar 2003

[8] N. Yabuki, N. Miki, "Detection of max speed sign and discrimination of max speed in road scene image", IPS. Trans., vol. 76, no. 18, pp. 127-134, 1992

[9] T. Asakura, Y. Aoyagi, "Image recognition of traffic speed marks using neural networks", JSME. Trans., vol. 61, no. 589, pp. 206-212, 1994

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

[11] 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

[12] <http://ftp.pets.rdg.ac.uk/pub/PETS2001/DATASET5/TESTING/>

[13] <http://mi.eng.cam.ac.uk/research/projects/VideoRec/CamVid>

[14] <http://gavrila.net/Datasets/Daimler_Pedestrian_Benchmark_D/Daimler_Mono_Ped__Detection_Be/daimler_mono_ped__detection_be.html>