Project: This Way!

by

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Abstract

Our thesis project explores communication and gameplay interaction between a VR player and a Real World player (RW) when both must collaborate from different perspectives in order to complete this cross-reality and co-present experience. To conduct this research, we designed and developed a local two-player, VR experience when only one VR headset is available. We looked at interpersonal communication skills and how the information being sent and received impacted each player's experience. This effort was possible by creation of a VR environment containing visual puzzles that must be translated verbally and physically to the RW Player in order to receive the correct information, answers and hints. In this two-player VR experience with co-presence, players must communicate, interact and collaborate in order to make their way through the puzzles and VR rooms. User testing was conducted at the VR Mixer at Game Developer's Conference, Maker Faire Bay Area and *If You Weren't: Playing with Realities in ARG, AR and VR*. We discovered how to create an engaging and immersive two-player VR experience by focusing on three main aspects: VR room layout, universal instructions for both players and increasing the RW player's features.

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Chapter 1

Original Concept

Virtual Reality has an isolation issue that affects not only the VR player, but also those who are in close proximity in the real world. Our challenge was how might we create an engaging and immersive two-player, collaborative experience between a player in VR and a RW player challenging their social and interpersonal skills through gameplay interaction and co-presence.

The VR experience that we created is about communicating what the environment appears to be and how to solve small puzzles to unlock the greater goal all while managing the amount of time allotted for each puzzle. The experience was developed using Unity and Maya as our primary software with the addition of VR Curator to bring the RW player's voice into the VR player's VR headset. The challenges we foresaw were that of learning Unity and also coming up with different ideas of mini-games that were challenging to players from both the VR and RW point of views.

Initially, for movement in the VR environment, we developed in Unity and used a console gaming bluetooth controller then transfered to the Oculus Touch controls once they became available to us. For the RW player's user interface, we created camera angle views of the VR environment with similar models and layouts from the VR scene in Unity in addition to clickable answers and instructions to solve the puzzles in the VR environment.

Chapter 2

Prior Art

1. Keep Talking and Nobody Explodes (VR, Collaborative game)

Keep Talking... was created by developer Steel Crate Games from Ontario, Canada. It was first released on the Gear VR in July 2015, for PC the following October and then became available for PlayStation VR. One player wears a VR head mounted device and is tasked with disarming a ticking bomb in a virtual room they are trapped in (*Keep Talking and Nobody Explodes*). The other player is the "Bomb Expert who cannot see the bomb, but has a manual for bomb defusal and must receive descriptions from the VR player in order to provide the correct instructions.

For our project, we created an interactive interface for the RW player that goes beyond the bomb defusal manual of Keep Talking... where the Bomb Expert can only read instructions to the VR player. The RW user in our project has the ability to click through their interface to find the answers needed by the VR player.

2. Google Maps (Software, Single User)

GPS location and Google Maps are web mapping services that allow the user to view their location, satellite imagery and plan routes from point A to point B. The view of Google Maps is a top-down/birds eye view providing street maps, names, and also photography of the landscape(*Google Maps*). When using Google Maps to plan a route, the users location is represented on the map by a triangle pointing in the direction the user is currently going, with turn-by-turn directions provided by an artificial voice. As the user follows the directions, they see their current location on the map move from one point to the next until they reach their final destination.

In Project This Way!!, direction-giving is provided by human-to-human interaction instead of having an artificial voice provide directions. This ability to communicate back and forth provides a collaborative, social experience for the VR player and the RW player where they are interacting with each other verbally and physically by understanding the other's description of what is being seen in the VR environment and comparing it to what is provided in the RW players user interface.

3. Portal 2 (XBOX 360, 2 Player, Collaborative game)

Portal 2 is a puzzple-platform game with a collaborative multiplayer option where 2 players utilize portal guns that create openings in walls and floors to solve puzzles and escape the room to move on to the next room(*Portal 2*). Players take turns or make moves in synchronization to accomplish solving the puzzle at hand. The majority of the game is played with both players speaking with each other and experimenting with solutions to complete puzzles by trial and error. The game has won multiple awards such as: Best Multiplayer Co-Op, Best Puzzle Game and many Game of the Year titles from various publications(*Portal 2*).

The puzzles in our project draw inspiration from the cooperative puzzles seen in Portal 2. The project does not allow both players to see each others' avatar in the environment as they do in Portal 2. To recreate the same back and forth communication of Portal 2, our two-player has both players in different roles that complement each other and in Portal 2, the users have the same abilities, views and affordances during their game play.

4. Black Hat Cooperative (VR, Multiplayer, Collaborative

Black Hat Cooperative is an award-winning VR stealth game that pits a VR player and their "Ally" against robot agents(*Black Hat Cooperative*). In this game, the VR player is traversing a map where they must avoid robots, lasers and exit the maze. In the VR environment, the VR player cannot see lasers or where the robot agents are located. This is where their Ally is needed for them to stay alive. The Ally is viewing a top-down view map of the environment where they can see exactly where the VR user is in real-time, as well as the location of the lasers and the robot agents. Black Hat Cooperative provides the human-to-human verbal interaction that occurs in Keep Talking and the real-time location viewing of the VR player by their Ally on a top-down view map. There are also aspects of Portal 2's puzzles in this game as some movements must be made in sync. For example, the lasers appear and disappear at certain moments and the Ally must tell the VR player exactly when to move forward as they cannot see the laser in their VR environment(*Black*

Hat Cooperative).

In addition to the human-to-human interaction for gameplay collaboration, our project has interactions for the RW player to utilize as the VR player is in their VR environment. This will enable both players the benefit of confirming the correct task at hand.

