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Course Code: ENSF 545
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Lab Number: B01
Instructor Name: Yaoping Hu
Student Names: Xian Wei Low, Chace Nielson
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Introduction

In this virtual reality (VR) project, we aimed to recreate a virtual version of the popular physical game, Jenga[1]. The goal is to make this game an engaging and dynamic experience within a digital world. The goal of this report is to showcase and analyze the results of in-person trials. Users had the opportunity to play the game and answer questions regarding their enjoyment and how well they felt the game played.

The game is made with Unity Game Engine[2] and attempts to introduce innovative elements, such as resetting the game at the press of a button. Unlike the physical version, where real-world physics dictates the movements and interactions, our virtual simulation demanded a meticulous consideration of how to translate these mechanics onto the digital screen. An important factor in the game is the use of a haptic stylus pen as the main controller[3]. The keyboard is also used to let the player manoeuvre around the tower and change the orientation of the haptic device(Fig 1) relative to the tower.

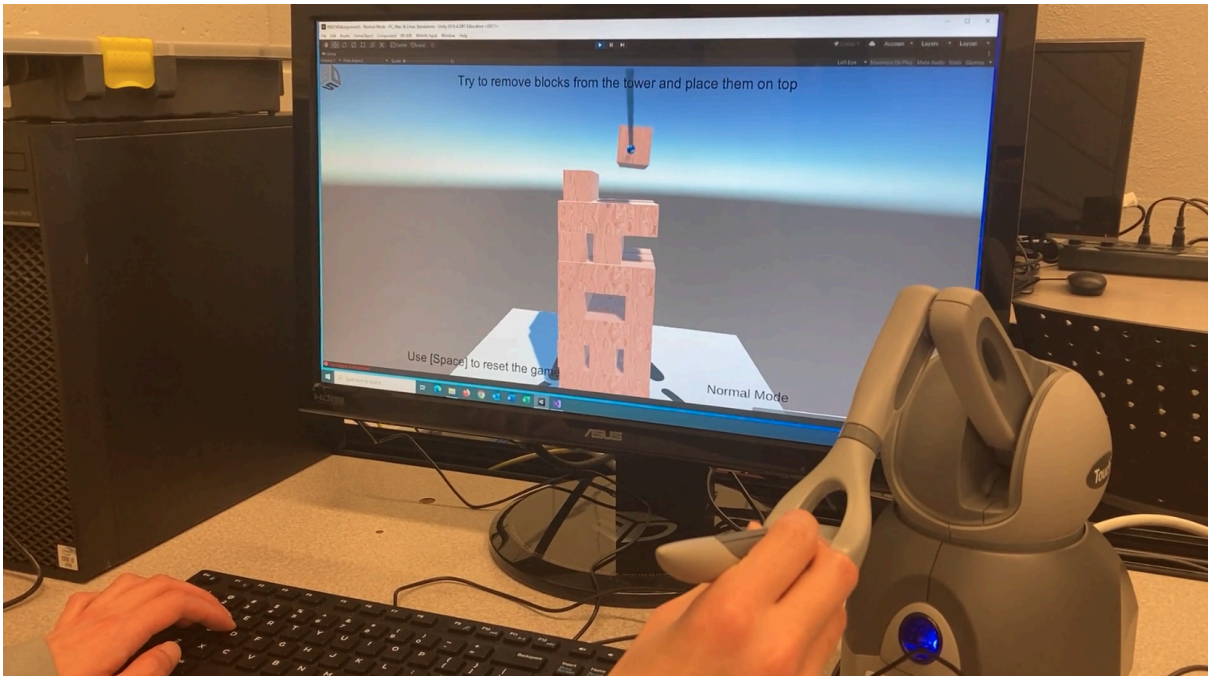

Figure 1. The haptic device being used to play the game

The game also has two modes of play(Fig 2). A normal mode with low friction on the blocks and a hard mode where the friction levels are increased. An important question that will be reflected on is which mode better encapsulates the real-world version of the game and is more enjoyable from a user perspective. The contrast between these two modes is a primary focus of the report and will be discussed later on.

