DriSMi

DRIVING SIMULATOR POLITECNICO DI MILANO

DriSMi – Driving Simulator Politecnico di Milano

POLITECNICO
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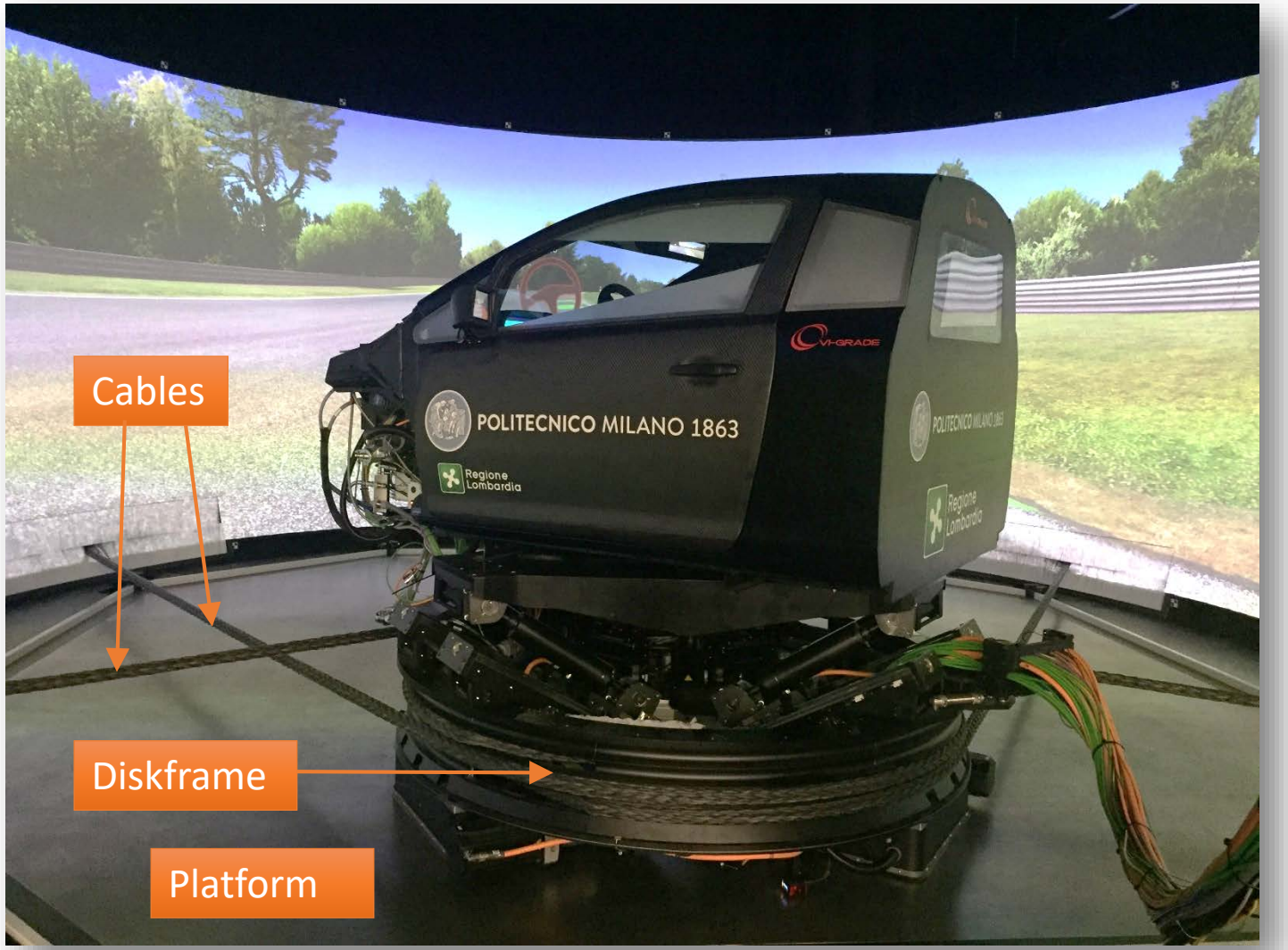
DriSMi: Dynamic Driving Simulator of Politecnico di Milano

- Innovative **cable-driven** DiM400 Dynamic Driving Simulator engineered by VI-Grade
- Used for performance studies of vehicles and subsystems related to:
  - New Material & Component Design
  - Ride & Handling
  - Active Safety Systems (ADAS)
  - Automated and Connected Vehicles
- The laboratory was created thanks to a substantial investment from the Government of the Lombardy Region
- The project has been promoted by the Lombardy Mobility Cluster

