AR & VR REPORT

Beerpong Team

Team

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1 Bio of the Team

1.1 Anand Bihari Gaurav

I was completely new to Unity software. But with the help and support of my team members and Professors I was able to contribute very well to the project. After proper discussion with my team members, I was assigned with below responsibilities in the game:

- Creating and Integration of Scenes

- Addition of Tutorial Video and Music in the Game

- Creating of Canvas and attaching buttons

- Photon Integration

- Trajectory Line

- Highlighting of the Cups

- GitHub Management

As the lead programmer on the VR Beer Pong project, my main responsibility was to write the code that would make the game functional. This included creating the game logic, implementing player controls, and integrating VR capabilities. One of the biggest challenges I faced was getting the ball physics to feel realistic, as it was crucial for the player to feel like they were throwing a ping pong ball. I spent countless hours tweaking the ball's velocity and trajectory to get it just right. In the end, my efforts paid off, as the realistic ball physics ended up being one of the most praised features of the game. In addition to my programming duties, I also contributed to the design of the levels and helped to optimize the game's performance. Overall, my contributions were instrumental in bringing the VR Beer Pong game to life and helping it achieve success.

1.2 Muhammed Maral

As the lead developer for the VR/AR Beerpong Game, I am thrilled to have been a part of bringing this innovative and immersive experience to players. My role in the project involved overseeing the programming and technical aspects of the game, from designing the user interface to implementing the AR and VR technology. Our goal was to create a game that not only offers a fun and engaging experience, but also pushes the boundaries of what's possible with this technology. I'm proud of what we've accomplished and can't wait for players to get their hands on it.

My responsibilities:

- GitHub management via GitBash,

- Developing the game logic:

- Ball physics,

- Cup destruction,

- Ball spawner,

- Ball destruction,

- Scoreboard,

- Shooting hints

One of the biggest challenges we faced during the project was project management. We spent a significant amount of time adjusting our project to team members' progress and ensuring that everyone was on the same page. This experience taught me that effective communication and collaboration are essential for any successful project. For those just starting out, I highly recommend getting support from academic staff on Git, GitBash, GitHub, and GitHub desktop. These tools will help you share progress and collaborate smoothly with your team.

In addition, I suggest that students starting out on similar projects take the time to plan and organize their work before diving into the development process. Also, breaking up the work into smaller tasks, and assigning them to the team members, and keeping track of the progress with a project management tool.

Overall, I am proud of the work that our team has accomplished, and I am excited for players to get the chance to experience our game. It was an exciting and challenging experience, and I am grateful for the opportunity to be a part of it.

1.3 Julian Ambacher

At the beginning of the project, I faced challenges familiarizing myself with the Unity software and the intricacies of virtual reality development. However, through persistent learning and experimentation, I was able to master the most important settings and functions, allowing me to contribute to the project at a high level.

As a member of the virtual reality Beerponggame team, I was responsible for:

- Developed complete modeling of table, ball, room, and entire equipment for beer pong game project

- Assigned materials and created textures for all objects within the game

- Developed a scoreboard for displaying the current score of game

- Assisted in the user testing phase of the project

- GitHub Mangement

I played a vital role in the development of our beer pong game as the main modeler and creator of the user testing phase. First and foremost, I was in charge of the complete modeling of the table, ball, room, and all the equipment for our beer pong game project. This involved creating textures and assigning materials for all objects in the game, ensuring that they were visually appealing and realistic. I also took on the role of GitHub administration, ensuring that all updates and changes were properly tracked and saved.

In addition to my modeling duties, I also began to develop together with the team a scoreboard for the current state of the game. This feature allowed players to easily track their progress and compete against one another, adding an element of competition and excitement to the game.

I also played a key role in the user testing phase of the project. I was responsible for creating the test, finding different ways to conduct it, and also summarizing the results and feedback in a good form. I evaluated the feedback, made the necessary recommendations for future improvements, and ensured that the final product was of the highest quality.

Overall, I am proud of my contributions as well as the exceptional teamwork and cooperation that we achieved throughout the project. The team spirit was very good and the correlation together was great, which made the project run smoothly and efficiently. Throughout the development of our virtual reality beer pong game, the team showed strong teamwork and a never-ending commitment to our common goal. The result of our collaboration is a polished and functional game with many additional features that can be improved or added in the future. The skills I acquired during the process will be useful in my future plans.