The rest of the report will explore the development process, the participant study and the outcome of the study. We will present the outcomes of the user trials conducted during the demo phase, offering valuable insights into user interaction, preferences, and the effectiveness of our implemented features.

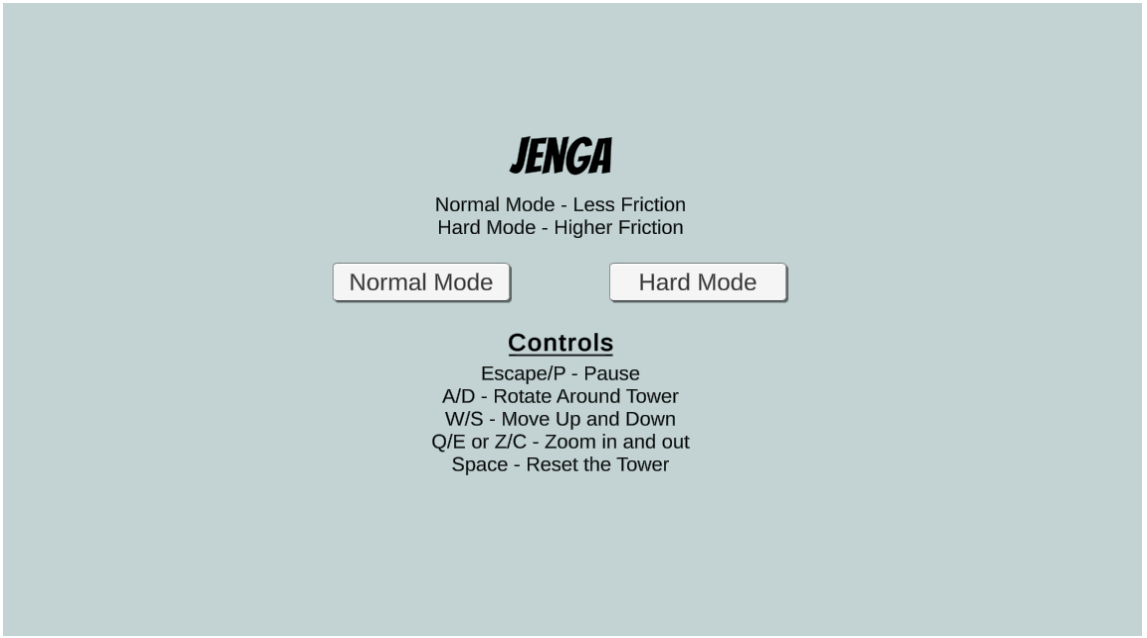

Figure 2. The game features two modes of play. Normal and hard mode.

Project Objectives and Scope

The primary aim of this project is to craft a lifelike rendition of Jenga within a digital environment, offering users an immersive alternative to the traditional physical game. The integration of a haptic device serves as a pivotal element, enhancing the overall gameplay experience. The significance of the haptic device is its ability to add a tactile dimension to the virtual Jenga game. This haptic device will appear in the virtual world as a stylus the user can manipulate with the real-world device(Fig 3). Unlike a conventional gaming experience that relies solely on visual and auditory stimuli, the haptic device introduces a sense of touch, allowing players to feel the presence of each block and its interaction with other blocks.

