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# Research & Development
# Plan: Virtual Reality Simulation

***Introduction:*** When the topic of gaming is brought up in a typical conversation, most people picture teenage kids sitting on a couch playing a violent shooter, sports, or racing game. Triple A titles are released each year and flood the markets of consoles and PC gaming that reinforce these three stereotypes of gaming. At this point in the field of video gaming, the idea of a consumer learning applicable information is considered impractical, and merely doesn't make sense. How could someone learn a real skill by just staying in their own house and looking at a screen or into a 3D world? This mindset and stereotype has effectively nullified the idea or mindset of using these devices for educational purposes.

Virtual Reality is a new and emerging video technology that seeks to free the end user from the chains of their screens. Typically used as a new way to play video games, a Virtual Reality headset places the end user into a 3D simulated world, where the possibilities and applicability is boundless. Although gaming is the major use case and platform that this technology is actively developed upon, it is not the only application. Companies are picking this up to ideate in a new 3D space for research and development, create real conference rooms across the world, and even teach individuals a real skill.

This application looks to harness the power of Virtual Reality not as a gaming engine, but as a training platform to teach a real, physically applicable skill in a lifelike and completely simulated world. This training application looks to build a framework for learning real skills through Virtual Reality. The first and pilot skill to use this framework will be tightroping. The application intends to take a user with zero experience walking or balancing and create a safe simulated space wherever they like, whether in their college dorm, house, or in the middle of a gym where they can learn tightroping. Through the use of a few strategically placed sensors in a room and pressure controllers, this application intends to make experienced tightropers.

***Discussion:*** Firstly, the controls for the application must be implemented allowing the user to interact with the application using the Oculus virtual reality headset and touch controllers. The sensors will shift the user's view based on the position and movement of their head and the headset. The touch controllers will be used in order to interact with the graphical user interface of the application. This will include general menus, options, and the title screen. The most important component of the controls will be the actual movement of the player in the three-dimensional space. This will be one of the first critical technical milestones. In each scene, a player is given a scenario along with a tightrope to use to reach their goal so that they may advance to the next scenario, which will have an increased difficulty level. Difficulty levels are based on the type of situation shown to a player. For example, tightroping between two tree stumps in a small backyard is easier than doing so between two skyscrapers. More specifically, situations are more difficult and or easier than others based on the psychological effect they have on the user, especially those with a serious fear of heights. Going back to the point about the movement of the user, the Oculus will comes packaged with two sensors (Figure 1) in order to calibrate the spatial position of the user in what it will consider as the valid simulation space.

