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VR Empathy Training Tool

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VR Empathy Training Tool

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ABSTRACT

A person's resilience to adversity and trauma is developed early on in his or her childhood. When parents display stress in front or neglect emotions of their children consistently, their children will form neural connections between areas of pain and stress. It is important to educate parents to properly handle children's emotions and also control their own emotions and mindfulness during these interactions.

We developed an iOS VR application accompanied by a Google Cardboard and a Mio Alpha fitness watch to record and display the stress level of the parent using his/her heart rate data. The progress of the users can be sent back to researchers for further study and also evaluation. This system allows parents to interact with a VR child to develop empathy, along with training their own emotional intelligence. Users can also view an intense scene of a VR parent displaying negative emotions in the child's perspective. This system will eventually be used as an educational tool in the Resilient Families Program in San Jose. In the future, more complex interactions can be achieved by adding animation assets, and also increased accuracy in stress sensing by replacing the heart rate monitor with a more accurate biometric system.

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Chapter 1

Introduction

1.1 Problem Statement

A person's resilience to adversity and trauma is developed early on in his or her childhood. When parents display stress in front of their children, these children will be feel the same pressure and would not know how to handle these stress. On top of that, stressful parents would be more likely to neglect their children's tantrums and discomfort. This causes permanent neural connections to form between areas of pain and stress. This causes these children to grow up being easily stressed and fragile to emotions. thus hindering their success in the future. Therefore, it is important to educate parents to properly handle children's emotions and also control their own emotions and mindfulness during these interactions. Seeing this need, the program "Safe, Secure, and Loved: Resilient Families" provides parenting education program for low-income families in the Santa Clara and San Jose area. A group of parents have meetings and workshops every week, led by Dr. Barbara Burns, the founder of this program and a psychology professor in Santa Clara University, and some community leaders, who are trained by Dr. Burns. However, the reach of this program is limited by how many leaders Dr. Burns can personally train, and the progress of these parents in the program is very hard to track. Therefore, there is a need for a more efficient training program and also a progress tracking system for parents to know how much they have improved overtime with the help of this program.

1.2 Related Work

Currently, the Virtual Reality (VR) industry is growing rapidly. It is mainly used in entertainment, such as games simulated in a realistic environment or virtual trips. However, it is also gradually being used as an educational tool. For example, Stanford University VR lab already has some research projects on using VR technology for children to experience being in the body of another person to learn empathy. With the increased popularity of this new learning tool, we partnered with Dr. Burns to build a VR application to be used on mobile device for parents to empathize with their children in face of discomfort to ensure parents to

react immediately to soothe the children .

1.3 Objectives

Some VR technologies in the current marketplace require expensive headsets and tools, and must be connected to computers with specific softwares. In order to keep our project affordable and useful for many parents in the community, we used a more basic and affordable headset as our VR tool. The application requires a Google cardboard VR headset, an IOS phone, and the Mio alpha fitness watch, which is optional. It provides the user with scenes of babies, toddlers, and/or preschoolers needing help or in discomfort. Parents can be in a parenting simulation to react to their VR children and learn to comfort their children promptly and compassionately in the real life. Parents have the options to pat, distract, or play with their VR children, and the children have responses or reactions according to the parents choices. The Mio Alpha fitness watch records the parent's heart rate and track data of their stress level. During these simulations, parents gain experience from real-world story lines, enhance their empathy from these exercises, and practice their stress management in face of chaos.

This application is used in a community setting as part of a community-based parent support program. Users will use the magnet on the side of their Google cardboard to make decisions in the application.

