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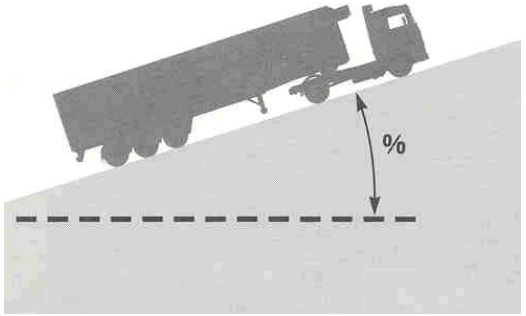
Dynamic Performance of Articulated Heavy Vehicles with Active Control Systems

Performance-Based Standards (PBS)

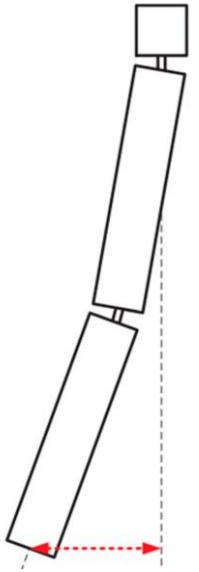
- Definition
- Emphasis on vehicle performance rather than prescriptive rules
- Improve safety, economic efficiency and environmental benefits
- Adoption of PBS in different countries: Canada, Australia, New Zealand, South Africa, Sweden, etc.
- PBS as a regulatory framework for dynamic performance evaluation
  - Longitudinal performance standards
  - Directional performance standards

Longitudinal Performance Standards

- Low-speed longitudinal performance measures:
  - Startability
  - Gradeability
  - Acceleration capability
- High-speed longitudinal performance measures:
  - Straight-line off-tracking
  - Stopping distance
  - Down-grade holding capability



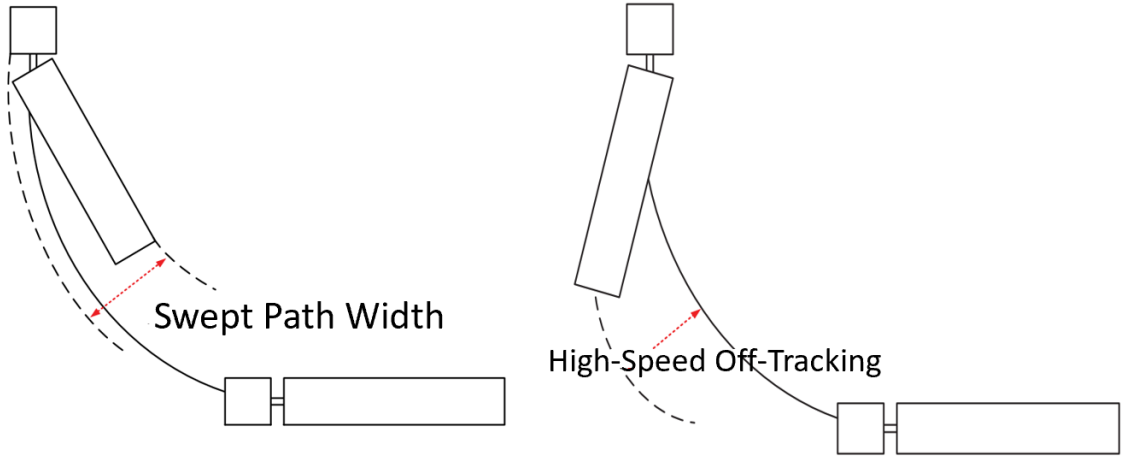
Startability

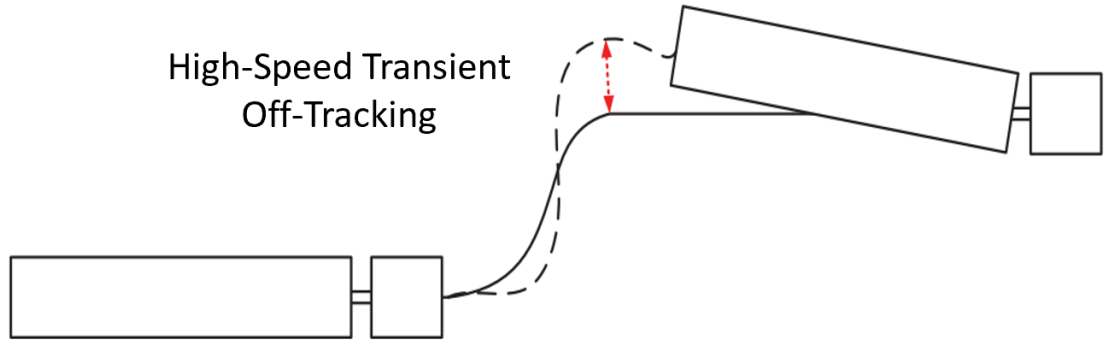


Straight-Line Off-Tracking

Directional Performance Standards

- Low-speed directional performance measures:
  - Swept path width
  - Frontal swing
  - Tail swing
- High-speed directional performance measures:
  - Rearward amplification
  - High-speed transient off-tracking
  - High-speed steady-state off-tracking
  - Yaw damping coefficient