5. The Stanley Parable (PC, Single Player, Co-Present AI, Narrative

"The Stanley Parable is an exploration of story, games, and choice (*The Stanley Parable*)." In this single-player PC game, a first-person perspective is used in an empty office building with a voice-narration that breaks the fourth wall. As the player moves around the game, the narrator provides the majority of the audio by dictating every move the player makes. Although this is a single player game, the voice of the narrator constantly guiding the player creates a type of artificial copresence. What we learned from the Stanley Parable is the choice of words and delivery style of verbal communication that can keep an experience with co-presence engaging. For our project, we focused on the choice of words and style of delivery when it comes to verbal communication between the VR and RW players.

6. Drunken Bar Fight (VR, Single Player, First Person and Third Person

Drunken Bar Fight is a self-explanatory VR game using the Oculus Touch controllers for left and right hand interactions. The view from the VR head mounted device is a direct first-person view, but the view displayed on the laptop or monitor of the VR system is in third-person view. Both views are displayed simultaneously during gameplay and the third-person view is accurate to displaying the VR user's actions in real-time. The goal of the game is to punch one's way through the bar to the exit door, by fighting through more than

10 or more other bar patrons. By getting closer to the exit door, the VR player must be careful to check behind themselves as to not be attacked from the rear. This is where use of the third-person view is essential to surviving the game. Anyone viewing the VR player's laptop or monitor screen has the ability to tell the VR player when he or she needs to turn around to avoid being attacked. This is a prime example of what Goffman calls "performance teams," where all the actors are involved, in this case, the VR player and whoever is viewing the VR player's laptop or monitor screen in the RW.

This is the type of visual interaction needed in our project. Instead of providing the exact same view of the VR player for the RW player to see, giving the RW player a third-person view of the VR player in their environment adds the element of visual co-presence (Ito 2005).

Chapter 3

Project Development and Methods

The plot of the VR experience is that two players are being tested for potential job hiring as Security Personnel for the search engine company, Poodle. The VR environment has a near-future look and the Real World Graphical User Interface (GUI) has a matching color scheme and design. Both the VR and Real World players are expected to communicate verbally. In addition to speaking to each other, the VR player performs body signals (see figure 10.1) in order to relay information regarding their current task.

Project Development for a VR experience consisting of two perspectives with asymmetrical gameplay (Steinke San Francisco, CA 2017) creates many difficulties in communicating the design and decision process between the VR environment, VR user interactions, the Real World player and GUI interactions. In the beginning of development, issues arose due to lack of communication and an inadequate work flow of the VR and Real World design process. The work flow chart (see figure 10.2) created was our first attempt at visually understanding the different aspects of our project in order to better prioritize our tasks.

3.1 Technology

HARDWARE

- ASUS ROG G20 VRPC Windows 10 64-bit Intel Core i7-6700 Processor DDR4 SODIMM 16GB NVIDIA GeForce GTX 1070 8GB HDD 1TB 2 X USB 2.0 2 X USB 3.0 2 X USB 3.0 + 2RJ45
- ALIENWARE 17 R4 Windows 10 64-bit Intel Core i7-7820 HK Processor DDR4 at 2400MHz 32GB NVIDIA GeForce GTX 1070 8GB HDD 1TB 2 X 3.0 USB ports
- MSI GE72VR Apache Pro Gaming Windows 10 32-bit Intel Core i7-6700Hq Processor NVIDIA GeForce GTX 1060 6GB GDDR5 2 X 3.0 USB ports HHD 1 TB 7200 RPM
- Oculus Rift 2 + Touch Controllers
- Logitech G933 (Headphones)
- Targus (USB splitter) 3 X 3.0 USB 1 X USB-C

SOFTWARE

- Google Drive
- LiquidPlanner
- Asana
- Overleaf
- Unity 5.5.1f1
- Visual Studio 2015
- Maya 2017
- Adobe Photoshop CC
- Adobe Illustrator CC
- Adobe Premiere CC
- Adobe AfterEffects CC
- VR Curator

3.2 History of Development

VR Movement and Simulation Sickness

One of the main problems discussed at Game Developer's Conference (GDC), Silicon Valley VR Expo and in our user testing is: VR movement. There is no correct way of addressing motion sickness in VR as previous methods used still cause VR motion sickness (Mack San Francisco, CA 2017). There are two known types of VR movement: first-person locomotion and teleportation. In first-person locomotion, the joysticks on bluetooth gamepads and the thumbsticks on Oculus Touch controllers (see figure 10.3) are used to move the VR player in their environment. This can be done while sitting or standing directly in front of the VR sensors.

Research of controlling VR movement brought us to specialized hardware such as the VRGO chair (see figure 10.4) created by Joe Ryan, which operates as a bluetooth joystick allowing users in VR to have full 360 degree movement and the ability to lean the chair to motion forward, backward and side to side. This device minimally helped with simulation sickness, but does not fully solve the issue.

The other option of VR movement is using teleportation to get from one position to the next. In order to teleport, the majority of VR software used the method of pointing with your finger to a desired location and then confirming by pushing a button or using the joystick. The VR player automatically appears in their new location. When this method was practiced, an issue was that the VR player's immersive experience was lessened. When a transition screen appears during teleportation, the break of immersion occurs.

VR Room Scale

In the first iteration, user testing showed that the environment was too large (see figure 10.5), forcing the VR player to wander around consistently creating a lack of communication with the RW player. This was due to the VR player trying to interact with objects, i.e. papers, computers and chairs, instead of following their objective or listening to the RW player. The second room was downsized (see figure 10.6) and the puzzles and interactions were made clearer to be seen. Even though the environment was smaller, the layout implemented was a confined room where the player cannot walk around, but is shown only what is needed.

3.3 Implementation Process

In our third iteration, we established a clear and functional process of creating and modifying a VR experience with two different perspectives of the same content. First, puzzle interactions and answers served as foundation to build the VR perspective, then the design of the RW GUI began simultaneously. All answers in VR and the RW GUI were created and confirmed first and then interactions for both VR and RW GUI were tested to run through the order of operations. After the order of operations between the VR player and RW player worked as expected, then it was safe to move on to the inclusion of the additional puzzle answers or options in both the VR environment and the RW GUI. We then user tested an entire run

run through and took note of gameplay holes, lack of information and bugs discovered in the alpha prototype test. After the project passed through alpha testing successfully, we moved onto beta testing with users other than the research team.