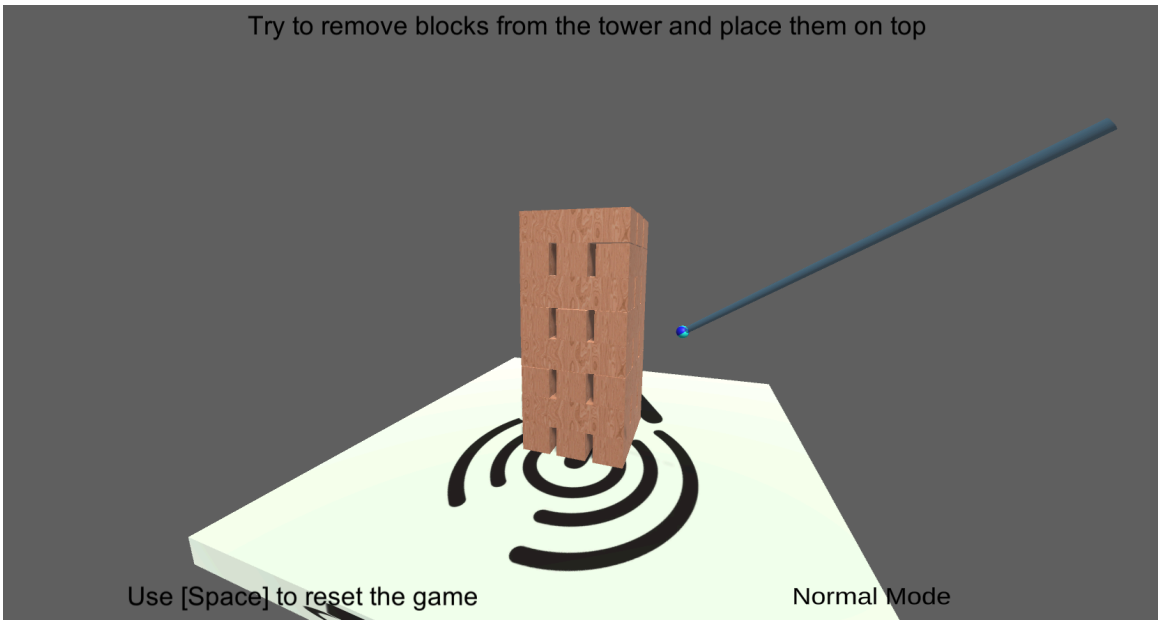

Fig 3. The view of the game and the haptic stylus pen as it appears in the virtual scene

By harnessing the capabilities of Unity[2] to build a simulation, our goal is to not only replicate the essence of Jenga but to elevate it into a digital experience that resonates with a diverse audience. Part of the attempt to make a game people enjoy is to provide two distinct modes of play(Fig 2). One is called the normal mode and will have low friction and the second is a harder mode with high friction. These friction changes are made in the hope they will provide diversity between the two modes of play.

It's important to gather user feedback to help improve the game and decide which of the two modes is preferred by users. Recognizing the subjectivity of user preferences, we place a strong emphasis on soliciting feedback from players to refine and tailor the virtual Jenga game to be universally enjoyable. The feedback, collected through a questionnaire (see Appendix 2), offers insights into the perceptions and opinions of participants. The collaborative input from users is integral to sculpting a realistic and engaging virtual rendition that captures the spirit of the physical game.

Tasks and Target Users

The target users are people looking for a realistic Jenga experience in the virtual world. This would allow the players to reset the tower without physically building the tower again. Also, we have described another target user as people who are looking for an online experience using haptic devices as a main core mechanic of the game.

As for the tasks, we have not changed the tasks that were completed for the project. Firstly, we had to create the scene with all the blocks stacked up to make the Jenga tower. All the blocks had to be set with a friction modifier but the two different versions will have different friction values. Next is to make sure all the blocks can be interacted with the haptic device. Once that is fully completed, the camera will have to be able to move which includes zooming in and out and moving the camera up and down. We also had to make sure the tower would reset after pressing the space key. Lastly, we had to choose different materials to make the experience as enjoyable as possible.

Developed Techniques

Each section of the project used various scripts and objects. The camera manager script and camera object were used in both normal and hard mode so the user would be able to move around the Jenga tower to produce a realistic experience for the user. The tower setup script was used by both versions so when a new game is started or is restarted, the tower will be set up for the user to play with again by recreating the block tower. The game manager script is used to determine which version has been chosen from the main menu. Once the version is chosen, the blocks are set up with the respective friction values to simulate the normal and hard modes. In the menu and pause menu, we had to create a script so that we could maneuver between the three different scenes which are the main menu, normal mode, and hard mode. The Jenga blocks have scripts written for them so that some of the blocks spawned have different heights which will allow the user to spot loose blocks to pick out of the tower. The different friction values are also applied using this script. Lastly, the floor will have a script attached to it so that the tower will stay in place and will not slip when no force is applied to the tower.