A cable-driven dynamic simulator

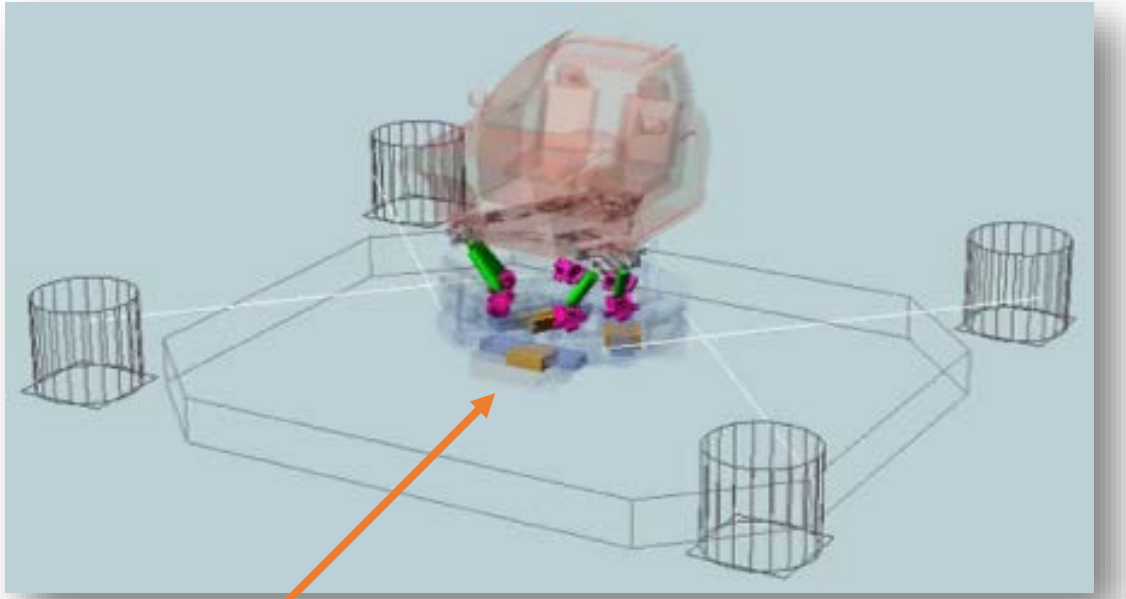


- DIM400 is mid-size dynamic driving simulator: **the platform is 6x6 m**
- It is based on a patented new technology allowing the movement of the diskframe through cables
- This solution allows for **more workspace** with respect to conventional solutions (electric-actuators)
- In addition, **translations and rotation** of the diskframe **are decoupled** throughout the platform

Performances of DriSMi

- The architecture allows increased workspace, meaning **larger accelerations:** up to **1.5 g** in longitudinal/lateral direction, **2.5 g** in vertical direction.
- **Less tilt coordination** and better perception of lateral sliding
- Bigger heave (**z: ± 280mm**) for a better vertical feel
- Manouvers like double lane change can be simulated in **1:1 scale**
- Overall latency ≈ 20 ms

DriSMi main features: diskframe movement



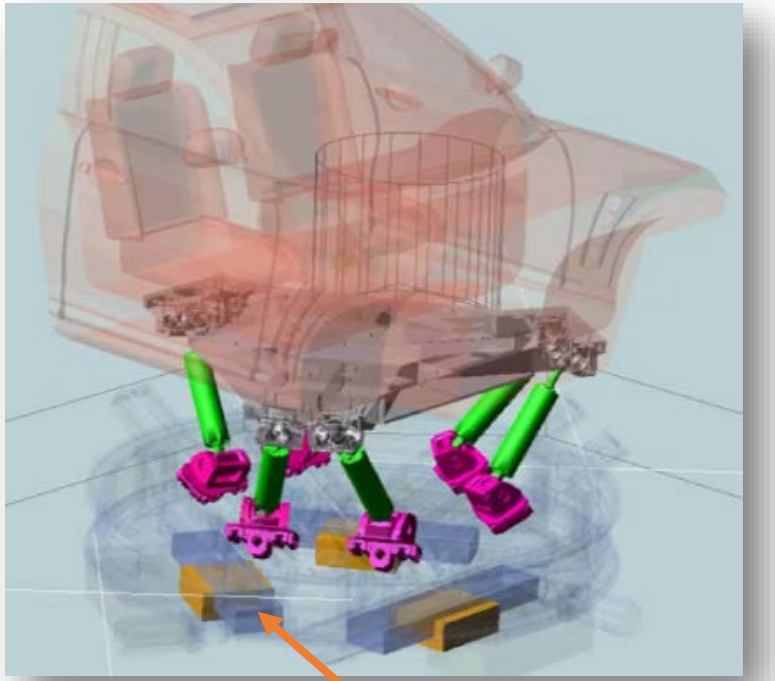
Diskframe **moved by 4 cables** over a 6x6 m horizontal surface: 3 dofs, **bandwith ~3 Hz**.