Production Pipeline from Maya to Unity

The 3D models created in Maya were first discussed between the game theorist and the 3D modeler as to what affordances each model needed for the puzzles in the game. A sketched layout of the VR environment showed locations of the 3D models and included another discussion between the 3D modeler and the Unity programmer, who created scripting interactions for each model. These discussions were constant between the 3D modeler, game theorist, and Unity programmer which allowed the order of operations for puzzles to be finalized and solved correctly. Without an efficient production pipeline from Maya to Unity, productivity and development were delayed.

RW GUI Asset and Morse Code Keyboard

In the first iteration of the RW GUI, the purpose for their asymmetrical views of the same environment was to create the co-dependent relationship between the two players that would foster the gameplay interaction needed to play the game together. After learning that motion sickness was a big issue, we decided to scale down the VR environment and the amount of movement, which in turn meant a much smaller room where the multiple camera views would no longer be suitable for gameplay in such small proximity. As the VR environment changed, the gameplay interaction changed as well, resulting in the need for a total redesign of the RW GUI layout. In order to save time in development, we used a GUI pack from the Unity3D Asset Store called the "Clean and Minimalist GUI Pack" (*Clean and Minimalist GUI Pack* 2017) that provided buttons, scene transitions, logos, textures and interactive user interfaces with customizable scripting. We were able to redesign the entire RW interface within 4 days and began user testing with the new VR environment the following week. Research of different forms of communication between two locations using different technologies and methods showed that Morse Code was a notional form of interaction as a cooperative puzzle.

Chapter 4

User Testing

User Testing for this project was based on the perspective of user-centered design and tech development, there were three main testing objectives looked at: 1) the efficiency of user interaction: affordances and signifiers, 2) VR user's learning curve regarding interaction with virtual objects and moving in VR content, 3) evaluating navigation during the game received by the VR user and transmitted by the RW player. It was expected that the VR and RW player would be able to communicate the needs of one another efficiently in order to solve the puzzles the VR player sees in his/her environment. Affordance refers to the relationship between an object and a person(Norman 2013) which entails the possibilities of how a person interacts with the targeted object. To achieve effective affordance, the affordances of objects have to be perceivable to the person viewing the object. Signifiers such as visual markers (signs, labels, arrows, etc.), sounds (error or success beeping), or any perceivable indicator (highlighted or blinking objects) that communicate appropriate behavior to a person increase the effectiveness of known affordances.

Observing players' learning curve of interacting with virtual objects and moving in VR content helped us to design a more easily digestible VR experience. In the VR environment, we used interactive sound and lighting effects as basic navigation after particular actions were finished; including sounds for pulling the levers, the opening of the ceiling vent, using correct or incorrect key cards, pressing buttons, opening of locked boxes, win or failure scene sounds, and warning lights accompanied by sound when committing errors. The VR users are expected to understand the meanings behind these sounds in order to successfully utilize their interactive navigation of objects.

User and Project Experience was measured by degrees of difficulty and comfortability expressed during feedback discussions with the VR and RW players. The number of times the VR player tried to figure out how to interact with virtual objects was counted. Next, how long the VR player spent learning how to interact with those objects and how to properly move in the VR environment. Designed navigation was surveyed as to how likely it was for players to completely understand the purpose of the interactive objects. As we discussed these objectives with the players, their comments were noted directly relating to how long it took to fully understand how to play the game together, the ease of movement in VR environment, the affordances within the VR environment, the ease of understanding instructions and progression of the RW GUI and the overall experience of communicating through co-presence via the bluetooth headset.

The testing process consisted of players choosing the VR role or the RW role in the game. Once the VR user is geared up with their HMD and Oculus Touch controllers, they are instructed on how to properly use their controllers to move. The VR player learns to use their index and middle fingers to squeeze trigger buttons in order to interact with virtual objects. As the VR player and the RW player communicate with each other, we watched the VR player's point of view on the VR PC and the RW's interaction with their GUI. After the game ends, by successfully completing the puzzles or reaching the maximum amount of errors, we spoke with each player separately. The VR player was asked about their movement through the environment and his or her ability to understand what their tasks and goals of the game were; while the RW player was asked questions regarding his or her ability to understand what their role and responsibilities were in relation to their VR counterpart. After individual discussions with the VR and RW players were completed, group discussions with both players together allowed them to share their perspective with each other to provide an understanding of what their partner experienced during the game. The VR and RW players' comments were noted and organized by objective after user testing was completed.

In the first iteration of the VR environment, we planned for the VR player to traverse a lobby area that they would need to walk across. The first round of user testing occurred at the GDC VR Mixer where testers complained of feeling motion sickness within 2-3 minutes of continuous movement by locomotion. Although we were aware of VR motion sickness, it was unexpected that it would occur in our VR environment.

When it came to gameplay interaction, we did not expect that both the VR and RW player would have difficulties in understanding how they are to interact with each other to solve puzzles. The lack of communication between the VR player and the RW player meant that neither one took the lead to start the game. The RW player was supposed to initiate the game with the VR player following the RW player's directions regarding how they would need to start their communication between each other. However, without enough of an introduction with explicit instructions for both players, they had difficulty when starting game. Once the VR player adapted to their VR environment, they would look and move around while attempting to interact with perceivable objects, thus distracting them from communicating to the RW player. Both players were not able to immediately intuit the purpose of the game and needed additional instructions to be able to play the game as intended. In a majority of user testing case, we had to step in to provide directions and clarifications to the VR and RW players simultaneously during their actual gameplay.

