Ford F-Max Platooning Project

Güliz Kıvançlı

05.10.2020
• What is Platooning?
• About Ford Otosan Platooning Project
• Platooning Scenarios
• Platooning Development Phases
• Overall Simulation Block Diagram
• Controller Approaches – Platooning Controller Problem
• Validations & Testing of Controller Approaches
• Implementation with TruckMaker
• Ford Otosan Final Demo Video
• References
• Contact Information
WHAT IS PLATOONING?

Platooning Holds Great Potential To Make Road Transport Safer, Cleaner And More Efficient In The Near Future

CFD results for a platoon of two HDVs with varying inter-vehicle spacing[2]

- **Safe** → Automatic & Immediate Braking
- **Efficient** → Up to %10 Fuel Economy Benefit[1]
- **Clean** → Reduce CO₂ Emissions
Aim of the Project:
- SAE-Level 2 Automated Truck Platooning Technology

- With SAE-L2 Automated Truck Platooning, trucks will be able to handle platooning management of forming, merging, dissolving, on top of distance control and lane centering under the supervision of driver.

- ERTRAC Roadmap suggests implementation start in 2020 with C-ACC [3]
- Platooning requires change of current road regulations (20+)
PLATOONING SCENARIO-1

1. Merge Platoon

2. Create & Keep Platoon

3. Detect Slow Moving Vehicle Ahead

4. Brake Platoon to Follow Slow Moving Vehicle

5. Come to Full Stop

---

- Step 1: Merge Platoon
- Step 2: Create & Keep Platoon
- Step 3: Detect Slow Moving Vehicle Ahead
- Step 4: Brake Platoon to Follow Slow Moving Vehicle
- Step 5: Come to Full Stop
PLATOONING SCENARIO-2

1. Merge Platoon

2. Create & Keep Platoon

3. Split Platoon

4. Cruise Together

5. Highway Exit for Pass Car
PLATOONING DEVELOPMENT PHASES

- Requirements
- Model in the Loop
- Software in the Loop
- Software in the Loop
- Hardware in the Loop
- Hardware in the Loop
- Test & Validations ViL
• Initial Virtual Validations/Simulations for longitudinal and lateral control algorithms are performed using IPG/TruckMaker for Platooning project:

• **High level longitudinal controller** (Distance control between vehicles)

• **Low level longitudinal controller** (Acceleration demand / torque convertor)

• **Lateral control** (Steering angle control of Bosch Servotwin EHPAS steering support)

• Vehicle dynamics model of trucks are correlated with our F – Max truck in TruckMaker.
CONTROLLER APPROACHES

Platooning Control Problem

Decentralized controllers maintain a desired intervehicular spacing in a vehicle string in the presence of uncertainties and disturbances and use various available feedforward/feedback information.

**Difficulty:** To ensure that the spacing errors (deviation from the desired intervehicular spacing) do not amplify from vehicle to vehicle along the platoon

**String Stability:** It is required to ensure that the spacing errors do not amplify upstream from vehicle to vehicle in a platoon. [5]

**Spacing Policies**
- Constant separation (spacing) (constant)
- Constant headway time (linear)
- Constant safety factor (quadratic)

**Conditions**
- Individual Vehicle Stability
- String Stability
- Zero steady state spacing error

ACC with constant spacing[4]  
ACC with constant headway time[4]  
CACC[4]
VALIDATIONS OF CONTROLLER APPROACHES

- Variety of controllers are tested in SIL and MIL environment to have more testing opportunity at field to avoid nonlinearities or uncertainties of prototype vehicle.
- First implementations of the algorithms are done in MATLAB/Simulink Environment.
- Model-in-the-loop testings and validations are done in TruckMaker Simulink Environment.
- Further simulation studies like 3 or more trucks included TruckMaker SimNet Add – On can be used.

- The lower level controller determines the throttle and/or brake commands required to track the desired acceleration.
- The upper (higher) level controller determines the desired acceleration for each vehicle.

An example of MATLAB/Simulink testing results
IMPLEMENTATION WITH TRUCKMAKER
REFERENCES


Thank you for listening

- If you have any further questions do not hesitate to contact:

  - Sertaç Akın
  - SV – Veh. Eng., AV & ADAS
  - Development Engineering
  - Email: sakin2@ford.com.tr

  - Eren Aydemir
  - Autonomous Vehicles Engineer
  - Email: eaydemi4@ford.com.tr

  - Elif Aksu Taşdelen
  - Autonomous Vehicles Engineer
  - Email: eaksu3@ford.com.tr

  - Ersun Sozen
  - Autonomous Vehicles Engineer
  - Email: esozen1@ford.com.tr

  - Güliz Kivançlı
  - Autonomous Vehicles Engineer
  - Email: gkivancl@ford.com.tr