Driver - Vehicle Environment simulation

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Summary

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- Overview of SSDrive model
- Matlab® Simulink SSDrive model
- SSDrive model validation: VTI driving simulator test
- Preliminary results. VTI data vs SSDrive prediction 1/2 & 2/2
- SSDrive final release
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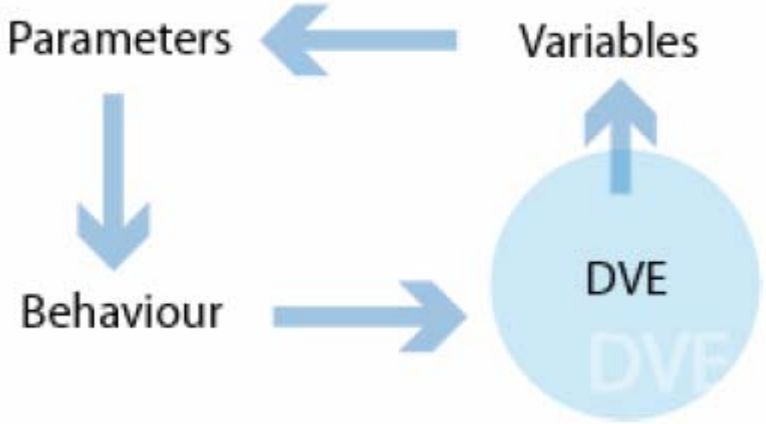
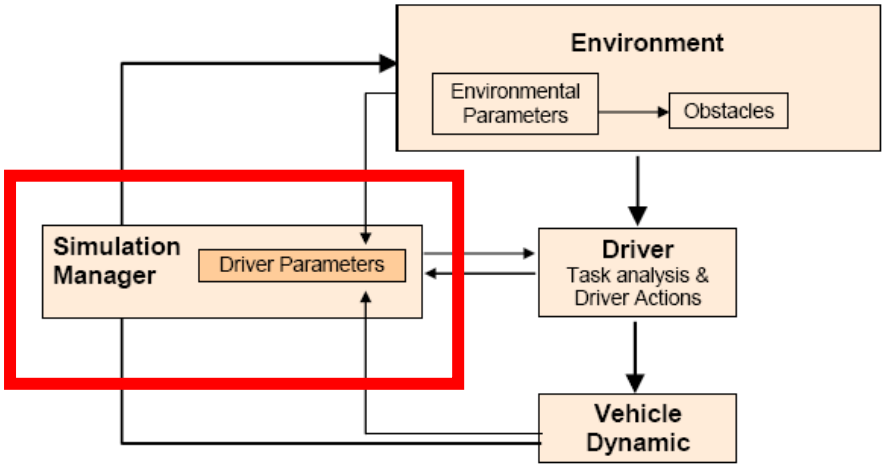
  - Environment model
  - Images of SSDrive simulator final release 1/3, 2/3 & 3/3

From the DVE to the SSDrive tool

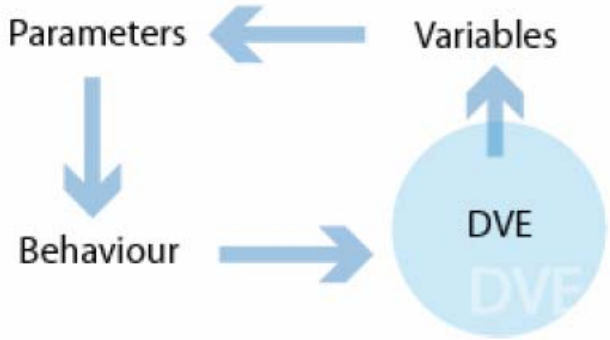
- The theoretical formulation of the Embedded Driver Vehicle Environment system was reproduced on a numerical simulation called SSDrive (Simple Simulation of Driver).





