A Demonstration of SwiVRChair: A Motorized Swivel Chair to Nudge Users' Orientation for 360 Degree Storytelling in Virtual Reality

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Abstract

We present a demonstration of *SwiVRChair*, a motorized swivel chair to nudge users' orientation in 360 degree storytelling scenarios. Since rotating a scene in virtual reality (VR) leads to simulator sickness, storytellers currently have no way of controlling users' attention. *SwiVRChair* allows creators of 360 degree VR movie content to be able to *rotate* or *block* users' movement to either show certain content or prevent users from seeing something. To enable this functionality, we modified a regular swivel chair using a 24V DC motor and an electromagnetic clutch. We present two demo scenarios in which participants can experience both mechanisms (*rotate* and *block*) using the Samsung GearVR. In a previous user study (n=16) comparing *SwiVRChair* to *Foot Control*, users rated the experience using *SwiVRChair* to be significantly more immersive and enjoyable whilst having a decrease in simulator sickness.

Author Keywords

SwiVRChair; Virtual Reality; Consumer Virtual Reality; Virtual Environments; 360 Degree Video; 360 Degree Storytelling; Nomadic VR; Mobile VR

ACM Classification Keywords

H.5.2. [Information Interfaces and Presentation (e.g. HCI)]: User Interfaces

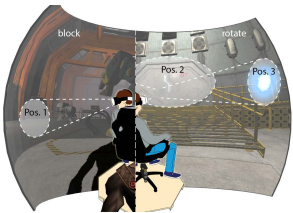**Figure 1:** The physical prototype of the *SwiVRChair*

Figure 2: On the left, the concept of *block*: The user is turned away from the monster (Pos. 1) and only sees its shadow in front of them. On the right, the concept of *rotate*: The user is guided through the scene and certain content such as the purpose of the door (Pos. 2) is explained in more detail.

After Oculus announced the formation of the Oculus Story Studio[1], a team focusing solely on creating virtual reality movies, the field of 360 degree story telling has received more public attention and can become one big selling point of consumer virtual reality (VR). However, 360 degree movies are a fairly new medium. That is why creators are facing several challenges such as controlling the attention of a user. In traditional movies this is done by applying cuts and tracking shots which is not possible or advisable in VR since rotating the virtual scene in front of the user's eyes will lead to simulator sickness [4]. One of the reasons this effect occurs is when the physical movement (measured by the vestibular system) and the visual movement are not coherent (sensory conflict theory).

Since most current VR content is advisable to be consumed using a swivel chair [2], we present the concept of physically moving the user by rotating the chair with an attached motor (figure 1). We implemented *SwiVRChair* by adding a 24V motor and an electromagnetic clutch connected through a timing belt (figure 3).

The magnetic clutch allows the user to still resist and break free of the controls of *SwiVRChair* without harming the motor. Therefore, we do not try to fully control the user's view but consider it more as a nudging and an immersing of the user into the scene. This distinguishes *SwiVRChair* from most current motion platforms for VR which are designed based on the Steward platform [6].

SwiVRChair is motivated by the work of Vosmeer et al. [7], which distinguish the levels of engagement of a cinema experience ('lean back') and game experience ('lean forward'). SwiVRChair offers a mix of both which is considered fitting for 360 degree cinema. One of the early applications of

these concepts of story telling to virtual reality was done by Pausch et al. [5].

In this demo we present SwiVRChair [3] and showcase two application scenarios to let participants experience the sensation of being physically rotated inside a virtual 360 degree movie scene.

Concept and Design Space

The goal of *SwiVRChair* is to offer a low-cost motion platform which can be used in current households and enhance the experience for VR content such as 360 degree movies. *SwiVRChair* uses a common swivel chair which is already wide spread in households and enhances it by adding a motor and a clutch (figure 3) to be able to automatically rotate the chair.

This offers a design space based around rotational movements to control the user's orientation inside a virtual 360 degree scene. We emphasize in our concept two basic actions *rotate* and *block* which we offer as a tool for content creators to use inside a 360 degree immersive virtual environment (IVE).

rotate. In the basic scenario the user is rotated towards certain content inside the IVE (figure 2). This allows the content creator of 360 degree IVE to simulate aspects of movies such as cuts or tracking shots. Similar to traditional movies these can be used to introduce the scene or have a more artistic aspect.

