Step

A Big Step Forward for Virtual Reality
Team Members

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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]

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]

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

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

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

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

- Forward Motion
- Data Processing I/O System
- VR Environment
- Hand and Arm Movement
Physical Block Diagram

- Smartphone and VR Headset
- PC processor and data transmitter
  - Data Compiler and interfacing
  - Data Transmitter via Wifi
- Elliptical
  - Sensing Board
  - Raspberry Pi
- Hand and Arm Movement
  - Kinect Center Sensor
  - Kinect Left Sensor
  - Kinect Right Sensor
- Forward Motion
  - Speed Data
  - Kinect Data
Physical Block Diagram

- Forward Motion
  - Elliptical
  - Sensing Board
  - Raspberry Pi

- Hand and Arm Movement
  - Kinect Center Sensor
  - Kinect Left Sensor
  - Kinect Right Sensor

- PC processor and data transmitter
  - Data Compiler and interfacing
  - Kinect Depth Processing
  - Data Transmitter via Wifi

- Smartphone and VR Headset
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
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

Alternatives
- 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]

Kinect Implementation Plan

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

Forward Motion
- Elliptical
- Sensing Board
- Raspberry Pi

Hand and Arm Movement
- Kinect Center Sensor
- Kinect Left Sensor
- Kinect Right Sensor

PC processor and data transmitter
- Data Compiler and interfacing
- Kinect Depth Processing
- Data Transmitter via Wifi

Smartphone and VR Headset

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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?