2   Link to the GitHub Project

https://github.com/MamiMrl/VR-Beerpong-THI.git

3   Introduction

3.1   Overview of the Project

As a team, we thought about developing a game that not only teaches the user something, but where the user also has fun. We came up with the idea of designing a Beerpong game, as this is not yet very widespread as a VR application and can be played in multiplayer mode. Our Beerpong application can be played by one player or max. 2 players. The player stands at a fixed position and tries to hit a ping pong ball into the cups with the controller, which is marked. A scoreboard on the side counts the number of cups hit into. The player who has hit all the cups has won the game. In addition, with the help of videos and throw analysis, the player learns how to make a perfect throw to hit into a cup.

Abbildung 1: Beerpong Game

The game is aimed at teaching the user playfully, step by step, how to make an optimal trajectory of a throw. The individual factors are also shown, e.g. how the trajectory changes when the throwing angle is changed.
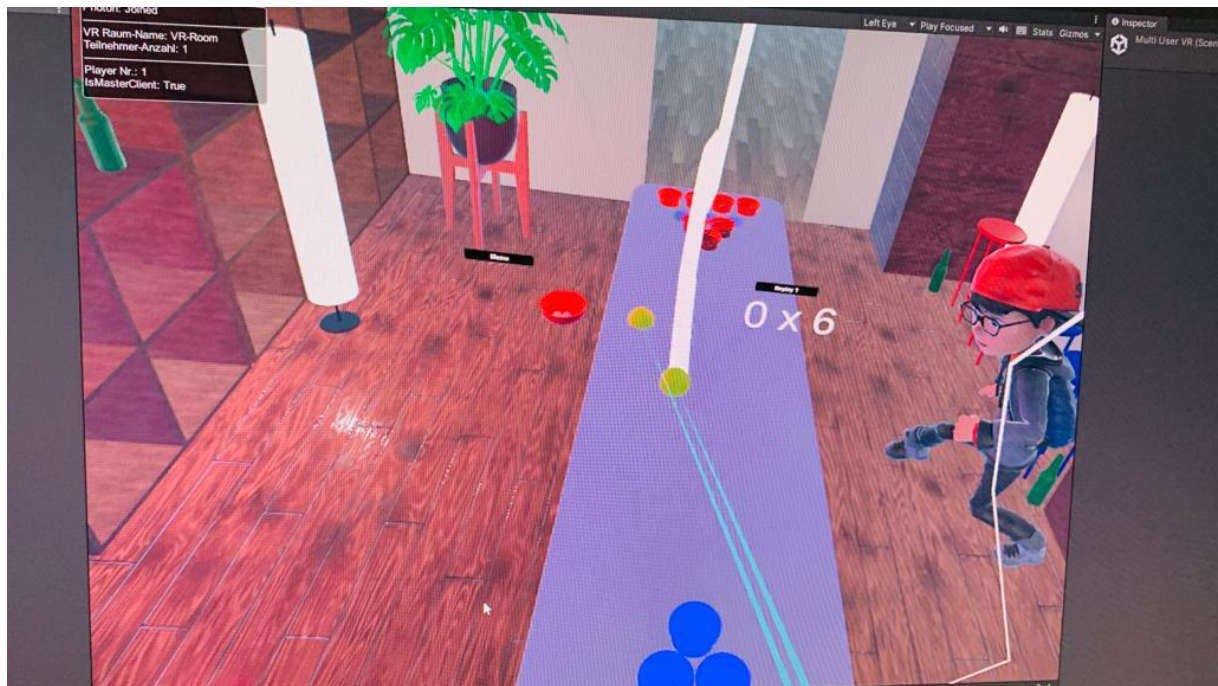
Abbildung 2: Beerpong Tracing Line

3.2 Problem

The problem we dealt with as a team was that in general, athletes or players of a beer pong game should learn how to make a perfect throw. The only thing that matters is the technique with which they throw. While using our application, they should learn how exactly to throw in order to make the longest and most precise throw possible.

Since our application does not have 100% the same controls as in reality, it should at least give you the technique and a feeling of how to perform a perfect throw.

Abbildung 3: Image of Testuser 2

Abbildung 4: Image of Testuser 1

3.3 The Objectives

The respective objects and applications in our application are listed and described individually
below.

3.3.1   Environment

The environment includes an ordinary room where the Beerpong game would take place again.
This room is furnished with some plants and furniture to make it look more cosy and ordinary.