Thanks to **3 airpads**, the diskframe slides over the platform

DriSMi main features: hexalift and ICS

Hexalift moving with the diskframe **adding** further **6 dofs** to the cockpit; **bandwith ~30 Hz**.

8 on-board shakers (**bandwith ~200 Hz**) to reproduce vibration coming from the engine or road irregulartities



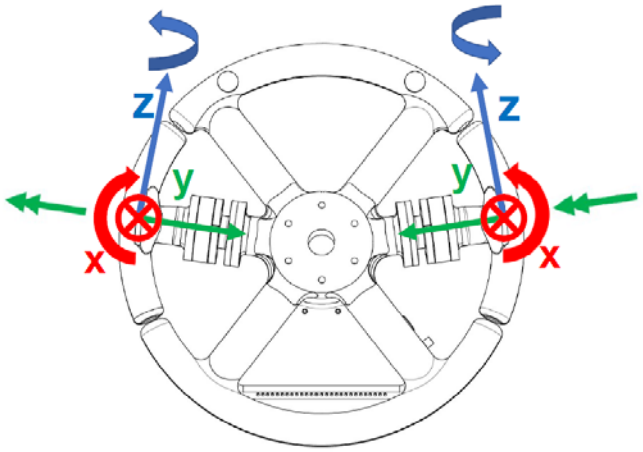
Inertial compensation system (ICS)

DriSMi main features: realism and immersivity

- **Active belts/active seat** mimic the effects of **sustained** longitudinal/lateral **accelerations**
- Provided with **active steering** for a realistic feedback and simulate active steering control systems
- Provided with **active brake** to reproduce the proper pedal feeling and the effect of active controls like ABS
- **5 speakers** inside the cockpit reproduce the noise sources inside and outside the vehicle

DriSMi additional sensors: instrumented steering wheel

- Real-time acquisition of **forces, moments and grip force** at each hand
- Specifically **designed at Politecnico di Milano**
- Can be adapted and improved for specific projects



Left Right

DriSMi additional sensors: biometry

- Characterizing **physiological reactions**

- Eye tracking
- Heart rate (chest vests)
- Skin conductivity

An immersive environment

- 270° screen allows to set the driver at the centre of the scenario
- Urban scenarios can be simulated, adding the presence of other road users like pedestrians, bikers, and other vehicles
- Weather conditions as well as lighting conditions can be changed

Research activities, Department of Mechanical Engineering

Characterization, modeling and testing of vehicles and components before outdoor tests

- Pre-selection of vehicle set-up
- Pre-selection of components (e.g. tires)

Modeling and testing of active controls, ADAS and automated driving

- Driver feedback
- Tuning of control parameters
- Test of acceptability, including ethical aspects
- Fault injection
- Interaction with traffic and other road users

Driver characterization and modelling

- Physical reactions
- Physiological reactions
- Psychological reactions

Example of research: highway test

- Research carried out in **cooperation with UniSR and VIGrade**
- 30 non professional drivers (volunteers) characterised through questionnaires
- **Driving on a highway** for approximately 10 km; long periods of ordinary driving with **some events like road works**, sudden traffic jam…
- Monitoring driver physiological reactions (heart rate, skin conductivity), driving commands
- Evaluation of **immersivity and realism** of the experience through questionnaires

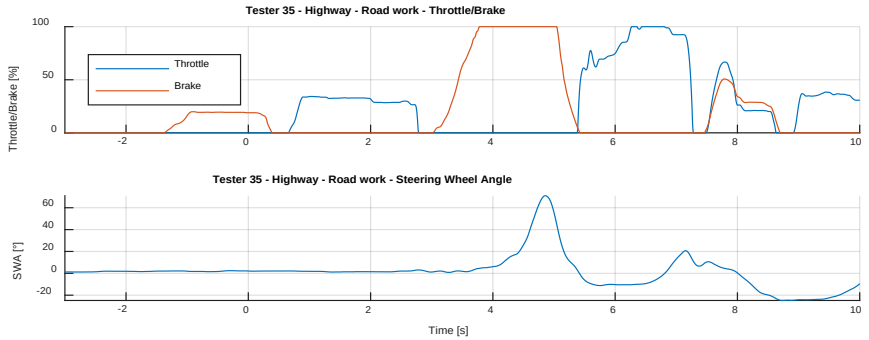
Example of research: highway test, reacting to road-works