Chapter 2

Requirements

2.1 Functional Requirements

- Critical:
  - Users can choose to experience with a VR baby, toddler or preschooler
  - Users can choose to interact with an VR baby/toddler/preschooler, or just view as an baby/toddler/preschooler
  - Users' heart rate can be recorded when they were interacting with a VR baby/toddler/preschooler if they have a Mio Alpha fitness watch connected to the application
  - Users can view their heart rate data in a diagram
  - VR experiences is accompanied by audio
  - Users can use the built in cardboard magnet to choose from menu
  - Users can quit at anytime during their experience by clicking the exit button
  - Users can interact with VR children without heart rate monitor, but the heart rate will not be collect to the user data
  - Users need active Internet connection if they need to record their heart rate
- Recommended:
  - The baby/toddler/preschooler changes their behavior randomly
  - The users' dataset will be sent for research under users' agreement
- Suggested:
  - The experience automatically will stop if the user is feeling uncomfortable

2.2 Non-functional Requirements

- Critical:
  - The application is user-friendly
  - Users can only view their own history heart rate data
  - Users need iPhone 5 or higher, and running IOS 8 or higher
  - VR characters respond in at most 1 seconds after user chooses the reaction
  - Users heart rate measured at some point when the user is interacting with an VR baby/toddler/preschooler
  - The system stores at most 10 heart rate data of each user. After 10 data stored, the system will ask the user if he/she needs to delete previous data.
  - The interaction experience has 5 minutes timeout
- Recommended:
  - Support in English and Spanish
  - The application does not cost much phone device energy
  - The application is easy to configure
- Suggested:
  - The application will be modified for future update and enhancement.
  - The release package is not too large

2.3 Design Constraints

- Must run on iOS 8 or higher
- Must be a Google Cardboard application
- Users need a Mio Alpha fitness watch in order to have heart rate measured
- Google Cardboard

Chapter 3

Use Cases

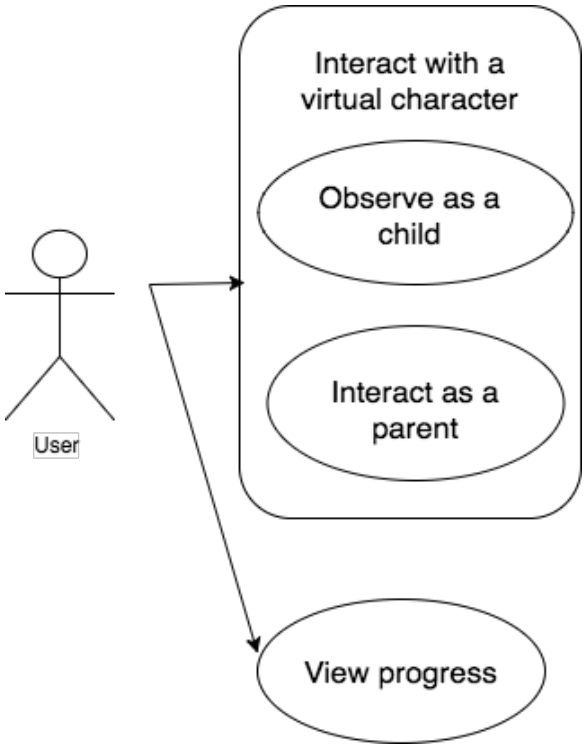

Figure 3.1: Use Cases

When user opens the application with a Google cardboard and wears an oximeter for measuring heart rate, he or she enters the main menu. The main menu allows the user to interact with a virtual character or view his/her progress. If the user chooses to interact with the virtual character, he/she can choose to observe in children's perspective or interact in parent's perspective.

3.1 Use Case 1: Interact with a virtual character

3.1.1 Sub-Use Case 1: Observe as a child

- Name: Observe as a child
- Goal: Let parents experience in their children's view
- Actor: Users/parents
- Precondition:
  - Google Cardboard
  - Choose to observe as a baby/toddler/preschooler
- Steps:
  - Use Google cardboard to observe
  - Experience as a children by watching a VR parent is talking towards you
  - Exit by clicking the exit button
- Postcondition:
  - User experienced a child's perspective in VR environment
  - Back to the main menu
- Exception: If the user is feeling uncomfortable, he or she may exit.

3.1.2 Sub-Use Case 2: Interact as a parent

- Name: Interact as a parent
- Goal: Let parents gain parenting experience by taking care of a virtual child, while learning to calm themselves down during the process.
- Actor: Users/parents
- Precondition:
  - Google cardboard
  - Active Internet
  - Wearing a Mio Alpha fitness watch

  - Choose to practice taking care of a baby/toddler/preschooler

- Steps:
  - Use Google cardboard to choose actions from menu
  - The user's heart rate will be measured at the beginning and the end of the process
  - The VR character child may change his/her emotion based on the actions the parent takes.
  - The VR character's emotion state can be seen from the health bar at the right top of the screen

- Postcondition:
  - The VR child is happy
  - Or exit by clicking the exit button
  - Or timeout after 10 minutes
  - Back to the main menu
  - The user's heart rate is been measured when exit

- Exception: If the user is feeling uncomfortable, he or she may exit the system.

