# Step



A Big Step Forward for Virtual Reality



Department of Electrical and Computer Engineering

Advisor: Professor Goeckel

#### **Team Members**



Ryan Daly Electrical Engineer



Jared Ricci Electrical Engineer



Joseph Roberts Electrical Engineer



Steven So Electrical Engineer

#### Problem



- Modern smartphone VR isn't immersive
  - Discontinuity between virtual actions and physical actions
  - Limited to sight and sound
- Less control in a virtual environment leads to a higher occurrence of disorientation [1]

[1] Sharples, Sarah. "Virtual Reality Induced Symptoms and Effects (VRISE): Comparison of Head Mounted Display (HMD), Desktop and Projection Display Systems." *Displays* 29.2 (2008): 58-69. Print.

#### Step



### Societal Significance

- Potential for:
  - Engaging exercise
  - Educational experiences
  - Infantry/first responder training



## World Problems

- Obesity is a growing problem in America
- "obesity can lead to other illnesses from chronic to acute some very severe and deadly, such as diabetes, high blood pressure... and even cancer" -Arizona State University [2]

Figure 6.1. Prevalence of obesity among adults aged 20 and over: United States, 1997– 2015



Obesity findings of the Center of Disease Control and Prevention [3]

[2] Begay, Dion. "What Can Obesity Lead To?" Obesity in the Latino Population. N.p., Spring 2005. Web. 13 Oct. 2016.
[3] Nunes, Keith. "C.D.C.: Prevalence of Obesity among U.S. Adults at All-time High." Food and Beverage News, Trends, Ingredient Technologies and Commodity Markets Analysis. N.p., 26 Feb. 2016. Web. 13 Oct. 2016.

#### **Conveniency and Educational Problems**



 Being able to conveniently visit places, such as colleges, is inconvenient and costly

 Virtual tours are insufficient in thoroughly experiencing the environment

#### **Incompetent Training**

- "One of the study's findings was that Soldiers lack access to realistic TC3 simulation that could improve the individual and collective skills Soldiers and squads need to manage the complex environment of simultaneous combat and casualty management." -Mike Casey, Combined Arms Center US ARMY [4]
- Prevent deaths and save lives, not just in the military, but also in first responder training



[4] Casey, Mike. January 25, 2016. "Improving Tactical Combat Casualty Care to save Soldiers' Lives." *Www.army.mil.* N.p., 25 Jan. 2016. Web. 13 Oct. 2016.

#### **Overall Requirements**

- User is able to freely move in virtual environment
- Hand and arm motion is translated to in-game action
- User does not have to wear any equipment beyond VR headset
- Maintain framerate at 60 FPS



"You cannot drop below 60 FPS. Period. Ever." -Chris Norden, Senior Staff Engineer, Sony [5]

[5] Hall, Charlie. "Sony to Devs: If You Drop below 60 Fps in VR We Will Not Certify Your Game." *Polygon*. Vox Media, 17 Mar. 2016. Web. 13 Oct. 2016. http://www.polygon.com/2016/3/17/11256142/sony-framerate-60fps-vr-certification

### Design Alternatives (PC Based)

#### **Oculus Rift**

- User is static in reality but moving in the virtual world
- User input via game controller

#### **HTC Vive**

- User movement limited by room size
- Wire tether and handheld equipment limit immersion





### Design Alternatives (Smartphone Based)

#### **Google Cardboard**

- User is unable to interact with the virtual environment via any kinesthetic movements
- Experience is strictly stationary

#### **Google Daydream**

 User can interact with the environment solely through the use of a controller



#### **Our Solution**

- Create a system to immerse the user in virtual reality
- Allows motion in endless environment
- Detects movement without added hardware
- Users movements will be reflected in the virtual world (walking, running, flailing)



### Logical Block Diagram



#### Physical Block Diagram



#### Physical Block Diagram



## Forward Motion

#### Requirements

- Accurately read user speed within 0.5 MPH
- Transmit user movement speed to host PC with 150 ms latency
- Securely attach to equipment without interfering with user movement



### **Elliptical Sensor Implementation**

- Hall Effect sensor to detect rotation speed
- Raspberry Pi attached to sensing board will send data to PC via WiFi
- Sensor will be mounted directly to elliptical



## Physical Block Diagram



#### Department of Electrical and Computer Engineering

#### I MassAmherst

### Arm Motion Sensor

#### Requirements

- Real-time processing and transmitting
- Depth within 1" tolerance for arm movement

#### **Choice: Xbox Kinect**

- Simple interface with computer
- Detects full body of motion





- Leap Motion
  - Valuable for processing a couple of hands, not entire upper body [6]







#### **Kinect Problems**

- Poor depth performance
  - "The depth data registered by the Kinect 1.0
    [360] has poor quality ... the structured light
    approach is not always robust enough to provide
    a high level of completeness." [7]







[7] D. Pagliari and L. Pinto, "Calibration of Kinect for Xbox One and Comparison between the Two Generations of Microsoft Sensors", *Sensors*, vol. 15, no. 11, p. 27571, 2015.

#### **Kinect Implementation Plan**







- Add second Kinect at different angle
- Determine depth, leveraging pre-existing development kits
- Evaluate quality, implement additional Kinect(s) as needed

### Physical Block Diagram



#### PC and Communication Requirements

Requirements for PC

- 1. Supply power to the kinect
- 2. Process and compile the data from kinect and elliptical
- 3. Needs to be able to communicate and transfer data to the android efficiently
- 4. Latency Rate 200 ms





#### Data Compiler Implementation

- Elliptical input will be a value, the kinect data output that will contain user's position
- Data can be compiled into one data set which will then be the data used to send



## Communication Implementation Plan

#### Wifi

- better than bluetooth
- high transaction rates
  - Latency 150ms vs 200ms
  - Bit-rate 600Mbps vs 2.1Mbps

#### Program

- there are already ways to interface PC-Android communication via Wifi
- Using eclipse and java to send data to android



#### Physical Block Diagram



26

#### Smartphone and VR Headset Requirements

- No additional weight
- VR application is able to process data sent from Kinect and elliptical



Frame rate = 60 FPS



#### **Smartphone Application Implementation Plan**

- Application will be developed in the Unity Game Engine environment with C# scripting
  - C# scripts will be capable of referencing data sent from the Kinect and elliptical







#### **MDR** Deliverables

Interactive VR game in which the user can walk along a straight path whilst controlling their speed of travel, and using their arms to pop bubbles.

- Demonstrates:
  - a. precise speed control with elliptical
  - b. adequate kinect motion sensing
  - c. data processing and transmitting to android
  - d. a programmed VR environment using inputs



#### **Questions?**

