Poster: Characterizing Driving Behaviors through a Car Simulation Platform

Sébastien Faye, Sasan Jafarnejad, Juan Costamagna, German Castignani, Thomas Engel
University of Luxembourg, SnT
6 avenue de la Fonte, L-4362 Esch-sur-Alzette, Luxembourg
Email: {firstname.lastname}@uni.lu

***Abstract*—Human mobility has opened up to many themes in recent years. Human behavior and how a driver might react to certain situations, whether dangerous (e.g. an accident) or simply part of the evolution of new technologies (e.g. autonomous driving), leaves many avenues to be explored. Although experiments have been deployed in real situations, it remains difficult to encounter the conditions that certain studies may require. For this reason, we have set up a driving simulator (comprising several modules) that is able to reproduce a realistic driving environment. Although, as the literature has already demonstrated, the conditions are often far from reality, simulation platforms are nonetheless capable of reproducing an incredibly large number of scenarios on the fly [1]. In this poster, we explain how we conceived the simulator, as well as the system we developed for collecting metrics on both the driver and the simulation environment. In addition, we take advantage of this conference to publicly share a dataset consisting of 25 drivers performing the same road circuit on the "Project Cars" [1] game.**

I. Overview of the Driving Simulator

As illustrated in Figure 1, the driving simulator is broken down into four main complementary parts: (i) a seat equipped with a motion platform, developed by Next Level Racing, which allows the user to feel the effects of his movements in the driving scenario; (ii) a virtual reality headset (HTC Vive), which immerses the user more intensely into the driving scenario by providing a 360 degree view of the simulated surroundings; (iii) foot pedals and a steering wheel with force feedback (Logitech G920); and finally (iv) the software that controls all this equipment and allows the collection of data from the 3D simulation environment. If realistic environments are currently being developed to favor an urban scenario, we focus the study described here on the use of a popular game, Project Cars.

II. Dataset

The data collection software is interconnected with each of the simulator components. The data coming from the steering wheel (e.g. angle), the pedals (e.g. throttle) and the headset (e.g. head orientation) make it possible to describe the behavior of the user, while data coming directly from the simulation interface make it possible to monitor environmental conditions and simulate on-board car computer metrics (e.g. speed, rpm). In the case of Project Cars, it is possible, for example, to collect the position of the car on the circuit. These metrics are described in Table I.

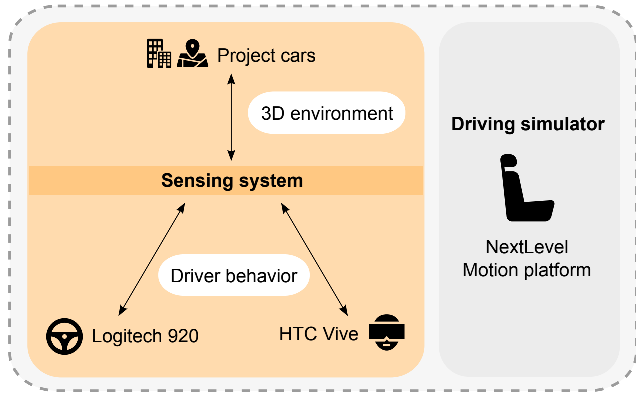


Fig. 1. Overview of the driving simulator

As part of this conference, we make a dataset available online[2]. This dataset was collected in June 2017. All users were instructed to ride on the same circuit under the same conditions. The dataset covers 25 users and 46 sessions. It contains the types of data described below. Figure 2 serves as an example and describes two users from our dataset, showing the effect of different behaviors on two driving metrics (i.e. throttle and steering axis).

III. Poster & Research Perspectives

Through a poster, the authors would like to show the potential of using a driving simulator, in addition to release the dataset described in Section II. We will also introduce the ongoing research and future research perspectives for the introduced platform and its resulting dataset.

