JoysteerVR

Degree programme: BSc in Computer Science
Specialisation: Computer Perception and Virtual Reality
Thesis advisor: Prof. Marcus Hudritsch
Expert: Daniel Voisard
Industrial partner: Bozzio AG, Nidau

Creating an accurate virtual driving experience in Virtual Reality is an interesting idea with an important real-life application. A company is making an alternative electric steering system for people with physical disabilities that can be installed in almost any car. They need a training tool that enables these people to practice their driving skills in a safe environment. In this thesis, such an immersive virtual driving experience has been realized.

Introduction

For people with physical disabilities, driving a car is a near-impossible task. They are highly dependent on others to stay mobile in an increasingly fast-paced world. The Bozzio AG has responded to this challenge with a solution: an electric steering system, the „Joysteer" drive-by-wire system, that can be easily installed in any car. This Human-Machine Interface (HMI) can be controlled using only the fingers and enables many disabled individuals to get back on the road. However, practicing how to drive such a vehicle presents its own challenges. People are not accustomed to controlling a heavy car with just their fingers. Creating a virtual environment where these people can practice their driving skills with the Joysteer controls in a simulation could prove to be a vital tool for both their safety and that of others on the road.

Goals

A prototype for this project existed before work began in September 2024. That prototype was created using the Unity game engine. For cost-related reasons, the project first had to be ported to the Godot game engine, a modern open-source engine. It is free to use for industrial purposes and lightweight in features, which makes it ideal for this project.
To create a virtual driving experience, a suitable driving environment was required. This was taken from the previous prototype. Equally important was a realistic car model. For testing purposes, Bozzio AG provided driving data from a VW T6 equipped with the Joysteer system. For the project, a one-to-one model of the T6 was acquired and had to be adapted to be drivable within the simulation. To ensure a realistic experience, models of the Joysteer controllers were added, the steering wheel was properly animated, the side and rear-view mirrors were made to function like real mirrors, and the car's behaviour was implemented to resemble its real-world counterpart as closely as possible. Of course, the car is controlled with the actual HMI controls of the Joysteer system.

Due to time constraints, the focus of this thesis was on the correct implementation of the car, rather than on the design of the environment in which the trainee would drive. The feeling of driving the car with the HMIs had to match the real vehicle as closely as possible. The trainee could only drive on a sample road and load a few scenarios where they could practice some maneuvers set up with traffic cones.

Realistic Driving Behaviour

The Godot engine includes a basic implementation of car logic. This logic had to be extended and adapted to replicate a car with an automatic transmission. To achieve this, configurable parameters were added that controlled acceleration, braking, steering, suspension stiffness and other key factors. Determining the correct values for these parameters was a classic optimization problem.
To solve this problem, driving data from the real VW T6 was fed into a regression model using a popular data science library in Python. The model adjusted the parameters of the car model and ran simulations in which the virtual car received the same input data as the real-world test vehicle. This process was repeated until the resulting speed curves of the two cars matched as closely as possible.

Results

The implementation of the car logic went very well. Godot was easy to get started with and a solid foundation for the training simulation was established. The car's behaviour closely matches its real-world counterpart, and driving with the HMIs in virtual reality feels intuitive and natural. The project can be expanded to include more detailed scenarios.

Marko Bozic
marko.bo1997@gmail.com