block. The concept of blocking allows for the orientation of *SwiVRChair* to be kept at a certain angle (figure 2). This can be used to hide certain information from the user (e.g. a monster approaching from behind). This is a novel technique to story telling which derives from the freedom of looking around inside a 360 degree scene.
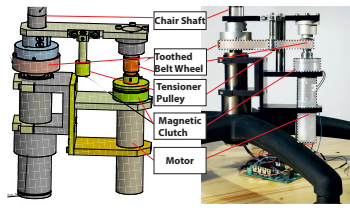
Figure 3: On the left, the 3D model of the chair construction and on the right the actual implementation showing the attachment to the chair

Figure 4: The electronic components which were used to power *SwiVRChair* and getting rotational commands from the GearVR

One of the main lessons current storytellers in VR made is "Let go of forcing the viewer to look somewhere" which firstly sounds contrary to the *SwiVRChair* concept but is something that we built as an essential part into the concept of *SwiVRChair*. Both concepts of *SwiVRChair* (*block* and *rotate*) always allow the user to break out of the chair's movement. Therefore we see both concepts just as a nudging, which the user can either accept and enjoy or can choose to break out of and explore the whole environment by themselves.

Implementation

SwiVRChair is powered by a type G42x40 24V DC Dunkermotor having a torque of 5.7 Ncm and 3100 rpm. In addition we use a planetary gearbox (PLG G42 S) consisting of metal gear rings having a 32:1 gear reduction. We added a further gear reduction using a toothed belt with a ratio of 3:1 resulting in an overall torque of ≈5.5 Nm and ≈33 rpm (without any load). Using our setup (running on 20V) we are able to rotate an up to 100kg heavy participant from a standing position in 2.3 seconds half a revolution.
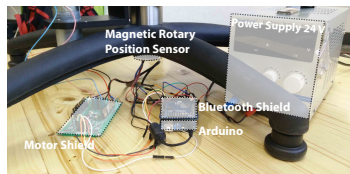
The magnetic clutch (Kendrion) consists of two parts, one attached to the drive shaft on the gearbox and the other attached to the toothed belt wheel. These two parts are not connected mechanically. The electromagnetic field created by applying 24V locks the two parts and the rotation of the motor is transfered through the toothed belt to the chair shaft. Once a user blocks the rotation using their feet the force generated exceeds the maximum capacity of the clutch and the electromagnetic field breaks. This principle allows the user always to break free of the movement of *SwiVRChair* without harming the gearbox and without having to apply too much force. To measure the precise orientation of the chair we attached a magnetic rotary positions sensor by arms (AS5047D) at the bottom of the chair shaft.

Figure 3 shows the implementation of *SwiVRChair*. We removed the rollers from a standard office swivel chair to block movement during a rotation and placed the chair on a wooden platform to position all the cables underneath. The motor and clutch were placed inside a metal frame and attached to the chair shaft. Both the motor and the clutch are controlled using a motor shield (figure4) connected to an Arduino Mega 2560. The motor shield is connected to a 24V power supply and transfers an incoming PWM signal from the Arduino to a Voltage (0 - 24 V). The Arduino communicates via a bluetooth shield (BLE Shield) with the Samsung GearVR headset running a Unity3D application of the IVE. This allows us to control the rotation of the chair from within the Unity scene.

Demonstration Scenes

We implemented two different scenes which make use of the two new narratives *SwiVRChair* introduced (*rotate* and *block*):

The first scene (*warehouse scene*) took place in a space warehouse having the participant sit on a virtual chair in the center of the scene. A visual guide leads the user through the scene and introduces them to the environment. At the end a power breakdown shuts down the lights of the scene and simulates a malfunction of the virtual chair, turning the user away from an entrance. The user now has to fight *SwiVRChair* to turn towards the door seeing only the shadow of a creature approaching them from behind. The scene ends with the user being turned towards the creature and virtually punched in the face to end the scene spinning.

The second scene (*witch scene*) takes place in a forest inside a house of a fairy. The fairy enchants and spins several items (as well as the user) inside her home and brews a magic potion. After enchanting and scaring the user (fig-

Figure 5: Picture taken from one participant during the user study and his emotions during the study being scared by the fairy inside the *witch scene*

ure 5), the fairy's kettle explodes spinning her and the user out of the house. The whole experience consists of 3 full rotations (360 degree),6 half rotations (180 degrees) and 18 minor turns (90 degrees).

Conclusion

In this work we present *SwiVRChair*, a motorized swivel chair to control user orientation in 360 degree movies. We introduced the concept of nudging the user's orientation by rotating the chair and how to build *SwiVRChair*. We explored the design space and present two simple narratives (*block* and *rotate*). We demonstrate two example 360 degree cinematic experiences which make use of the newly introduced narratives and allow participants to experience the sensation of being physically rotated inside a virtual 360 degree movie scene.

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