From the VR player's perspective, we found areas in need of improvements relating to: motion sickness, environment layout, affordances of objects, immersion distraction leading to lack of communication and the obliviousness of tasks and goals at hand. On the RW player's perspective utilizing the GUI, areas in need of improvements were found in: the clarity of tasks and goals of the game, affordances of symbols and buttons on GUI, a disinterest in gameplay due to lack of communication when VR player is distracted by immersion and the desire to view the VR player's POV directly when waiting on the VR player to complete a task. We were able to address the majority of gameplay issues with three main redesign concepts: 1) Creating a smaller VR environment layout to decrease motion sickness and influence the VR user's focus on the current objective in order to keep communication with the RW player as a constant interaction due to their need for information, 2) Providing a Third Person View of the VR user in the VR environment for the RW player to view during gameplay to increase engagement and interaction with the VR environment from the RW's perspective and 3) Adding "Universal Instructions" that can be seen by both the VR and RW players simultaneously to ensure affordances of objects, tasks and goals are initially clear and understandable. We hope that these three redesign concepts will also provide "Learning Cause and Effect" (McGonigal Stanford, CA 2017), which is the realization of understanding what one can learn by repeating interactions to discover which objects have affordances.

Chapter 5

Results

Surveys, player discussions, and video documentation were collected and analyzed for results. After data collected was organized, they were systematically arranged into areas of 3D model interactions, User centered design, and RW GUI and copresence.

5.1 VR Room Scale and 3D Model Interactions

For 7 out of 10 VR players, the layout was too substantial in navigation to the next puzzle and the players would get lost without external involvement. We chose a smaller layout for the VR environment that constant communication and interaction with the RW player. The 3D objects' size was a problem for 8 out of 10 players due to the Oculus Rift sensor height set up. When sensor height was corrected, the 3d models still were not at the correct height of the VR player requiring them to reach down and out to grab objects or move their avatar closer to the object.

In the majority of cases, VR players would try to grab objects that were designed to be non-interactive and function only as identifiers. In post game discussions, VR players expressed their desire to interact and pick up objects based on the affordances of the drinks on desks.

5.2 Affordances and Indicators

9 out of 10 VR players understood that levers, buttons and cards had the ability for interaction. VR players were pulling levers with their hands, pushing buttons with a single finger, and picking up key cards by closing their hand completely. With the the addition of indicators, some VR players could finish expected actions independently. We placed direct lighting onto puzzles and specific objects that were both interactive and non-interactive.Although the goal was to use lighting as direction for the VR player, user testing showed that it was often ignored. Some of the indicators were too subtle for VR players. For example, many VR players were not hearing the sound of the ceiling vent opening when the ID cards are dropping on the nearby desk.

5.3 RW GUI and Copresence

The first iteration of the RW GUI contained an overhead map of the VR environment and clickable camera views with info buttons to allow the RW player an inside look into the VR environment and quick access to information the VR player would need. Because the camera views did not provide real-time views of the VR environment. The decision was made to remove all camera views for the next iteration and focus on the interaction and progression of information on the RW GUI. The original interface provided minimal click and reveal answers. This was deemed unappealing for the RW player as the static graphics increased the loss of interest quickly. To address the issue of boredom on the RW side, on hover scripting and multiple options for the RW player were added. The order of operations regarding puzzle solutions are: VR body signals for finding which Lever to pull that would release a set of ID cards that the VR player peruses, while the RW playing is describing the correct ID card by also clicking on the correct lever on their RW GUI. 7 out of 10 RW players were able to utilize the RW GUI correctly by clicking the info buttons and the next and back arrow buttons to progress to the next page of information.

Visual communication was received by the RW player by viewing the arm positions of the VR player when decoding the body signals of Room 1. 10 out of 10 RW players were able to correctly match the body signals of their VR player on the RW GUI, but only 5 out of those 10 were able to complete the full combination of the 3 body signals correctly. Half of our RW user testers did not follow the body signals in the correct order to reveal the correct lever. The addition of matching colors and leading lines between body signal combinations assisted in addressing difficulty RW players had completing the 3 signal combinations. Verbal communication is provided to the RW player by the VR player through the Morse Code portion of Room 2. The VR player would view a poster with a series of dots and dashes representing a word in Morse Code. The VR player would communicate what they were seeing to the RW player by verbal description; "dash dash" or "dah dah" for lines and "dot" or "dit" for dots in the code. Instructions on the RW GUI interface explained how to move through the Morse Code Tree keyboard in order to decode the VR player's verbal speech of the coded word. 2 out of 10 RW players were able to successfully use the Morse Code Tree keyboard without external instructions from our research team. For the final iteration regarding how to decipher Morse Code between the two players, we will be placing universal instructions with the same wording for both the VR and RW player in order to avoid confusion between the two not knowing how to decode the dots and dashes initially.

The core of our project is the shared feeling of the VR Experience across virtual reality and the real world. The interaction between both VR player and RW player highlights the two most important capabilities in VR, which are "presence (being in a different place) and copresence (sharing a different place with others)" (Marks 2017). Through our research, co-presence was achieved intermittently during gameplay as the result of certain factors greatly influenced the final redesign for the last iteration of our project. First, the significant factor in the creation of copresence is the ability for the VR player to hear the RW player's voice in their HMD headphones by way of VR Curator software and a bluetooth headset connected to the VR player's laptop. This would occur 8 out of 10 times when the VR player is searching for the correct ID card. As the RW players would view the VR player's laptop, they would see the VR player's hands picking up the ID cards and placing them down in search of the right one. The connection created from the RW player's view of the VR player's hands, with the addition of the RW player's voice in the VR player's HMD headphones is similar to that of "intimate visual copresence" where viewpoint sharing creates "shared visual context that they are jointly aware of [and] the sense of of engaging in joint side-by-side activity is maintained..." (Ito 2005) creating a strong feeling of copresence where the VR player is directly sharing their virtual space with the RW player in real-time.

Chapter 6

Discussion

With visible affordances of virtual objects, such as levers shown in Figure 10.7, VR players quickly understand the possibilities of interaction. A lever is designed to be pulled and a button is designed to be pressed. With shared knowledge of similar interaction experiences in the real world, the mental models of both VR player and designers are automatically connected. It to be a useful signifier that can communicate the appropriate action needed by the VR player. In the case of key cards (see figure 10.8), VR players understood that they were able to pick up cards by performing a hand grab with the Oculus Touch controllers.

