Vehicle Powertrain Co-simulation with a Moving Base Simulator
Anders Andersson
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Overview

Collaboration between LiU and VTI

- Motivation
- Experimental equipment
- Co-simulation with motorway driving
- Results
Motivation

Linköping University built a new vehicle propulsion laboratory in 2011 close to VTI.

- LiU: Expose driveline systems to specific and controlled driving scenarios
- VTI: Enhance driver perception of powertrain dynamics by using HIL in the simulators
Driving simulator Sim III

Motion system
Pitch angle: -9 to +14 degrees
Roll angle: ± 24 degrees

External linear motion
Maximum amplitude: ± 3,75 m
Maximum speed: ± 4,0 m/s
Maximal acceleration: ± 0,8 g

Vibration table
Vertical movement: ± 6,0 cm
Longitudinal movement: ±6,0 cm
Roll angle: ± 6 degrees
Pitch angle: ± 3 degrees

Visual system
Forward view 120 degrees
Rear view in three mirrors
Average resolution: horizontal 4,2 arcmin./linepair, vertical 3,9
Vehicle propulsion laboratory

Dynamometers control torque/rpm at wheels

2009 Volkswagen Passat Ecofuel DSG, gas and methane, dual clutch semi-automatic transmission

Installed brake pressure sensor
Pedal robot

Accelerator:
• Dynamic load of 210 N
• Maximum speed of 250 mm/s

Brake:
• Dynamic load of 420 Nm
• Maximum speed of 215 mm/s

Controlled via UDP messages from Sim III
Controlled on position and brake pressure
Network connection
Vehicle model

Tradeoff
torque vs rpm
Results – pedal robot

Accelerator pedal
Results – pedal robot

Brake pedal
Results – vehicle speed

The graph shows the vehicle speed over time for two different scenarios: simulated (blue line) and test vehicle (red line). The y-axis represents vehicle speed in km/h, and the x-axis represents time in seconds. The graph indicates fluctuations in speed, with a notable increase around the 150-second mark and a decrease towards the 450-second mark for both scenarios.
Results – time delays

- Pedal position in Sim III
- Pedal position in pedal robot

- Test vehicle torque
- Accelerator pedal position
Conclusions

Is it possible to obtain a realistic driving experience with this type of large co-simulation?

Yes

- Already as concept accelerator pedal works good
  - RMS error of ~1 percent
- Brake pedal needs more work
- Network performance is not limiting
- Except for brake pressure sensor, 30 min to change car
Final words


Could be the first successful co-simulation using two large equipment at two different locations. (We know others are trying but as far as we know they have not succeeded…)