Abbildung 5: Beerpong Game Room

In addition, some glass bottles have been inserted into the room to give it a party atmosphere. These glass bottles should give the player the feeling that he is at a party where he is playing the beer pong game.

Abbildung 7: Glasbottles 1

Abbildung 8: Glasbottles 2
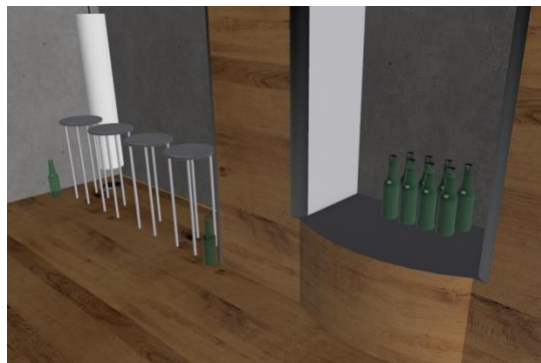

Abbildung 6: Glasbottles 3

3.3.2 Infinite ball spawn

In this application, the ball should reappear infinitely so that the user always has the opportunity to throw and get a new ball. The player needs as many balls as necessary until he has destroyed all the cups of the opposing team. The balls should only reappear when the player has taken a ball.

Abbildung 9: Bowl of Balls

3.3.3 Highlighted cups

Before it is the turn of a game, a cup is marked. The player should then hit into this cup.

3.3.4 Cup destroy

After a player has hit a cup, it is destroyed. This happens through a script that is applied when the ball touches the inside of the cup.

3.3.5 Tracing line

This application makes it possible that the ball is clearly more visible and can also be tracked. The trajectory can also be displayed better here, as a line shows this. This makes it easier for the player to see when a throw was good and when it was not so good.

3.3.6 Learning Video

The learning video is intended to show the player how to make a perfect throw. In addition, the video also shows which factors are important in order to execute it. An example is shown here of how a ball is thrown and what distance it reaches. The player can follow the video and learn which factors are important for a perfect throw.

3.3.7 Scoreboard

In this element, the points of the respective team are displayed and listed. The number of points increases depending on how many cups a player has already destroyed. However, a maximum of 10 points per player can be reached to win the game, as there are only 10 cups.
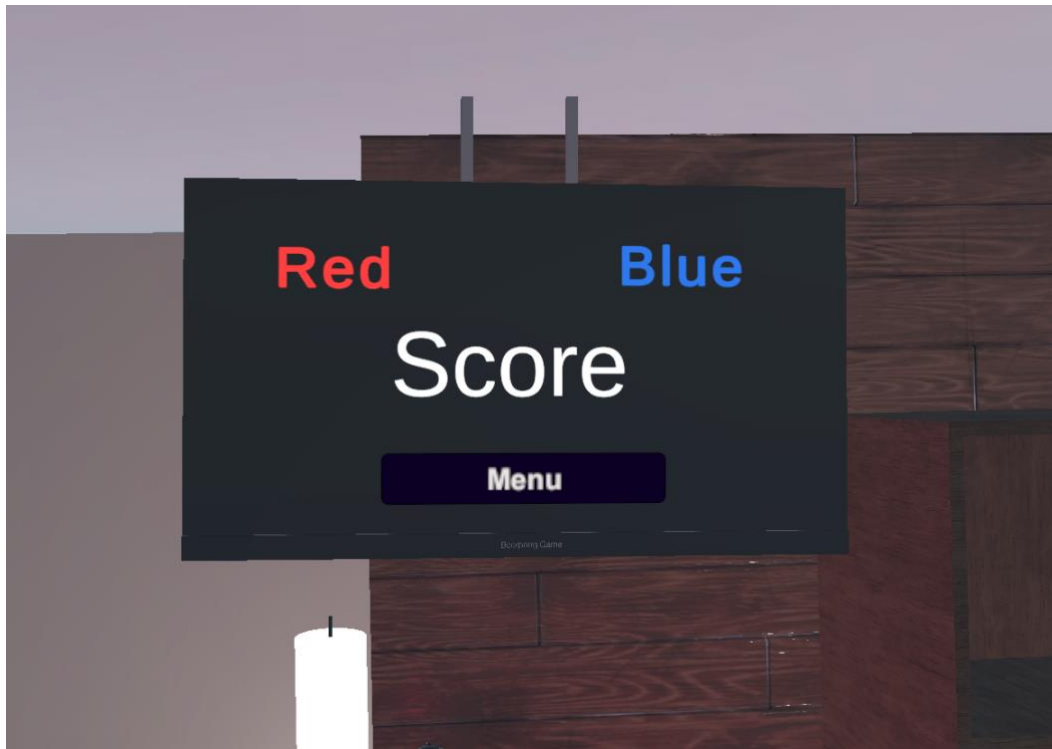
Abbildung 10: Scoreboard on TV

