Jedi ForceExtension:

Telekinesis as a Virtual Reality Interaction Metaphor

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Abstract

Virtual Reality (VR) enables us to freely operate in a space that is unconstrained by physical laws and limitations. To take advantage of this aspect, we have developed a technique for pseudo-telekinetic object manipulation in VR using slight downward tilt of the head to simulate Jedi concentration. This telekinetic ability draws inspiration from The Force abilities exhibited in the *Star Wars* universe, and is particularly well suited to VR because it provides the ability to interact with and manipulate objects at a distance. We implemented **force translate**, **force rotate**, **force push** and **force pull** behaviours as examples of the general concept of **force extension**. We conducted exploratory user testing to assess telekinesis as a suitable interaction metaphor. Subject performance and feedback varied between participants but were generally encouraging.

Keywords: Virtual Reality, 3D interaction, 3D Selection, object displacement.

Index Terms: H.5.2 [Information Interfaces and Presentation]: User Interfaces—Input Devices and Strategies.

1 Introduction

Virtual Reality (VR) supports expressive interaction techniques, allowing users to become immersed in realities that have seemingly limitless possibilities. Given this, we are interested in exploring how the idea of superhuman abilities can be harnessed to produce useful VR interaction techniques. The *Star Wars™* universe has a deep fan base and rich lore. We draw on these here to explore how The Force powers can be used to manipulate objects at a distance. Our approach extends position-control interaction gestures to rate control, similar to work introduced for 2D gestures by Wang & Lindeman (2013). While Wang & Lindeman use multi-touch pressure to control the rate of change, our system uses head tilt as a metaphor for concentration to signify a telekinetic intent for 3D gestures. The main advantage of this approach is that it combines the dexterity of the hands with the simple gesture of head tilt, so many different 3D position-control gestures can be extended via rate-control.

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2 Related Work

There has been little work on the use of superpowers for 3D interaction. Mostafa et al. (2014), discuss using superhumans as a design metaphor, to provide user experiences in VR beyond that of the real world experiences. They found that care was needed when adapting specific superhuman abilities of theatrical or historical sources, in order to preserve the user experience.

Bowman & Hodges (1997) describe a taxonomy of techniques that can be used to manipulate objects at a distance. One method, “Go-Go hand” created by Poupyrev et al. (1996), was used to grab an object at a distance and return it to the user such as in “Go-go gadget” cartoons. Another method used raycasting to select an object for manipulation. They furthered this method to include the ability to push and pull objects away or towards the user. However, these methods lacked rotational control about an object.

Wang & Lindeman (2013) designed a 2D multi-touch gesture interface for manipulating a camera object through the virtual environment. They used a pressure sensitive multi-touch touchpad to recognise standard 2D gestures such as two-finger rotate, pinch zoom, and swipe to translate, then extend these position-control mappings to rate control by applying pressure on the fingers at the end of the gesture. In essence, pinch-zoom became pinch-zoom-then-press, two-finger rotate became two-finger rotate-then-press, etc., allowing arbitrary 2D position-control gestures to be extended using rate control.

3 The ForceExtension: Telekinesis State Machine

From the Bowman & Hodges (1997) survey of interaction metaphors, we build on the ego-centric raycasting method and combine it with Wang & Lindeman’s ForceExtension technique (2013). As depicted in Figure 1, we use a state machine to transition between the different states of INDICATING, SELECTING, TRANSLATING, ROTATING, PUSHING, PULLING, and EXTENDING. Every gesture is extendable, meaning that the user can perform the action in a rate-controlled manner using a head-tilt or “concentration” gesture. Spatial controllers (e.g., HTC Vive, Oculus Touch) provide high-precision, low-latency support for 6-degree-of-freedom (6-DOF) manipulation. We are currently evaluating three specific 3D gestures to be extended, imbuing users with The Force, in order to manipulate objects at a distance with scaled actions, such as making an object fly off in a desired direction.

Our method could be used with VR gloves or bare-hand tracking, so that a more-natural ability to control objects could be achieved with hand gestures as opposed to button presses. However, because we are focusing on the state machine, we have chosen to extend controller-based gestures for the user experience.