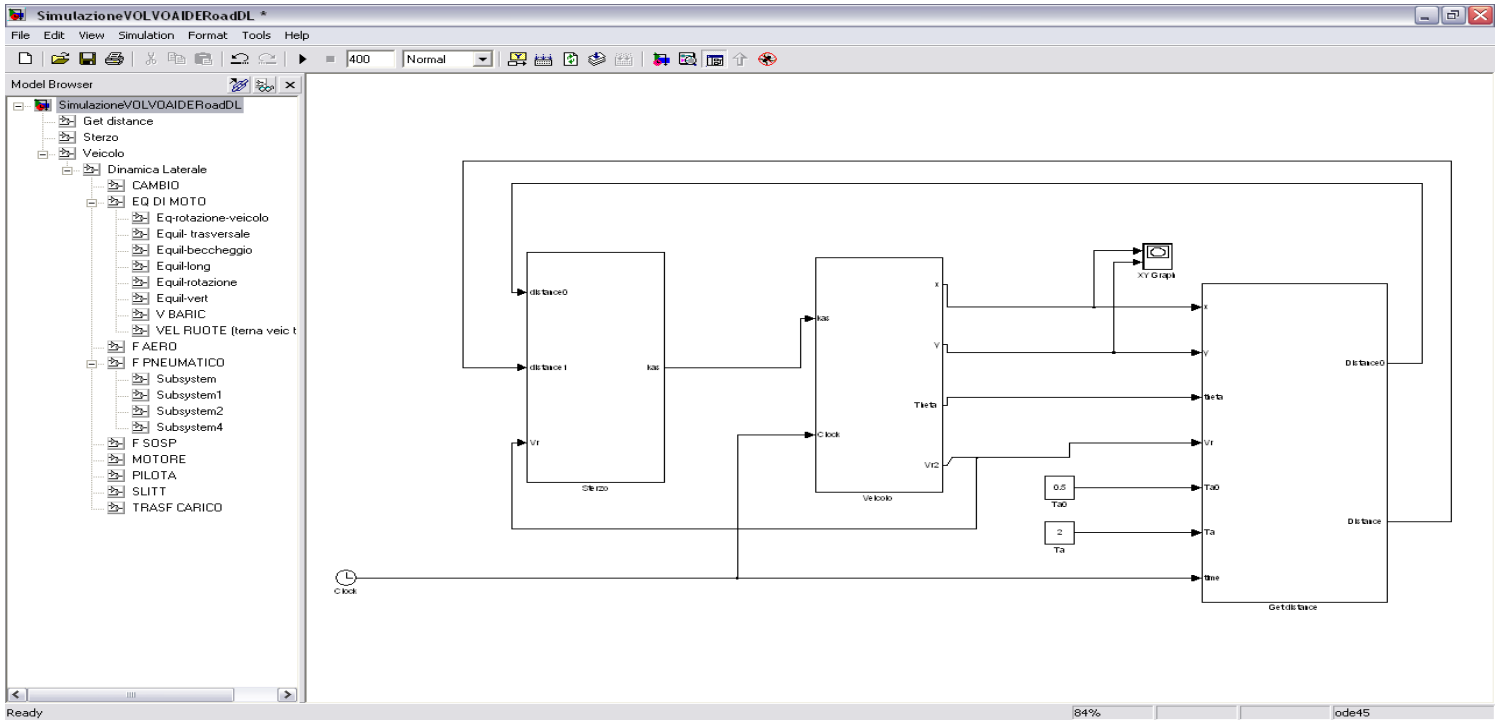
Overview of SSDrive model

- **Driver's decision making**:
  - Attain higher speed, change lane, overtake, maintain speed
  - Error generation
  - Permanent tasks: keep lateral safety margins, keep longitudinal safety margins
  - Normative and descriptive driver behaviour.
- Main **parameters** describing the Driver model:
  - **Experience**
  - **Attitude**
  - **Task Demand (TD)**
  - **Situation Awareness (SA)**
  - **Driver State (DS)**



Matlab® Simulink SSDrive model

- The first release of the SSdrive was developed in Simulink,
  - Firstly with model of steering based on Control Theory.
  - Then by means of an approach based on Proprioceptive and visual anticipation & Empirical Correlations

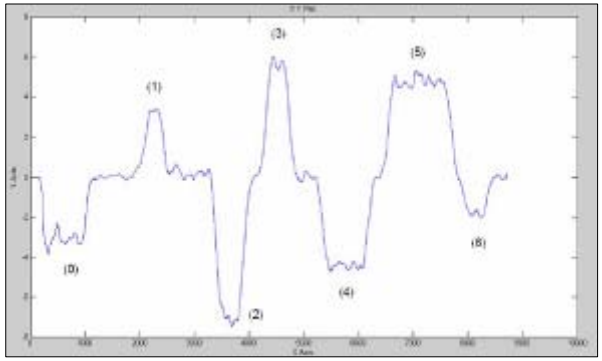


SSDrive model validation: VTI driving simulator test

- The test involved 36 persons divided into Novice, Average and Professional drivers (according to their age and driving experience).
  - Drivers were asked to drive in a 60 km dry road maintaining a 90km/h speed
  - An on board display simulated the activation of an IVIS (HASTE arrow task)
  - Three driving events (e.g. pedestrian crossing) caused the driver to slow down.
- Data on driver behaviour (steering wheel angle, speed, lateral position, etc.) were recorded to validate the SSDrive system.