Abbildung 11: Scoreboard Player won

Abbildung 12: Scorebaord Multiplayer

3.3.8 Sound

The sound that is played during our application should also convey the atmosphere of a party room. This should also motivate the player and build up tension.

4 Description of the project concept

For the project concept we designed some personas and user stories, which were also starting points for our application. The user stories and Design considerations are described below.

4.1 User stories

- As a user, I want an introduction of the game so that I learn the operations and actions in the application.
- As a user, I want a description of what I'll learn in the application.
- As a user, I want a near-realistic movement as it is in a real Beerpong game.
- As a user, I want to have fun during I am playing the game.
- As a user, I want an environment where I feel like I'm in a room where there's actually a party going on and the game is being played.
- As a user, I want to have fun while learning a perfect throw.
- As a user, I want to know more about the virtual world and how it is used.

4.2 Design considerations

In the beginning, we had to define who our target group is. To do this, we created three personas that helped us to define the requirements of our application exactly and to work them out. We also created some user stories, which we then revised again and again (as described above). In addition, we assigned goals and pain points to each persona, which also helped us to understand what was important to the target group. After that, we defined and adapted our application more and more precisely. This helped us a lot to adapt our application to our target group.

5 Planned user activities & multiuser interactions

5.1 User Interactions

For the game, the player is equipped with virtual reality glasses and two controllers with which he can look around the game 360° and control the game with the controllers. The player presses the various buttons on the controller to grab the table tennis ball, bring it to the right distance and then throw it. Throwing is done by releasing the button.

Furthermore, at the beginning of the game, the player can select with a button whether he wants to start the game directly or whether he first wants to watch an instructional video to understand how a perfect throw can be executed. In addition, the system plays a sound during the game to further motivate the player to play the game and win.

5.2 Multiuser interactions

In our application, several players can play the game at the same time. However, this can only be done in pairs at most, as the throwing position is only ever given to one player per team. In addition, the opposing players can communicate and talk via an audio chat. Both players have the same requirements and must each hit the cups of the opposing team.
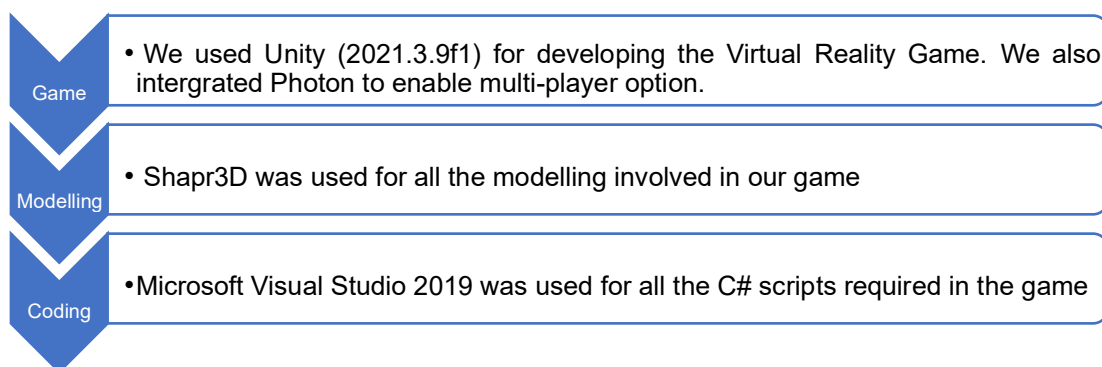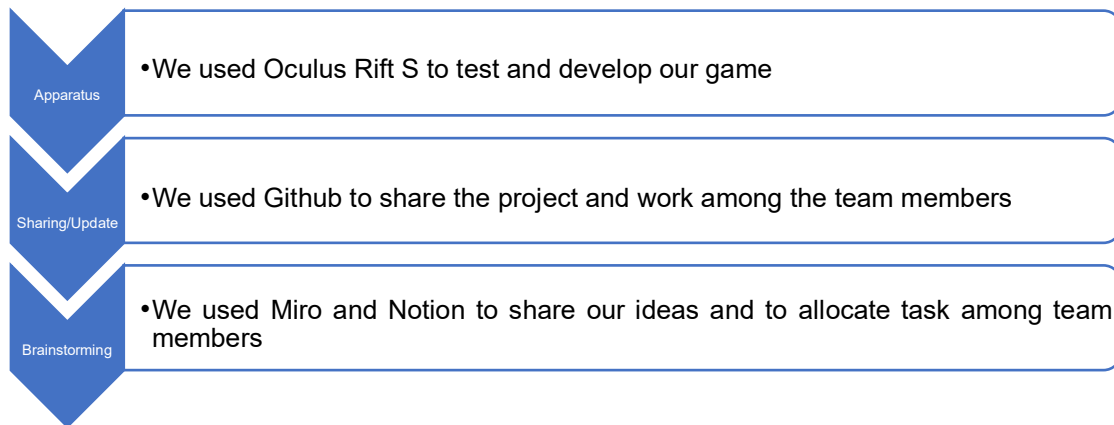
6 Methods