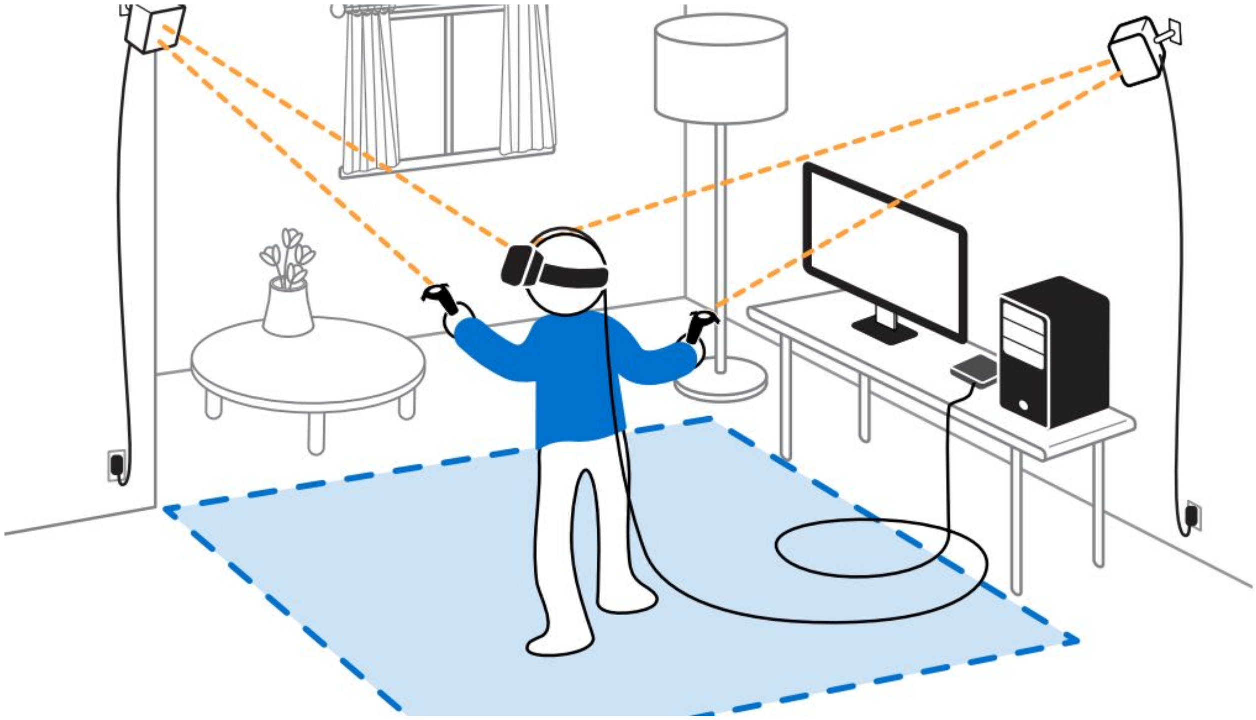

***Figure 1:*** Sensor Placement in a Generic Room

In order to make the simulation feel more realistic and in order for the pressure sensors to have accurate readings, a tightrope like object will be constructed for the user to step on as they complete the simulation. This way the user will have more of a feel of what being on a real tightrope is like and the foot pressure sensors will be able to better gather data based on the actual pressure being forced onto a region of the foot as it would be in a real life version of this situation. To be more specific, the foot sensors being used for this application will be Arduino powered flat circular pressure sensors that will be attached to foot soles that the user can slip into their shoes (Figure 2). These sensors will be connected to an Arduino Uno, and will communicate over a PWM to the Arduino a calibrated pressure value relative to the users' weight. This data can then be sent to the game engine over a serial USB connection for further processing.

To make matters more convenient for the consumer, however, test shoes will be created in order to more easily keep the Arduino attached to all the required sensors and out of any harms away of the user's actions during the simulation. Extracting data from these sensors with the arduino will be another early technical milestone. This pressure data will be continuously ingested throughout the simulation. Upon ingestion into the processing engine, the data will be compared to a delta over time to see if a large change is present. Depending on this, the simulation will give positive or negative feedback towards the users' performance via the user interface. In addition, there will be research done on the act of tightrope walking in order to understand exactly what points on the feet need to have more pressure than others. This research may include more active means such as questioning professionals that work in the Health and Wellness department or any other relevant department at The George Washington University.