3.2 Use Case 2: View Progress

- Name: View Progress
- Goal: Let users view their history data, and learn about their progress
- Actor: User/ parents
- Precondition:
  - The user has used the application to interact with a VR child before
  - The heart rate and time duration have been successfully measured
  - The heart rate and time duration were been successfully stored in the user database

- Steps:
  - View the history data in a diagram

- Postcondition:
  - User gets his/her history data in a diagram

  - Exit by clicking the exit button
  - Back to main menu

- Exception: New user, or the user never interacts with a VR child

Chapter 4

Activity Diagram

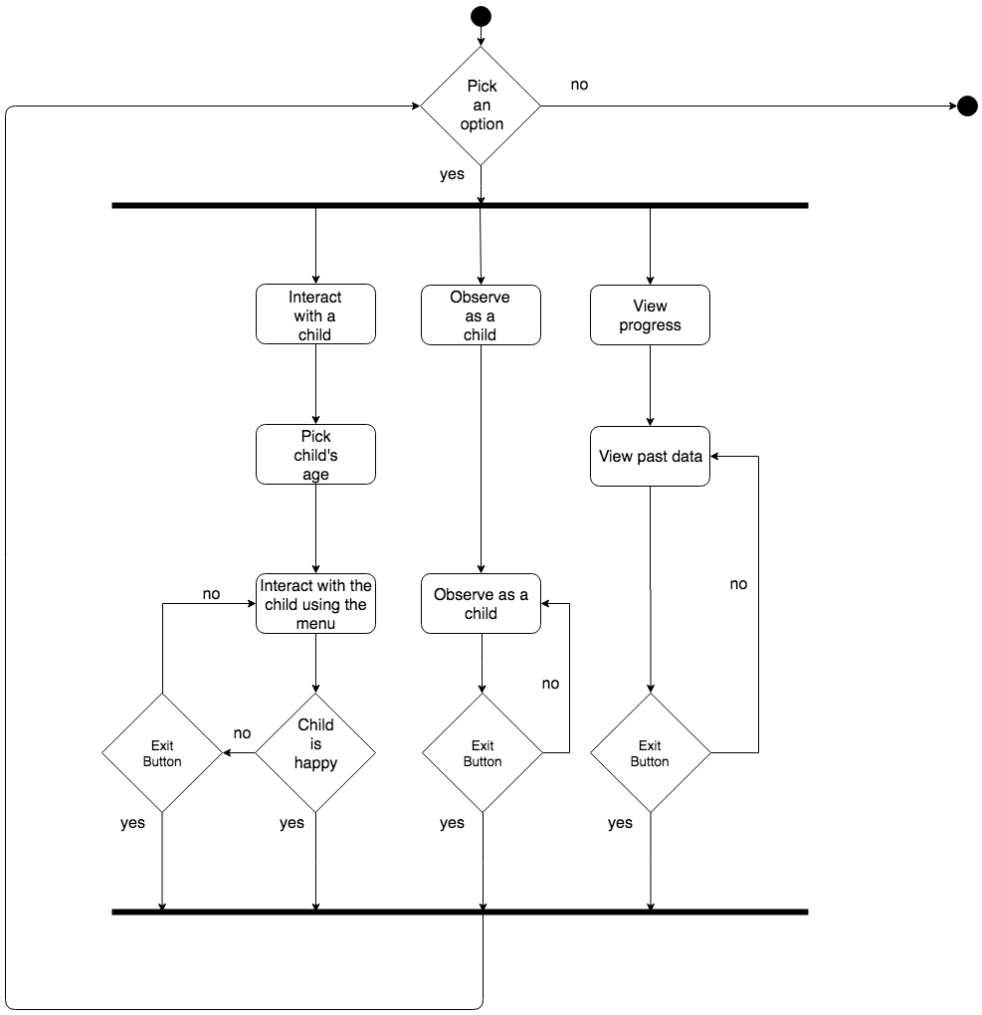

Figure 4.1: High level view of userś activities

The user first needs to pick an option from the main menu, if he/she does not choose to quit the application. The menu allows the user to choose to interact with a VR child (baby/toddler/preschooler), observe as a child, or view progress.