The VTI driving simulator

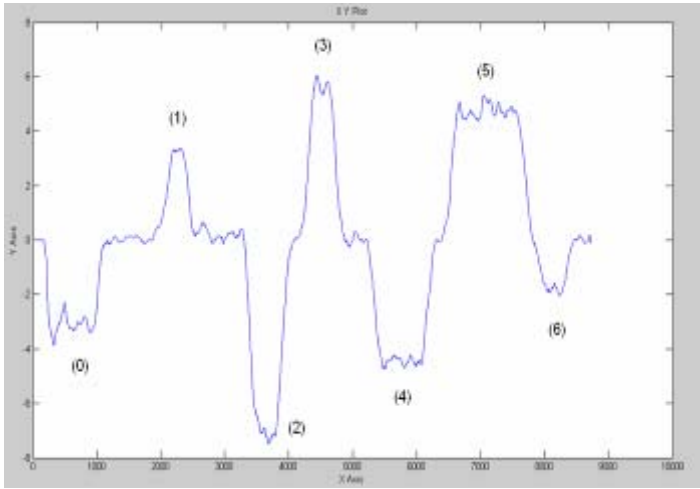
Driving scenario and tasks



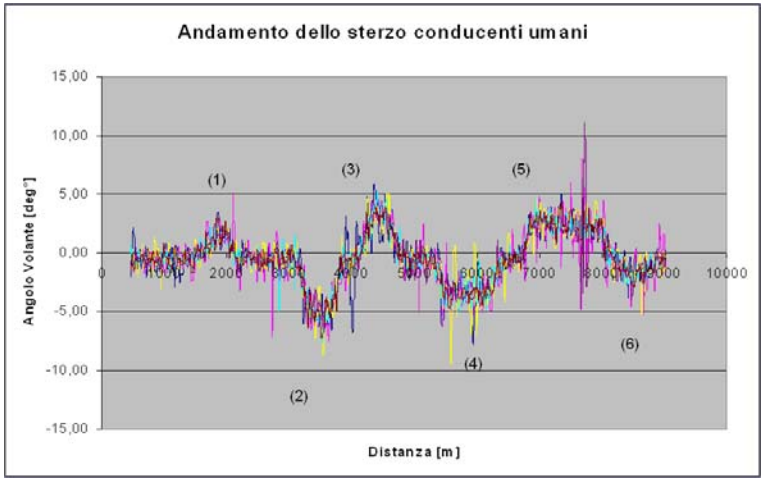
Collection of data (e.g. steering angle variation) for SSDrive validation

Preliminary results: VTI data vs SSDrive prediction 1/2

- Observed measures of driver behaviour on VTI driving simulator vs SSDrive model prediction



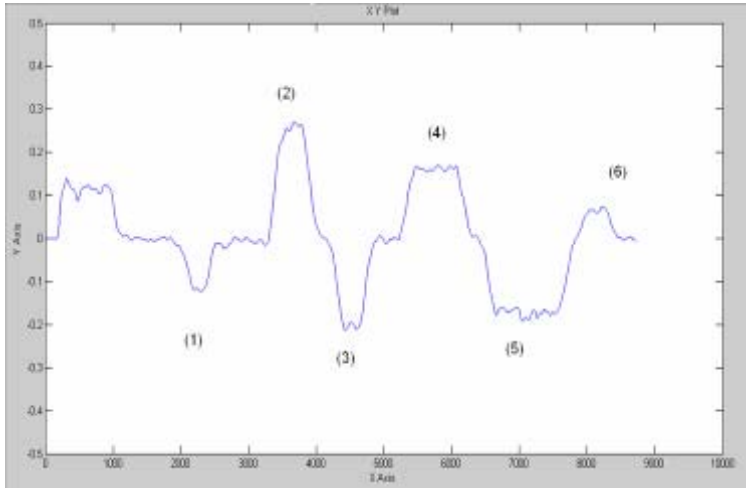
Predicted *steering angle (deg) vs driven distance (m)*