The development of the VR Game comprised of various steps, and we followed the below design cycle to deliver our project. We tried our level best to ensure that we involve our users in each stage of the development so that we can have real time feedback. We have really worked upon those feedback to deliver a successful project.

Designing and developing a game requires multiple steps and division of work among team members.

We were very much clear from the beginning that we will keep things very much simple and organized our work.

Game	• We used Unity (2021.3.9f1) for developing the Virtual Reality Game. We also intergrated Photon to enable multi-player option.
Modelling	• Shapr3D was used for all the modelling involved in our game
Coding	•Microsoft Visual Studio 2019 was used for all the C# scripts required in the game

Apparatus	•We used Oculus Rift S to test and develop our game
Sharing/Update	•We used Github to share the project and work among the team members
Brainstorming	•We used Miro and Notion to share our ideas and to allocate task among team members

After we were able to develop the game, we conducted usability test to know, how well the game performs in front of user's expectations. The interview with the users were conducted very smoothly. We allowed the users to speak their mind whatever they are feeling about the game during interaction, which helped us to gain important insights. We asked standard usability questions to the users to convert their feedback into quantitively data. These data helped us to figure out the existing gaps in our game.

7 Usability test

Objective: The main objective of the usability test was to ensure that whether the logic of the game was achieved or not. We wanted to know from the user's perspective about any missing elements in the environment that will help us to deliver our project effectively. All the participants were really excited during the briefing of the project as they were always confused about the topic of "Projectile Motion" in their time. We explained them the game flow and the educational aspects of the project. We divided the usability test into three stages:

- Gauging the Target group and experiences if any

- Testing by the users and feedback

- System usability scale

A. Gauging the Target group and experiences if any

- During this phase, we questioned the participants about their age, occupation, highest degree, and VR experiences. We were curious as to how they felt about using virtual reality to change the educational landscape. We also inquired about any difficulties they may have encountered when using and interacting on these platforms before. This helped us in understanding our target audiences.

B. Testing by the users and Feedback

- The participants were allowed to use the VR headset after the complete briefing of the project. In this phase we wanted our environment to be tested thoroughly and the participants must interact with the environment. To ensure that we get the real time feedback we kept on asking them question while they were interacting in the environment. We also asked any changes or features they want in the game to make it more engaging and immersive. All their answers and suggestions were recorded and analyzed by our team.

We focused our questions to below domain while the participants are interacting with the game environment:

- Test the controls: Make sure that the controls are intuitive and easy to use.

- Test the accuracy: Make sure that the game accurately detects when a ball goes into a cup and when it misses.

- Test the immersion: Make sure that the VR experience is immersive and that players feel like they are playing beer pong.

- Test the replay value: Make sure that the game is enjoyable and has enough content to keep players coming back for more.

- Test the difficulty: Make sure that the game is challenging, but not too difficult, so that it remains enjoyable for players.

- Test for any bugs or glitches: Make sure that the game is stable and free of any bugs or glitches that might disrupt the player's experience.