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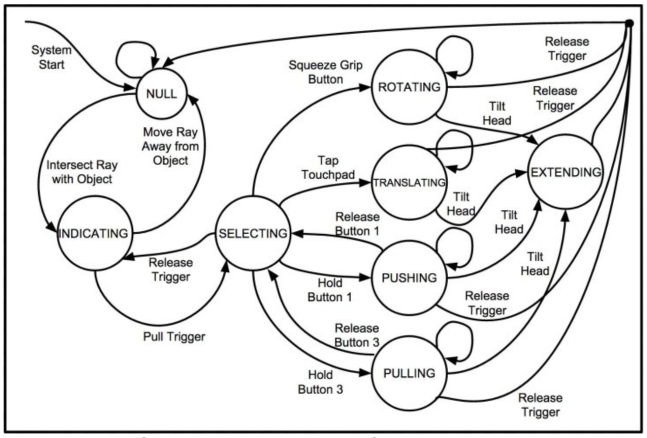

Figure 1: State-transition diagram for Jedi ForceExtension.

Here we describe each state of force control behaviour and how to enter into each state using the state machine. In the NULL state, the user has not brought the laser pointer into contact with any object. Once the laser pointer intersects an object, the state transitions to INDICATING, and stays in this state until the pointer is moved outside the object, or the trigger is pulled. Once the trigger is pulled, the state changes to the SELECTING state, and actual manipulation of the object can take place. There are two three modes of manipulation: rotation, translation, pushing, and pulling. Squeezing the grip button activates the ROTATING state, which uses one-to-one (position-control) rotation mapping. Alternatively, while in the SELECTING state, tapping the trackpad activates the TRANSLATING state. While in these two states, the user can initiate the corresponding manipulation by rotating or translating the object, respectively, using a position-controlled mapping. From the SELECTING state, the user can also trigger PUSHING and PULLING states using the touchpad. Holding one of these buttons down will move the object away from/towards the user at a constant rate.

While in any of the ROTATING, TRANSLATING, PUSHING or PULLING sates, if the user tilts his head down, the movement switches to a rate-controlled mapping, and the state changes to EXTENDING. This was chosen to resemble what Jedi Knights do when they “concentrate” while using The Force. Actions are completed by releasing the trigger and/or accompanying buttons, returning the state to INDICATING if the laser pointer is still intersecting an object, or NULL otherwise.

The HTC Vive allows us to detect head pose and movements through its tracking system, which can be used as a variable-rate input such as proposed by Mine et al. (1997). We achieve this by taking the starting angle of the HMD when a manipulation state has been entered, and comparing it to the current tilt angle. When the tilt threshold is reached, we enter the EXTENDING state. This is analogous to the way Wang & Lindeman (2013) use trackpad pressure.

4 FEEDBACK & DISCUSSION

To get a better understanding of the usability of our approach, and to gather feedback from the design, a pilot study was performed (Figure 2).

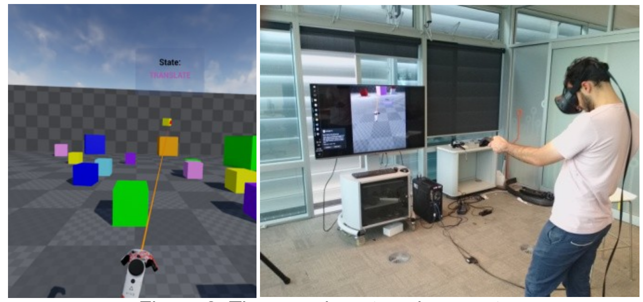

Figure 2: The experiment environment.

The study involved participants moving coloured cubes around and placing them on top of larger stationary cubes. In total, eight participants tried our system during the pilot study. Most people appreciated using the Jedi ForceExtension when performing the manipulation tasks. However, the parameters for controlling the extension trigger (head tilt/nod) needed work. Participants reported difficulty with performing a nod gesture and keeping focus on the object. This proved difficult when they wanted to make an object go upwards, which ended up taking it out of the visual field. Several participants felt that the interaction state could be better conveyed using special visual effects on the object. For example, providing a coloured glow around the object when indicating, and then changing the colour when selected. Also, providing an indication of the path the object will travel when released was mentioned. Another response was that the PULL/PUSH movements were not very noticeable at a distance, and that the PUSH/PULL velocity should be scaled depending on the distance away from the controller. These points provide us solid design insights on how we should alter the approach.

5 CONCLUSIONS & FUTURE WORK

The pilot study shows positive signs for the metaphor, so we will continue to improve the system, exploring different methods for switching selection and manipulation states. We also plan to explore other abilities from other fictional universes and see how they might translate for VR interaction.

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