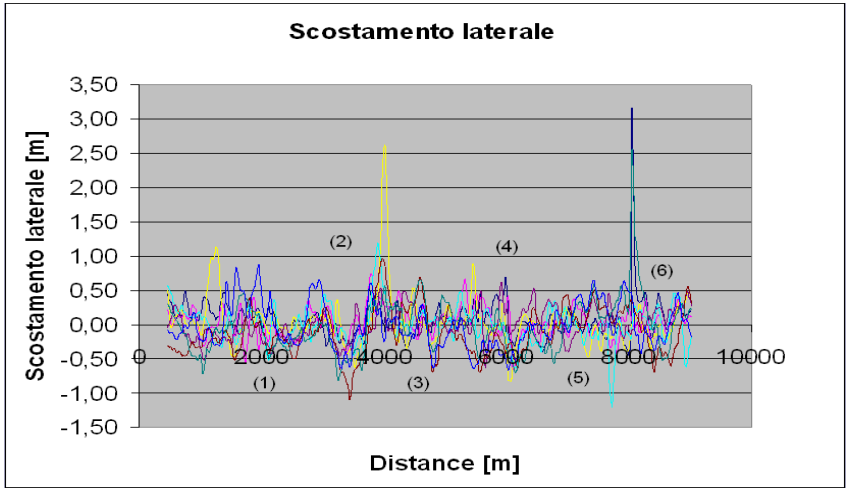
Observed *steering angle (deg) vs driven distance (m)*

Preliminary results: VTI data vs SSDrive prediction 2/2

- Comparing observed mean values from the SSDRIVE simulation with those supplied from the experiments in the VTI simulator, small differences are found (19%).



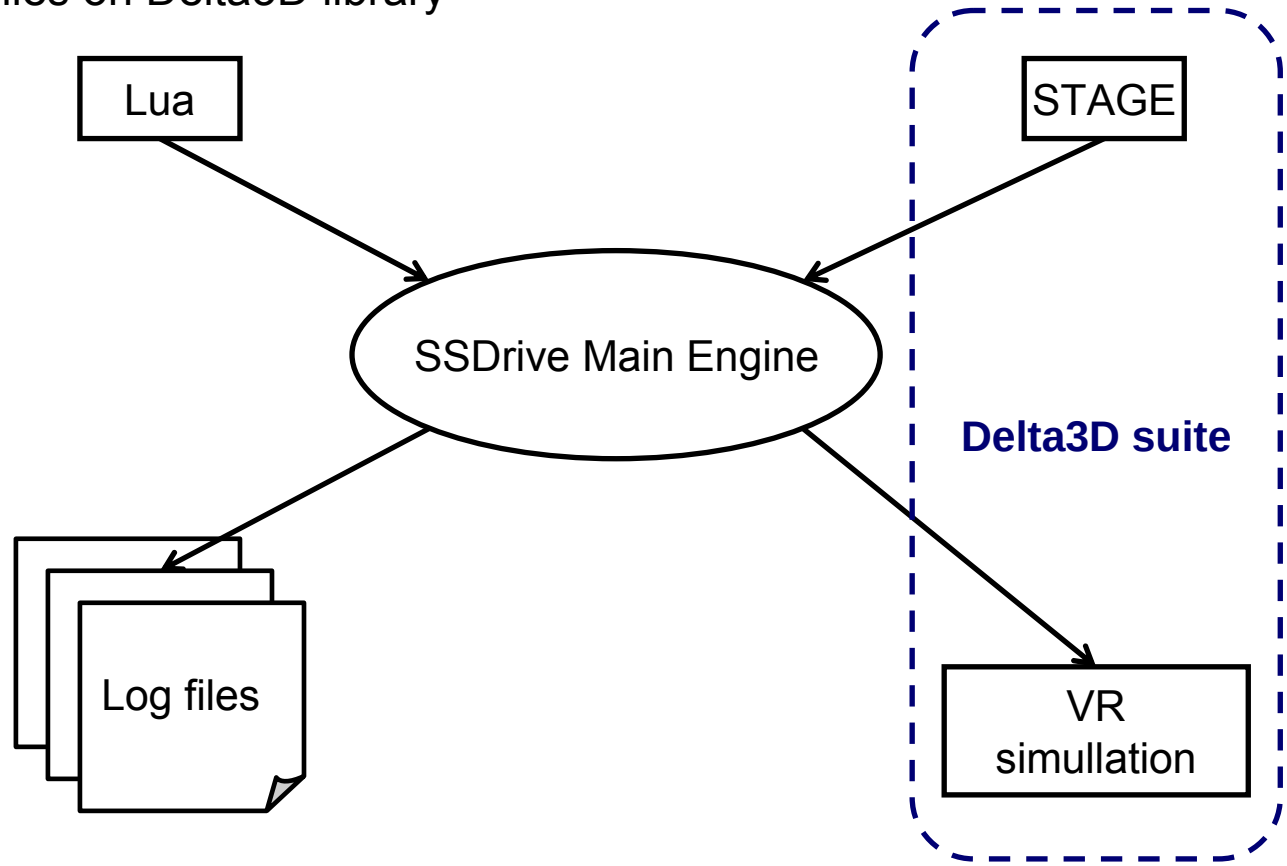
Predicted *lat. dist. from lane centre-line (m) vs driven dist. (m)*



