Development of Driver Assist Systems for Implementation in Semi-autonomous Vehicles

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Introduction

94% of all road accidents occur due to human error!

Aim of the project is the development of ADAS System. Consists of 3 sub-tasks,

1. Steering wheel torque estimator.
2. Analysis of driver’s response to stimulation.
3. Modelling of 2 artificial driving agents.

Steering Wheel Torque Estimator

✓ Torque estimation using a external observers.

$$\dot{\check{v}}_\Theta = T_d + T_f - \lambda\, sgn\,(\dot{\check{v}}_\Theta)$$

$$\dot{\check{v}}_2 = \frac{T_m + T_d}{J} + \frac{T_m + T_d}{J_D} - 1.1\, f^+\, sgn(\check{x}_1)$$

Effect of Haptic Actuator on Driver behaviour

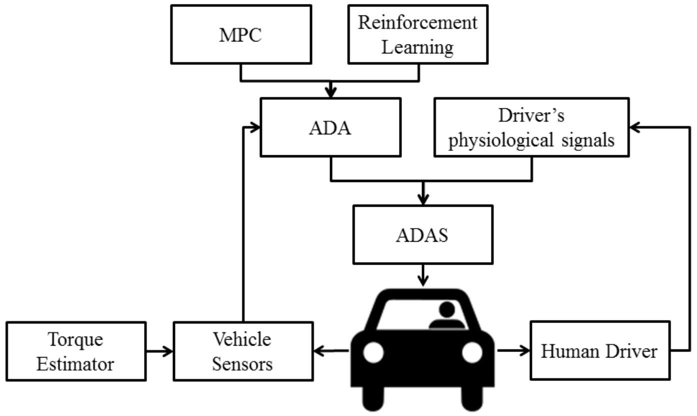
✓ Eye blink rate, heart rate and heart rate variability is used to detect a change in state of the driver.

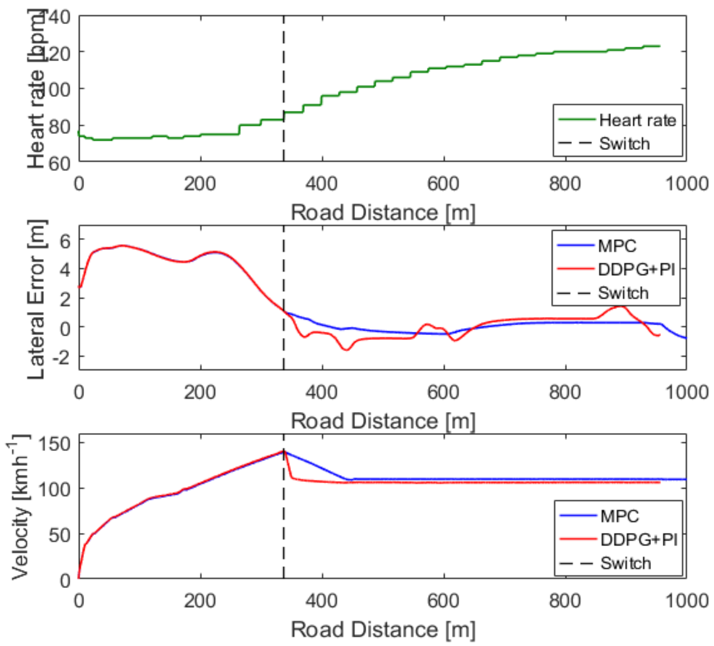
✓ Haptic actuator is used to modify drivers control inputs.

✓ Haptic actuator may cause stress to the driver.

Integrated ADAS System

- Capable of semi-autonomous driving – lane keeping and cruise control
- Takes over the control of the car in the event of a ‘stressed’ driver or unsafe driving





Artificial Driving Agent (ADA)

Reinforcement Learning

- Deep deterministic policy gradient is used for vehicle control.
- Two controllers developed - Racing controller maximises speed whilst safely completing lap. Tracking controller tracks a reference velocity.
- RL tracking is sub optimal.
- Racer controller is used as base for steering control. Cooperates with a PI controller for longitudinal control.

Model Predictive Control

- ‘Predicts’ future state of vehicle to generate control inputs.
- Two controllers:
  - Adaptive MPC for Longitudinal Control
  - Implicit MPC for Lateral Control
- Good tracking performance at low velocities. Unsafe at higher velocities due to limitations.

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