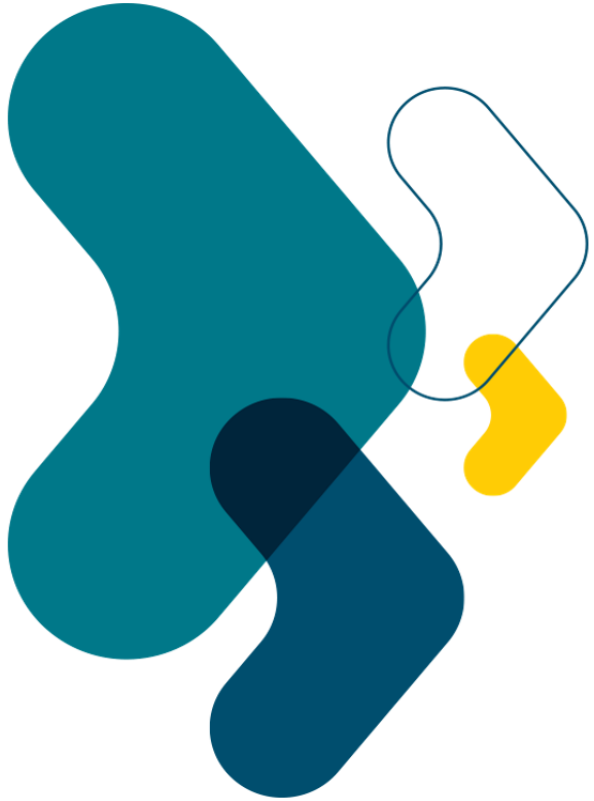




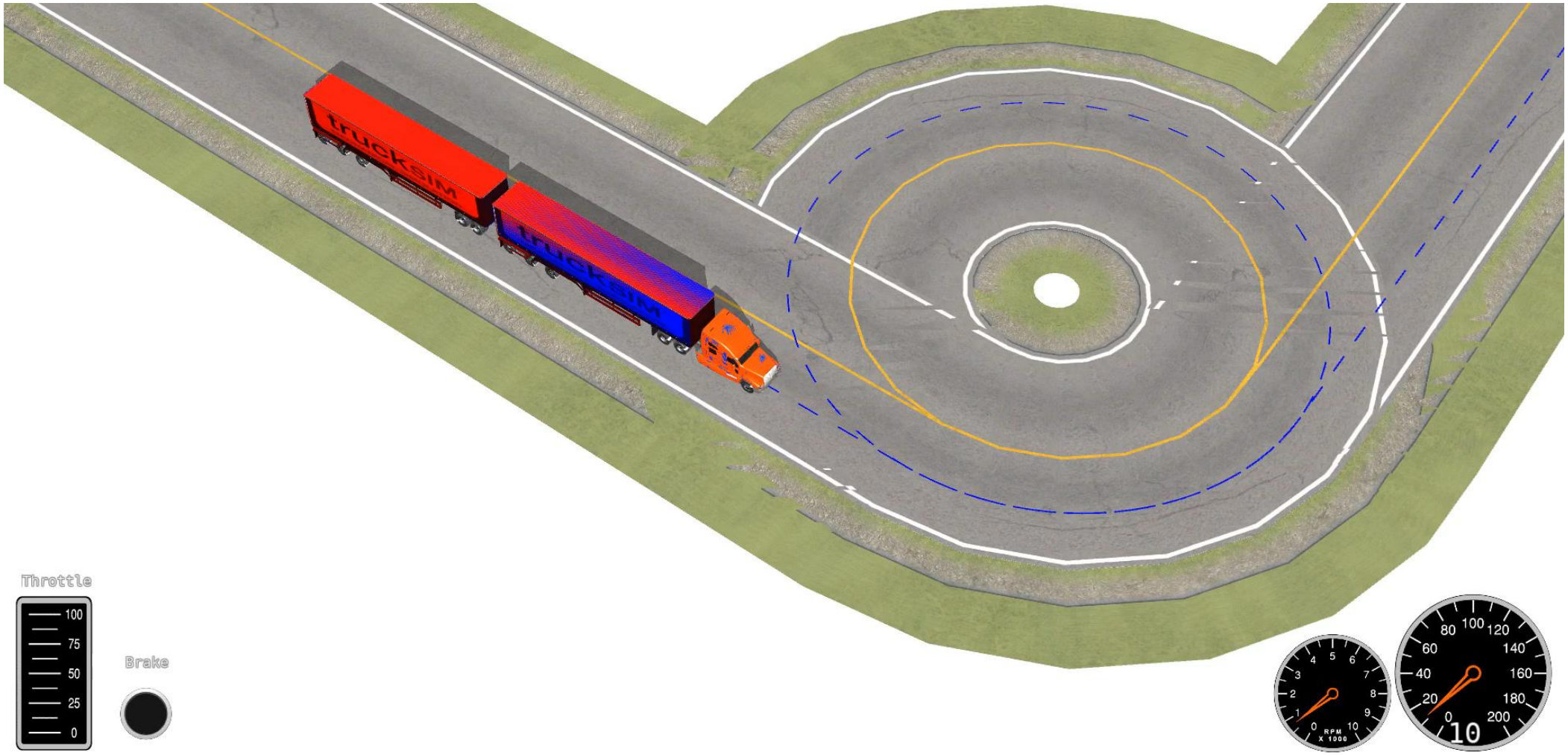
Active Control Systems

- AHVs present unique challenges due to large sizes, high center of gravity, and multi-unit structures
- Active control systems employ a combination of sensors and intelligent controllers to actively monitor, adjust, and optimize various vehicle parameters in real-time
- Examples: Active Trailer Steering, Active Trailer Differential Braking, Electronic Stability Control, Roll Stability Control, Active Suspension, etc.
- Objective: Enhancing dynamic performance, vehicle and traffic safety, and productivity

