**Assessing Dexterity - A Study of Virtual Reality Haptic Gloves and Alternate Input Methods**

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Hi there my name is Ryan Blocker and I am a senior here at Colorado State University. For my CS464 research project I am building a pair of working haptic gloves to be used in virtual reality experiences. The goal with building this hardware is to give users a more natural feeling of immersion and feedback with picking up objects without being hindered by the hardware. Helping the user feel like they are using their actual hands and picking up objects is extremely important if we are ever to accurately emulate the sensation we feel when we pick up objects with our real hands.

Below are several papers that I found during my research that discuss measuring the dexterity of users in virtual and mixed reality. Most of the papers discuss the concepts I am testing in a clinical context but my study will be more broad. I have provided a summary of each study below and how it relates to my study:

*B. Joyner, J. M. Cagle, A. M. Simon, and T. A. Kuiken, “Comparison of Dexterous Task Performance in Virtual Reality and Real-World Environments,” IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 29, pp. 1-9, 2021*

In this study, their goal was to test able-bodied participants who manipulated a virtual prosthesis and a real-world prosthesis to complete eight activities of daily living. The paper found that the results varied extremely based on the task at hand and it was much more difficult to manipulate smaller objects. This study was helpful for me when creating my experiment especially when it came to the tasks the proctor gave the participants.

*H. Martinez, A. Garcia, and F. Molina, “Assessment of Manual Dexterity in VR: Towards a Fully Automated Box and Blocks Test,” in 2019 IEEE 5th International Conference on Virtual Reality (ICVR 2019), Chengdu, China, 2019, pp. 1-6*

In this study, they implemented a virtual version of the BBT (Box and Blocks Test). The important takeaway from this that applies to my study is that this study reported that they found that those who were able to complete the task in real life with their hands, were able to complete it just as well in virtual reality.

*E. Collins, J. Freeman, S. Chatterjee, and P. Haggard, “Comparing a Finger Dexterity Assessment in Virtual, Video-Mediated, and Unmediated Reality,” IEEE Transactions on Haptics, vol. 8, no. 3, pp. 299-306, 2015.*

This study looks at the NHPT (Nine-Hole Peg Test) and has healthy participants complete the task in both VR, AR, and real-life. The purpose was to measure the accuracy of the users. They reported that the difference in performance in virtual-reality and real-life was “not-significant.”

For this study I will be measuring dexterity of the user or in more plain terms I am measuring how well the user is able to articulate and manipulate objects in a virtual environment based on the input method they are using. This study will hopefully further our knowledge on what are the most intuitive and accurate ways to control virtual objects with our hands. This differs from the previous studies I mentioned because I will first be comparing different input methods instead of testing with multiple different types of tasks.

Below is a photo of the haptic glove in its current state. Sadly I had to backtrack slightly because my 3D printed part snapped so I don't have a photo of it at the moment with the haptic modules installed because my rigid mount snapped at the last second so I had to remove them for now. As of today I actually am printing a new one in the RDC prototype lab:

|  |  |  |
| --- | --- | --- |
| **View of the task within the headset:** | **Types of Input:** | **Current Haptic Glove:** |
|  |  |  |

My current plan for my experiment is to have the participant go through 4 rounds of testing completing the same task every time. My current vision for the task is something as simple as making a stack of blocks in virtual reality. The user will have to move, grab, and balance the blocks to complete the task. During the task itself I will be measuring the amount of time to complete the task, the number of dropped blocks/times the stack is knocked over (errors), and finally the amount of deviation the participants stack is from the ideal stack position. Building on this, I then will administer a survey to the participant that will ask questions regarding grip strength, fatigue after the task, how intuitive the input method is, etc. The independent variable in this study is the type of input method. Currently my plan is to have the users use 4 different methods: Meta Quest 2 Controllers, Valve Index Controllers, HTC Vive Controllers, and finally my haptic gloves. After all of this data is collected hopefully I will be able to extrapolate some meaning out of the sata based on the input method used and how it either hindered or improved performance in dexterity.

Overall I am so thrilled to conduct this project and learn more about how to doncust HCI experiments. Additionally I am so excited to finally complete a pair of working haptic gloves that the lab can use in experiments to come.