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Subjective Validity of Bicycle Simulator

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Murad Shoman obtained his bachelor degree in Civil Engineering at An-Najah National University-Palestine. As a part of ERASMUS MUNDUS program, he moved to Italy where he got his master in Territorial Infrastructure Planning at University of Bologna. Murad is currently a PhD Student at Gustave Eiffel University (UGE) and MSCA Early Stage Researcher within SaferUP project. His research is focused on studying the effects of road surface characteristics and geometries on safer user behavior.

Introduction

- Bicycle simulators is a promising tool to address challenges:

1. learning to drive .
2. awareness of risks.
3. road safety.
4. Studying road-user behavior .

- Two categories of bicycle simulators:

1. motionless simulators.
2. mobile-based simulators.

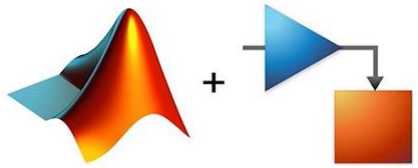
Objectives

- Develop new dynamical model for PICS-L bicycle simulator, taking into account road characteristics.
- Validate the model **Subjectively** and **Physically** through experimentation.

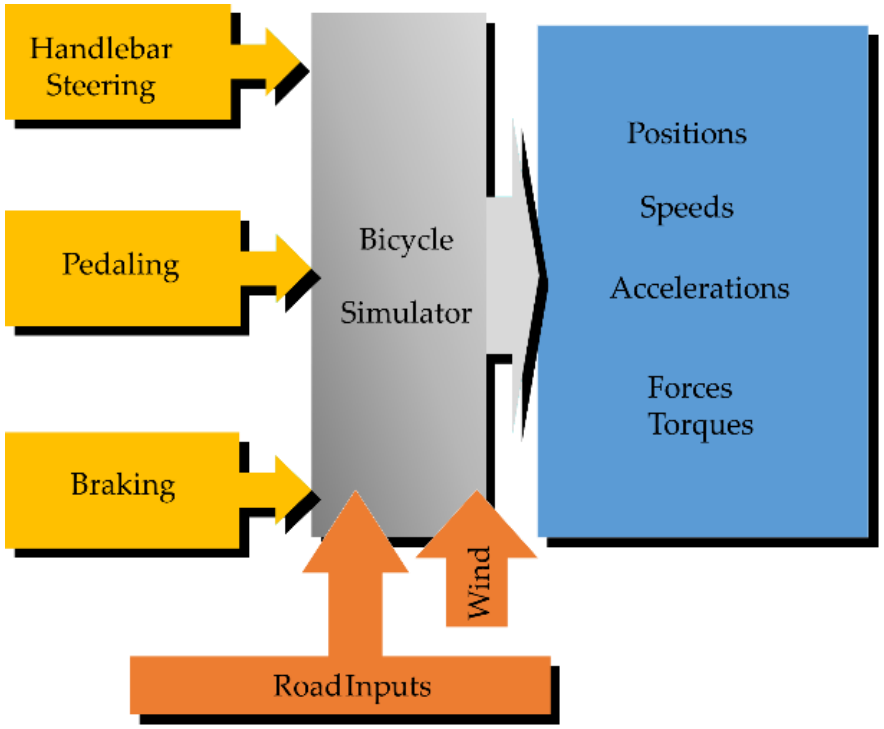
Dynamical Modeling

- The following forces was included while developing the model:

$$m.\frac{dv}{dt} = F_F + F_a + F_c + F_B + F_g$$



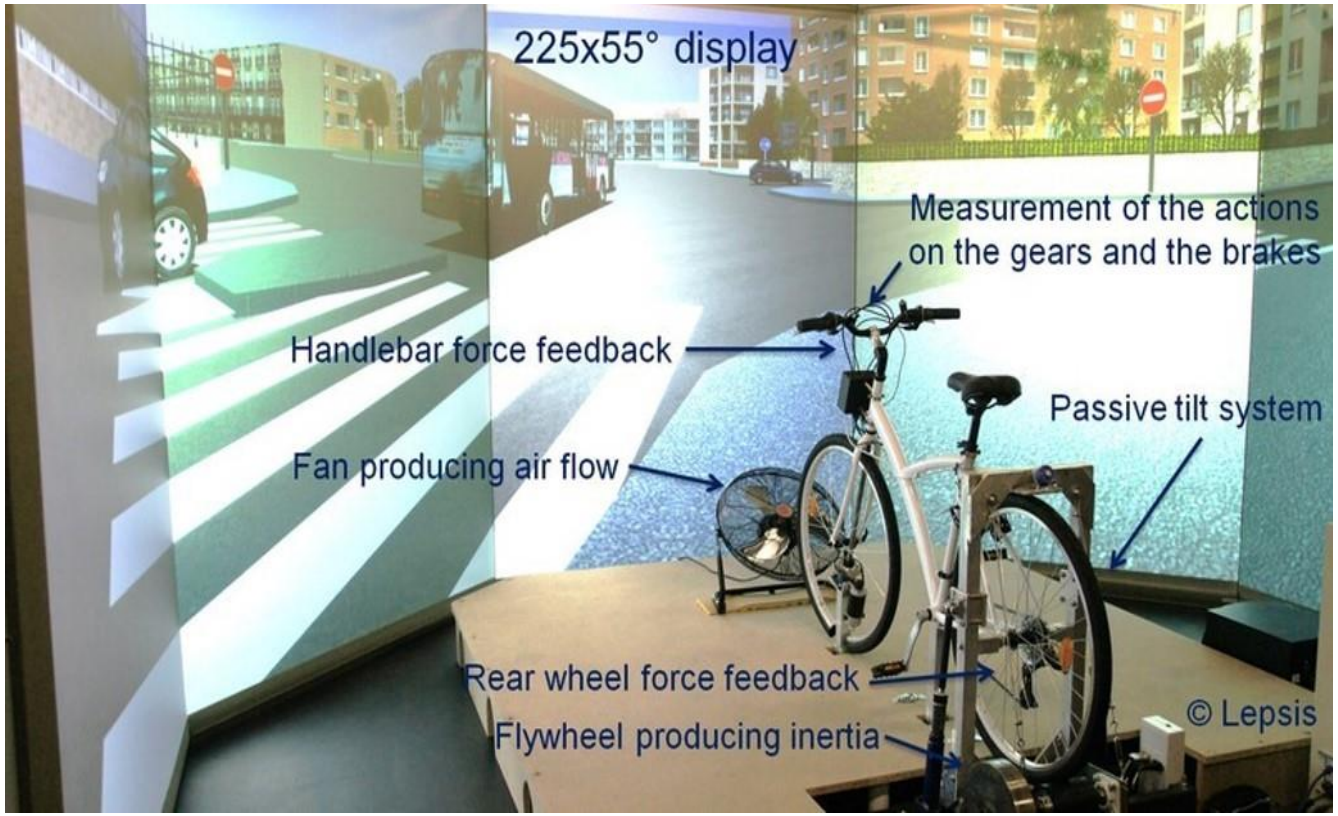
Simulink+ Matlab 2019



Input/Outputs of the bicycle simulator.

Experimental Setup

- The experiment was conducted using PICS-L bicycle simulator, the different features appears in the figure bellow.



PICS-L bicycle simulator

Experimental Scenario (1/2)

- 10 subjects (6 M and 4 F).
- The simulated urban environment consists of two sections: the first is a **bicycle-bus** shared lane, the latter a **separated** bike lane.
- They rode the bicycle for 10 minutes using the handlebar, pedals, gear and brakes.

A subject during the experiments.