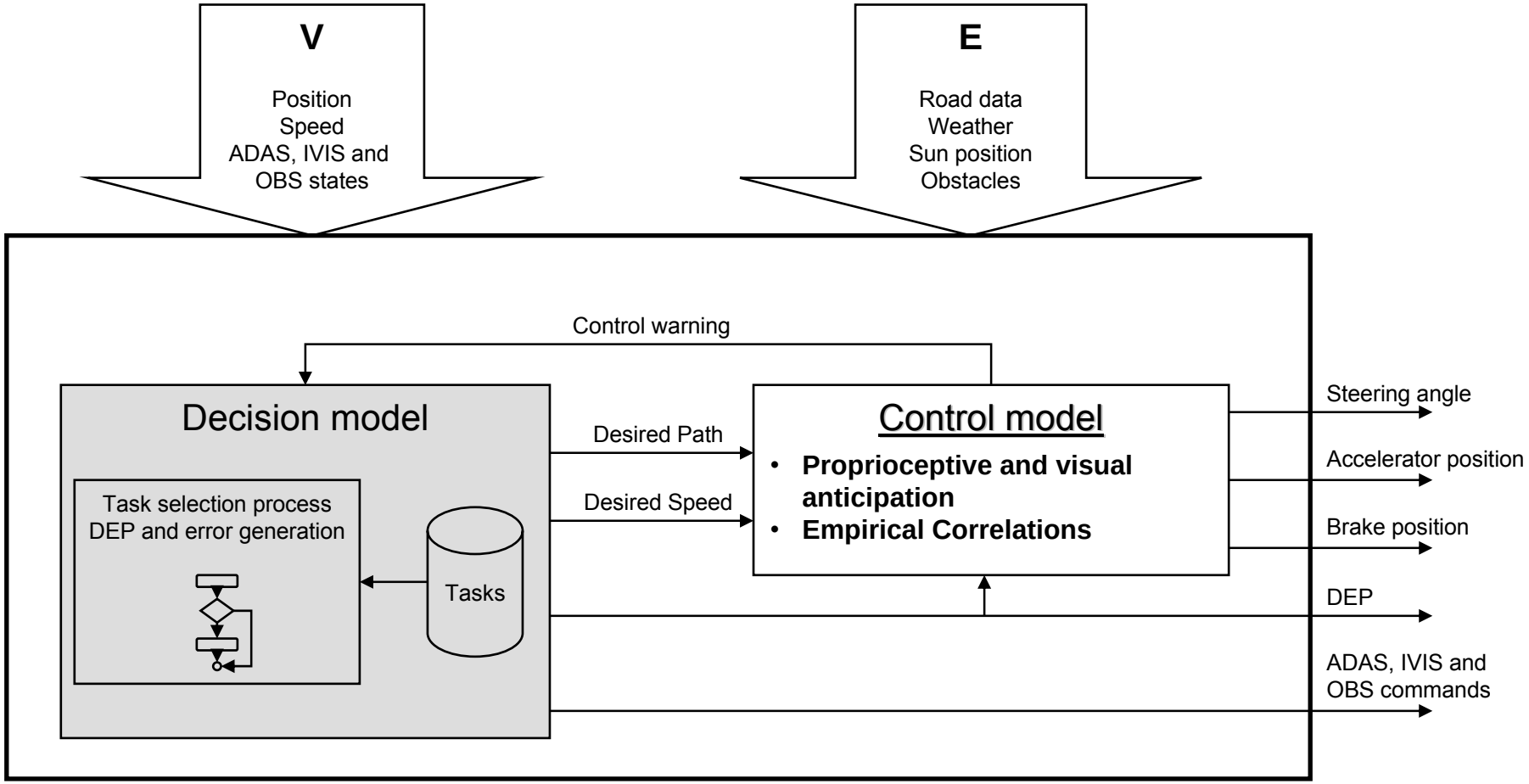
Observed *lat. dist. from lane centre-line (m) vs driven dist. (m) in VTI Simulator*

SSDrive final release

- C++ code which relies on Delta3D library
- Input:
  - STAGE
  - Lua script
- Output:
  - Log files
  - VR Simulation