Since VR is a fast-growing medium, it is not a daily application for the masses. At our second round of user testing, we needed to show VR players how to use the Oculus Rift and Oculus Touch controls. For most people who were first-time players of the Oculus Touch, it would take them more time to adapt to the hand controls. We noticed, children picked up the usage of VR faster than adults. The Oculus Touch is famous for its ergonomic design and is clearly made for the shape of the human hand when balled into a fist. VR players can naturally let their fingers fall into place over the triggers, buttons and thumbsticks, which makes using the device intuitive. To interact with virtual objects using the Oculus Touch, VR players are using similar hand muscles. This helps remove any cognitive dissonance between players brain and targeted objects. Unlike Leap Motion, the sensors on the Oculus Touch help so that VR players do not have to hold both of their hands in front of their headset. Oculus Touch does not increase the difficulties of usability and greatly decreases the gaps of interaction between VR players and virtual objects. As a result, most VR players will spend less than one minute to learn how to interact with the virtual objects and move in VR environments using the Oculus Touch.

To create an efficient game flow, we designed interactive sound and lighting effects that triggered after particular actions were finished. Most sound effects worked as expected during user testing because VR players were able to notice them instantly and understood the meaning behind them simultaneously. Only the sound of the vent opening was not as obvious for VR players to hear since the radius of the stereo sound was set to a small proximity. If sounds are to be noticed for relevance, the radius of the stereo sound must be taken into consideration. In most cases, VR players did not need lighting effects on interactive objects to indicate where interactivity could take place. As a result, VR players receiving instructions from the RW player to find the location of specific objects were able to do so quickly regardless of directional lighting.

Intermittent Copresence

As mentioned previously, copresence was experienced intermittently during the entirety of the VR experience depending on the level of interaction the VR player encounters in their environment, the amount of communication being relayed between the VR player and the RW player, and the degree of mental effort exercised by both players when engaging in joint side-by-side activities resembling “intimate visual copresence” (Ito 2005) where visual information is maintained through exchanges over a virtual space. With the aim of our research based on finding methods, techniques or degrees of communication and interaction in order to create an engaging, shared experience of the VR environment with the RW player, it is worth noting that the levels and details of copresence experienced from either perspective differ in reception, but the understanding and awareness of the other’s copresence in their own reality is a shared, mental experience.

Chapter 7

Dissemination

Project: This Way! was promoted via our Facebook Group page at http://facebook.com/CrossRealityVR and our research website at http://multimedia.csueastbay.edu/research/thisway. We were also fortunate enough to have explained and provide demos of our research at these events:

VR Mixer @ GDC, March 1, 2017

Our first event as exhibitors demoing Project: This Way! was through user testing the VR environment and interactions at the VR Mixer at Game Developer's Conference presented by Silicon Valley VR and San Francisco VR. We had a total 3.5 hours user testing with VR developers, UX/UI designers, venture capitalists, VR startups, bloggers and evangelists. The amount of feedback from our initial user testing influenced the changes to our gameplay interactions when developing our second iteration.(See Figure 10.9)

Center for Student Research Poster Session, April 19, 2017

As Project: This Way! received funding from the CSR of CSU East Bay, we participated in the CSR Poster Session where we created an academic poster explaining our research question, development, process and current results. This event allowed us to share our project with Dean Rountree of our college for the first time face-to-face.(See Figure 10.10)

Maker Faire Bay Area, May 19-21, 2017

For three days straight, we exhibited our research project at Maker Faire in San Mateo which provided us a much younger audience to user test as compared to those we encountered at the VR Mixer, which was a 21+ event. Those that demoed at Maker Faire were between the ages of 4 and 45-years old with at least 90 percent of the users being under the age of 12. Being able to user test such a wide age range with almost all of the users not coming from a VR development background gave us unprecedented feedback informing us on how to better develop the experience for VR beginners and initiates (See Figure 10.11)

If You Weren't: Playing with Realities in ARG, AR and VR, May 23, 2017

We were fortunate enough to have been invited by Professor Greg Niemeyer to speak on a panel at a symposium for alternate reality games, augmented reality and virtual reality at Stanford University presented by the Stanford University Graduate School of Education and the Brown Institute for Media Innovation. For our panel discussion, our research was under the theme of copresence due to the communication and interaction we found between the VR player and the RW player. After our panel discussion, we provided a demo of our project as a proof-of-concept of copresence interactions in VR experiences. The audience at this event consisted of game design academia and industry professionals, including Jane McGonigal. The feedback we received at this event was significant to our research as it was the only audience we user tested with the closest interest in VR development and experiences our project explores. The ideas and comments shared with us for improvements were extremely valuable as they confirmed our own realizations from our user testing experiences at Maker Faire. Of all of the events attended, this symposium provided the best learning experience and feedback our team could have received.(See Figure 10.12)

Chapter 8

Conclusion

8.1 Affordances in VR Environments

It is very important to incorporate the idea of affordances of virtual objects into optimized scripting processes for the VR user experience.

Same as it is in the real world, the visible affordances of interactable objects in VR environments are clues to appropriately describe the possible behavior between users and objects. During user testing, most game objects were proved with visible affordances. For scripting, it is required to design a particular area for triggering special actions. We realized during testing only certain areas where players interacted with had to be designed with particular areas as triggering areas. Scaling down triggering areas as needed is to avoid unexpected interferences between objects. It also helps to optimize scripting. After we defined triggering area, then we used RaycastHit for Unity to detect the distance between users virtual hands and the targeted objects.

In addition, after our user testing, we realized some navigation techniques didnt work as we expected. We found some of the users missed the signs because when the interactive navigation happened, the VR players didnt look at it. To decrease the likelihood of ignoring any interactive navigation during the game, the UI indicators are a useful solution as they are clearly visible from any direction of the VR player is looking in.

