Product Requirements Document
Wheelchair VR

Luke Manship, lukem9@cs.washington.edu, 4/11/19
Ilya Kucherov, i.d.kucherov@gmail.com, 4/11/19
Kyle Yan, kyleyan@cs.washington.edu, 4/11/19
David Chen, davidissleeping@hotmail.com, 4/11/19

Summary

Our project aims to create empathy and understanding by having users simulate a day in the life of a wheelchair user through a VR experience in which the user attempts to navigate a non-wheelchair friendly environment.

Project Description

Our project will be a VR simulation in which users will sit in a chair and wear a Windows Mixed Reality headset, which will transport them to a virtual building through which they will attempt to navigate. Users will have to use their arms to physically turn the wheels on their real-life chair (the chair will have wheels on the side with Mixed Reality controllers attached that will move with the wheels to track wheel movement), which will turn the wheels of their VR wheelchair in order to move about the virtual building and reach their goal area, giving them a better idea of how tired one's arms can get while trying to get around. In addition, the Mixed Reality headset will have a Leap Motion attached to the front of it, allowing the user to use their hands to interact with the VR environment when not using their hands to move the wheels of the wheelchair. Our team's aim is to put users into a situation they may not have been before, presenting them with a powerful new perspective that provides insight into the problems one faces when forced to use a wheelchair to move throughout their daily life.

We will create the VR space using Unity, allowing us to create the navigable building and the wheelchair that the user will use to move around. We will create a single three-story building through which the user can move, but may create more than one if time allows. We want to make the experience difficult for the user in order to accurately simulate the troubles that wheelchair-bound people face day-to-day, so we will likely be creating the building such that wheelchair accessibility will prove difficult (one of the elevators not accessing all floors, stairs being the easiest point of access with elevators deeper in the building, etc). We hope that this VR experience will give users who have the use of their legs better perspective on some of the very real difficulties that people in wheelchairs face in their daily lives.

User Experience

When trying our product, we want the user to feel greater empathy towards those that live their lives using a wheelchair for movement. We want the user to experience both the physical strain of moving the wheels of a wheelchair rather than using one's legs and the mental strain of constantly looking to find the wheelchair-accessible points of a building. The user should be forced to confront the reality that certain paths will not be accessible and that they will be required to find wheelchair-friendly paths through the environment. We hope that the user will feel challenged by the experience and evaluate the importance of keeping the challenges that those with disabilities face in mind in their personal and professional interactions.

Hardware Platform/Device

Windows Mixed Reality Headset

Deliverables

Describe the features of your product in three phases:

- **Minimum Viable Product**: Our minimum viable product will be a single story of a building with simple interactable obstacles (chairs, desks, etc.) in it. We will have a working VR wheelchair and the user should be able to move through the environment using the wheels of the VR wheelchair.

- **Target Product**: Our target product is a three-story building that the user will attempt to navigate through. This should be a challenging environment and will have more interesting obstacles that the user will encounter (elevators, stairs that the user cannot go up, etc.). The user will be able to move physical wheels on a physical chair and the wheels on the VR wheelchair should move as well. The user should be able to use their hands to interact with the VR environment objects using Leap Motion to track the user's fingers. There should include a clear goal area (area the user will attempt to reach).

- **Stretch Goals**: Our stretch goals include a second navigable building that presents different challenges to the user and an environment that takes place outdoors (based on Downtown Seattle) with steep roads that are harder to wheel up. We plan to attempt to implement these if time permits.

Performance Metrics

How will you evaluate if your product is operating as intended?

- Accuracy/Realism: does this experience accurately and respectfully depict the experience of an actual wheelchair user? Are the things that should be difficult accurate? Are the things that aren't actually that difficult accurate? We will be talking with a manual chair user to determine our baseline for accuracy/realism.
- User Experience/Effectiveness: does this experience force the user to evaluate their own experiences/does this create greater empathy for wheelchair users? Is the wheelchair intuitive to use?
- Performance: does the experience run without lag? Does it give the user motion sickness? Are turns in the wheelchair smooth?
- Functionality: does the wheelchair work in-game as you would expect when using the real-life approximation?

Milestones

- Week 3: Test out potential environments we want to use/investigate assets we may need to buy (Luke, Kyle, David) and begin experimenting on the movement of wheels of the wheelchair (Ilya).
- Week 4: Map out the planned three-story environment (Luke)/begin creation of first floor of environment (Kyle, David) and begin creation of actual wheelchair (Ilya).
- Week 5: Finish the first floor of environment (Luke, Kyle, David) and finish the actual implementation of the wheelchair itself (Ilya).
- Week 6: Ensure the interaction between the user's wheelchair and the first floor environment works as expected (Luke, Kyle, Ilya, David). MVP should be achieved by end of week.
- Week 7: Begin work on the second floor environment (Luke, Ilya) and implement the elevator that will be used to reach the second floor (Kyle, David).
- Week 8: Finish the second floor environment (Luke), test the interactions between the second floor and wheelchair (Ilya), and finish elevator to second floor (Kyle, David).
- Week 9: Begin third floor environment and begin testing wheelchair interactions for the third floor (Luke, Ilya), begin and finish third floor elevator (Kyle, David).
- Week 10: Finish third floor. Wheelchair interactions should be working and the goal area should be clear to a user (Luke, Ilya, Kyle, David).

Materials and any external help needed

- 3D assets for environments
- 2 wheels for our real-life chair
- 1 chair for the user to sit in (wheels will be attached to this)
- Expertise of mentor (John)

Budget

We will need to purchase:

- 3D assets for environments
- 2 wheels for our real-life chair
- 1 chair for the user to sit in (wheels will be attached to this)

Estimated Budget: $500 (we are unlikely to use all of this)

Risks and how they will be addressed

Describe at least three major risks to your plan. For each one, categorize it as low, medium, or high, and describe mitigations -- if Plan A doesn't work, we will execute Plan B, etc.

- Risk 1 - High: Inaccurate wheelchair user experience. We've categorized this as high because getting this wrong would be catastrophic to the project's goals. If the experience we create does not depict the experience of an actual wheelchair user, then we have accomplished what we set out to do. This could lead to people getting an misinformed/inaccurate idea about the disabled community. We have reached out to a real-life wheelchair user to get advice on certain things that may be difficult for them in their day-to-day lives so that we can actually accurately simulate these difficulties. This is extremely necessary to get right and we will be treating this subject with extreme care.
- Risk 2 - Medium: Motion Sickness issue. It is possible that our chair setup will produce motion sickness when turning. If this happens, our Plan B is to only use the wheels to move forwards and backwards and to control rotation using head movement. If that doesn't work, our Plan C is to have no real-life wheels and use a swivel chair; the user will use controllers to move VR wheels and the swivel chair will help them control turning movement.
- Risk 3 - Low: We make the environment too complicated and are unable to finish our three-story building with all the features we desire. To mitigate this, we will be mapping out our environment before building it out to ensure that it is of a scale and complexity that we will be able to accomplish. In the extreme event that we cannot finish three stories of the building, we may have to settle with two floors and a single elevator; we really don't anticipate this happening, but there that is the contingency plan if it does happen.