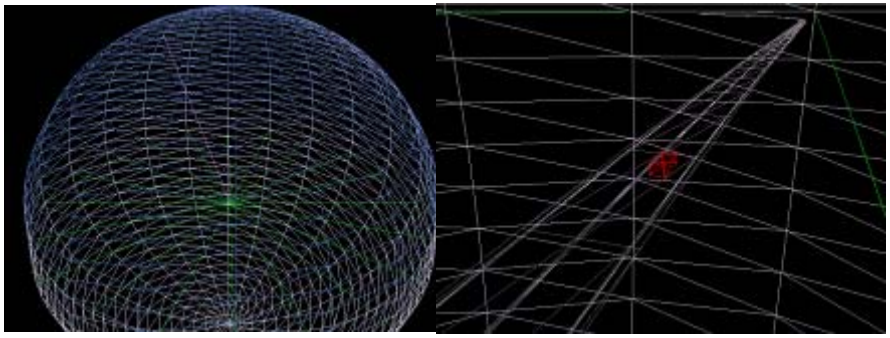


Driver model

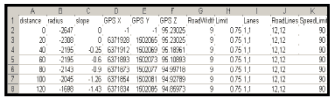


Environment model

VR representation



Road model



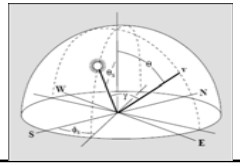
Traffic model

$$V_i(t) = fv(i,t)$$

$$P_i(t) = P_i(t-1) + V_i(t) \cdot \Delta t$$

Weather model

Sky dome model



