Dream-like simulation abilities for automated cars

DREAMS4CARS

Grant Agreement No. 731593

Deliverable: D4.3 – Cloud Environment

Dissemination level: CO – Confidential

Delivery date: 30/06/2018

Status: Final

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731593

Deliverable Title	Cloud Environment		
WP number and title	WP4 Agent evolution, evaluation of ability levels and final assessment of the Technology		
Lead Editor	Rafael Math, DFKI		
Contributors	Henrik Svensson, HIS		
	Riccardo Donà, UNITN		
Creation Date	20/03/2018	**Version number**	1.1
Deliverable Due Date	30/06/2018	**Actual Delivery Date**	29/06/2018
Nature of deliverable	x	R - Report	
	x	DEM – Demonstrator, pilot, prototype, plan designs	
		DEC – Websites, patents filing, press & media actions	
		O – Other – Software, technical diagram	
Dissemination Level/ Audience		PU – Public, fully open	
	x	CO - Confidential, restricted under conditions set out in MGA	
		CI – Classified, information as referred to in Commission Decision 2001/844/EC	

Version	Date	Modified by	Comments
0.1	20/March/2018	Rafael Math	Initial definition of contents
0.2	22/May/2018	Rafael Math	Added content to chapter 2
0.3	28/May/2018	Rafael Math	Added content to chapter 3
0.4	08/June/2018	Rafael Math	Added content to chapter 1, 2 and 3
0.5	12/June/2018	Rafael Math	Added content to chapter 2, 3, and 4
0.6	15/June/2018	Rafael Math	Added content to chapter 1, 2, and 3
0.7	19/June/2018	Rafael Math	Edited bibliography, added exec. summary
0.8	22/June/2018	Rafael Math	Minor changes before internal review
0.9	25/June/2018	Henrik Svensson	Minor additions
1.0	27/June/2018	Rafael Math	Final version
1.1	29/June/2918	Mauro Da Lio	Version for upload

Definitions, acronyms and abbreviations

Abbreviation	Meaning
2WD	Two-wheel Drive
4WD	Four-wheel Drive
AD	Autonomous Driving
ADAS	Advanced Driver Assistance System
ADASIS	Advanced Driver Assistance System Interface Specification
API	Application Programming Interface
CAN	Controller Area Network
D4C	Dreasm4Cars
DLL	Dynamic Link Library
EGO	Autonomous vehicle
ER3D	Easy Roads 3D Pro
FEA	Finite Element Analysis
FSI	Fluid-Solid Interaction
GPS	Global Positioning System
GPU	Graphical Processing Unit
GUI	Graphical User Interface
JAXB	Java Architecture for XML Binding
jME	jMonkeyEngine
JNA	Java Native Access
JRE	Java Runtime Environment
JSON	JavaScript Object Notation
L3DT	Large 3D terrain generator
LIDAR	Laser Imaging Detection and Ranging (a laser range sensor)

MBD	Multi-body Dynamics
MPI	Message Passing Interface
OBJ	Object file (a 3D model format; file extension *.obj)
OpenDS	Open Driving Simulator
OpenMP	Open Multi-Processing
PDF	Portable Document Format
PGM	Portable Graymap (an image format; file extension *.pgm)
UDP	User Datagram Protocol
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to any (where x equals either vehicle or infrastructure)
XML	Extensible Markup Language
XODR	OpenDRIVE file (a road specification format; file extension *.xodr)

Executive Summary

This document reports on the work done in WP4.3 "Cloud-based simulation environment" which spans from month 7 to month 18. The work can be divided into two major tasks: the automatized generation of realistic driving scenarios (Chapter 2) and the development of a driving simulation environment tailored to the needs of the project, based on an existing open-source simulator (Chapter 3).

In order to provide a simulation environment for the iterative improvement of the Codriver agent which can support the evolution techniques (e.g. learning from real-world situations), a sophisticated generation mechanism for arbitrary driving scenarios is needed first. The initial situation – the manual creation of virtual driving scenarios – is analysed in Section 2.1 to find possible approaches for automation. In Section 2.2 we point out different concepts to logically describe a driving scenario (especially the layout of the terrain and road model) and investigate several road generation tools. After the selection of the optimal road specification standard and road generation software, the tool chain to create a 3D driving environment from a textual description is explained in detail in Section 2.3. Firstly, we elaborate on the interface used to set up terrain, road network, intersections, and traffic parameters. Then, we present the terrain generation process applying deformation to the terrain surface for fitting in semantic road segments at a later stage. Finally, we demonstrate how the exact road reference lines represented by two-dimensional coordinates can be extracted from the description in order to be used to create semantic roads matching with the terrain.

Section 3.1 lists the implemented features of the OpenDS driving simulator, the core of the cloud-based simulation environment, and illustrates the structure of the available driving task files, which are used to provide a basic description of the driving scenario, dynamic scene objects, and event-based changes in the simulation state. Concerning Dreams4Cars, several extensions and modifications had to be added to the initial simulation environment, which are described in Section 3.2. The most important extensions are:

- OpenDRIVE support: in order to access semantic information of the underlying road description and provide it to the Codriver, the simulator needs to read and understand the specification format.
- Integration of the Chrono physics engine: since the built-in physics engine lacks of a proper vehicle dynamics model, an alternative physics engine has been integrated which improves realism at the cost of performance.
- Codriver integration: a communication interface between Codriver agent and simulation environment has been implemented providing more than 50 vehicle and environment parameters to the Codriver several times per second. Conversely, the simulator receives data for longitudinal and lateral vehicle control.
- Sensor and V2X simulation: additional sensors providing high-level data to the Codriver and V2X data sources providing data about vehicles in the vicinity have been implemented. Sensor and V2X data constitute more than half of the parameters being sent to the Codriver.

Chapter 4 highlights the efforts concerning the validation of the road generation process and the testing of the Codriver integration.

In addition to this report, a software deliverable containing the latest version of the driving simulation and the complete road generation tool chain has been released. A hands-on tutorial demonstrating the features of the simulation environment from the road generation to the simulation of the Codriver-controlled vehicle has been provided.