
Real-Feel Rollers: A Rollers-Based Bicycle Simulator Requiring Realistic Steering Input for Balance Control

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Abstract:

I will give a brief overview of the functional properties of the Real-Feel Rollers (RFR) and their hardware implementations. For a quick visual impression, watch these video's: <https://youtu.be/WFevsm-Bn7U> and <https://youtu.be/a1wG-AeLNFk>. And for a detailed description including design drawings, read the filed patent application with identifier PCT/NL2022/050304.

The four main functional properties of RFR are the following:

1. The requirement for the rider to use realistic steering input (closely resembling the steering input on a regular bicycle path) for balance control.
2. Realistic pedaling forces are required for a given simulated acceleration.
3. Realistic visual feedback about the rider's speed and lateral position on a simulated bicycle path.
4. Potential obstacles (stationary and moving) on the simulated bicycle path, requiring navigation, attentional selection, and anticipation.

These functional properties are realized by a hardware implementation with the following components:

1. A platform containing three rollers with a width equal to the width of an average Dutch bicycle path (1.75 m).
2. The rollers' rotational inertia is close to the linear inertia of the average Dutch rider-bicycle combination.
3. A virtual-reality (VR) component that takes as its input a roller-attached speedometer and the position of the rider's head as measured using a motion capture system. This online feedback about the rider's simulated speed and position is used to calculate the image of a bicycle path, which is then projected on a screen in front of the rider.
4. A VR component that simulates stationary and moving obstacles (blocked roads, fellow cyclists) and provides feedback on a simulated collision.

The RFR is used for basic research on balance control as well as for more applied research on cycling rehabilitation. The cycling rehabilitation studies are conducted with physically vulnerable participants (mostly seniors), and therefore RFR has a robust and well-tested safety component (a harness with elastic suspension). These rehabilitation studies also make use of two additional features of the RFR:

1. Driving the rollers by an electromotor, allowing the riders to stay balanced only by steering (no pedaling).
2. Increasing the rolling resistance of the rollers, allowing to simulate cycling uphill or against a headwind.