Road shape, signs, restrictions

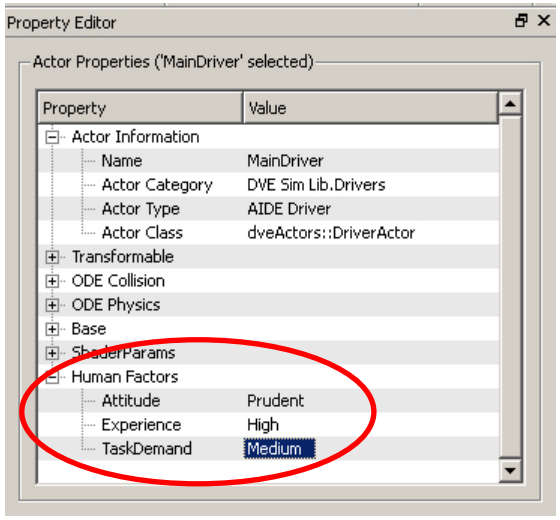
Obstacles

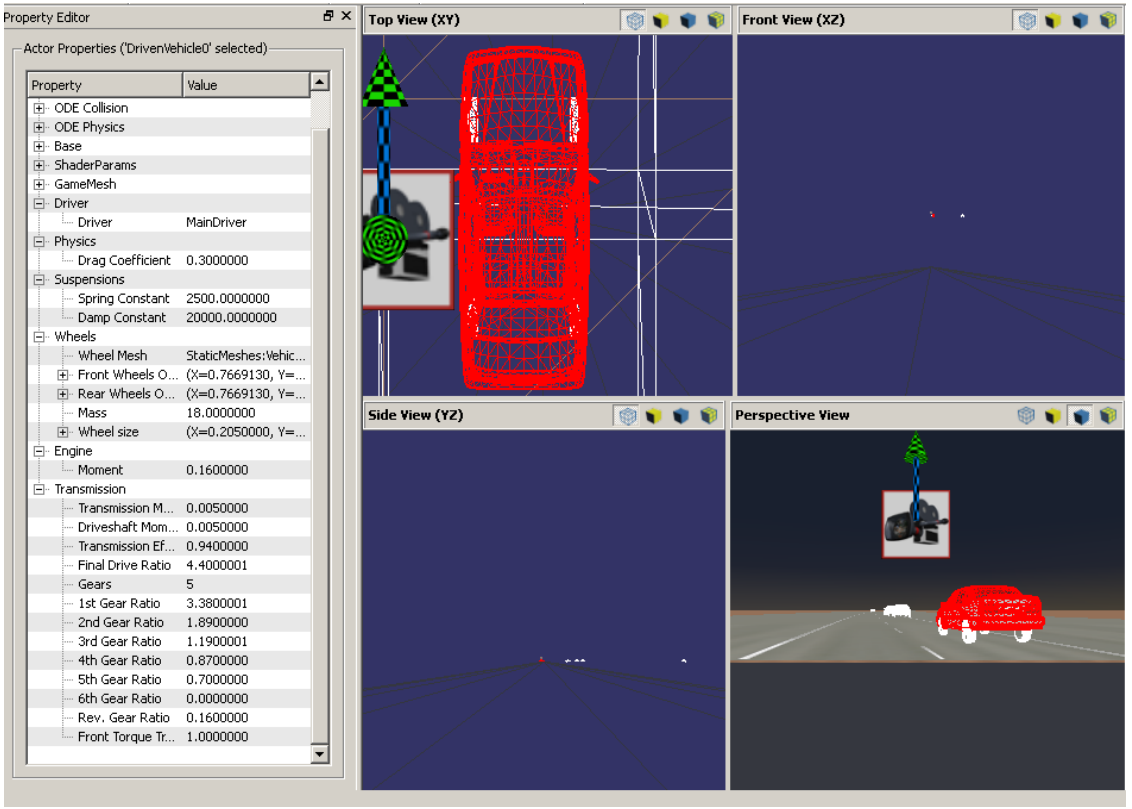
Weather condition

Sun position

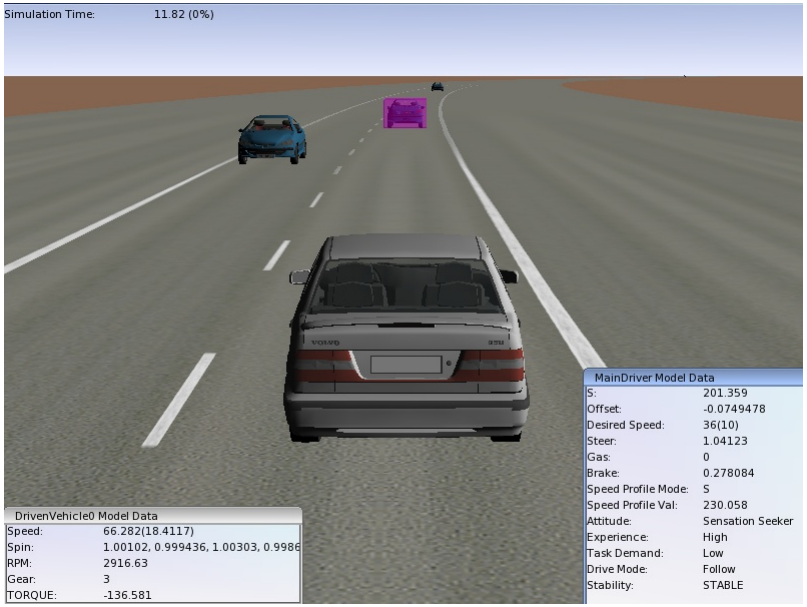
SSDrive final release 1/3

- Driver parameters, vehicle configuration and traffic conditions are set with the STAGE Editor Interface