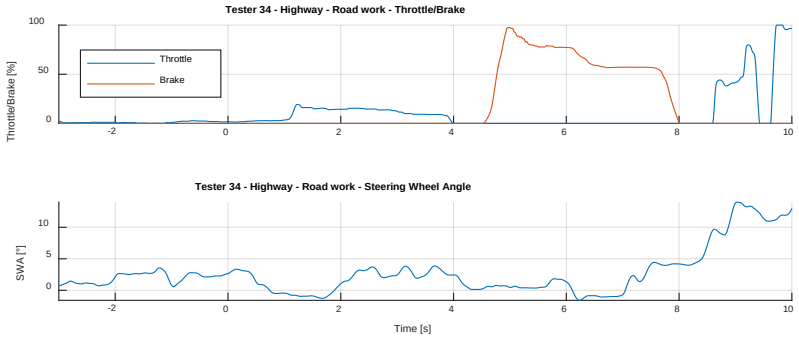
Imprudent driver

Cautious driver

Brake pedal/throttle [%]

Steer angle [°]

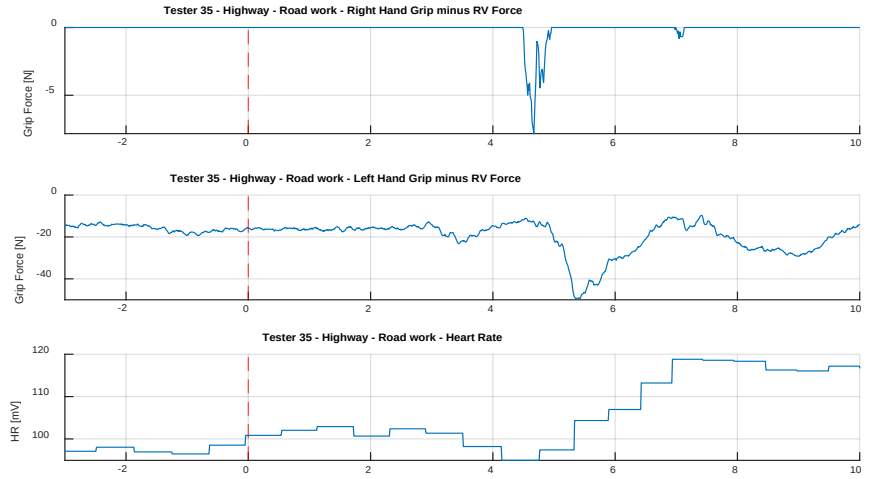


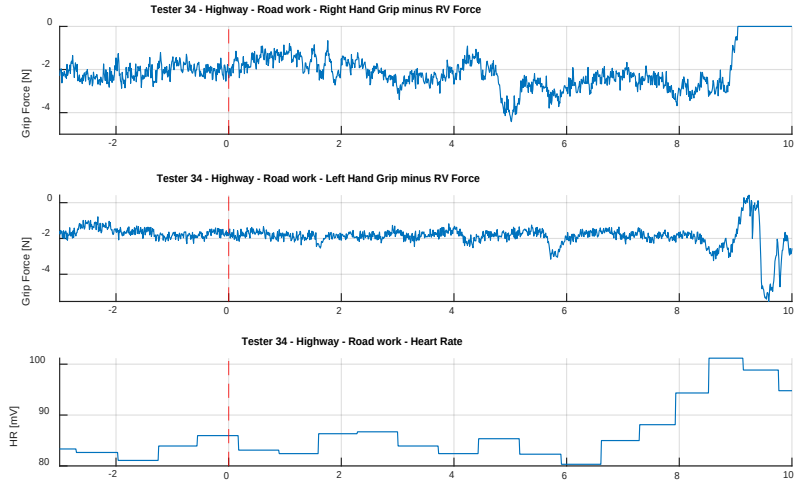


RH grip force

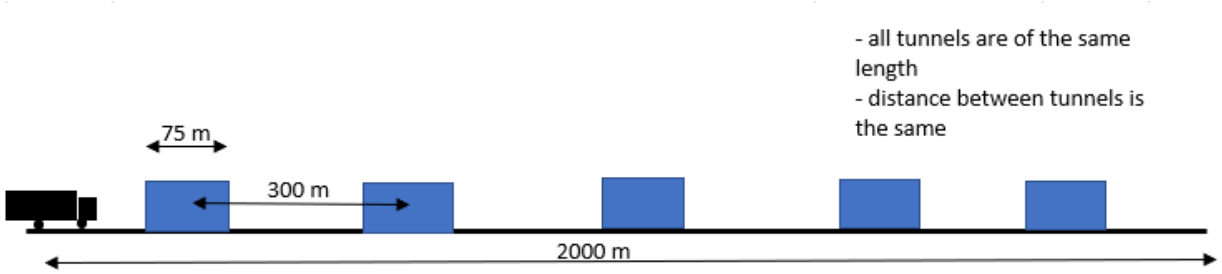
LH grip force

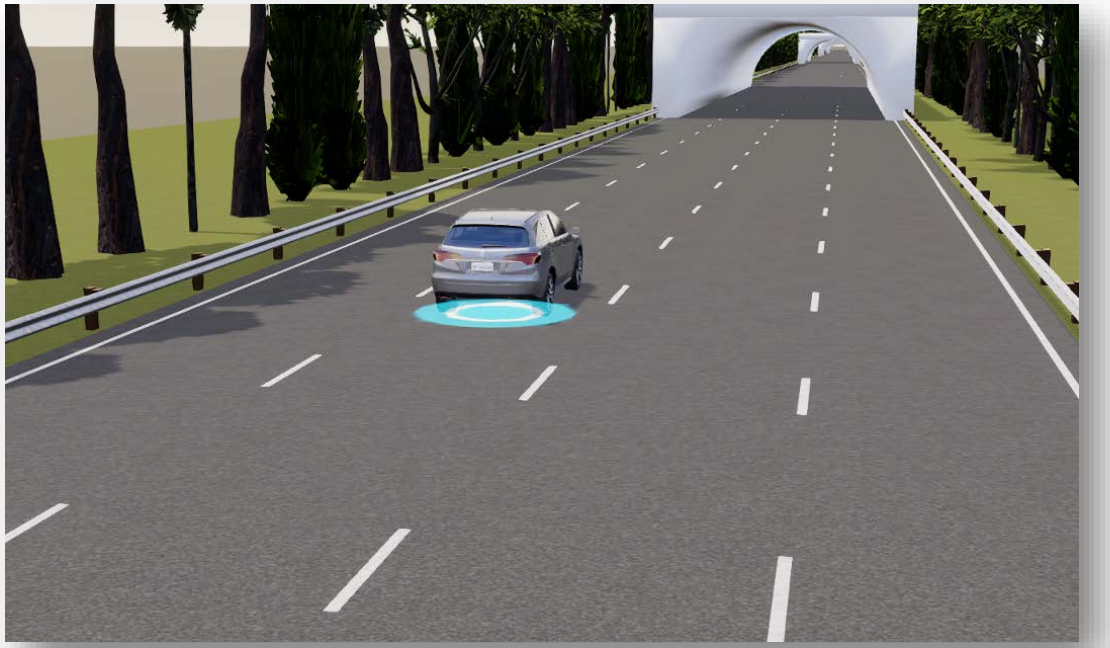
Heart rate





Example of research: controlling a van hit by side-wind





- Analyze driver's **response** to **side wind when exiting a tunnel**
- Aerodynamic forces applied on the Van obtained from wind tunnel tests
- Data collected with **28 drivers with different driving experiences**