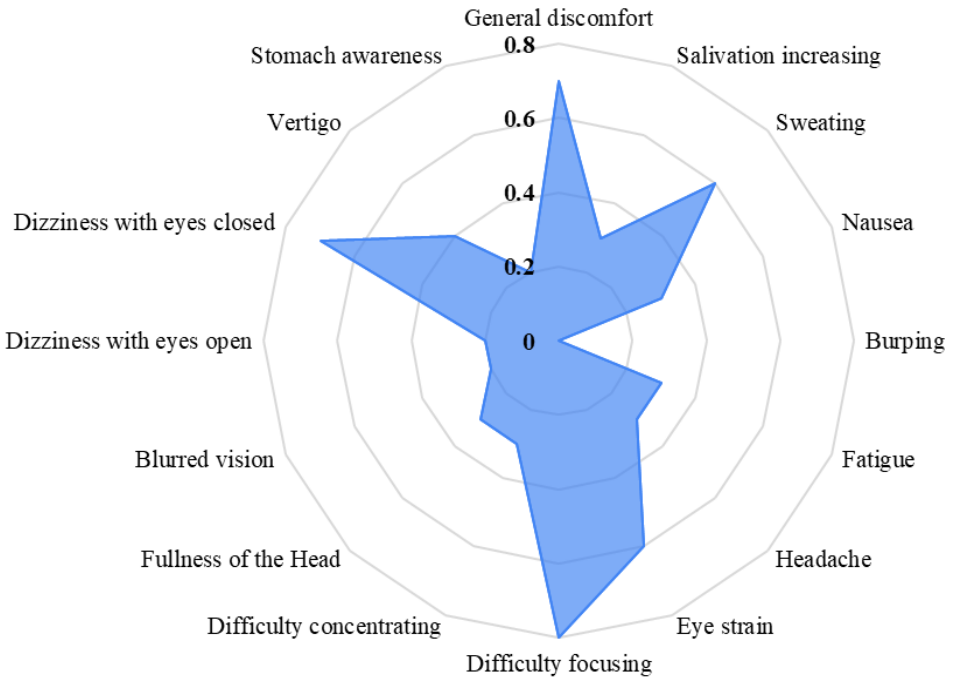
Experimental Scenario (2/2)

- After the end of the experiment participants answered 3 questionnaires:

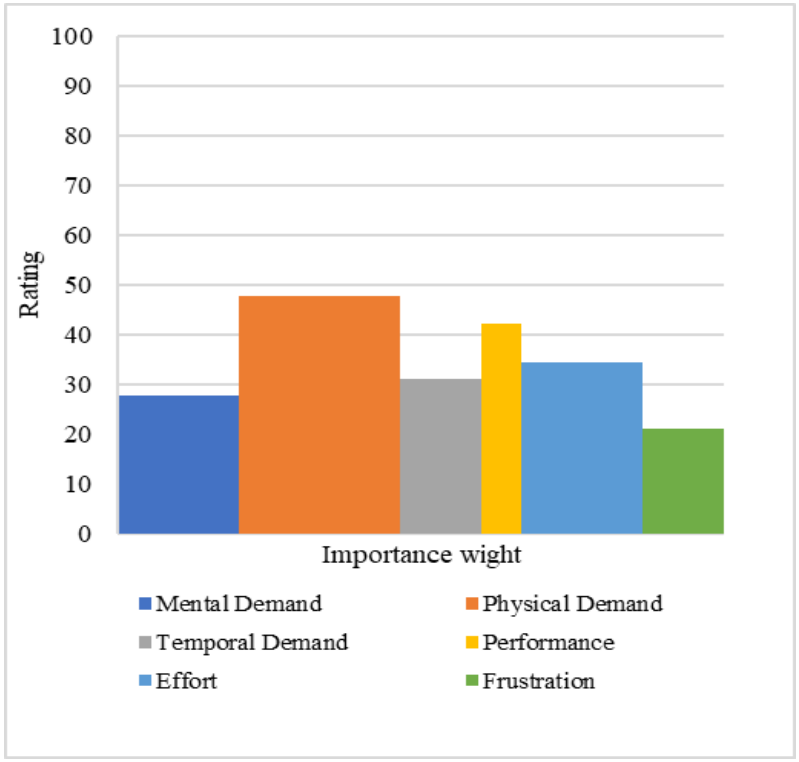
1. General questions and cycling experience.
2. Simulator Sickness Questionnaire (SSQ).
3. Nasa Task Load Index (TLX).

- Data were logged and analyzed through real time workshop/Matlab.