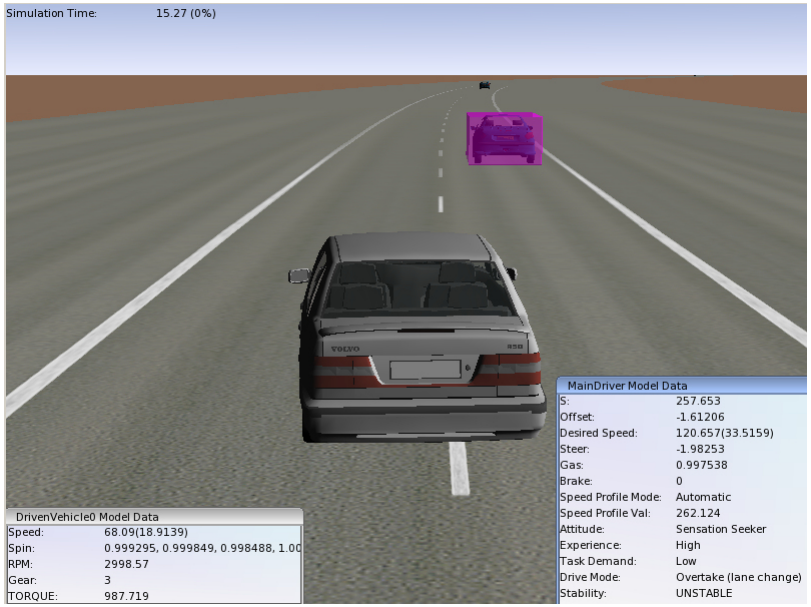


SSDrive final release 2/3



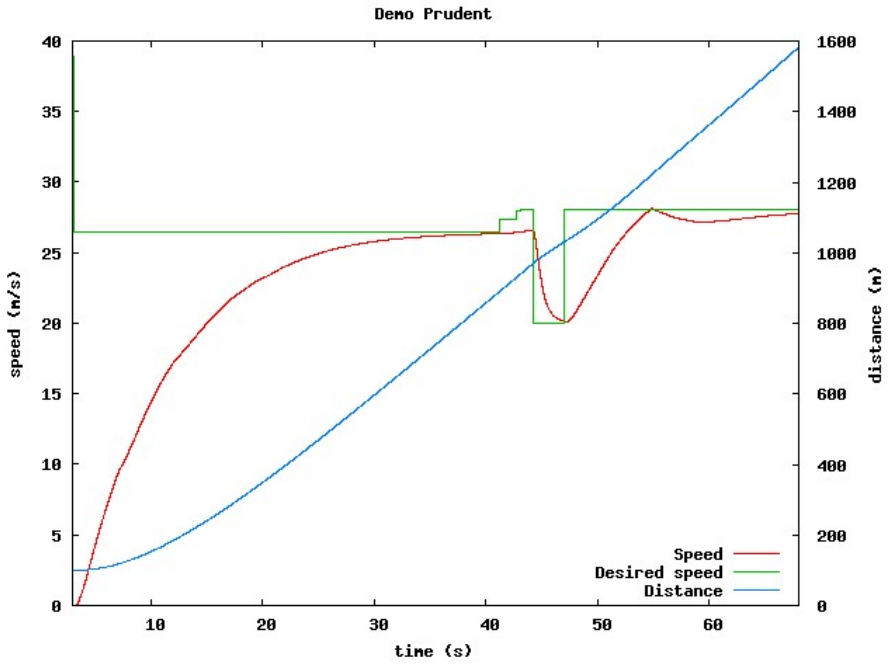
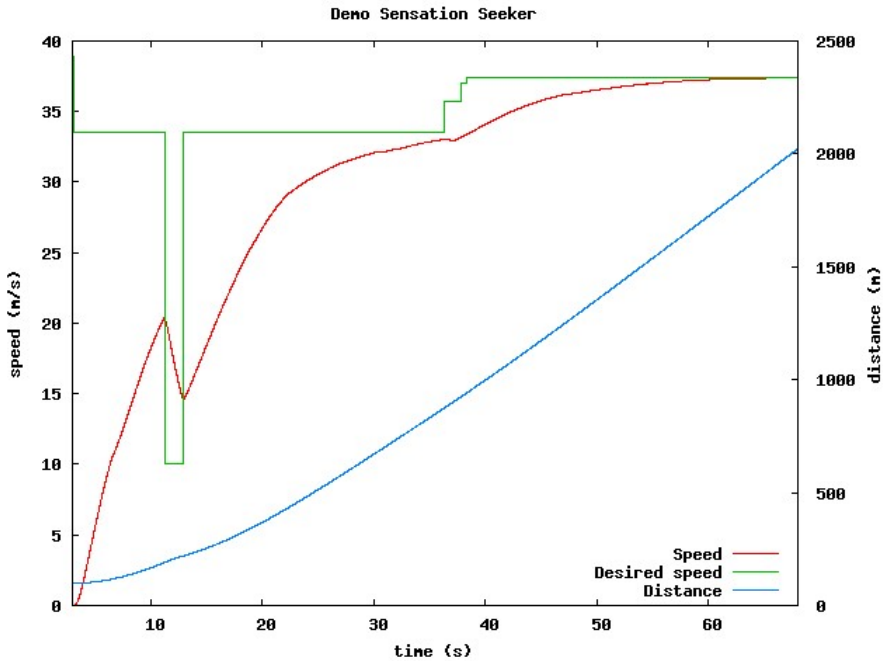
Follow

MainDriver Model Data	
S:	201.359
Offset:	-0.0749478
Desired Speed:	36(10)
Steer:	1.04123
Gas:	0
Brake:	0.278084
Speed Profile Mode:	S
Speed Profile Val:	230.058
Attitude:	Sensation Seeker
Experience:	High
Task Demand:	Low
Drive Mode:	Follow
Stability:	STABLE



Overtake:
Change Lane

MainDriver Model Data	
S:	257.653
Offset:	-1.61206
Desired Speed:	120.657(33.5159)
Steer:	-1.98253
Gas:	0.997538
Brake:	0
Speed Profile Mode:	Automatic
Speed Profile Val:	262.124
Attitude:	Sensation Seeker
Experience:	High
Task Demand:	Low
Drive Mode:	Overtake (lane change)
Stability:	UNSTABLE

SSDrive final release 3/3

- Different initial conditions lead to different dynamics