C. System Usability test:

- In the final stage of usability test a one-to-one interview was conducted with the participants we asked standard questions of System usability scale. The questions asked are shown below:

To calculate the SUS score, the responses to the questions are first reversed so that a higher score indicates a more positive response (e.g., a response of "1" becomes a "5"). The scores for all 10 questions are then added together and divided by 10 to get the mean score. The final SUS score is then calculated by multiplying the mean score by 2.5 and adding it to a constant of 50. The resulting score is on a scale from 0 to 100, with higher scores indicating a more usable system.

Below is the SUS results we got from the usability test:
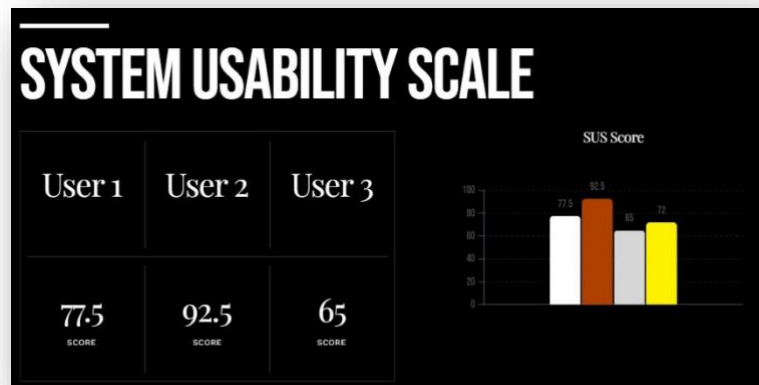
We received a SUS score of 72 which is a very good score at the current stage of the project.

8 Improvements based on usability test

After successfully conducting the usability test and analyzing the data recorded, we concluded that user's need below things in the game to enjoy it more

- Environment: User suggested that they would prefer a party environment with music and scoreboard to able to enjoy more.
- Guidance: Any audio / visual guidance is required for the users to navigate the game into different scenes and while throwing the balls.
- Learning Aspect: Users have recommended us to keep the learning aspect as optional and not too long enough to make them bore.
- Interaction: Users were happy with the working of the controllers and ability to pick the ball from the distance.
- Multiplayer: All our participants suggested to enable the multiplayer mode so that there can be two-way communication between the players.

Below are the graphical representations of their suggestions:
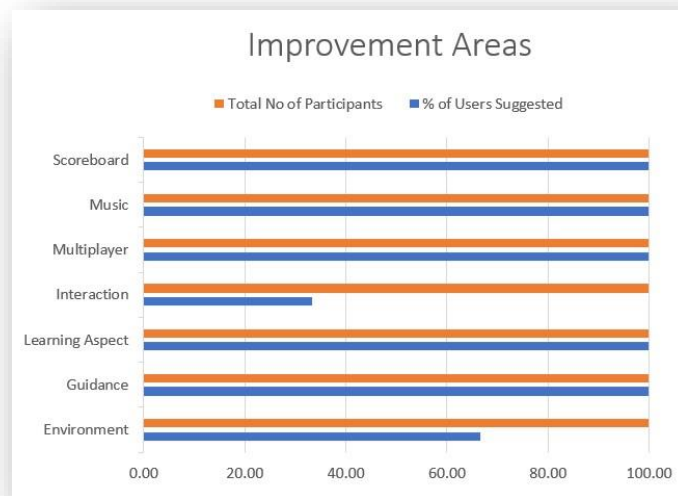
9 Challenges and limitations

The first challenge we faced to live up to the expectations of an actual Beer Pong game. Since we are expecting users to try VR Beer Pong game in place of normal Beer Pong game. We wanted to provide a great user experience to our users. We faced below challenges while executing our project:

➢ Technology limitations: VR technology is still relatively new and there may be technical limitations that impact the design and development of our game. We struggle a lot for the working of the controllers according to our desire.

➢ User experience: Designing a VR game that is immersive and enjoyable for players can be a challenge. It's important to ensure that the VR experience is smooth and comfortable for players, to avoid motion sickness or other negative side effects.

➢ Compatibility: Not all VR devices are compatible with all VR games, so you may need to consider the different devices that your game will be played on. The game is compatible with Oculus Rift S but when we tried our game on Oculus Quest 2 some functions were not working properly.

➢ Development time: Developing a VR game is very time-consuming, especially when we are creating a complex game with multiple levels or features and with less experience.

➤ Immersive Game: Creating a game with 100% immersion was a challenging factor as while throwing the ball the users suggested that they can't feel the weight of the ball and, they are not sure whether the gravity is working fine or not.