If the user chooses to interact with a child, he/she needs to choose an age that he/she wants to interact with. Then the user can use the menu to choose actions during the interaction. The VR child gives reactions responding to the user's chosen actions. The heart rate of the user is being recorded and displayed for the user to be mindful about his/ her own emotions during the interaction. The interaction experience will end when the experience takes 10 minutes, and go back to the main menu. Otherwise, the user can continue doing actions using the menu. The user can also click the exit button anytime during the experience. If the user chooses to observe as a child after picked the childs age, the user will experience in a child's perspective, and can exit anytime by clicking the exit button.

If the user chooses to observe as a child, the user can also exit by clicking the exit button, and go back to the main menu

If the user wants to view his/her progress, the past record of user's heart rate and duration during the experience of interacting with a child will be displayed in a diagram on the screen. The user can exit by clicking the exit button, and the button will bring user back to the main menu.

Chapter 5

Design Rationale

5.1 Google Cardboard

We used Google Cardboard (Cardboard) as our VR headset because it is cheap ($25 per headset) and can be implemented with an iOS app on an iPhone. We wish to help parents in different communities, including marginalized communities who are not financially capable of accessing an advanced VR headset. Cardboard is also detachable from the mobile device, so during meetings, parents can share Cardboards and their performance will be stored on their own mobile devices. Google also provides packages for Cardboard app on Unity and iOS, so that our system can be built using the desired platform that we want.

5.2 User menu for interaction

Since we used Cardboard as our VR headset, it recognizes tilting, 360 degree vision, and screen tapping with the built-in magnetic button. User can do the above mentioned actions to explore the environment and also interact with the system. We used menus for user to interact with the system. To interact with the system. User can:

1. Move the headset
2. Aim the cursor to the desired menu option
3. Press on the button on the headset

By standardizing the form of interaction on the system, parents can learn how to use the system easily and quickly. It also minimizes the chance of experiencing discomfort by tilting or spinning the head too much for selecting options in the system.

5.3 Heart rate measurement

We integrated live heart rate measurement into the system to train parents to calm themselves before or while calming the child from discomfort or being upset. This feature is added because many parents experience distress and feeling of incompetence by hearing an infant cry (Source: Baby please stop crying: an experimental approach to infant crying, affect, and expected parenting self-efficacy). This tool is designed to remind parents to be mindful to their own emotions while taking care of their children. The heart rate is one of the immediate source of information we can pull while the user is using the system. The heart rate data is also an indication of the users performance over a period of time.

5.4 Event-based Architecture

The event-based architecture allows our system design be more responsive, because event-driven design is more normalized to unpredictable and asynchronous environment. Furthermore, the components in the architecture design are loosely coupled.