For the detailed list of scripts and objects created specifically for the project see Appendix 1.

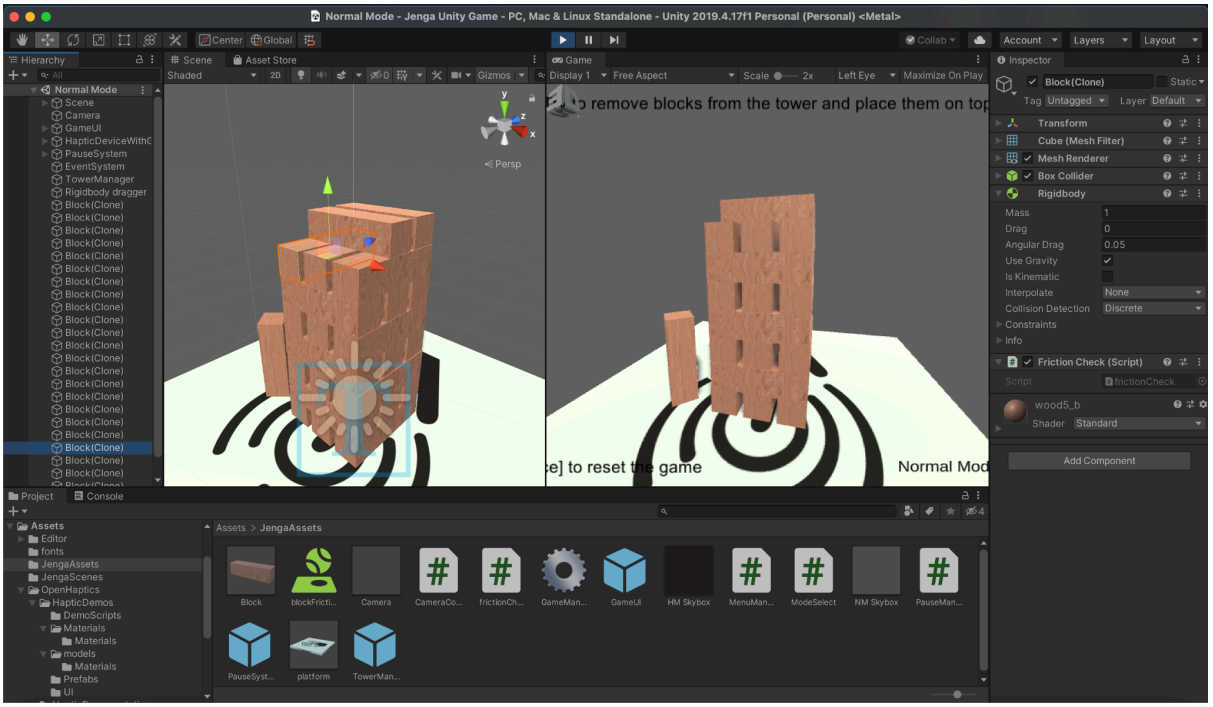

Figure 4. The Unity Scene and some of the assets used to create the game

Detailed Hypothesis

Within this experiment, we are going in with two hypotheses that will be explored using the data gathered from the users using the simple questionnaire. For the first hypothesis, we believe that the normal mode will be much easier when compared to the hard mode. During the development of the Jenga tower, we believed the blocks within the hard mode setting were much harder to remove from the tower than the normal mode. We felt this mode required much more skill and would be seen as inferior to the normal mode and therefore less enjoyable.

Our second hypothesis is that the normal mode will be preferred to play as a party game. We believe that because the game is easier to play people we be included to want to play this mode with friends. Using the data that we gathered during the demo session using the questionnaire, we will be able to see if our hypothesis is correct or not.

