Accuracy & Precision in Virtual Reality with the HTC Vive

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Introduction

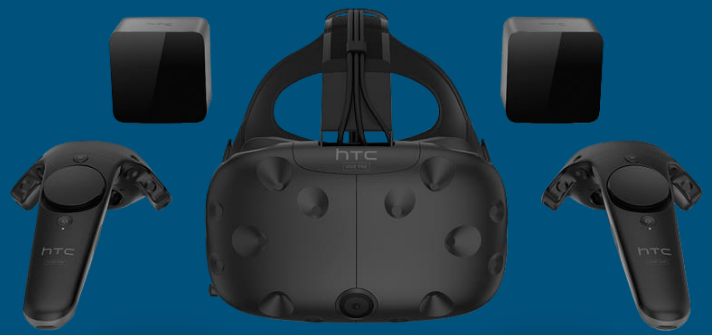
- ”Does the perceived space in VR affect the user and how well can we improve accuracy and precision in reality using VR?”
  - Once the projectile has been launched, there is no possibility of control, differentiating this task from much better studied tasks such as pointing and tracking. Instead, one has to learn strategies from an iterative process of error estimation and correction from one trial to the next.
- Program a virtual environment using Unity for the HTC Vive where we would throw tennis balls at a target at 10, 15, 20, and 25 feet.
  - The results would be compared to real life testing.

Virtual Reality

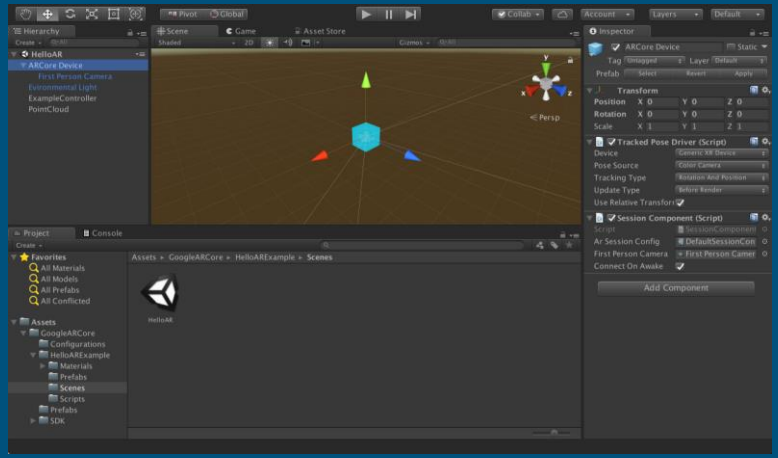
- Virtual Environments and Virtual Reality-based Training Systems (VE & VRTS)
- Seeks to create a 3D environment that can be perceived as real through sight and interaction.
- Different from Augmented Reality, which is an overlay or real world objects with software added ones.
- Multiple applications from entertainment to education.
- More immersive experiences require more advance hardware and software.

VIVE

- The HTC Vive has the best tracking compared to other VR systems.
  - Better lenses and tracking. Higher frame rates and more interactivity.
- The headset uses “room scale” tracking technology, allowing the user to move in 3D space and use motion-tracked handheld controllers to interact with the environment.
- Oculus for example does not require a room scale setup.



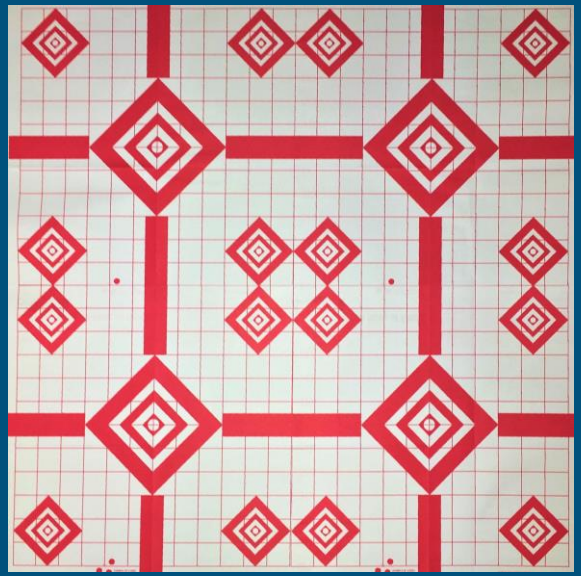
- Unity is commonly used for making video games but can be used for various applications.
    - Assets are added in the library to add support for different types of inputs and outputs, such as controllers and Head-Mounted Displays (HMDs).



- Multiple applications from film to computer-aided design(CAD)
- Unity uses a 3rd party API called SteamVR made by Valve, unlike the Unreal Engine.
- It does not have a native text editor so, it allows for 3rd party text editors.

Methodology

- Hit a target with a tennis ball.
- Distances of 10, 15, 20, and 25 feet.
- Initial Physical Test: Five attempts at each distance.
- Replicated within the Virtual Space, with a target of the same size and distances.
- Final Physical Test: Five attempts at each distance