Chapter 6

Architecture Design

6.1 Architectural Diagram

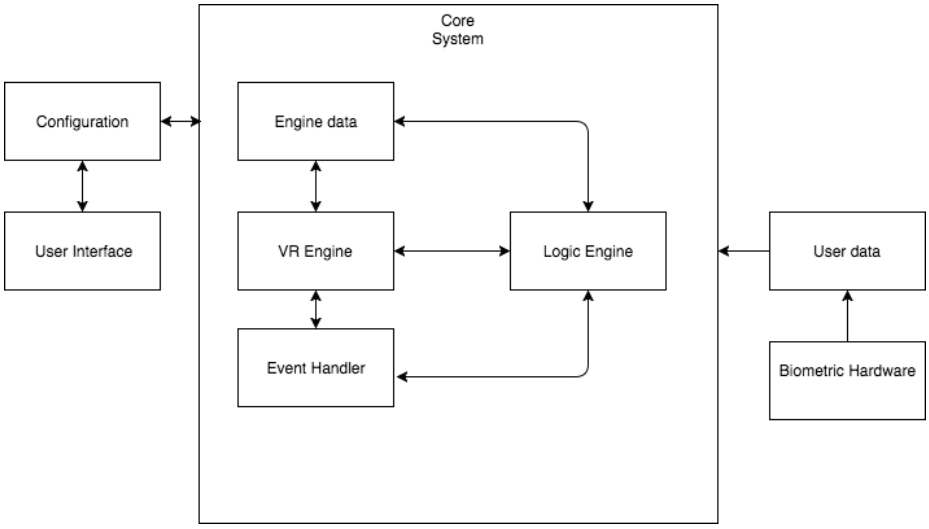

Figure 6.1: Event-driven architecture diagram

Due to the fact that our system building is designed to use different technologies, we decided to use event-driven architecture to design our system because it is suitable for loosely coupled structure of systems. The user sees and controls the user interface using Google cardboard. When the user makes decisions on the user interface, the input will be sent to configuration, and the configuration is connected to the core system. The user also needs to use a biometric device to collect the heart rate. The heart rate result will be stored in the user database which is also in the core system.

In the core system, we used Unity3D as the VR engine. It's a cross platform and powerful engine that comes with an intuitive set of tools to create interactive 3D content. The logic engine executes the application logic. It's been done in Unity3D using custom native functions in C# scripts. When the user makes a decision by clicking the magnet, the message will be sent to the system. The logic engine will figure out what the next step is, and send the message to others. Event handler is the code that gets executed when an event is detected. It's been done by using event triggers in Unity3D. The engines also connect to a database which stores the engine data.

Chapter 7

Technologies Used

7.1 Unity Engine

Unity is a multi-purpose game engine that supports 3D graphics, drag and drop functionality and scripting using C#. It supports the low-level APIs Metal on IOS. It allows specification of texture compression and resolution setting for each platform that the game engine supports. It also supports both IOS and Android for DayDream and Google cardboard, and adapts easily. The unity asset store provides off-the-shelf contents which helps to make the development faster and easier.

7.2 Xcode

Xcode supports source code for a lot of programming languages, including C# and Swift. Using the IOS SDK, it can also be used to compile and debug applications for IOS. It includes the GUI tool instruments, and basically everything needed to create a mobile application. The unified work-flow for user interface design, coding, testing, and debugging is easy to use. It Includes Xcode IDE, Swift, and Objective-C compilers, instruments analysis tool, simulators, the latest SDKs, and hundreds of powerful features.

7.3 Google Cardboard

We use Google cardboard because it's affordable and compatible as explained in the Design Rationale section.

7.4 Google VR SDK for Unity

Google VR SDK for Unity provides additional features like spatialized audio, utilities and samples. It also provides integrations with Google VR, such as users head tracking, detect user interaction with the system, distortion correction for a VR viewer's lenses, etc.

7.5 App Store

App Store is a digital distribution platform for mobile applications on its IOS operating system. It can be used to publish our application, so users can browse and download the application. It's easy to use for IOS users, and it provides application information to users before downloading or installation.

7.6 Programming languages

- C#
  - Unity engine uses C# as its primary scripting language
  - Native Components
  - JavaScript/UnityScript and Boo are alternatives which can also be used to develop VR in Unity. We choose C# because we are more familiar with C. Scripts can be combined using multiple languages, but it's hard to do.

Chapter 8

GUI

8.1 Menu

Figure 8.1: Menu

This is the main menu of the application. User can select to ”Play as Child”, ”Play as Parent”, or ”View Progress”.

8.2 Play as Child

Figure 8.2: Play as child

This is the scene when the user click ”Play as Child”. The user views a VR parent talking, and can click the Exit bear to quit the experience. After the experience finishes, or when the user presses ”Exit”, it will jump back to the main menu.

8.3 Play as Parent

8.3.1 Select child

Figure 8.3: select child

This is the scene when the user clicks ”Play as Parent”. User can choose to interact with a VR baby, toddler or preschooler.