Procedures of Data Collection

Two users will play a game of Jenga. They will first select the normal mode and enter the scene containing a Jenga tower. The users will not be limited in how they interact with the game, they will only be instructed to play a regular game of Jenga. If they are unfamiliar with the game it will be explained to them. One at a time they will be asked to use the haptic device to remove a block and place it on top. Users will perform this operation and hand the haptic device controls to the next player. The game will continue until one of them knocks the tower over. They will be allowed to play multiple times if the session time frame allows for it. After playing a couple of games they will be instructed to return to the main menu and select the hard mode. They will be instructed to play the game in the same manner.

The researchers will be watching the game and will be able to make subjective observations of the user's ability to play the game. Once the users finish playing Jenga they will be asked to fill out a questionnaire as seen in Appendix 2.

Methods of Performance Analysis and Measurement Metrics

From the data that we have gathered during the demo session, we will be comparing the results for both modes. In the questionnaire in Appendix 2, we have created related questions for the normal and hard modes. This was done so that we could find out how each mode stacks against the other so we can identify which version overall is the favoured amongst the participants. Since most of the questionnaire answers are not answered with numbers, we will have to take some of the answers with a grain of salt. Since every participant has not gone through a background check on things such as personal interests, background experiences with haptic devices, and any previous Jenga experiences. It will not be possible to know if the enjoyability has been affected due to lack of experience in either the lack of haptic device experience or lack of previous Jenga experience. To combat this issue, we will assume that everyone knows how to play Jenga and will have no prior experience with the haptic device used in this experiment other than the time we were able to use it in our designated lab slot.

If we are to look at our results with the above assumption, then we will be mainly comparing and looking at how the two modes stack against each other. For example, the rating of how hard each of the modes will be averaged out so we can get an overall image of how hard each mode is. The most definitive question that will be answered will be which mode they would rather play if presented in a party environment. This will allow us to see how many people prefer one mode over the other. For the answers that relate to the haptic experience of the overall system, we will be considering that for any further improvements to our system such as the pen enhancing the game experience for the user.

Results From Comparing Both Applications

Below are the results obtained for the questionnaire all participants filled out (See Appendix 2). The results are based on the answers of 6 participants and show how they answered the questions. They are listed as the answer and the number of people that gave that answer.

How enjoyable was the normal mode? Enjoyable: 6 people	**How enjoyable was the hard mode?** Enjoyable: 4 people Somewhat enjoyable: 2 people
Which mode would you rather play if this was presented in a party setting? Hard mode: 4 people Normal mode: 2 people	**Rate the effectiveness of the haptic feedback in enhancing your gaming experience** Very Effective: 3 people Effective: 3 people
How challenging did you find the virtual Jenga compared to the traditional physical version? Very challenging: 3 people Challenging: 3 people	**Did the haptic stylus pen enhance your sense of presence in the virtual environment?** Completely: 2 people Very much: 2 people Moderately: 1 person

On a scale of 1-10, how hard did you find the normal mode? Rating of 3: 1 person Rating of 5: 2 people Rating of 6: 1 person Rating of 7: 2 people Avg rating: **5.5** **Rate the overall realism of the virtual Jenga experience:** Very realistic: 1 Realistic: 5	Slightly: 1 person **On a scale of 1-10, how hard did you find the hard mode?** Rating of 7: 1 person Rating of 8: 3 people Rating of 9: 2 people Avg rating: **8.167**

Table 1. The totals from each of the questions in the questionnaire (see Appendix 2)

Comparison Between the Two Modes

Question	Normal Mode	Hard Mode
How enjoyable was each mode?	Enjoyable: 6	Enjoyable: 4 Somewhat enjoyable: 2
Rating each mode on a scale of 1 to 10 for how hard it was	Avg rating: 5.5	Avg rating: 8.167
Which would you prefer in a party setting	2 people	4 people

Table 2. Comparative results based on answers to the questionnaire (see Appendix 2)

Critical Analysis and Discussion of Obtained Results

Overall the game was seen as more challenging than normal Jenga based on the results. A few possibilities could account for this. Participants had never used a haptic device for a game like this and while they enjoyed the game there was a learning curve to understand how to play. It's possible that given more time to play participants might have found the game easier.