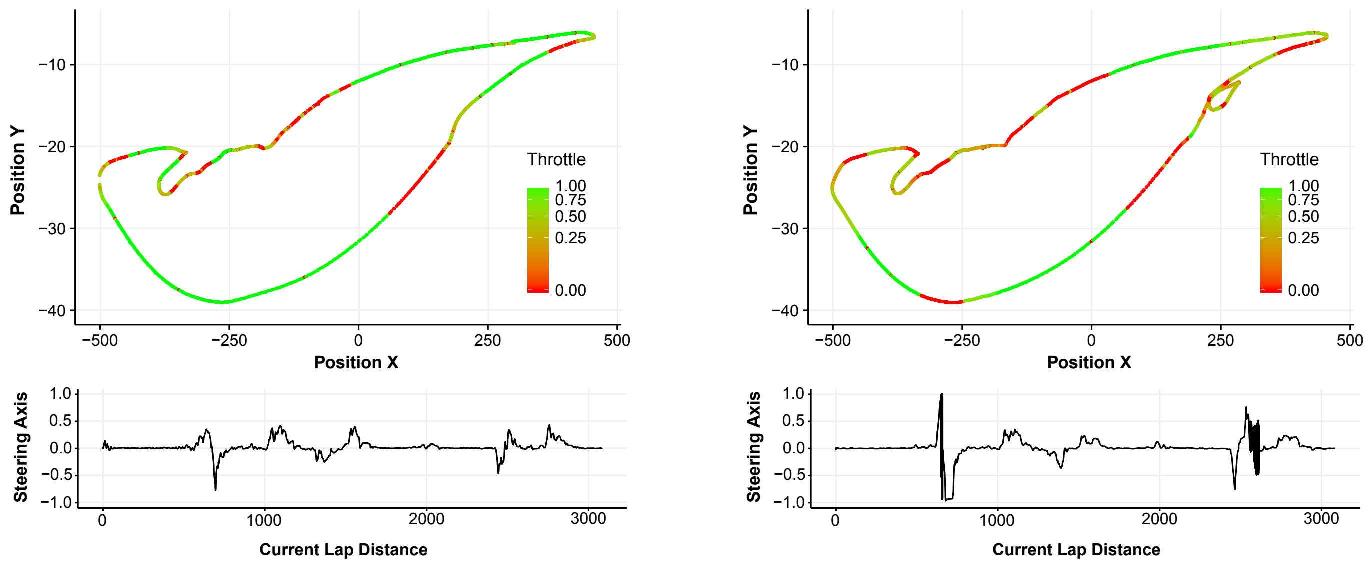
One of the topics of interest is the study of driver behavior. The way in which people move or apprehend a situation arises from characteristics that remain personal. The ability to model driving style to the same level as the modeling of all the decision-making factors taken by a driver remains a topic of great interest, both in the research community and in industry. At a time when car manufacturers are increasingly looking for personal systems, we believe that modeling and studying these aspects makes sense. Thus, this simulator has been created for the purpose of reproducing and studying these characteristic

[1] `http://www.projectcarsgame.com/`

[2] `https://goo.gl/sKxPeS`

TABLE I
KEY METRICS COLLECTED BY OUR SENSING SYSTEM.

Devices	Metrics	Unit	Recording rate	Comment
Headset (HTC Vive)	Position (X,Y,Z)	meters	29 Hz	Meters in reference to VR center
	Orientation (X,Y,Z)	Quaternion [-1,1] (X,Y,Z)		In unit represents the angle in reference to the front of the VR
Driving controls (Logitech G920)	Steering	[0 , 65535]		Axis of the Steering Wheel
	Throttle	[0 , 65535]		Magnitude of the slider
	Brake	[0 , 65535]		Magnitude of the slider
	Clutch	[0 , 65535]		Magnitude of the slider
3D environment (Project Cars)	Speed	m/s		Current speed of the car
	Race state	Boolean		State of the game
	World position (X,Y,Z)	m		Position of the car in the game
	Brake	[0 , 1]		Magnitude of the slider
	Throttle	[0 , 1]		Magnitude of the slider
	Orientation (X,Y,Z)	Euler Angles		Orientation of the Car
	Terrain	enum		Terrain of each wheel
	Steering	[-1,1]		Axis of the Steering Wheel
	RPM	Revolutions per minute		Current Revolutions per minute
	Current Lap Distance	m		Current distance in meters done
	Lap number	Integer		Current Lap



(a) Good driver (i.e. low lap time)

(b) Bad driver (i.e. high lap time)

Fig. 2. Comparison of two driver profiles. The first driver (at the left) has more constant accelerations, while the second one (at the right) has more sudden gestures and does not follow the circuit accurately.

phenomena in an experimental way – this environment being a good intermediary between purely numerical simulations and real deployment.

Using this platform, it is for example possible to analyze how a driver approaches a turn both in terms of speed adjustments using the pedals and the steering angle they take when entering the turn. Such analysis can be used to develop new driver models. As part of our ongoing research, we have recently developed a driver identification model based on driving style [2]. We intend to further validate this model using the above mentioned dataset and present the results in the poster. We are also actively working on other technologies, such as smart devices that have the potential to be integrated into the driving simulator [3].

Since our research group is also active in modeling aggressive and distracted driving, we also have an interest in adapting the simulation platform so that we can analyze how certain distractions affect driving performance in urban environments. Therefore, in the future, we aim to explore urban scenarios, or the ways in which users can get distracted by certain elements of the simulation interface. This component can open new doors for researchers to model driver distractions and their influence on safe driving.

REFERENCES

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