Active Trailer Steering

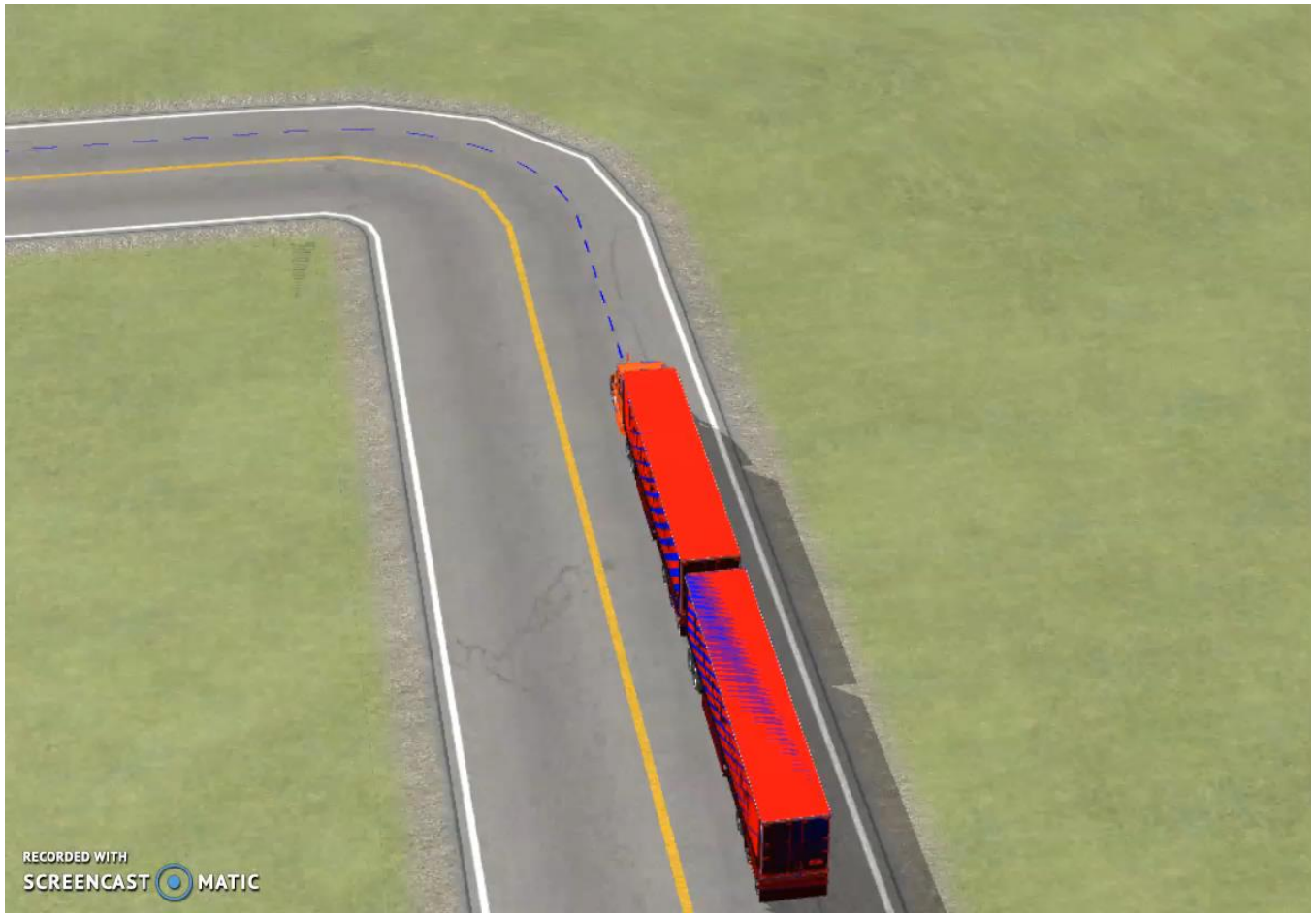


Roundabout Turn - Active Trailer Steering (Blue) vs. Conventional (Red)



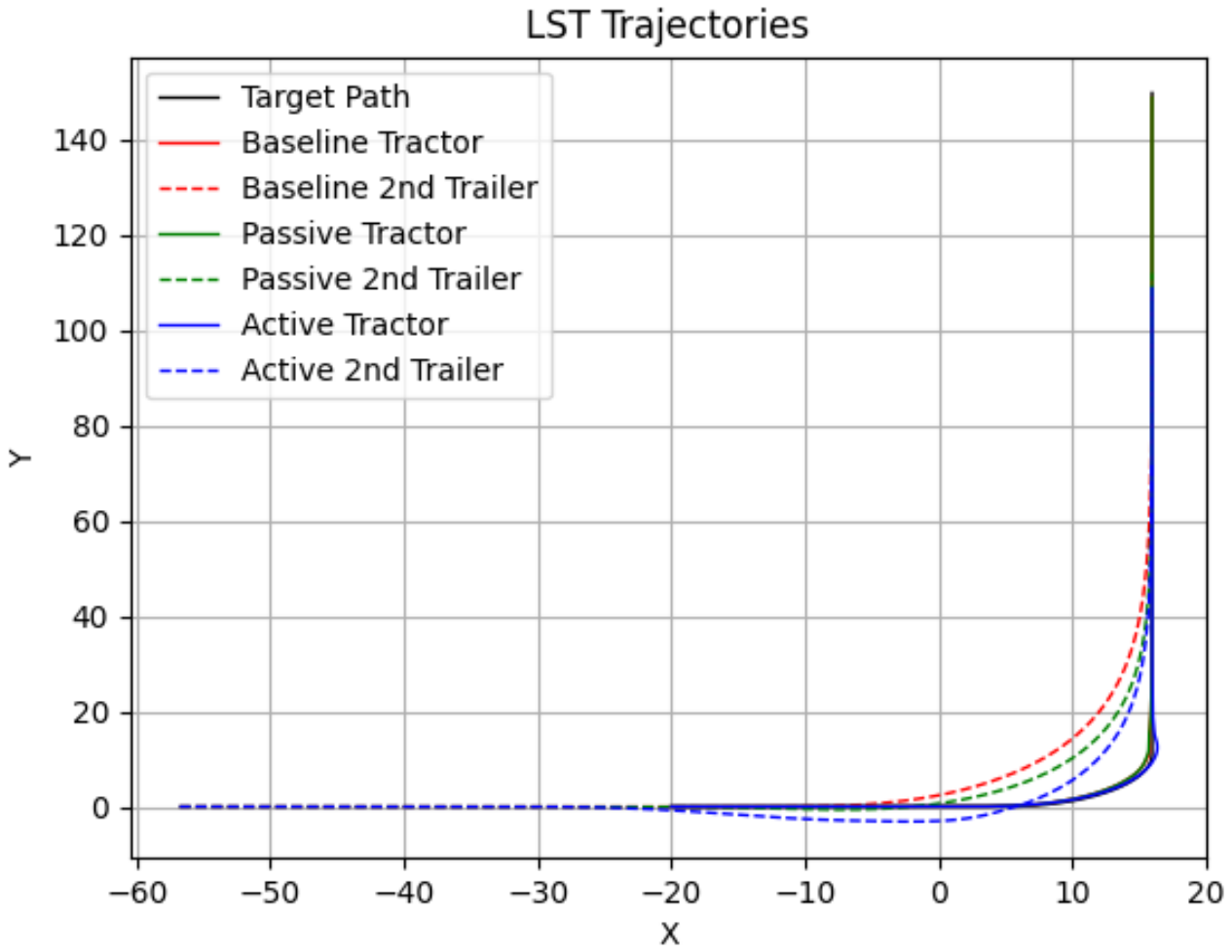
Video 1

90-degree Curve Turn - Active Trailer Steering (Blue) vs. Conventional (Red)