Overall the haptic pen and its feedback was seen as a benefit to feedback for the game. However, the haptic pen didn't do much to increase the users' feeling of presence. The feedback improved the ability to feel and place blocks. This allowed users to get a sense of realism from the pen. The presence wasn't very high as the pen alone didn't offer an immersive experience. Solutions to make the game more immersive could be to use a VR headset in the future and to introduce audio cues

The vast majority of users did find the experience to be realistic. This can be attributed to the game logic and feedback allowing users to have touch similar to the real game. The physics of the game could also play a large role in creating a life-like simulation of a real game.

From the comparisons between the applications, it was found that the normal mode was rated as more completely enjoyable. The hard mode was also rated as enjoyable but with more participants rating it

as somewhat enjoyable. This was not surprising as the normal mode had less of a learning curve and the hard mode required more skill to play.

Surprisingly the hard mode was favoured in a party setting as users found it better for playing with others. If users were given more time it's possible that the hard mode might have become the more enjoyable mode in all categories. Users likely liked the challenge when they were playing with others and found the normal mode too easy to fully enjoy playing competitively.

Our first hypothesis that users would find the normal mode to be easier was proved correct as the average difficulty rating for the normal mode was significantly less than the hard mode by just under 3 points.

The second hypothesis that users would prefer the normal mode as a part game was proven incorrect as most users preferred the hard mode. This is likely due to users wanting a challenge in a competitive game.

Software Engineering Lifecycles

Comments on the software engineering lifecycles, principles/methods applied to complete the project if one teammate is in the software engineering program.

In designing the game it was important to use various software engineering lifecycles, principles and methods. These included using version control to work on the project as a team. Being able to collaborate using Git[4] and GitHub[5] helped to improve the workflow. It was also important to create a plan detailing what the end goal was and the objects related to accomplishing this goal. The plan included requirements such as two different modes, a main menu, the ability to reset the game and the interaction of the objects. Planning was done to ensure the various requirements could be fulfilled.

Contributions

Chace Nielson

- Worked on developing design plan
- Set up the Unity project and worked on developing the design plan
- Wrote the logic for resetting the Jenga tower
- Wrote the friction logic for haptic interaction
- Wrote the logic handling the difficulty modes of the game
- Helped write the introduction section of the report
- Helped write the project objectives and scope section of the report
- Wrote the methods of performance analysis and measurement metrics section of the report
- Wrote the critical analysis and discussion of the obtained results section of the report
- Wrote the software engineering lifecycles section of the report

Xian Wei Low

- Worked on developing design plan
- Helped write project objectives and scope section
- Helped write the introduction section

- Wrote detailed hypothesis section
- Wrote performance methods of performance analysis and measurement analytics section
- Wrote developed techniques section
- Wrote tasks and target users section
- Wrote results gained from questionnaires
- Helped develop questionnaire questions
- General debugging of project

References

[1] Jenga, Available: https://www.jenga.com

[2] Unity Technologies. (2022). Unity - Game Development Platform. [Software]. Available: https://unity.com

[3] 3D Systems, "Touch Haptic Devices," [Software]. Available: https://www.3dsystems.com/haptics-devices/touch

[4] Git. (2022). Distributed version control system. [Online]. Available: https://git-scm.com/

[5] GitHub. (2022). Web-based platform for version control and collaboration. [Online]. Available: https://github.com/

Appendices

1. Unity Objects and Scripts Created Specifically for the Project

- Camera Manager Script
    - This script connected to the haptic device allowing it to stay in a relative position to the camera
    - This script allowed the camera to zoom in/out, move up/down and rotate around the tower
- Friction Setup Script
    - The friction changed on each block depending on the difficulty of the game
- Tower Setup Script
    - This Script allowed the tower to be created dynamically and also for it to be reset at the press of the space bar
- Game Manager Script for Difficulty settings
    - Depending on the mode selected this script changed the colour of the block and the friction elements in the scene.
    - This created difficulty modes and allowed the haptic device to interact with each scene differently
- Main Menu/Pause Menu Scripts
    - These allowed the normal and hard modes to be selected with ease
- Jenga Blocks as Objects
    - The blocks had default height and a slight random variation
    - The blocks having different heights allowed the game to feel like real Jenga with some blocks appearing to be loose
    - The blocks also had a specific friction depending on the mode type
- Floor Object
    - The floor also had a friction value that allowed the block to stay in place
- Game UI
    - The game had a user interface on each level

2. Jenga Questionaire

How enjoyable was the normal mode?