➤ Educational Aspect: We chose "Projectile Motion" as our educational aspect. The topic itself is little tricky and making the users understand the concept in a minute was a challenging task for us.

➤ Scripts: We were completely new with the C# coding, so it took us little time to figure things out.

➤ GitHub: This was all together a different challenge for us as we were new to it. We lost lot of time to establish why our activities were not reflecting on the GitHub. We tried many ways to share and merge our contents. We eventually found that we are comfortable with Git Bash to push and pull our changes.

10 Goals

Our project aims to design and develop a Beerpong VR/AR game in Unity that combines education and entertainment. The game is designed to teach players about projectile motion, a fundamental concept in physics that describes the path that an object follows when it is thrown or fired. By making the learning process fun and interactive, we hope to engage and motivate players to understand and retain this important knowledge.

10.1 Current Goals

1. Designing an environment with a party and fun feeling: This goal involves creating a virtual environment that evokes the atmosphere of a party, where the game of Beerpong would typically be played. This might include designing and modeling elements such as tables, chairs, cups, and other objects that are commonly found at a party.

2. Using VR controllers to simulate the real throwing motion: In order to make the game as immersive and realistic as possible, this goal involves using VR controllers to replicate the motion of throwing a ball in real life. This might involve programming the controllers to track the movements of the player's hands and arms, and to apply the appropriate forces and dynamics to the virtual ball.

3. Destroying the cups when the user scores, and having a scoreboard: This goal involves programming the game to track when a player scores a hit by sinking a ball into a cup, and to remove the cup from the game. The game should also keep track of the score for each player and display it on a scoreboard.

4. Having a trajectory line that follows the ball path when it's thrown: In order to help players understand the physics of projectile motion, this goal involves adding a visual element that shows the path that the ball follows when it is thrown. This might involve displaying a dotted line or other visual representation of the ball's trajectory.

5. Having 3 jokers, and in each joker the user would be able to choose which cup to destroy, and then get the throwing guide to get a successful shot: In order to add an element of strategy to the game, this goal involves implementing jokers, which are special abilities that players can use to gain an advantage. In this case, the jokers allow players to choose which cup to destroy and to receive a throwing guide to help them make a successful shot.

6. Being able to display the dependencies of the ball and the trajectory in UI, such as speed, angle, max height, and landing point of the ball: This goal involves adding a user interface (UI) element that shows the key variables that influence the trajectory of the ball, such as the speed, angle, and maximum height. This can help players understand how these variables affect the path of the ball and how to make adjustments to improve their throws.

Our team was able to successfully meet a number of our initial goals for the project, including:

1. Designing an environment with a party and fun feeling: We were able to create a virtual party environment that conveyed the atmosphere of a typical Beerpong game, including tables, chairs, cups, and other objects.

2. Using VR controllers to simulate the real throwing motion: We implemented the use of VR controllers to replicate the motion of throwing a ball in real life. Players were able to use the controllers to grip and throw the ball as they would in the real world.

3. Destroying the cups when the user scores, and having a scoreboard: We programmed the game to track when a player scored a hit by sinking a ball into a cup, and to remove the cup from the game. The game also kept track of the score for each player and displayed it on a scoreboard.

4. Having a trajectory line that follows the ball path when it's thrown: We added a visual element that showed the path that the ball followed when it was thrown, helping players to understand the physics of projectile motion.

5. Being able to display the dependencies of the ball and the trajectory in UI, such as speed, angle, max height, and landing point of the ball: We implemented a user interface (UI) element that showed the key variables that influenced the trajectory of the ball, including the speed, angle, and maximum height. This helped players understand how these variables affected the path of the ball and how to make adjustments to improve their throws.

However, we did make a change to one of our initial goals due to feedback from Andreas Löcken and Prof Munir Georges. Our original goal was to include jokers, which were special abilities that allowed players to choose which cup to destroy and to receive a throwing guide to help them make a successful shot. However, in order to save time and make the goal more feasible, we changed this goal to simply allow players to highlight a cup before shooting the ball.

10.2 Future Goals

1. Adding more levels or game modes: One possibility could be to add more levels or game modes to the game, each with its own unique challenges and objectives. This could help to keep the game fresh and interesting for players over time.