SSQ and TLX results



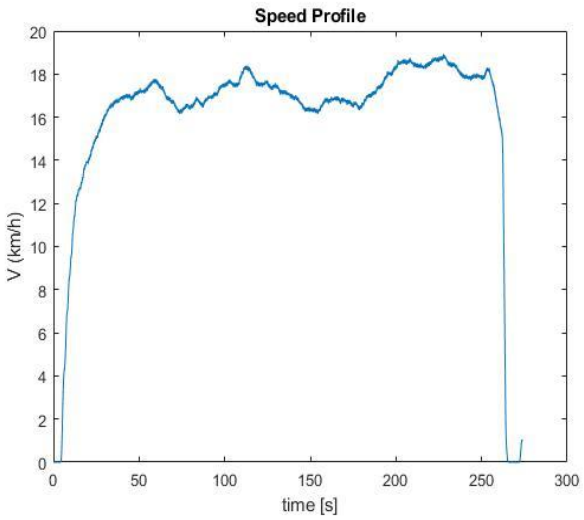
Mean scores observed in each item of the exposure of simulator sickness questionnaire.



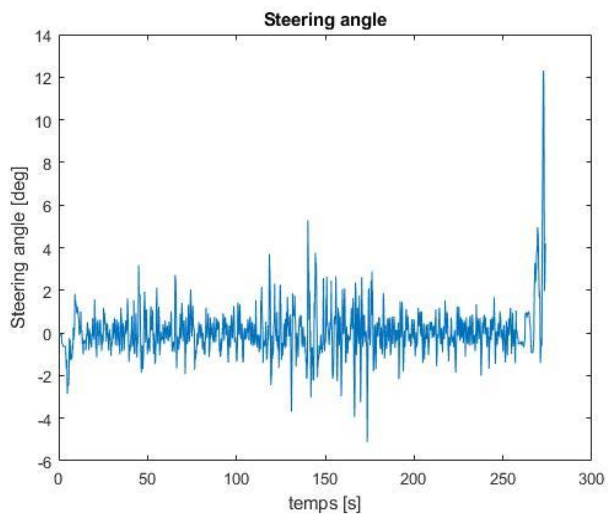
Graphic representation of the composition of a weighted workload score.

Simulation Outputs

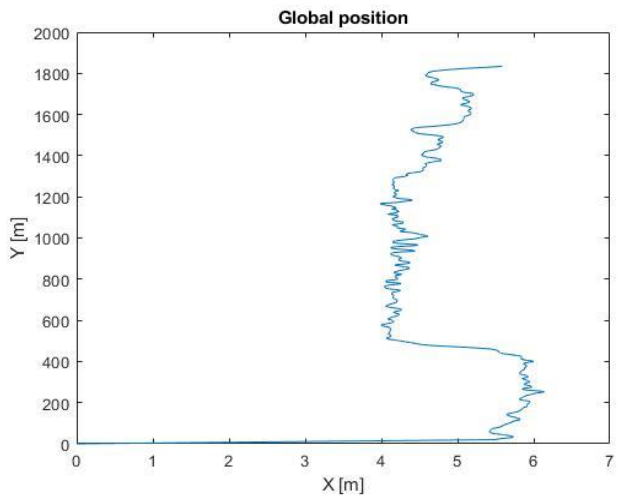
- Some outputs of the dynamical model of the simulator shown in the following figures, these outputs will be analyzed in the future to study the cycling behavior.



Speed profile of one of the participants in km/h.



Steering angle of the simulator handlebar.



Global position of the simulator extracted from the virtual environment.

Conclusion

- The bicycle simulator enables us to put cyclists in a riding situation and accurately measure their effective behavior, while controlling the variables at play and avoiding the risks associated with a real environment.
- The experimental results show low simulator sickness and relatively high workload, which could be explained by the effort done by the cyclist.
- A larger sample of 36 subjects participated in another experiment. The results of the new experiment will be published in an upcoming paper.

References

[1] M. Shoman and H. Imine, “Subjective Validity of Bicycle Simulator”, In VEHICULAR 2020, Porto, 2020.

[2] M. Shoman and H. Imine, "Modeling and simulation of bicycle dynamics ", In TRA 2020, Transportation Research Arena, TRA, 2020, doi:10.5281/zenodo.3775338.

Acknowledgment

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Thinking Beyond the Pavement

Université Gustave Eiffel

Thanks for attention

Questions?

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