⬜ Unenjoyable ⬜ Somewhat unenjoyable ⬜ Somewhat enjoyable ⬜ Enjoyable

---

How enjoyable was the hard mode?

⬜ Unenjoyable ⬜ Somewhat unenjoyable ⬜ Somewhat enjoyable ⬜ Enjoyable

---

Which mode would you rather play if this was presented in a party setting?

⬜ Normal mode ⬜ Hard mode

Rate the effectiveness of the haptic feedback in enhancing your gaming experience

⬜ Not effective at all ⬜ Slightly effective ⬜ Effective ⬜ Very effective

---

How challenging did you find the virtual Jenga compared to the traditional physical version?

⬜ Not challenging ⬜ Slightly challenging ⬜ Challenging ⬜ Very challenging

---

Did the haptic stylus pen enhance your sense of presence in the virtual environment?

⬜ Not at all ⬜ Slightly ⬜ Moderately ⬜ Very much ⬜ Completely

---

Rate the overall realism of the virtual Jenga experience:

⬜ Not realistic at all ⬜ Slightly realistic ⬜ Realistic ⬜ Very realistic

---

On a scale of 1-10, how hard did you find the normal mode? _____

On a scale of 1-10, how hard did you find the hard mode? _____

---

3. Participant Consent Forms

Participant 1

Name of Researcher, Faculty, Department, Telephone & Email

Xian Wei Low, Software Engineer, xian.low1@ucalgary.ca
Chace Nielson, Software Engineer, chace.nielson1@ucalgary.ca

Supervisor

Dr. Yaoping Hu, Software Engineer

Title of Project

Unity Jenga Tower

Sponsor:

There are no parties that are sponsoring this project.

Disclaimer

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

Participation is completely voluntary, and anonymous.

Purpose of the Study

The goal of this study is to gather user feedback related to the Jenga Tower game. This feedback will serve to improve the application and to understand the effect that different friction settings have on a user's ability to play and enjoy a game of virtual Jenga.

What Will I Be Asked To Do?

You will be asked to play a game of virtual Jenga with a partner. After playing a game you will be asked to fill out a survey with questions about your experience. Then you will be asked to repeat this with a different version of the game.

If there is any part of the testing that the participants are unwilling to do such as answering a certain question, they are ultimately allowed to refuse participation altogether without any penalty or drawback.

What Type of Personal Information Will Be Collected?

No personal identifying information will be collected in this study, and all participants shall remain anonymous. The only information recorded will be your answers to questions related to playing the virtual Jenga game.

Are there Risks or Benefits if I Participate?

During the testing of the product, there will be no risks or benefits that come along with the experiment other than those that come with looking at a computer screen.

What Happens to the Information I Provide?

Participants are free to withdraw until 01/12/2023 after data collection.

No one except the researchers and our supervisor will be allowed to see or hear any of the answers to the questionnaire. There are no names on the questionnaire. The data will be summarised and used in a final report that only the supervisor will see.

Signatures

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Participant's Name: (please print) _ALLIANA DELA PENA_____

Participant's Signature: _____ALLIANA DELA PENA_____

Date: ____01/12/2023_____

Researcher's Name: (please print) XIAN WEI LOW,

Researcher's Signature: _____Xian Wei Low_____

Date: ____*24/10/2023*_____

Researcher's Name: (please print) CHACE NIELSON

Researcher's Signature: _____Chace Nielson_____

Date: _____*24/10/2023*_____

Questions/Concerns

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Participant 2

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Xian Wei Low, Software Engineer, xian.low1@ucalgary.ca
Chace Nielson, Software Engineer, chace.nielson1@ucalgary.ca

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Participant’s Name: (please print) _____AIDEN PARK_____

