IC Touch Lab

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# Exploring Usability of a Virtual Haptic Piano With Virtual and Augmented Realities

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## Introduction

### Problem

An iteration of the original piano simulation was only conducted in VR. We wanted to increase realism and have added and AR mode as well. A previous iteration of AR inclusion was tested and found to have a poor SUS and NASA TLX scores.

### Objective

We want to make the simulation as immersive and usable as possible by employing a Meta Quest 3 headset as the head-mounted display (HMD). The end goal is to conduct a study with patients of Parkinson's disease and see if using this simulation can reduce tremors. A high usability is necessary to accommodate that need.

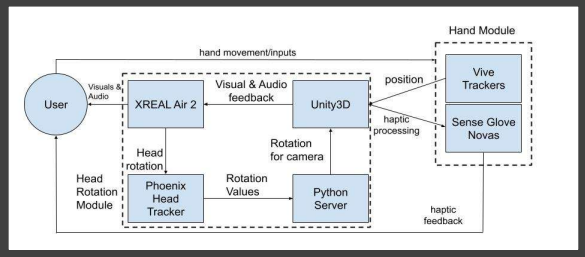
## Method

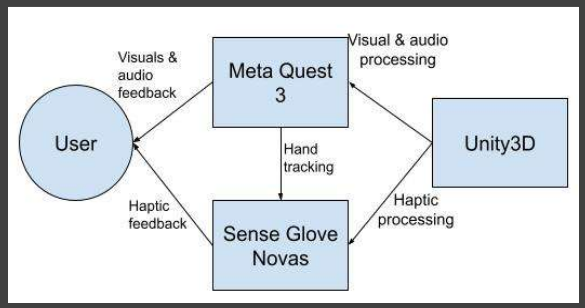
We used the following technologies as described to improve the usability of the simulation

- Unity Game Engine
  - Updated Version 2022.3.62f3 to meet AR package compatibility
- Meta Quest Feature Group
  - Use of Quest 3 controllers to simplify the setup and improve hand tracking
  - Quest 3 headset provides both VR and AR capabilities


Top: Participant during the study
Left: Simulated VR view Right: Simulated AR view

- AR foundation Package
  - To add passthrough capabilities of the Quest 3 to the Unity Environment
- Nova Haptic Sense Gloves
  - Implements the haptic feedback to increase realism of the simulated piano



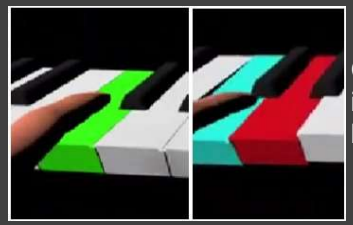




The original system (top) has been simplified (bottom)

## Testing Procedure

- Participant can move and rotate the piano into whatever position they desire
- They undergo 6 trials of either AR or VR, with 3 of those 6 having vibration feedback and the other 3 having force feedback.
- The visual modality switches, and another 6 trials with the above specifications occur

One trial consists of playing of one simple song. The notes to play turn blue, prompting the user to press them. Correctly played notes are green, incorrect notes turn red. Upon completion of the song, the trial ends.



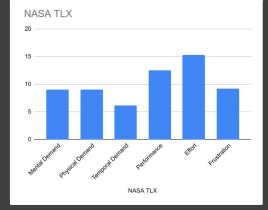
Correct, to-press, and incorrectly pressed keys

## Results

- 6 Participants (5 male, 1 female), across varying levels of experience with haptics, AR, VR, and piano
- They were asked to complete NASA TLX and SUS forms upon completion of all trials, in addition to a qualitative questionnaire
- Results of the SUS and TLX forms overall show that the system is in a much more usable state than the previous iteration

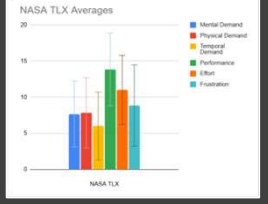
Previous AR

| | |
|---|---|
| Your SUS score is: | 60 |
| Your Grade is: | D |
| Your Rank is: | D (Okay) |



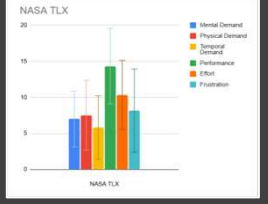

AR

| | |
|---|---|
| Your SUS score is: | 67 |
| Your Grade is: | C |
| Your Rank is: | C (Good) |




VR

| | |
|---|---|
| Your SUS score is: | 70 |
| Your Grade is: | C |
| Your Rank is: | C (Good) |




## Discussion

- It shows a much higher usability score than the previous iteration overall
- VR has overall better scores than AR
- Every single participant preferred the force feedback over the vibration
- Standard deviation is very high for all TLX results

## Acknowledgements

We would like to thank the following people and groups for providing useful materials and advising, which made this study possible.

- Lane Simpson – original creator of the haptic piano project
- The Nova SenseGlove team – Provided the files necessary to create the mounts to attach the Quest controllers to the Nova Sense Gloves
- Meldin Bektic – Printed out the mount files very quickly so we had time to do the experiment