Video 2

90-degree Curve Turn - Active Trailer Steering (Blue), Passive Trailer Steering (Green) and Conventional (Red)



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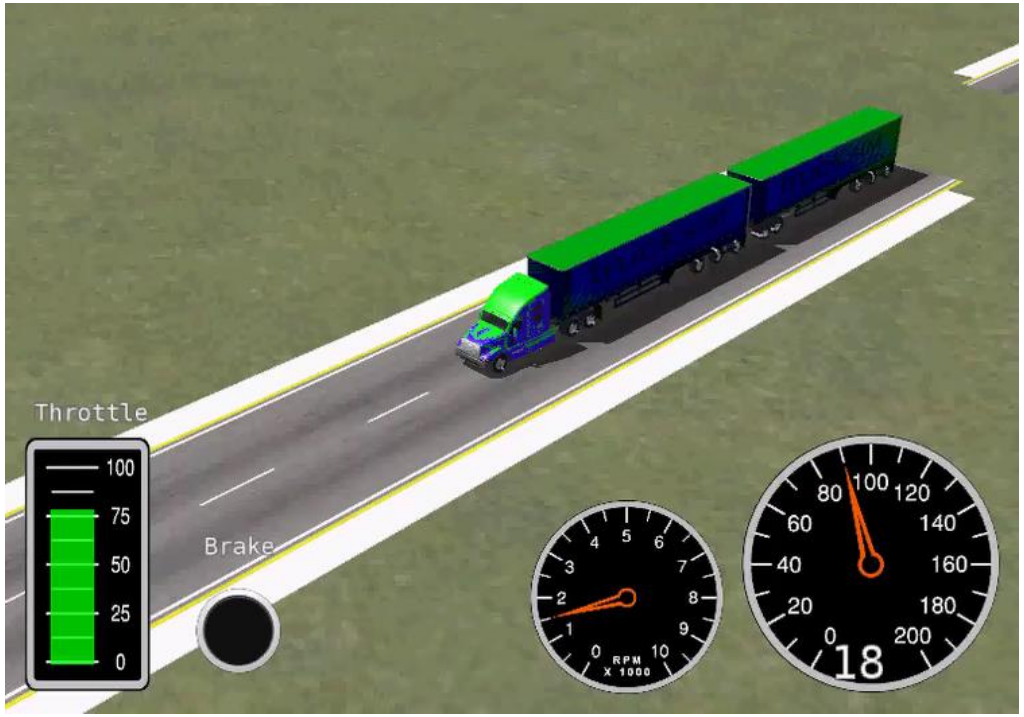
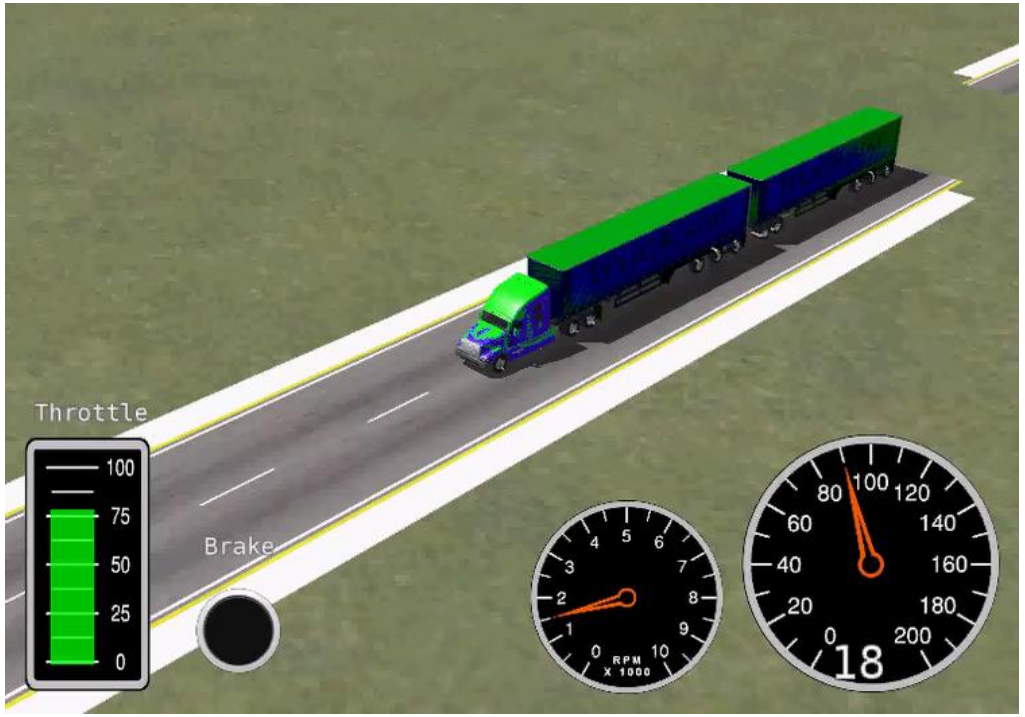
High-Speed Lane Change - Active Trailer Steering (Blue) vs. Passive Trailer Steering (Green)