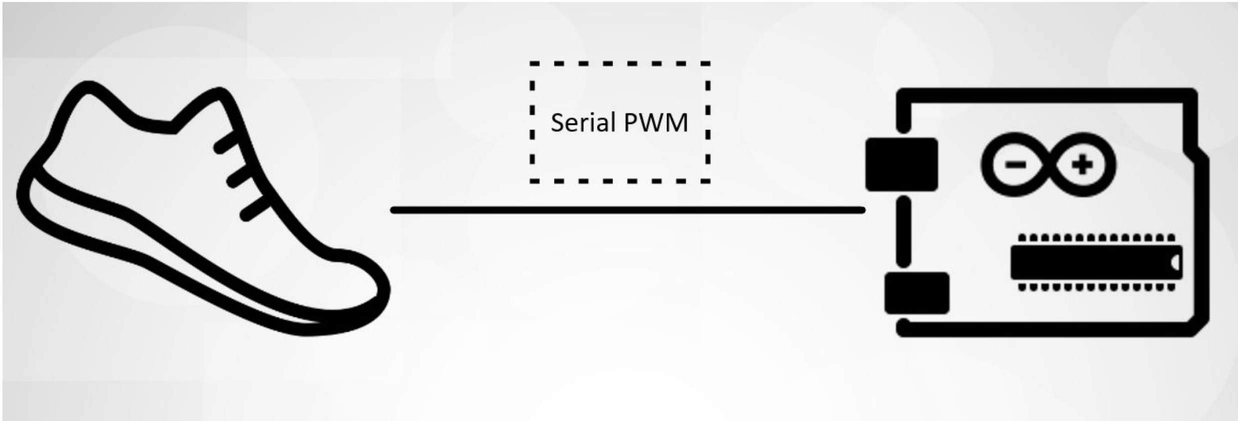


***Figure 2:*** Arduino Pressure Sensors & Shoe Sole

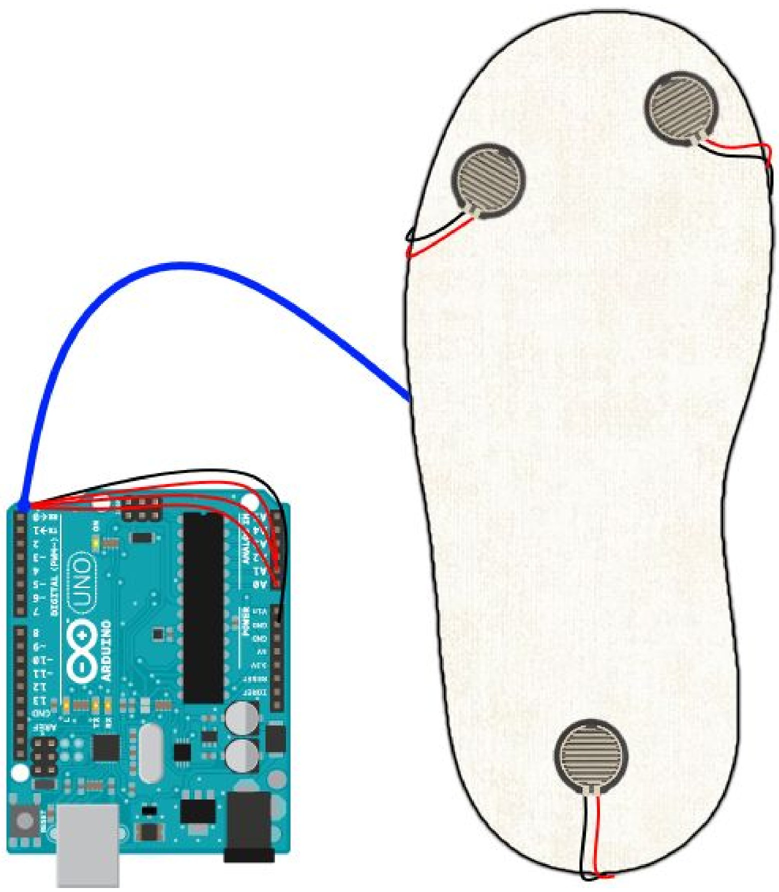

***Figure 3:*** Sole Pressure Sensor Placement

Another critical technical milestone that comes with building this type of application is integrating the code between the Arduino and the Unity Game Engine. This connection will allow the Unity Engine to retrieve data from the Arduino, and therein create a way for the end user to receive active responses from the simulation, i.e: a feedback loop. Ultimately, the goal of this application is to become a viable teaching tool for tightrope walking. Therefore, having such data is important for the application to process it with its own code and being able to output any advice the user should be given to help them succeed in learning this skill. Therefore, this output must be visually shown to the user through a user interface.

A graphical user interface (Figure 3) will be created to show the consumer their current progress along the tightrope during a simulation as well as any advice or guidance when on the verge of failure or in need of course correction. The application will determine significant changes in the pressure data being retrieved from the foot pressure sensors. It then would processes the changes, i.e. “delta” to see if they fit the guidelines for the proper footing position for tight rope walking. If the way they are crossing the tightrope converges to proper form under this guideline, then the simulation would elicit a congratulatory response so that the user understands that they are on the correct path towards success. This will add psychological encouragement and motivation to continue across the entirety of the rope. If the user doesn’t have the correct footing position, then the simulation will note the difference between the user’s footing and the accepted footing for tightrope walking and output a response or alert to explain what they are doing wrong and how they can improve themselves. Other user interface features would include a foot pressure mapping icon that indicates which points on the feet the user is putting pressure on, which will give them a better idea of how they need to change their footing position.


***Figure 4:*** Graphical User Interface Alert

As mentioned previously, there will be a title screen for the user to interact with upon launching the tightroping simulation. This will consist of a difficulty selection, allowing the user to select which stage of difficulty they would like to begin with in case they are more experienced and would like to bypass the more trivial simulations. This way they can better challenge themselves with the more psychologically taxing simulation situations, in which he or she is tightroping at a much higher altitude around structures that naturally are much higher from the ground. Completing the detailed mechanics of the graphical user interface and designing it to be user friendly and self explanatory is another technical milestone.

To expand on the difficulty stages, at least three stages have been planned for users to practice on. The easiest difficulty level has the user begin in a backyard where the user is very close of the ground and must tightrope walk between two wooden stumps. The second difficulty level would have the user tightroping in between two skyscrapers looking over a city. The third difficulty level would have the user tightrope walking between two mountains in a more natural and treacherous looking setting. It is highly imperative to make these scenes aesthetically pleasing in a realistic sense, so that the user feels like they are really in those types of situations. A more realistic feel with better looking three-dimensional models and assets would make the psychological effects of acrophobia (fear of heights) more taxing on the user, which in turn would make them more apt to handle similar or less intense situations in the real world.

When testing the application, it will be important to ask test subjects how they felt across all difficulty levels in order to get an idea about if the simulations are inflicting some sort of stress and or relaxation (depending on the simulated situation addressed). Having surveys after each testing session for the subjects would be a great way to test customer satisfaction before release. In the end, there would have to be more detailed tests that would combine every component of the application. These final components would include the controls of the Oculus, the user interface, the feedback loop, arduino operations, and the overall experience of the consumer throughout the entire testing session. The experience as a whole is especially important since this simulated experience is supposed to have a very user friendly set up and be designed in a way that makes it feel second nature to anyone who attempts to learn how to tightrope walk.

In order to progress towards completion, this simulation has a determined set of steps that must be performed. The order is represented in the figure below.


***Figure 5:*** Timeline