Participant’s Signature: _____AIDEN PARK_____

Date: ____01/12/2023_____

Researcher's Name: (please print) XIAN WEI LOW,

Researcher's Signature: _____Xian Wei Low_____

Date: ____*24/10/2023*_____

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Researcher's Signature: _____Chace Nielson_____

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Chace Nielson, Software Engineer, chace.nielson1@ucalgary.ca

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Participant's Name: (please print) _____SAUD AGHA_____

Participant's Signature: _____SAUD AGHA_____

Date: ____01/12/2023_____

Researcher's Name: (please print) XIAN WEI LOW,

Researcher's Signature: _____Xian Wei Low_____

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Researcher's Name: (please print) CHACE NIELSON

Researcher's Signature: _____Chace Nielson_____

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Chace Nielson, Software Engineer, chace.nielson1@ucalgary.ca

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The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

Participation is completely voluntary, and anonymous.

Purpose of the Study

The goal of this study is to gather user feedback related to the Jenga Tower game. This feedback will serve to improve the application and to understand the effect that different friction settings have on a user's ability to play and enjoy a game of virtual Jenga.

What Will I Be Asked To Do?

You will be asked to play a game of virtual Jenga with a partner. After playing a game you will be asked to fill out a survey with questions about your experience. Then you will be asked to repeat this with a different version of the game.

If there is any part of the testing that the participants are unwilling to do such as answering a certain question, they are ultimately allowed to refuse participation altogether without any penalty or drawback.

What Type of Personal Information Will Be Collected?

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Are there Risks or Benefits if I Participate?

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Participant's Name: (please print) _____SHANZI YE_____

Participant's Signature: _____SHANZI YE_____

Date: ____01/12/2023_____

Researcher's Name: (please print) XIAN WEI LOW,

Researcher's Signature: _____Xian Wei Low_____

Date: ____*24/10/2023*_____

Researcher's Name: (please print) CHACE NIELSON

Researcher's Signature: _____Chace Nielson_____

Date: _____*24/10/2023*_____

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact:

Xian Wei Low, Faculty of Software Engineering xian.low1@ucalgary.ca	Chace Nielson, Faculty of Software Engineering chace.nielson1@ucalgary.ca	Dr. Yaoping Hu, Faculty of Software Engineering huy@ucalgary.ca

If you have any concerns about the way you've been treated as a participant, please contact the Research Ethics Analyst, Research Services Office, University of Calgary at 403.220.6289 or 403.220.8640; email cfreb@ucalgary.ca. A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

Participant 5

Name of Researcher, Faculty, Department, Telephone & Email

Xian Wei Low, Software Engineer, xian.low1@ucalgary.ca
Chace Nielson, Software Engineer, chace.nielson1@ucalgary.ca

Supervisor

Dr. Yaoping Hu, Software Engineer

Title of Project

Unity Jenga Tower

Sponsor:

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Participant’s Name: (please print) _____NICOLE ZACARUK_____

Participant’s Signature: _____NICOLE ZACARUK_____

Date: ____01/12/2023_____

Researcher's Name: (please print) XIAN WEI LOW,

Researcher's Signature: _____Xian Wei Low_____

Date: ____*24/10/2023*_____

Researcher's Name: (please print) CHACE NIELSON

Researcher's Signature: _____Chace Nielson_____

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Participant 6

Name of Researcher, Faculty, Department, Telephone & Email

Xian Wei Low, Software Engineer, xian.low1@ucalgary.ca
Chace Nielson, Software Engineer, chace.nielson1@ucalgary.ca

Supervisor

Dr. Yaoping Hu, Software Engineer

Title of Project

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Participant's Name: (please print) _____KENNY JEON_____

Participant's Signature: _____KENNY JEON_____

Date: ____01/12/2023_____

Researcher's Name: (please print) XIAN WEI LOW,

Researcher's Signature: _____Xian Wei Low_____

Date: ____*24/10/2023*_____

Researcher's Name: (please print) CHACE NIELSON

Researcher's Signature: _____Chace Nielson_____

Date: _____*24/10/2023*_____

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