Video 3



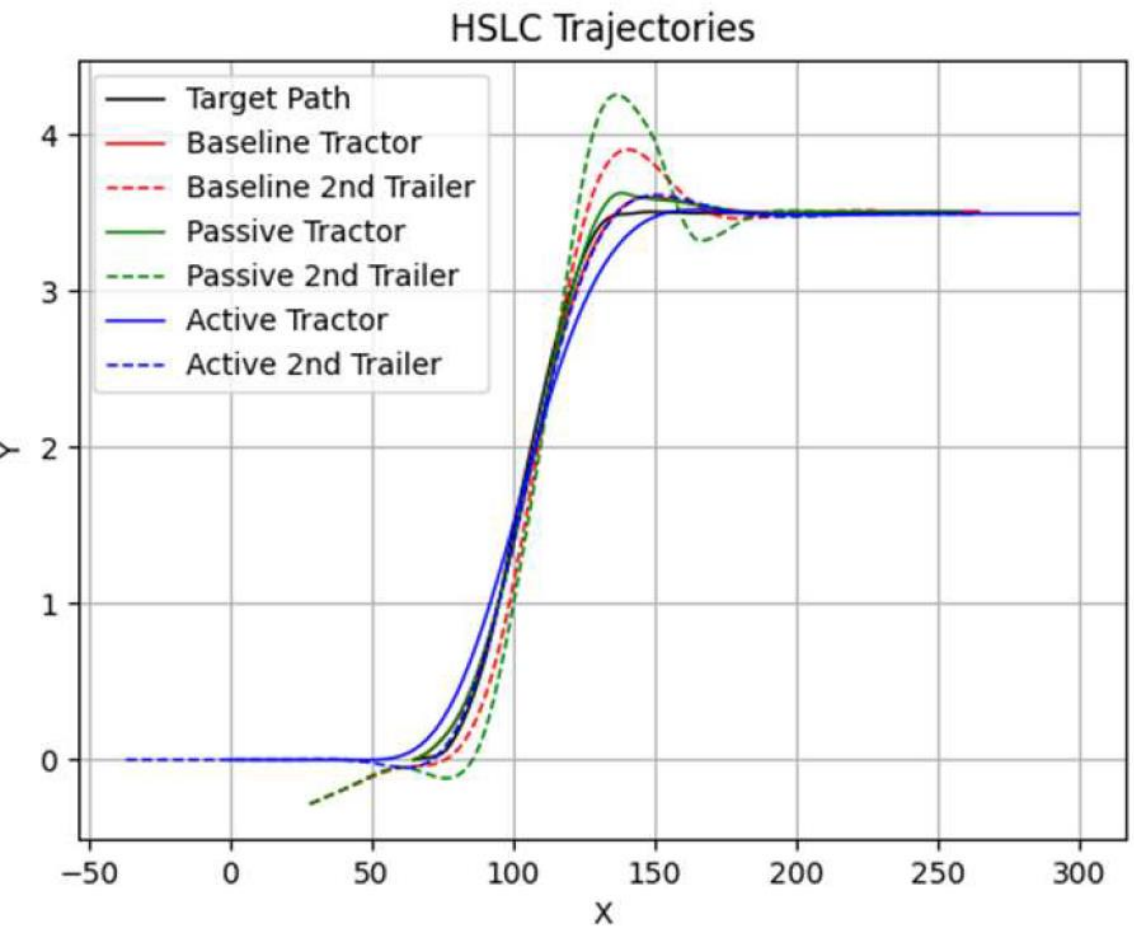
(a) High Friction Road Condition

Video 4

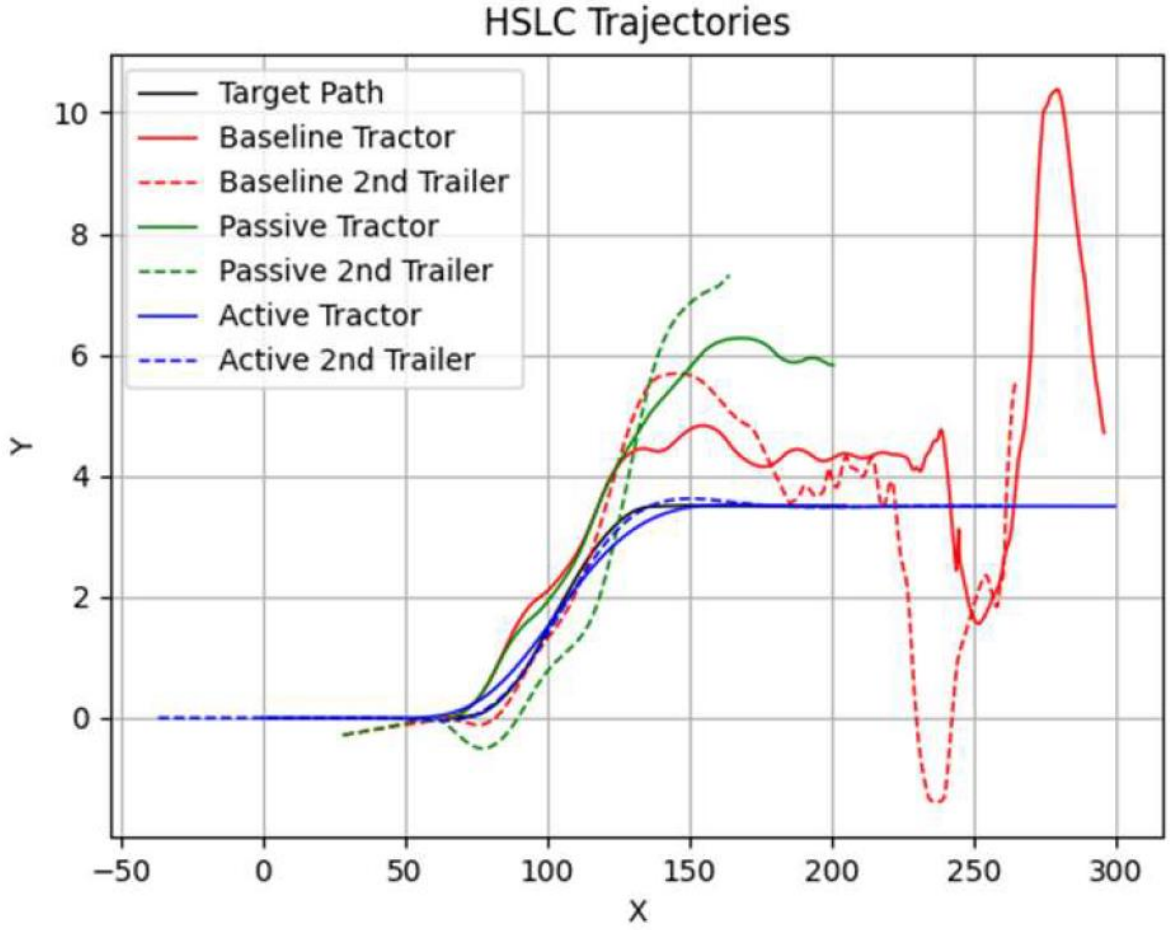


(b) Low Friction Road Condition

High-Speed Lane Change - Active Trailer Steering (Blue), Passive Trailer Steering (Green) and Conventional (Red)