8.2 Room Layout Afterthoughts

Room layouts after testing needed to always be scaled down to its audience. The game started as a larger level and an exploration for finding clues to where the puzzles might be. But when the game was taking shape it should have also changed to what the real part of the experience is, communication. The VR player is not the one who needed the focus. Players will always be entertained on the new experience of being in VR. You would need the RW player to really understand that you needed which was a smaller layout to control the actions of the VR player to keep them focused on the task at hand.

8.3 Concurrent Co-Presences in Locally Social VR

Although it is possible to hear the RW user's voice without the use of a microphone outside of the HMD's headphones, hearing the RW user's voice “outside” of the HMD headphones creates the sense that the RW user is conceptually "outside" of the VR user's VR environment. When using a bluetooth headset to directly inject the RW user's voice into the VR user's VR environmental audio, an auditory sense is created that allows the VR user the ability to feel as if the RW user was actually in the VR environment because the source of their voice is coming from the same source as the VR environmental sounds. Also, the RW users reported a stronger sense of connection to the VR environment and the VR user's experience when they were able to see the VR environment in real time allowing them to see what the VR user is seeing by way of the VR laptop screen.

From these various combinations of interactions with asymmetrical perspectives and auditory reception between the VR player and the RW player, I have come to the conclusion that both the VR and RW players are actively passing in and out of multiple variations of copresence depending on the level of immersion due to their proximity, type of communication and interaction. I have narrowed them down to four variations of human colocation (Zhao 2003) and social presence (Goffman 1963):

Corporeal Co-presence: when both users are aware of each other's physical proximity and "are within range of each other's naked sense perceptions" (Zhao 2003) by being able to see or hear each other with the addition of an electronic device.

Unidirectional Remote Presence: when there is only a "one-way flow of information" (Zhao 2003), as experienced by the RW user when they are idling waiting for the VR user to communicate with them or complete a task. The RW user has the ability to provide information to the VR user through their bluetooth headset into the VR user's HMD headphones.

Virtual Telecopresence: is when "one is present in person at the site and the other is present through a digital representation" (Zhao 2003) or avatar in a virtual environment. In our research, this would occur when the third person view of the VR user is accessible to the RW user via the laptop screen the VR system is operating off of. In this form of colocation, the VR user is aware of the of the presence of the RW user and the RW user can visually see a physical representation of the VR user in the third person view, but not vice versa.

Corporeal Telecopresence: is when users interact with each other by "face to device, person to person via a communications network plus an interface device" (Zhao 2003). This type of co-presence is probably the most consistent colocation for both users as they are always interacting and communicating with each over the VR Curator software.

With this new understanding of the variations of copresence in relation to VR experiences, I would further like to understand the degrees of influence and immersion when it comes to different forms of copresence that include language translation, interpersonal and empathic communication, and instructional situations for performance teams (Goffman 1963).

Chapter 9

Recommendations

9.1 Communication, Co-Presence and Cross-Reality

Creating Engaging Communication

A deeper look into collaborative and team-building puzzle and situations utilizing interpersonal communication and visual cues would help in creating challenging interactions between the VR player and the RW player. Studying to recreate situations geared for "performance teams," where individual performances depend on more that just one's own abilities but on the abilities of those socially present as well (Goffman 1963), may provide the foundation for building highly codependent puzzle solving.

Enhancing Copresence

Currently, the audio input via the bluetooth headset is a one way transmission: the RW player's voice into a microphone that the VR player receives in their HMD's headphones. In our research, we feel that if the RW player could also hear the VR environmental audio through their headphones, it would bring the sense of copresence closer as they will then have the ability to hear what they see on the VR player's laptop. Also, with the VR player being aware of the RW player's ability to hear their environment further enhances the side-by-side experience audibly. The VR Curator software can only provide one way transmission from the RW player to the VR player, so further research into software limitations or technical aspects to create a two-way transmission would be the next step in enhancing co-presence greatly through users' audio.

Exploring Methods Towards Cross-Reality

Creating other virtual interactions to bridge the connection between the VR player and the RW player are to be further researched and explored if trying to attain actual cross-reality experiences. How can the RW player impact the VR player's environment and performance? If it were possible for the VR player to affect the RW GUI during gameplay, will their realities be separate of each other or combined? Researching the amount of input interaction from the VR player to the RW player and vice versa should be compared, tested against each other and then adjusted according to the results in order to create the equal amounts of immersion from either perspective. This may prove difficult as the VR environment alone is highly immersive even if one were to be standing still doing nothing, but is it possible to create such a cross-reality experience implementing all factors of copresence, shared interactions, verbal and visual communication with real-time input effects from the RW player to the VR environment, that the entire experience will truly feel like one experience from two different perspectives? Further research in additional VR and RW user interactions should be explored and tested to find out.

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Chapter 10

Appendix

Figure 10.1: The RW player confirming the VR player's body signal.