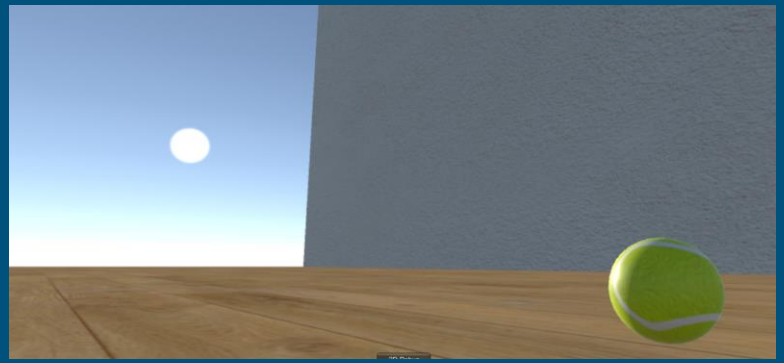


Methodology - Scoring the throws

- A point value was assigned to each throw based on the distance away from the center of the target.
  - Less than or equal to 2 in. from the center = 15 points.
  - Greater than 2 in. but less than or equal to 6 in. = 12 points.
  - Greater than 6 in. but less than or equal to 9 in. = 9 points.
  - Greater than 9 in. but less than or equal to 12 in. = 5 points.
  - Greater than 12 in. but less away but still in the target = 3 points.
  - Throws that were outside of the target = 0 points.
- Average amount of points were calculated for:
  - For each subject, per each distance
  - For the group combined, per each distance
- Statistical analysis was performed to compare results between initial physical test and final physical test

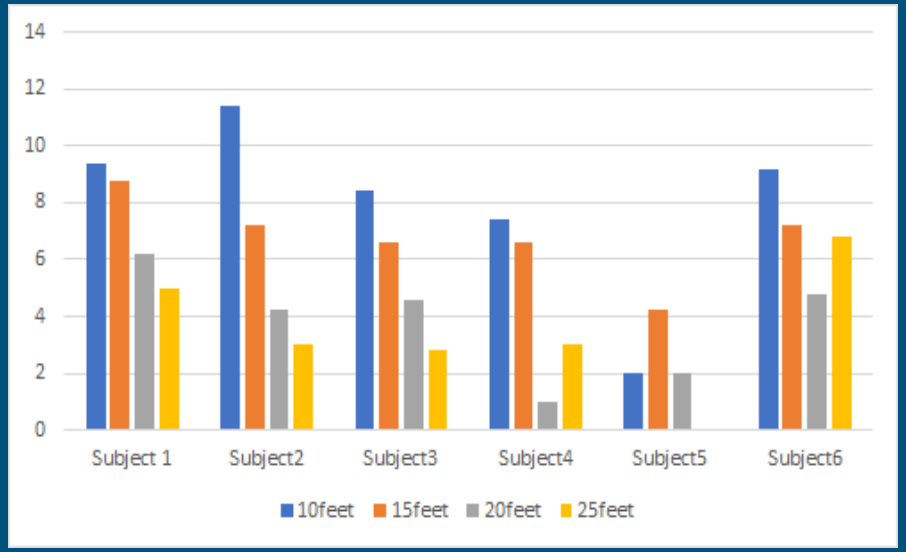
Video

Link to Video on YouTube (https://youtu.be/ITSCO8_pkT0)

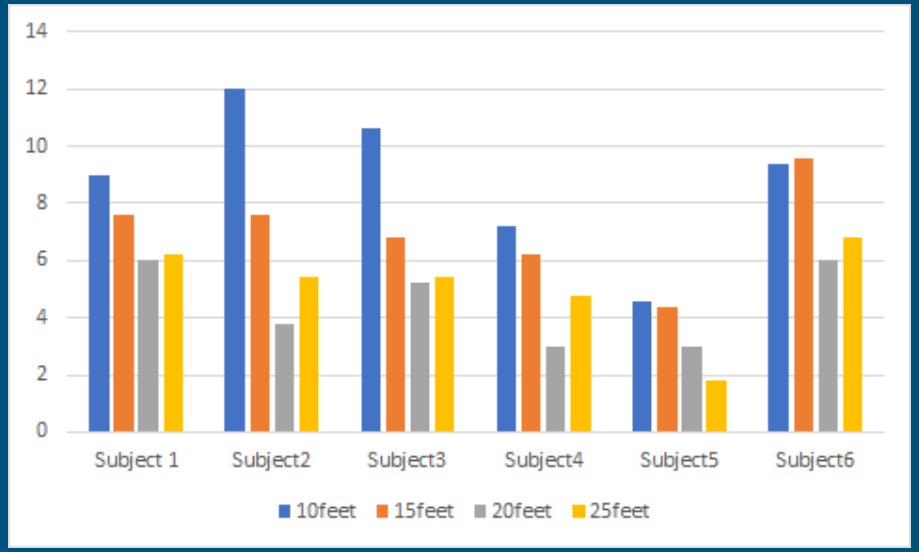


Results & Analysis

Initial Physical Test Results



Final Physical Test Results



Results & Analysis

Distance	Initial Physical Test Mean	Final Physical Test Mean	T-test P-value
10 feet	7.97	8.8	0.21
15 feet	6.77	7.03	0.71
20 feet	3.8	4.5	0.29
25 feet	3.43	5.06	0.04

- T-test results
  - **No statistically significant** difference between initial and final means for distances of 10, 15, and 20 feet
  - **Statistically significant** difference between the initial and final means for the 25 feet distance

Results and Analysis - additional metrics

Distance	Initial Physical Test Mean	Final Physical Test Mean	T-test P-value
10 feet	0.9	1.0	0.21
15 feet	0.76	0.9	0.71
20 feet	0.56	0.7	0.29
25 feet	0.46	0.76	0.04

- Accuracy
  - Measured as the percentage of throws to hit the target area from the total number of attempted throws
  - Generally decreased as the distance increased
  - Slight improvement across all distances between the initial test and the final test

Unity Troubles

- No previous experience in game development.
- Becoming familiar with C# SteamVR API
- Mainly time, to polish things and do more analysis
- Finding a non-reflective setup environment