VRChairRacer: Using an Office Chair Backrest as a Locomotion Technique for VR Racing Games

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ABSTRACT

Locomotion in Virtual Reality (VR) is an important topic as there is a mismatch between the size of a Virtual Environment and the physically available tracking space. Although many locomotion techniques have been proposed, research on VR locomotion has not concluded yet. In this demonstration, we contribute to the area of VR locomotion by introducing VRChairRacer. VRChairRacer introduces a novel mapping the velocity of a racing cart on the backrest of an office chair. Further, it maps a users' rotation onto the steering of a virtual racing cart. VRChairRacer demonstrates this locomotion technique to the community through an immersive multiplayer racing demo.

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CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Virtual reality**.

KEYWORDS

Virtual Reality, Locomotion, Racing Game

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Figure 1: Users are playing VRChairRacer. User photos are added to the picture for better clarity.

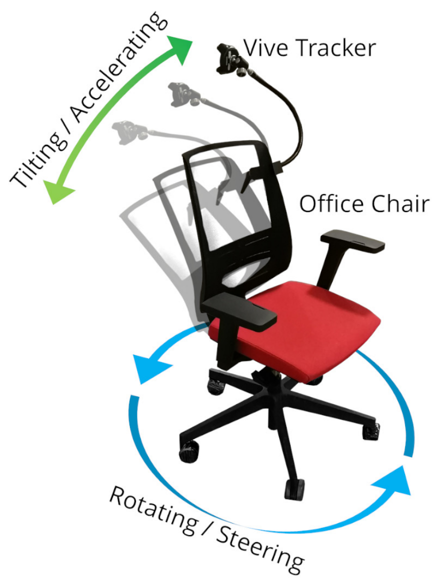

Figure 2: The mapping of a regular office chairs' movement onto our VRChairRacer racing cart. An HTC Vive Tracker is used to recognize the chair's position and for accelerating through tilting the back. Rotating the chair is used for steering.

INTRODUCTION & BACKGROUND

Room-scale VR is becoming increasingly popular and can be found in more and more homes. However, one of the current problems of room-scale VR is the limited tracking space that is available in the physical space. In contrast, the virtual worlds that users are experiencing using VR can be nearly endless. To overcome this shortcoming, novel ways of providing locomotion have been proposed. Related approaches were using the redirected walking [6] technique to make the users believe that they are walking in a straight line while in reality they are walking in circles. Further common techniques are walking-in-place, e.g. VR-STEP [8], or using teleportation enabling the users to change their orientation [2] while teleporting.

Figure 3: Ingame screenshot of a single chair racer on track.

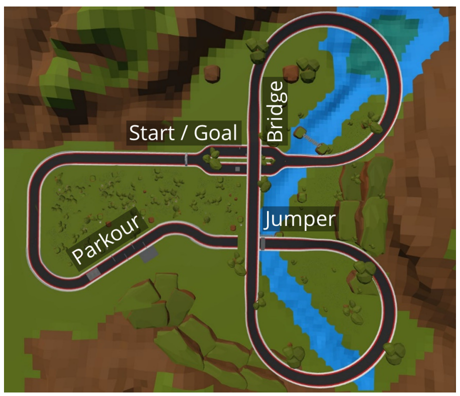

Figure 4: Overview map of our default racing track.

[1]https://www.yawvr.com/ - YawVR (last accessed 01-07-2019)

[2]https://www.vive.com/uk/vive-tracker/ HTC Vive Tracker - last access 01-07-2019

Moreover, locomotion in VR racing games is done by giving the user a possibility to accelerate and to steer the direction of a vehicle. The traditional way of accelerating and steering in a VR racing game is either pressing a button, or using external hardware, e.g. pedals or a steering wheel [4], which mimic the feeling of sitting in a real car and steering it.

Recently, research equipped chairs with sensors and actuators to use users' chairs as an additional prop for providing input and output in VR. For example, Rietzler et al. [7] are using an oscillating movement to trick users into perceiving a forward motion while sitting on an office chair. In contrast, Gugenheimer et al. [3] actively rotate users into a specific direction to support user rotation as a method for interactive story telling. Further, there are already commercial products which enable users to experience a 3DoF motion simulation e.g. YawVR[1], which actively provides motion to the sitting user (similar to swiVRChair [3]).

When looking at the challenges that were identified for VR driving simulators over 20 years ago [1], we can see that almost everything except the haptic feedback has been resolved. While in this research we do not use any additional haptic props, we are re-purposing the 1-directional movement of a common backrest of an office chair to trigger acceleration and provide a kinesthetic illusion.

With this demonstration, we contribute to the field of VR locomotion by introducing VRChairRacer. By mapping the velocity of a virtual cart onto the movement of the backrest of an office chair.

CONCEPT: CHAIR-BASED LOCOMOTION

We propose VRChairRacer, which uses a traditional office chair as a controller for vehicle-based locomotion in VR. VRChairRacer maps the degrees of freedom that are required to control a vehicle (acceleration / breaking and steering) onto an office chair. Accelerating and breaking of a racing cart is mapped onto the 1-dimensional axis movement of the backrest of a traditional office chair. Further, the rotary motion of the chair is used to steer the direction of the cart. The mapping used for the VRChairRacer locomotion technique is depicted in Figure 2.

VRCHAIRRACER: IMPLEMENTATION

The proof-of-concept implementation of VRChairRacer uses off-the-shelf hardware to make standard office chair compatible as a VR locomotion device. By applying a standard HTC Vive Tracker[2] on the chair's backrest, the system is able to track the chair's backrest position and rotation. This makes it easy to be used by other researchers and designers. For the acceleration, the tracker's height is logged when the backrest is in its fully upright and fully tilted back position before the race starts. While racing, the current tracker height is linearly mapped to the chair's speed, using almost instant acceleration. The angle between the tracker's up vector on the world forward is used to calculate the current heading, changing the virtual chair's movement with a slight drift to retain a certain racing feeling. The Vive Space's rotation is locked around the world's up axis to keep the steering angle consistent. Minimizing acceleration time, drifting and keeping the Vive Space's rotation locked is aimed towards reducing the sensory mismatch between the displayed and felt acceleration in order to reduce cyber sickness as proposed by LaViola et al.[5], aided by matching the perceived gravitational acceleration to the visually perceived acceleration. Finally, a virtual representation of the office chair (figure 3) is used to give the user a frame of reference for their interaction with the game world. VRChairRacer is written in Unity using HTC Vive VR headsets that are equipped with wireless transmission modules to prevent getting entangled in the cable.

An overview of our default track is depicted in Figure 4. The system implements a multi-player mode to enable racing against colleagues. Our setup will host two simultaneous drivers. To enable passersby to see what the users of VRChairRacer are experiencing, our system streams the race using an external projector or display. A scene of the racing track with three players is depicted in Figure 1.

CONCLUSION

This demonstration proposes and presents a new interaction technique for providing locomotion in VR. Through mapping the velocity of a virtual cart onto the backrest of a traditional office chair and further transferring the the rotary motion of the user on the office chair into VR, we provide a low-cost and realistic racing experience. As our demonstrator contains a multi-player functionality, we make the dream of having an office chair race amongst multiple colleagues come true.

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