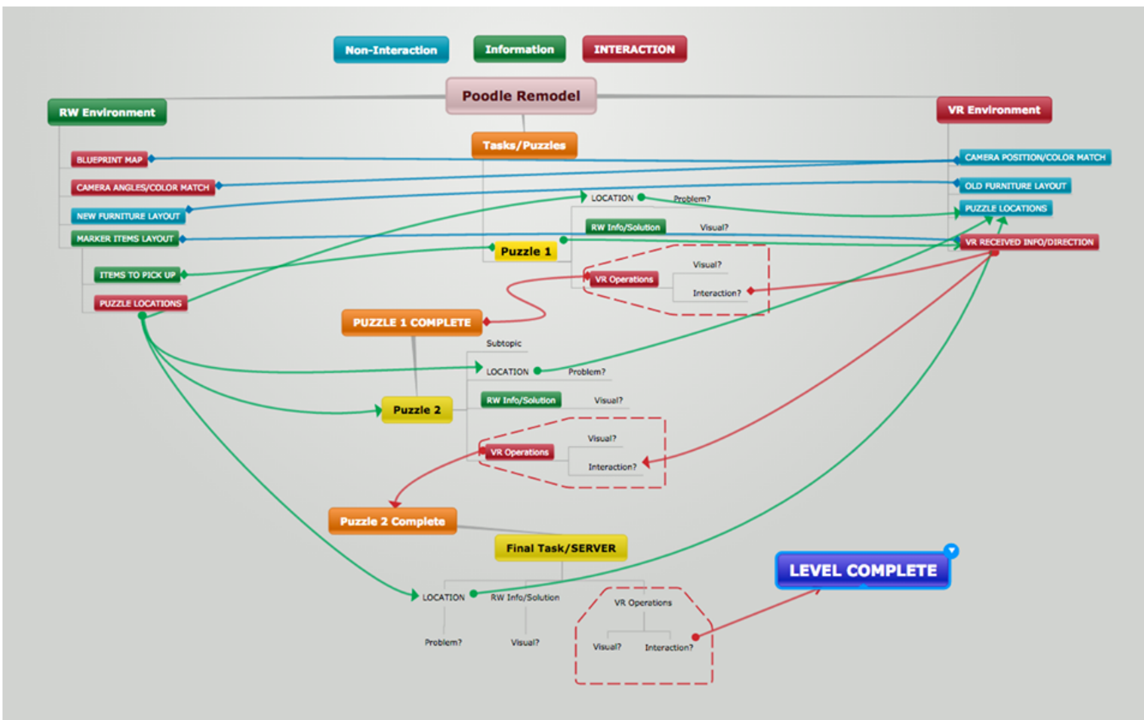

Figure 10.2: Flow chart visually designed to show where communication is needed and prioritization of tasks between the VR environment, Real World GUI, and how puzzle interactions are performed by the players.

Figure 10.3: Oculus Touch controllers have thumbsticks that control movement in VR.

Figure 10.4: The RW player confirming the VR player's body signal.

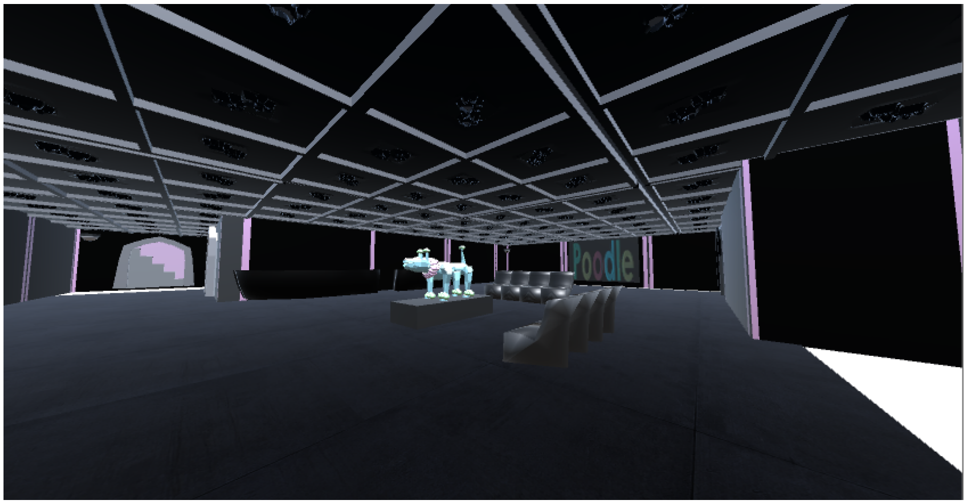

Figure 10.5: First iteration of the VR environment with large room scale.

Figure 10.6: Second iteration of the VR environment with room scale downsized.

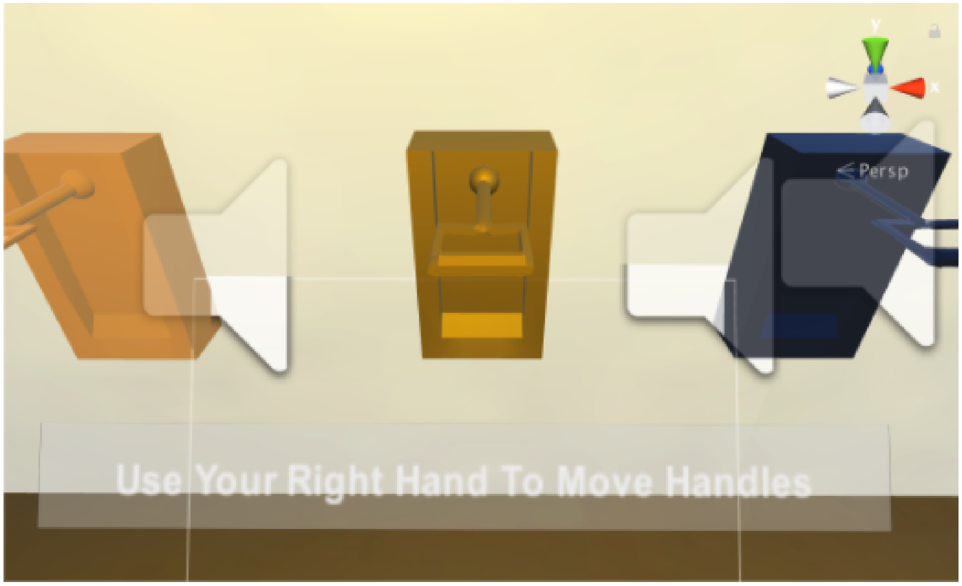

Figure 10.7: Three levers in the VR environment that can be pulled.