8.3.2 Interact with a preschooler

Figure 8.4: Interact with a preschooler

8.3.3 Interact with a toddler

Figure 8.5: Interact with a toddler

8.3.4 Interact with a baby

Figure 8.6: Interact with a baby

8.4 View Progress

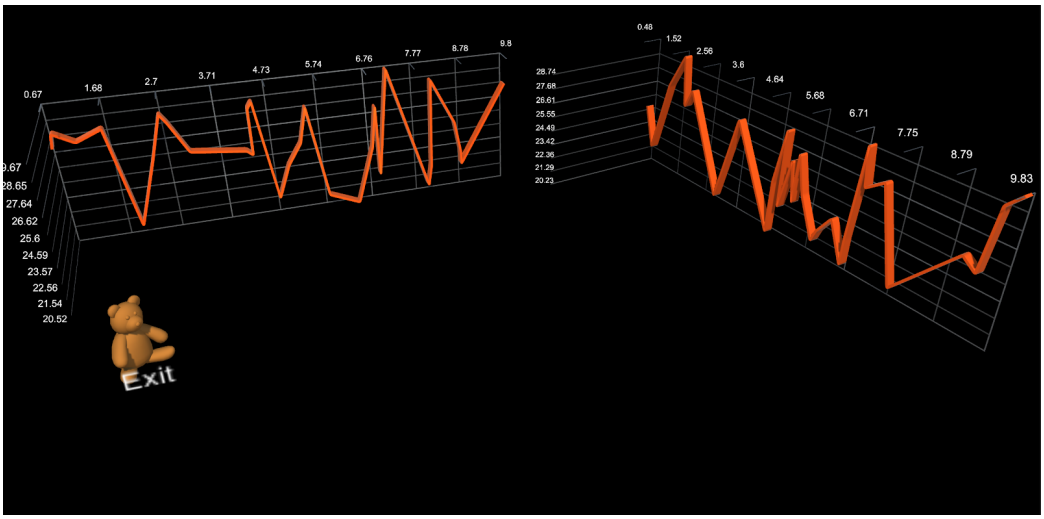

Figure 8.7: View progress

User will jump to this graph scene by clicking ”View Progress”. These two graphs display user past experience of interacting with the VR character. One graph shows the heart rate improvement, while the other graph shows the time duration. Both graphs contain the most recent 10 data results.

Chapter 9

Test Plan

9.1 White Box Testing

9.1.1 Unit Testing

We split functionalities up into modules to implement unit testing. For example, we tested the interaction with a VR baby, toddler or preschooler individually, and we tested each interacting reactions in the menu separately. We also tested if the main menu and the exit button work right. This way, our final testing process is be more efficient and the system will be more reliable.

9.1.2 Integration Testing

After the unit testing, we combined some individual modules to test as a group. For example, we started from the main menu, and checked if the option links to the right page. Then we tested the interaction and observation separately. We tested if the interaction or observation is constant, and also tested if the exit buttons work after the interaction or observation. Finally, we went to ”view progress”, and check if the history data has been displayed.

9.1.3 System Testing

In the system testing, we tested the GUI, turnaround time, compatibility, and load. The main menu was been tested, and checked if it follows the activity diagram. We also tested the application in two different iPhone versions. The database was tested by recording more than 10 times.

9.2 Black Box Testing

After the application passed the white box testing, we obtained a permission to test on human from SCU for testing during Dr. Barbara Burns' Resilient Families Program.

Chapter 10

Societal Issues

10.1 Ethical

This project uses VR technology to prompt users to be compassionate with their children by simulating real life scenarios. It is an ethical project because it does not deliberately create discomfort for the users, but merely being a platform for practicing their parenting skills and also mindfulness. The users have options to leave the scene anytime if they are feeling uncomfortable. For privacy, we allow users to opt-out from the researcher's data collection program anytime if they have any concerns.

10.2 Social

This project is non-profit and designed to aid "Safe, Secure, and Loved: Resilient Families" program. It equips parents with stress management techniques and also develop empathy towards their children.

10.3 Economic

Our project uses Google Cardboard as our VR device for it can be made in less than $10. It allows members in low-income community to access our training tool. We also decided to make our project an iOS application, detached from our VR headset, so that these headsets can be shared amongst a group and individual progresses can be saved.