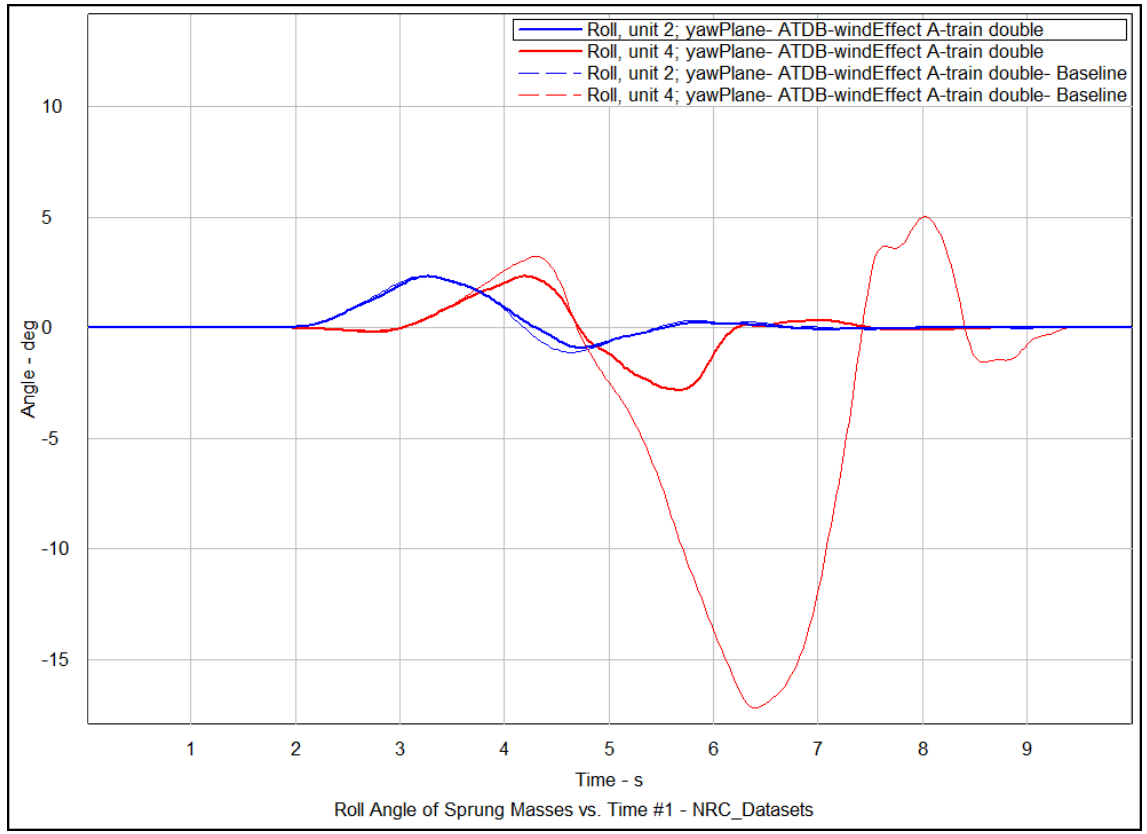
(a) High Friction Road Condition



(b) Low Friction Road Condition

Active Trailer Differential Braking

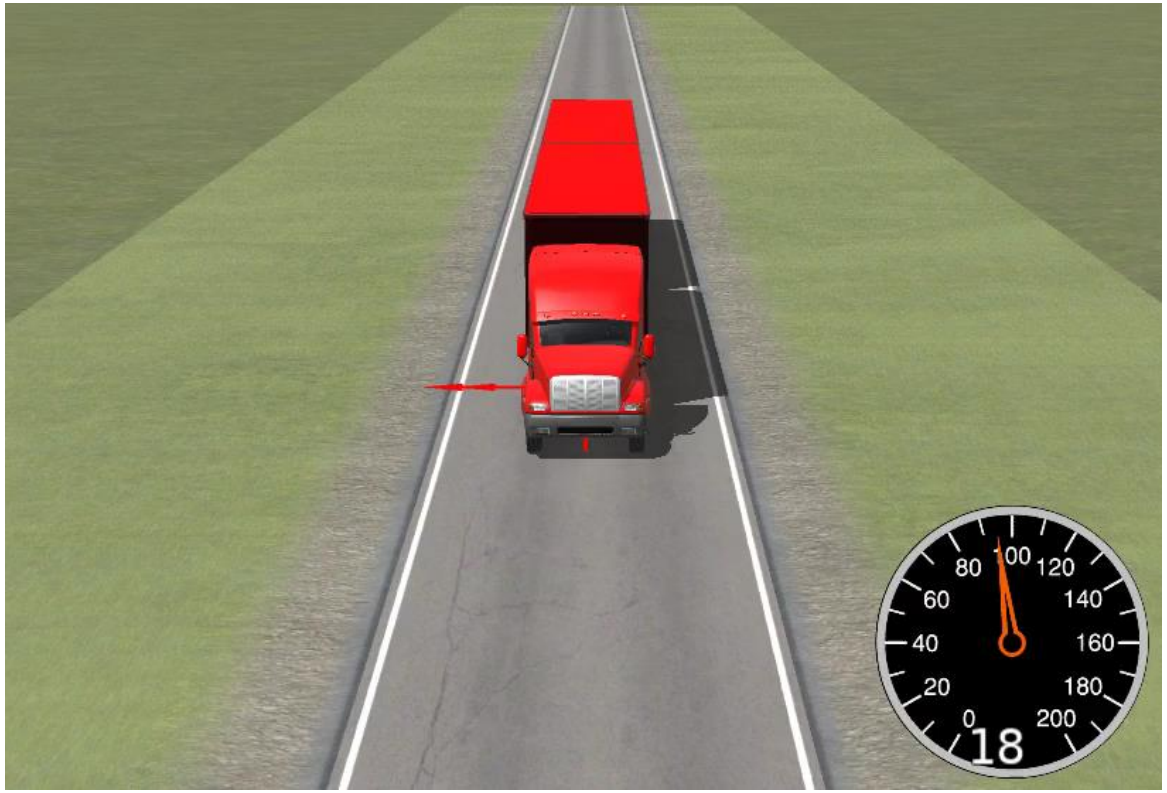
Mitigating Wind Gust Effect with Active Trailer Differential Braking System (ATDB)



