Studying Interactive Interfaces in Virtual Reality

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Background

Virtual Reality (VR) is a digital technology that has been around since the mid-1960's. This technology uses a Head-Mounted Display (HMD) to mediate the physical world around you with a computer generated, three-dimensional environment which creates an enclosed, immersive visual experience. Within the realm of Mixed-Reality devices, VR technology is more accessible than ever. VR systems are now used in our workplaces for testing and training, our personal computers for work or entertainment, and even our smartphones.

Despite this wealth of access, little work has been done studying what kind of interactions and interfaces are most intuitive, efficient, and effective across multiple VR platforms and devices. Consumer-available VR platforms such as the HTC Vive and Oculus Rift both use different controller designs to interact with virtual environments. This means that there is a minimum number of actions that users can utilize across these platforms.

Related Work

Researchers at Carnegie Mellon University and Stitchbridge have been working to engineer new educational experiences in VR. However, these experiences are passive, and do not use VR controllers to facilitate environmental interactions [1].

Iowa State University has conducted research describing the process of cross-platform development of VR experiences from a software point of view, but their project was also passive, and did not utilize the capabilities of VR controllers [2].

Nielsen, Stőrring, Moeslund, and Granum developed a methodology for finding natural gestures to represent actions that could translate to actions taken in a virtual environment. They found that gestures which could be easily understood by a computer were difficult and in some cases impossible to perform for humans [3].

Proposed Experiment

For this research project, we propose designing a virtual environment in which test participants will use a variety of interactive interfaces to accomplish a goal. we plan on using either the Godot and Unity game engines to develop the virtual environment for this research.

The goal of the experiment will be for participants to complete various tasks administered by a screen. The environment will follow a similar format to the mobile game *Spaceteam*[4], which prompts the user to activate a variety of interfaces to keep a virtual spaceship flying (figure 1). My experiment would borrow this mechanic to introduce a controlled sense of stress. This sense of urgency will hopefully be beneficial in identifying the kind of interactions that allow for fluid, intuitive interactions within virtual environments.

To measure success, we would like to design a number of interfaces designed around a minimum set of actions that many consumer-level VR systems can utilize. These actions are accomplished by utilizing a controller (such as that which comes with the HTC Vive, figure 2). These interfaces would incorporate one or more of the atomic actions listed in figures 3 and 4.

Figure 1:
Spaceteam's mobile interface
(Image from Henry Smith, Developer)

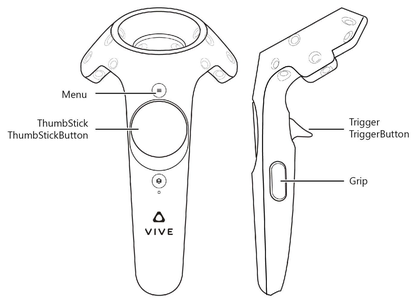

Figure 2: Diagram of HTC Vive Controller

TRIGGER	UNSUSTAINED ACTIVATION
GRIP / HOLD	SUSTAINED ACTIVATION
COLLISION	PASSIVE ACTIVATION (CAN BE SUSTAINED OR UNSUSTAINED)
MULTI-CONTROLLER INTERACTION	COMBINATION OF SUSTAINED AND UNSUSTAINED ACTION

Figure 3: Atomic interactions
on VR controllers

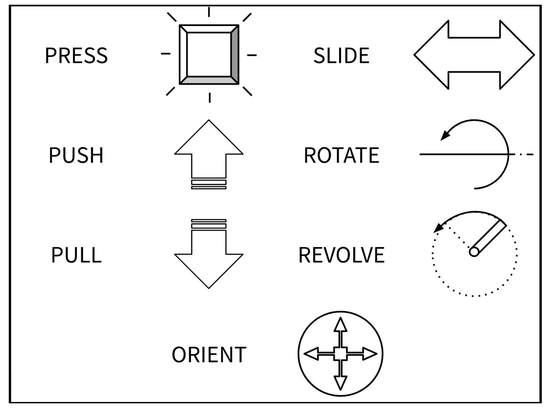

Figure 4: Atomic movements
on VR controllers

Anticipated Results

Through this research we hope to identify what interactive interfaces are the most effective and intuitive across VR platforms. My hypothesis is that Interfaces that users are able to use faster and with more accuracy indicate more intuitive actions, and therefore are better interactions to include as standards in VR applications.

This research will hopefully provide a template of interfaces and interactions for VR applications in the future, regardless of the platform. My hope is to perform these experiments during the fall semester of 2019

References

[1] Ralph Vituccio, Jaehee Cho, Tsung-Yu (Jack) Tsai, and Sarabeth Boak. 2018. Creating compelling virtual reality and interactive content for higher education: a case study with carnegie mellon university. In ACM SIGGRAPH 2018 Educator's Forum (SIGGRAPH '18). ACM, New York, NY, USA, Article 1, 2 pages. DOI: https://doi.org/10.1145/3215641.3215647

[2] Schlueter, Jonathan; Baiotto, Holly; Hoover, Melynda; Kalivarapu, Vijay K.; Evans, Gabriel; and Winer, Eliot H., "Best practices for cross-platform virtual reality development" (2017). *Mechanical Engineering Conference Presentations, Papers, and Proceedings*. 193. https://lib.dr.iastate.edu/me_conf/193

[3] Michael Nielsen et al. "A procedure for developing intuitive and ergonomic gesture interfaces for man-machine interaction". In: (2003).issn: 1601-3646.url:http://www.visagesoft.com

[4] Henry Smith, *Spaceteam*, (2019) https://spaceteam.ca/

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