# Undergraduate Research Symposium

## Simulation of Heavy Duty Vehicle Platooning Control Architecture

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## Introduction:

- Transportation of products, people, raw material, across vast distances has been a pivotal reason for the success of human race.
- Even a small increase of efficiency in transportation systems at ground level can save crores of rupees for government and businesses.
- Here we simulate a control architecture which was developed in [1], which involves platooning.
- Platooning involves vehicles moving in a specific pattern(primarily a straight line) in order to reduce the effective drag of the group of vehicles.
- The control architecture presented in [1] provides a safe, cost effective method to impliment platooning.


***Figure 1.A typical implimentation of platooning.***
*Source:Google images*

## Literature:

- There are two main areas of focus in implimenting a platooning
  1. Reducing drag of follower vehicles
  2. Safety
- The control architecture is based on three hirarchial sub-problems
  1. mission planner
  2. platoon controller
  3. low level vehicle controller
- While simple look-ahead control is suitable for a single vehicle, it actually decreases the fuel efficiency of platoons.
- A two layered approach is presented in [1] which involves.
  1. The platoon coordinator computes the fue-optimal speed profile for the entire platoon.
  2. The vehicle coordinator takes input form platoon coordinator and computes the real time input from each platoon.
- The platoon coodinator relies on dynamic programing formulation and the vehicle controller relies on distributed model predictive control.

## Methods:

- The Vehicle model is based on three parameters, which are:
  1. Engine
  2. Driveline dynamics
  3. Rolling conditions
- Fuel model has been obtained by by calculating the energy required to move the vehicle and dividing it with the calorific value of fuel.
- For the purpose of this simulation, we neglect the look ahead control and assume a constant throttle of 0.7.
- The saftey aspect is taken care of by triggring the braking system when the the distance between two vehicles reduces to a critical value.

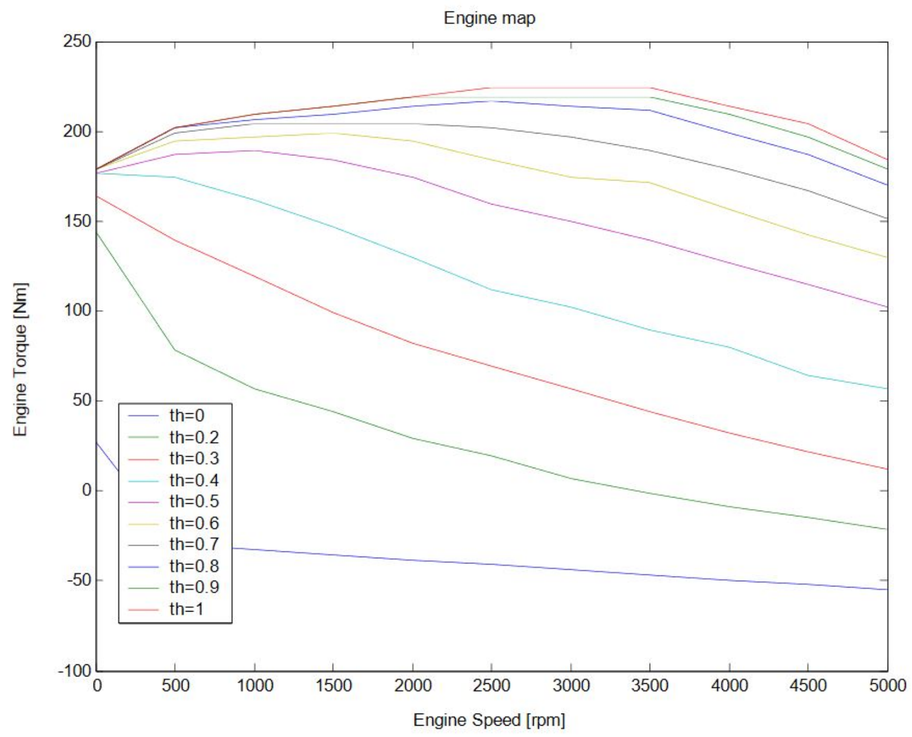


***Figure1.2: The engine map of the simulated HDV***

## Analysis:

- We have simulated a two vehicle platoon with constant throttle.
- For the road profile, we just designed a simple sinosoidal road profile.
- For the purpose of simulation we have considered two vehicles seperated by a gap of ten meters(gap is the distance between rear end of first vehicle and front end of second vehicle.
- While not a part of this simulation, look ahead control can be achived by minimising the weighted cost function

$$C = fuelconsumed + \beta * Timetaken$$

## Results:

- Our results can be summed up by the figure below.

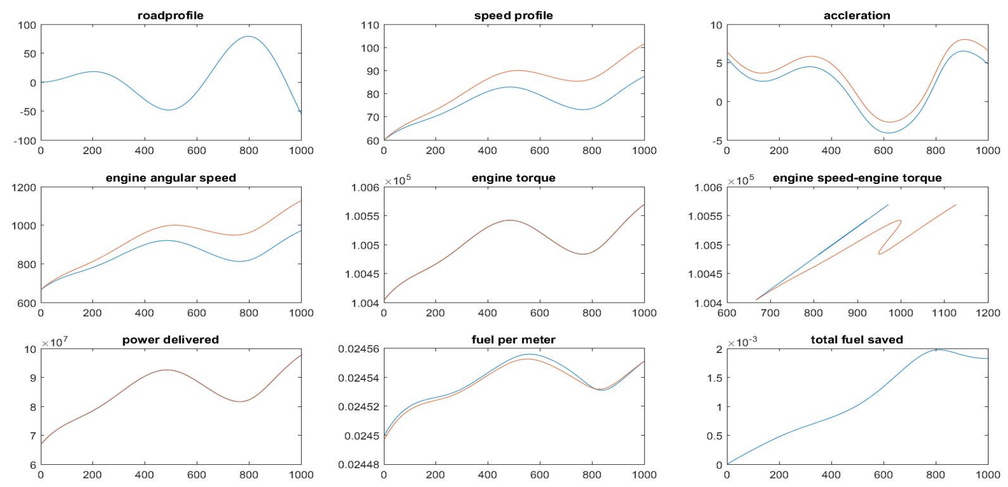


***Figure1.3: Various parameters of the simulaton.***
(Red represents lead vehicle abd blue represents follower vehicle.)

## Conclusions:

This model of platooning has experimentally shown to increase fuel efficiency, reduce travel time and reduce the number of gear shifts. The average fuel efficiency was improved by 3.5%, this may not look like a big number but considering the fact that HDV's account for millions of barrels of fuel consumption, the total fuel savings add up to a lot.

## Important References:

**[1]Valerio Turri, Bart Besselink, Karl H. Johansson,2015**,Cooperative look-ahead control for fuel-ecient and safe heavy-duty vehicle platooning

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