Blue: AHV with ATDB

Red: Conventional AHV

Video 5



- Lateral wind speed= 120 km/h
- Vehicle speed= 95 km/h

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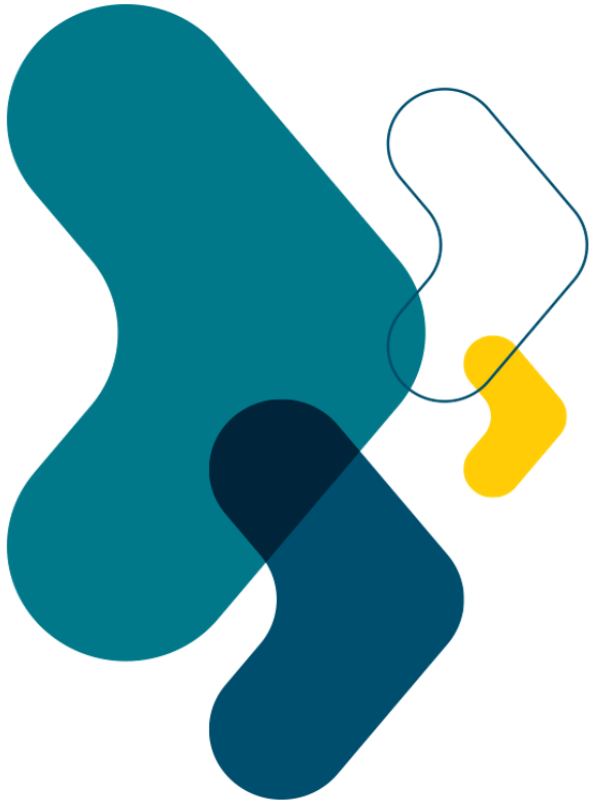
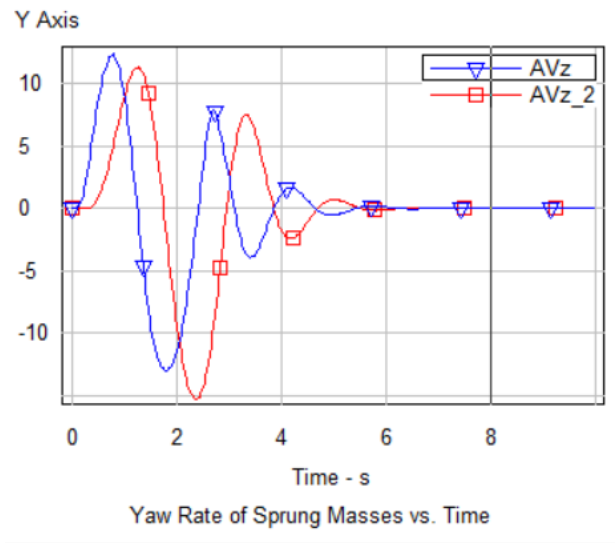
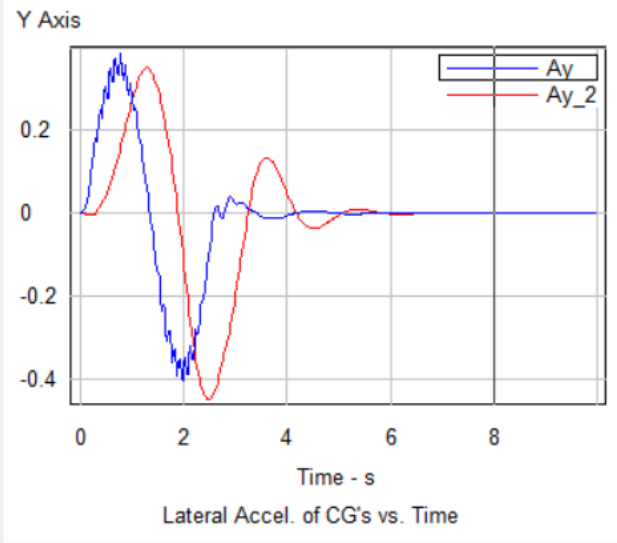
Autonomous Driving

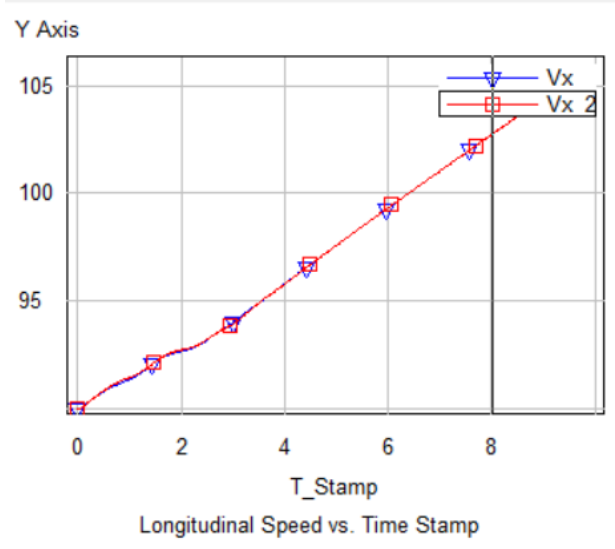


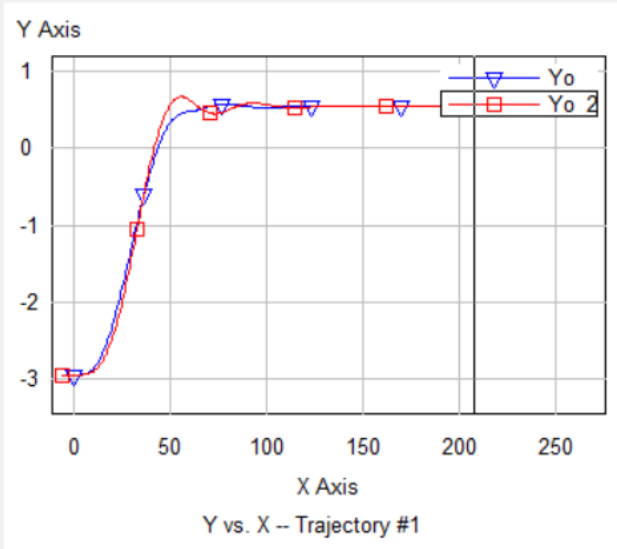
Autonomous Control of Steering and Speed during High-Speed Lane Change