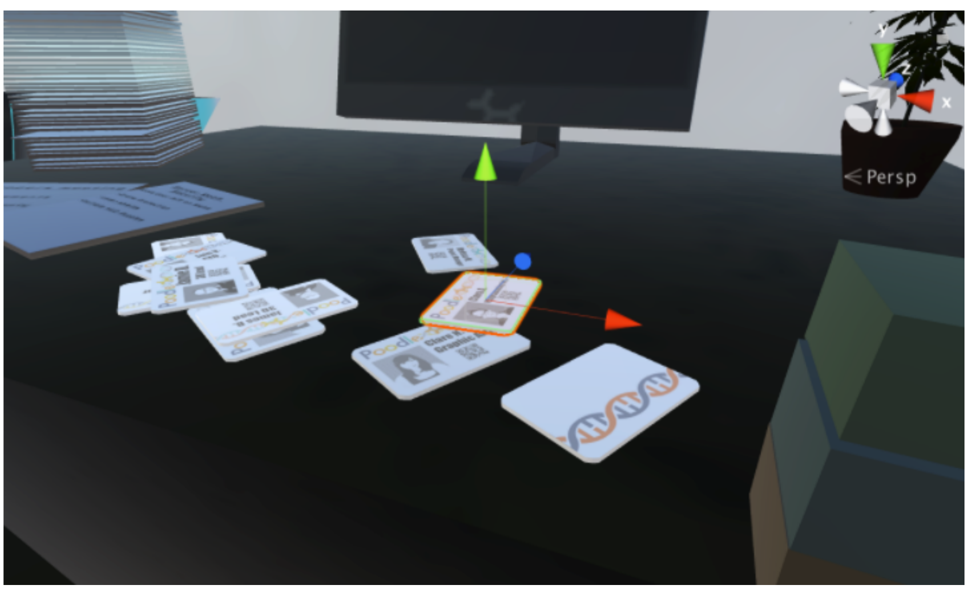

Figure 10.8: Key cards in the VR environment.

Figure 10.9: Set up of the VR environment for user testing at VR Mixer at the Game Developer's Conference.

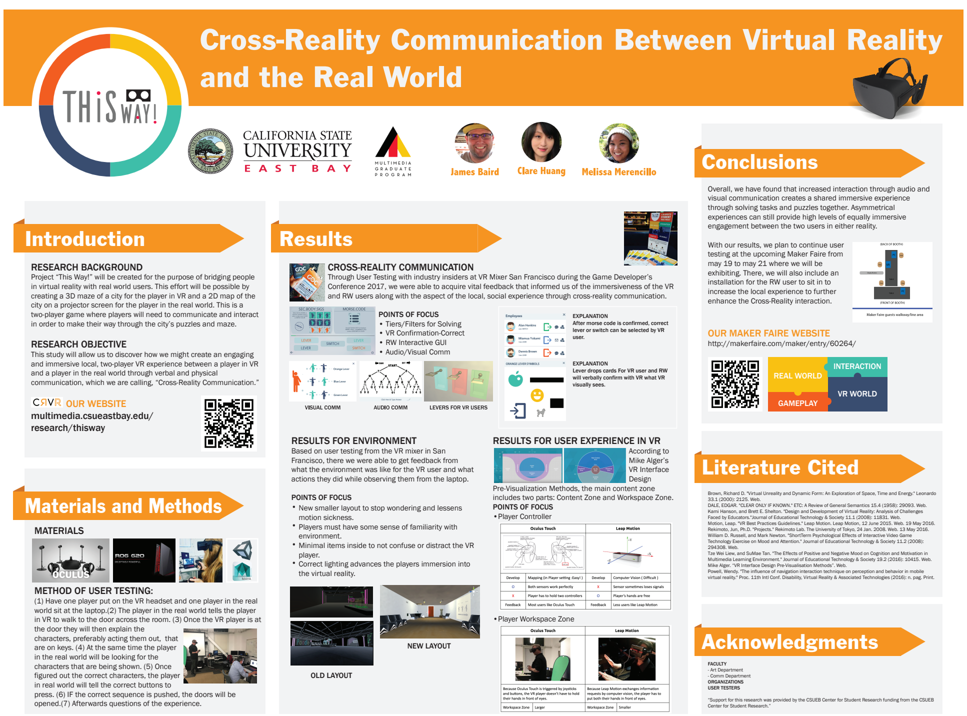

Figure 10.10: Project: This Way's research poster for the Center for Student Research Session.

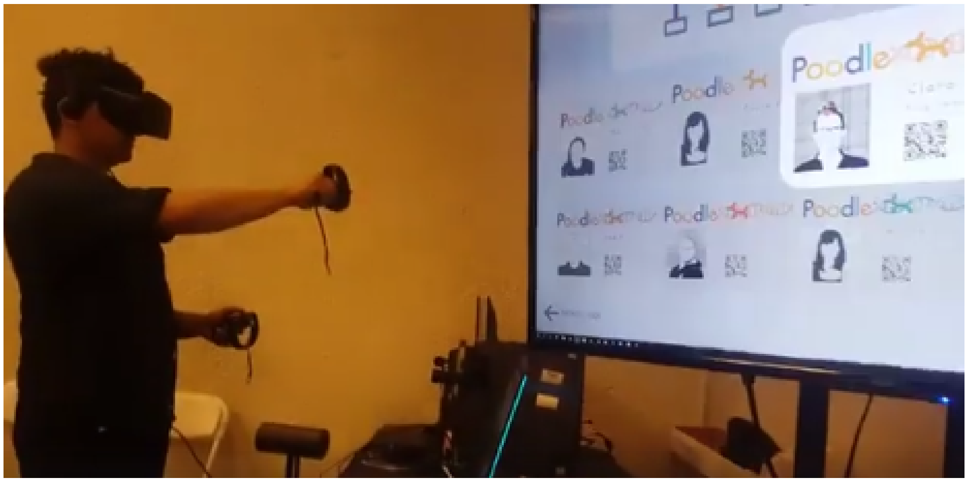

Figure 10.11: Maker Faire attendee looking for the correct key card in VR described by the RW player.

Figure 10.12: Project: This Way! speaking at a Stanford symposium about copresence.