Product Requirements Document
Wheelchair VR

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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 through several non-wheelchair friendly environments/interactions.

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 through three scenarios through which they will have 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 through three difficult virtual environments and complete the goal in each section, giving them a better idea of how tired one's arms can get while trying to get around and how difficult something as simple as trying to move can be. 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 spaces/interactions using Unity, allowing us to create the navigable situations and the wheelchair that the user will use to move around. We will create three different interactions through which the user will move, but may create more than that 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 be creating the interactions based on everyday scenarios that wheelchair users have told us prove difficult. The interactions

we have chosen to implement are: moving through a public bathroom, finding an alternate way to get to the second floor of a building when an elevator breaks, and moving through a public transport station. 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 areas of the environments in our interactions. 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. We hope that the user will feel challenged by the experience and evaluate the importance of keeping the struggles 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 two interactions: moving through a public restroom and finding an alternate way to get to the second floor of a building when the elevator is broken. We will have a working VR wheelchair and the user should be able to move through the interactable environments using the wheels of the VR wheelchair without getting motion sickness.

- **Target Product**: Our target product consists of three interactions that the user will attempt to navigate through: moving through a public bathroom, finding an alternate way to get to the second floor of a building when an elevator breaks, and moving through a public transport station. These should be challenging and will have interesting obstacles that the user will encounter (broken elevators, stairs that the user cannot go up, etc.). The environments that the interactions occur in should be more fleshed out than in the MVP. 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 in each interaction (area the user will attempt to reach).

- **Stretch Goals**: Our stretch goals include an even more detailed environment (more things the user can interact with, more space the user can explore), more detail in the interactions (for example, when you move the wheels, your in-game hands get dirty), 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: investigate assets, Kyle: test automatic door interactions, David: test elevator interactions) and begin experimenting on the movement of wheels of the wheelchair to limit motion sickness (Ilya).
- Week 4: Finish experimentation with motion sickness and make a final decision on how wheelchair will move (All: make final decision on wheelchair implementation), map out how each of the three interactions should play out (Luke), continue working on using

movement of the wheels to move VR wheelchair (Ilya), begin work on the broken elevator interaction (Kyle: environmental aspects, David: elevator interaction).

- Week 5: Finish the creation of the actual wheelchair (Ilya, Luke), finish the broken elevator interaction (Kyle: environment details, David: goal area and navigable path creation). Begin work on the public bathroom interaction (Kyle: bathroom stall creation, David: general environment creation) and test how the wheelchair will work with the broken elevator interaction (Luke: test navigable path and achievable goal, Ilya: test wheel movement and avoidance of motion sickness).
- Week 6: Finish the public bathroom interaction (Kyle, David), make sure that it is sufficiently difficult in terms of wheelchair interaction (Luke/Ilya: test to ensure that the wheelchair moves in the environment and it is possible to get into/out of the stall) and ensure the MVP is ready for demonstration (Luke, Ilya, Kyle, David).
- Week 7: Begin working on public transport station interaction, particularly turnstiles and elevator. (Luke: top floor environment, Ilya: bottom floor environment, Kyle: turnstile interaction, David: elevator interaction).
- Week 8: Continue working on public transport station interaction (Luke: more detail for top floor environment, Ilya: more detail on bottom floor environment, Kyle/David: subway interaction).
- Week 9: Finish working on public transport interaction (Luke/Ilya: test wheelchair interaction with completed environment design, Kyle/David: implement last interactions/environmental features).
- Week 10: Add further details to the environments of each interaction, ensure all interactions work as intended, and prepare to demo (Luke/Ilya: complete last tests of interactions with scenarios, Kyle/David: more detail to the environments, All: prep how we're going to perform the demo).

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
    - Furniture that we cannot create ourselves (Estimated Price: $20)
    - Bathroom materials that we cannot make ourselves for our bathroom scenario (Estimated Price: $15)
    - Assets relating to the public transport subway experience (Estimated Price: $50)
- 2 wheels for our real-life chair (estimated price: $20)
- 1 chair for the user to sit in (wheels will be attached to this) (Estimated Price: $15)

Estimated Budget: $140 (cushion of $20 to account for potential variation in costs)

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 interactions too complicated and are unable to finish all three of our interactions in the time available, with all the features we desire. To mitigate this, we will be mapping out how we want our interactions to operate beforehand so that we don't run into unexpected issues relating to the layout of our environments/complexity of our interactions. In the extreme event that we cannot finish all three desired interactions, we may have to settle with two interactions that we implement well; we really don't anticipate this happening, but there that is the contingency plan if it does happen.