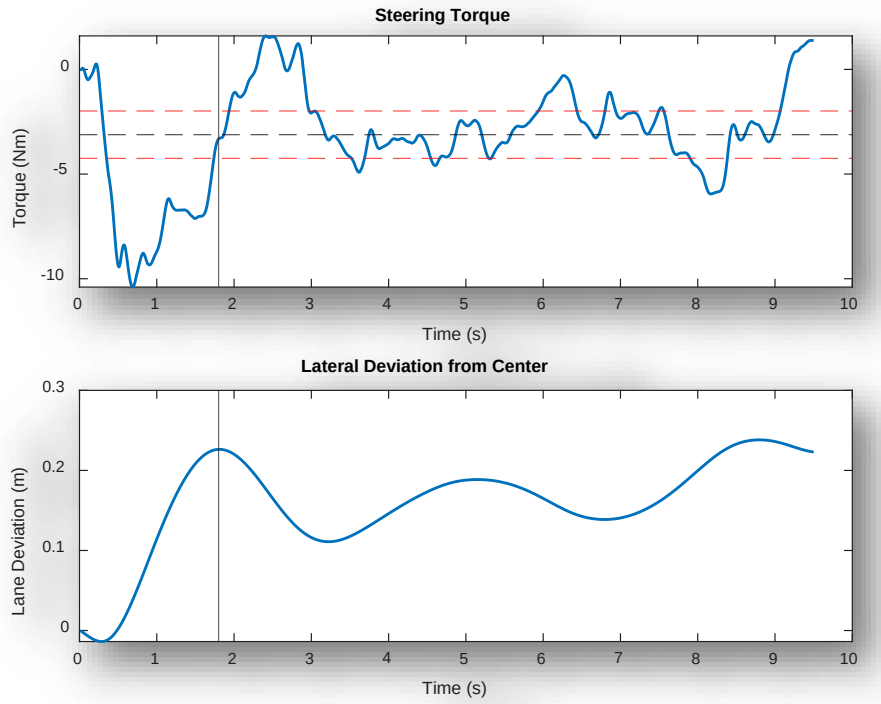
Vehicle Configuration	Vehicle Speed	Wind Speed
Empty	65 km/h	± 15/20/25 m/s
	80 km/h	± 15/20/25 m/s
Laden	65 km/h	± 20/25/30 m/s
	80 km/h	± 20/25/30 m/s

Example of research: controlling a truck hit by side-wind

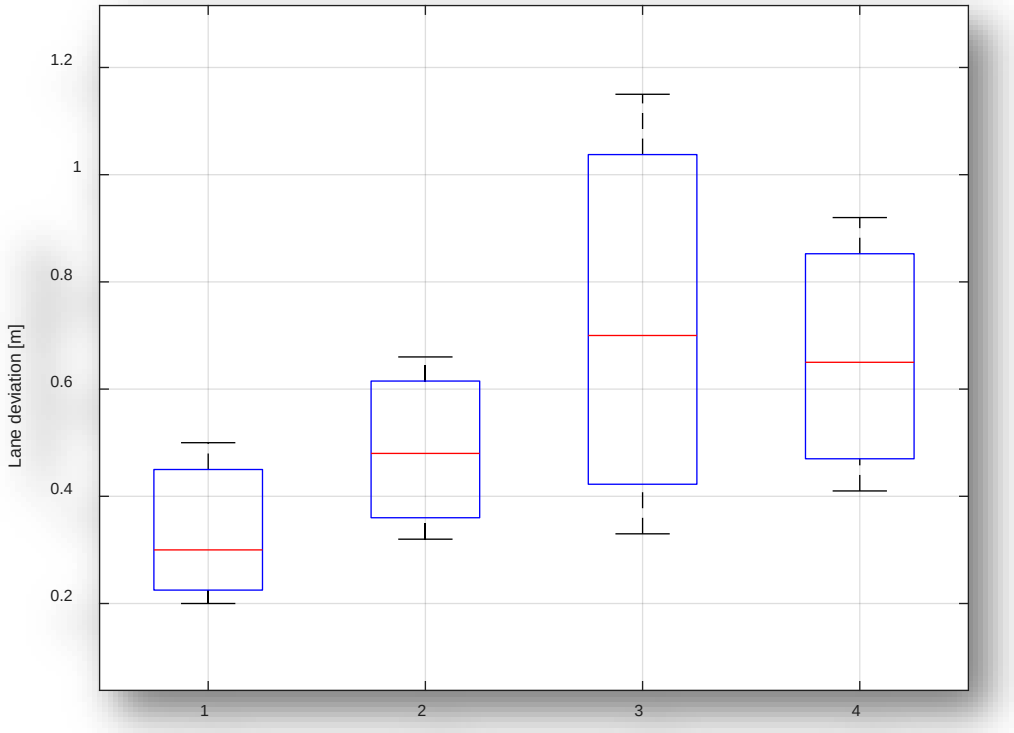
Response recorded in a single test

Steering torque [Nm]

Lane deviation [m]



Lane deviation [m]



65 km/h, 15 m/s | 65 km/h, 20 m/s | 80 km/h, 15 m/s | 80 km/h, 20 m/s

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Thank you for your attention!

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