Eurobike

PENDLERATD

HEILBRONN UNIVERSITY OF APPLIED SCIENCES

UniTyLab

Virtual Reality Bicycle Simulation

A PendlerRatD research project in cooperation with UniTyLab (Heilbronn University)

BACKGROUND AND OBJECTIVE

Cycling is gaining relevance as a sustainable mode of urban mobility, yet many individuals still **feel unsafe** sharing the road with motorized traffic.

To address these challenges, researchers at Heilbronn University's UniTyLab developed an innovative **VR-based bicycle simulator**.

The goal: simulate real-world cycling conditions in a safe, controlled, and immersive environment.

This project combines physical hardware, real-time sensor integration, and advanced simulation environments to support research in traffic safety, urban mobility, and cyclist behavior.

The VR bicycle simulator allows researchers to study rare or dangerous traffic scenarios without risking participant safety and opens new possibilities for evaluating infrastructure and training users with limited road cycling experience.





UniTyLab – VR LABORATORY & SETUP

- **Physical Setup**: A standard bicycle frame is mounted on a Saris MP1 motion platform, allowing realistic roll and fore/aft movement.
- **Sensors:** Includes a high-resolution steering encoder, rotary Hall brake sensor, BNO055 tilt sensor, Hall-effect speed and cadence sensors, and a reverse motion sensor.
- **Actuators:** Pedal resistance is managed via the ELITE Direto XR-T smart trainer. Incline simulation is handled by the ELITE Rizer, and airflow feedback is provided by the Wahoo Kickr Headwind.
- **Simulation & Communication:** Real-time data exchange between hardware and Unity simulation is achieved using UDP and Bluetooth Low Energy (BLE), coordinated through Python scripts.
- **Virtual Environment:** The simulation replicates German urban road scenarios implemented in Unity, with immersive visuals delivered through the HTC Vive Pro headset.

RESEARCH USE CASES:

- **Traffic Safety Studies:** Analyze cyclist behavior in high-risk urban traffic situations without real-world danger.
- **Cyclophobia Mitigation:** Provide a safe environment for users with fear of cycling to build confidence gradually.
- **Urban Infrastructure Testing:** Evaluate and refine new bike lane or intersection designs under controlled virtual conditions.



FINDINGS FROM USER STUDIES:

- **Immersion and Stress Response**
  Participants reported increased immersion and growing confidence with repeated use.
  Stress levels decreased noticeably in complex traffic scenarios after simulator exposure.
- **Adaptation and Motion Sickness:**
  Initial motion sickness was common, but symptoms decreased as users adapted to the system.

CONTACT

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Federal Ministry for Digital and Transport

Modellvorhaben NICHT-INVESTIV Radverkehrsförderung des Bundes