



Introduction

**50,000**  
Fatalities among cyclists

User Behavior

**90%**

Accident Triggers

Simulators as Tools

Research Plan

➤ **Mathematical Modeling** of the bicycle simulator:

- Road Characteristics.
- Bicycle Dynamic parameters.
- Aerodynamic resistance.

PICS-L Simulator.

➤ **Physical Validity.**

Simulink- Matlab.

➤ **Subjective Validity.**

➤ **Special needs of disabled and elderly.**

Interaction with infrastructure and other road users.

➤ **Experimentation with instrumented bicycles in bad weather conditions.**

➤ **Risky Situations experiments using the Simulator.**

➤ **Comparison studies between reality and simulation.**

Results

**Calculation of Displacements and Forces**

Road profile input ( $u$ ).

Vertical displacement ( $z$ ).

$$F_z = F_c + k(u - z)$$

Steering angle.

$$\alpha_F = -\beta + \delta_W - \frac{l_F \cdot \psi}{v_{COG}}$$

Side slip angle ( $\alpha$ ).

$$F_y = \alpha \times C_y$$

Adhesion coefficient ( $\mu$ ).

$$F_x = \mu \times F_z \times \cos \alpha$$

Vertical force ( $F_z$ ).

Front Wheel

Rear Wheel

Vertical force ( $F_z$ ).

Front Wheel

Adhesion coefficient ( $\mu$ ).

Front Wheel

Longitudinal force ( $F_x$ ).

Front Wheel

Side slip angle (deg).

Front Wheel

Steering angle (deg).

Front Wheel

Lateral force ( $F_y$ ).

Work Load & Simulator Sickness

➤ The participant tests the simulator for around 10 min.

Task Load Index

➤ The results obtained from experimental studies show the accuracy of the developed model as well as the validity of the simulator.

Simulator Sickness

References

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2. Stephane Caro and Silvia Bernardi. The role of various sensory cues in self-speed perception: a bicycle riding simulator preliminary study. In DSC 2015-Driving simulation conference, 2015.
3. Andrew Erwin Dressel. Measuring and modeling the mechanical properties of bicycle tires. Doctoral dissertation, The University of Wisconsin-Milwaukee, 2013.

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