# VirtualWars: An Immersive VR Experience

Fahim Dalvi
fdalvi@stanford.edu

Tariq Patanam
tpatanam@stanford.edu

## Motivation

"VR is not an engineering problem. It's a perceptual problem with an engineering solution."
Aaron Nicholls, Oculus

Our motivation behind this project was to hack the human perceptual system to the point that it cannot perceive a difference between the virtual and physical world. To provide this fully immersive experience is often unintuitive, so we set out to find the key factors.

## How we did it?

Unlike traditional screen media, VR is a meant to be a fully immersive experience. However, there are several aspects of the virtual world that are limited: Field of View, latency, the graphics pipeline, haptics, position tracking and more. We needed to get around these limitations without alerting human senses to the mismatch. Our focus was on four major components: Content, Audio & Lighting, Animations and Sensors.

## Results & Future Work

We encountered several key obstacles in our implementation of the immersive experience.

| Obstacle | Workaround | Possible Improvement |
|---|---|---|
| Network latency in transferring sensor data | Streamed data through USB | Use low latency networks such as bluetooth or interpolate data from faster but unreliable datastreams |
| Limited position tracking | Platform in virtual world equally constrained | Use bluetooth, WiFi, magnetic or other indoor tracking technologies |
| Haptic limitations | Made objects such as droids very low density so they seem to cut easily in the virtual world | Use vibration feedback on impact |

### Content

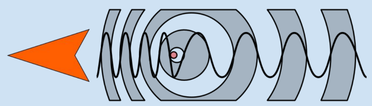
- Custom modelled most of the scene in Blender and Unity to have a coherent experience

unity blender Audacity

- Took advantage of rendering techniques such as bump and normal maps to make the geometry look more realistic
- Used shaders and particle systems in Unity to make realistic looking effects like rain or the destruct
- Increased physical interaction to mask the inaccurate aspects of VR: for instance, positional freedom gives the user less reason to look peripherally into the limited field of view

### Audio & Lighting

- Sound is a crucial factor in making a VR experience more immersive
- Incorporated stereo sound to give the user spatial cues and simulate real world phenomena like the Doppler effect

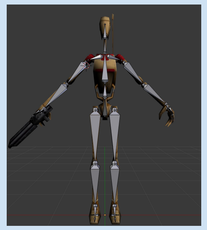


Demonstration of Doppler effect

- Added lots of background noises such as rain, passing ships, explosions to make the scene sound more natural
- Incorporated lighting changes coupled with audio to increase immersion, e.g. thunder and lightning occur in sync
- Used a combination of hard and soft shadows to increase realism while keeping the rendering loop efficient

### Animations

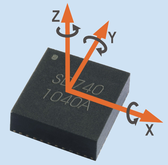
- Realistic physical movement is key to making things look natural
- Used Blender to rig and animate our models



Rigged Droid model

- Used inverse kinematics built into Blender for realistic pose manipulation
- Used animation curves in Unity to incorporate macro animations at the world level, e.g. droids approaching the player
- Also incorporated animations using scripts for finer control, e.g. shooting bullets from the ships at randomized intervals

### Sensors




We use an IMU integrated with a gyroscope and an accelerometer to perform tracking

- Bridging the gap between the vestibular and the visual system is an important aspect of a good VR experience
- Used Inertial Measurement Unit (IMU) to perform head tracking
- Used IMU to perform hand orientation tracking to control the lightsaber in the virtual world
- Used Kinect to perform position tracking of the user's body

Kinect 360
Uses an RGB camera and infrared projection based depth sensor to track objects in its view