Video 6









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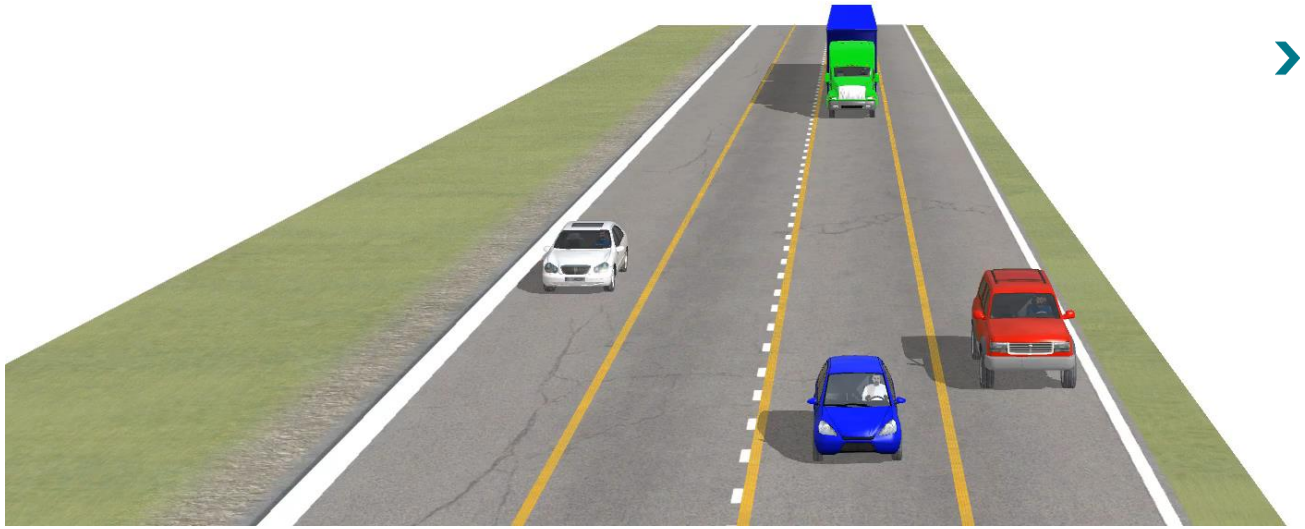
Perception, Planning and Control

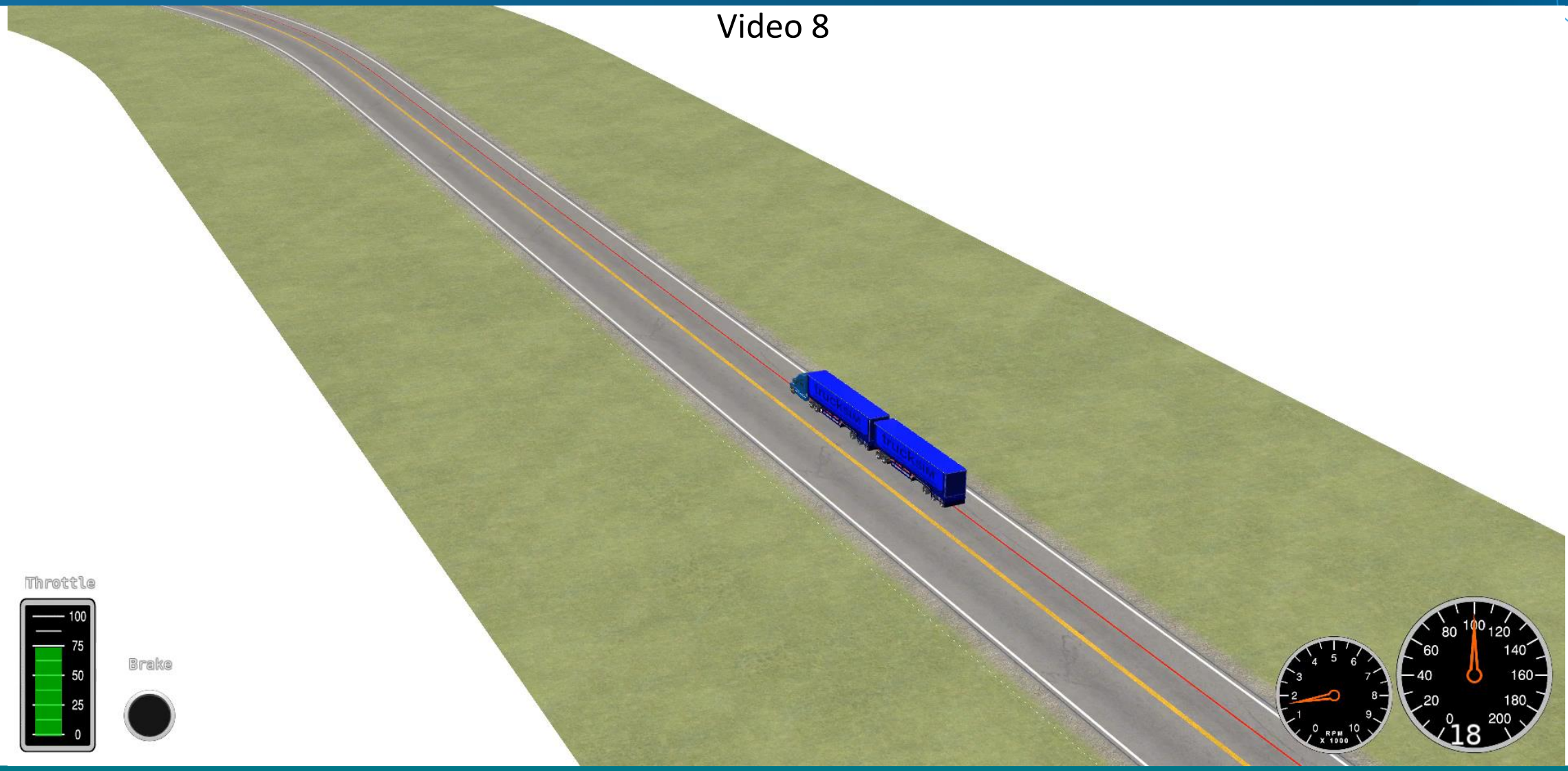
Video 7



- Collecting data from sensors;
- Using the data from the perception system to generate a safe and efficient path for the vehicle to follow;
- Executing the planned path, controlling the vehicle's speed, direction, and other aspects of its motion.

Engine, Braking and Steering Controls

Video 8



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