2. Improving the graphics and visual quality: Another goal could be to improve the graphics and visual quality of the game, perhaps by adding more detailed models, textures, and animations. This could enhance the immersion and enjoyment of the game for players.

3. Expanding the educational content: You could consider adding more educational content to the game, such as additional physics concepts or challenges that teach players about different aspects of projectile motion. This could help to make the game even more effective at teaching players about this important topic.

4. Adding multiplayer support: You could also consider adding multiplayer support to the game, allowing players to compete against each other online or in the same physical location. This could add an extra layer of competition and social interaction to the game.

5. Implementing more realistic physics: Another goal could be to further refine the physics of the game to make it even more realistic and accurate. This could involve implementing more advanced algorithms to simulate the motion and behavior of the balls and other objects in the game.

11 Conclusion & Insights

11.1 Conclusion

Through the development of our VR/AR Beerpong game, we sought to create an educational and entertaining experience that would help players learn about projectile motion in a fun and interactive way. By designing a virtual party environment, implementing VR controllers to simulate the real throwing motion, and adding features such as a tracing line, tutorial video, and scoreboard, we were able to create a game that met many of our initial goals. However,

we also made some changes to our original goals based on feedback from advisors, in order to make the project more feasible and efficient.

11.2 Insights

One of the key insights we gained from this project was the importance of adapting to feedback and making adjustments to our plans as needed. We learned that it is often necessary to be flexible and open to change in order to achieve the best results. Additionally, we gained valuable experience in designing and implementing a VR/AR game, including the challenges and opportunities of using new technologies. We believe that this experience will be valuable as we continue to develop and improve upon our game in the future.

Overall, we are pleased with the outcome of our VR/AR Beerpong project and believe that it is a successful and engaging educational tool that will help players learn about projectile motion in a fun and interactive way. We hope that users will enjoy playing the game and will continue to learn and improve their skills over time.

12 Suggestions for future Work

1. Add more levels or game modes: Add more levels or game modes to the game, such as more challenging cup layouts or obstacles, or incorporate new physics concepts or challenges. This will keep the game fresh and interesting for players over time and provide additional opportunities for learning.

2. Improve the graphics and visual quality: Enhance the immersion and enjoyment of the game by improving the graphics and visual quality, perhaps by adding more detailed models, textures, and animations.

3. Expand the educational content: Add more educational content to the game, such as additional physics concepts or challenges that teach players about different aspects of projectile motion. This will make the game even more effective at teaching players about this important topic and provide more opportunities for learning and growth.

4. Add multiplayer support: Allow players to compete against each other online or in the same physical location by adding multiplayer support to the game. This will add an extra layer of competition and social interaction to the game and make it more fun and engaging for players.

5. Implement more realistic physics: Further refine the physics of the game to make it even more realistic and accurate by implementing more advanced algorithms to simulate the motion and behavior of the balls and other objects in the game. This will make the game more lifelike and believable and make the educational content more accurate and effective.

6. Improve the tutorial video and other educational resources: Enhance the tutorial video and other educational resources in the game, such as the tracing line and throw analysis features, by adding more detailed explanations or examples or incorporating new media such as animations or interactive elements. This will make the educational content more engaging and effective for players.

7. Adding more interactive elements: Consider adding more interactive elements to the game, such as minigames or puzzles that teach players about specific physics concepts or help them practice their skills. This could make the game even more engaging and interactive for players.

8. Incorporating additional learning resources: Another possibility could be to incorporate additional learning resources into the game, such as text or video explanations or interactive quizzes. This could help to provide players with more detailed and comprehensive explanations of the physics concepts being taught, and could also help to reinforce their learning.

9. Enhancing the user interface: Consider improving the user interface of the game to make it more intuitive and user-friendly for players. This could involve redesigning the layout or adding additional features or tools to help players navigate the game and access the educational content.

10. Adding more customization options: You could also consider adding more customization options to the game, such as the ability to choose different avatars or environments, or to customize the appearance or behavior of the balls or cups. This could make the game more personalized and enjoyable for players.

11. Incorporating more realistic sound effects: Another possibility could be to incorporate more realistic sound effects into the game, such as the sound of the ball hitting the cups or the sound of the environment. This could enhance the immersion and realism of the game for players.

12. Adding more challenges and achievements: Consider adding more challenges and achievements to the game to give players additional goals to work towards and to reward their progress. This could make the game more rewarding and satisfying for players, and could also encourage them to continue playing and learning.