10.4 Usability

Our application design is intuitive with the incorporation of menus. To use our application, simply hold the headset against one's eyes and move one's head to manipulate the cursor. Once the cursor lands on the desired option, select the option by clicking on the button on the headset. This application will also be translated into Spanish to accommodate the needs of Spanish-speaking parents.

10.5 Lifelong Learning

Before taking on this project, both of us have never done anything related to VR or psychology. We learned a lot from our psychology advisor, Dr. Burns, about early childhood development and parenting. For actually developing the tool, we took classes online and watched a lot of tutorials to teach us how to develop a VR game on Unity for Google Cardboard. We also consulted Dr. Amer, our advisor, for general design directions and guidance on our design decisions.

10.6 Compassion

With our project, we helped to extend the reach of the program ”Safe, Secure, and Loved: Resilient Families” by allowing training to be done off-site and also independently. This means community leaders can be trained more efficiently, while parents with busy schedule can also practice at home with our training tool. With our tool, we helped this program to benefit more families to access parenting training, which is crucial for raising mentally resilient children.

Chapter 11

Conclusion

11.1 Works done

We have created a parenting training tool accessible to the community, with the use of Google cardboard and the users phone. We are able to track the reaction of the user with real time heart rate, and these data can be collected and be sent to researchers for studies. This means that we can alter the voices, actions or emotion states of the child, and study how strongly each parent reacts towards those combinations. In a few tests we had, we find that even though the graphics are cartoon like, we still feel worried when the child all toward us. This shows that we have created a real enough experience for the users to feel a connection to the VR child, and to practice calming themselves then to interact with the child.

11.2 Lessons Learned

From this project, we found there are always several approaches to solve the problem. We firstly tried to use the camera instead of a fitness watch to collect the heart rate. Touching the camera during the Google Cardboard VR experience is not that convenient. Even though the fitness watch may cost some money, but it provides better user experience.

11.3 Advantages

Our application is used for parents in a community, so it's accessible for them to use on their phones. It also used the heart rate as a measurement to tell if parents are improving themselves or not. It's a user-friendly that effectively helped people get more experience in parenting.

11.4 Disadvantages

Since we are using the Mio fitness watch as the heart rate monitor, it might not be accessible to everyone. The assets for VR avatars are also limited, so our VR characters have limited sound and animation. Moreover, in experience as a parent, the children's actions are random based on the algorithm.

11.5 Future Work

11.5.1 Sensor

The Mio Alpha can be replaced by another external low-cost sensor. It will be better to use a more accurate biometric sensor for detecting stress with lower cost, and still being easy to use and obtain.

11.5.2 Data

More data can be collected from this application. Other than heart rate and time duration, other data can be considered to measure the stress level and give more accurate results.

11.5.3 Avatar

The avatars can be improved in both their appearance and animations. We suggest adding more realistic avatars, animations and audio sources to the asset. For example, crying, screaming, laughing audio of children, and recorded dialogue audio would enhance the user's experience in the parent scene.

11.5.4 Algorithm

Algorithms to connect users actions and childs emotional responses can be improved. Different algorithms for good or bad emotion states can be added. This may also need a thorough flow graph of desired interactions and childs reactions from psychology department.

11.5.5 Eye Tracking

The eye tracking technique can be provided. Eye movement data can analyze how attentive the user is on the avatar, and be incorporated with algorithms. For example, the VR baby will cry harder if the user is not looking at him/her.

11.5.6 Hand Controller

The option boxes can be replaced by hand controllers to simulate a more realistic and complex interaction.

11.5.7 Platform

Application can be available on both IOS and Android. In order to make the application more widely used, the Spanish version can be added.

Chapter 12

Reference

de Cock, Evi S.A., Jens Henrichs, Catharina H.A.M. Rijk, and Hedwig J.A. van Bakel. 2015. B̈aby please stop crying: an experimental approach to infant crying, affect, and expected parenting self-efficacy.J̈ournal Of Reproductive & Infant Psychology 33, no. 4: 414-425. Academic Search Complete, EBSCOhost (accessed November 30, 2017).