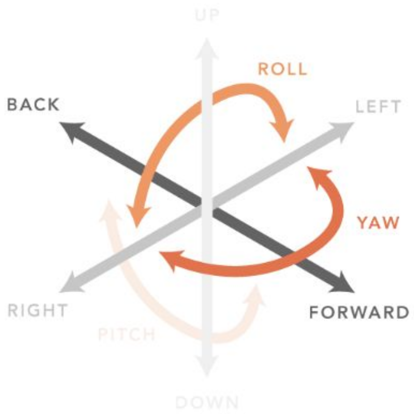
# 3DUI Challenge

TAIM 23/24 Final Presentation

# Goals

- 5 degrees of freedom movement
- Look and move freely
- Circle around a point of interest




# Requirements

- At most one trigger action
- Explicitly switch modes
- Adjust the movement speed

# Approaches

# WeLeap - Technical Specifications

**Overview of Leap Motion Technology**:

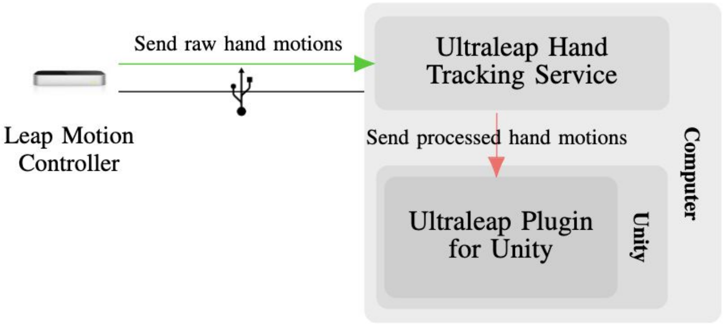
- Also known as Ultraleap.
- Hand-tracking device used in various applications like gaming, music performance, virtual reality (VR), and augmented reality (AR).

**Hardware Components**:

- Optical hand-tracking sensor.
- Camera to capture hand movements.
- USB-A port for connecting the device to other systems.

**Software Components**:

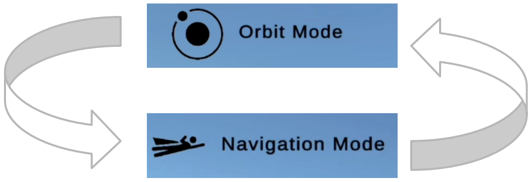
- Ultraleap Hand Tracking Service.
- Ultraleap Plugin for Unity.



# WeLeap - Navigation Control

**Two Modes of Operation**:

- **Navigation Mode**: Focuses on moving through space.
- **Orbit Mode**: Centers around rotating or orbiting around a point.




**Mode Switching**:

- Accomplished through a pointing gesture with either hand.

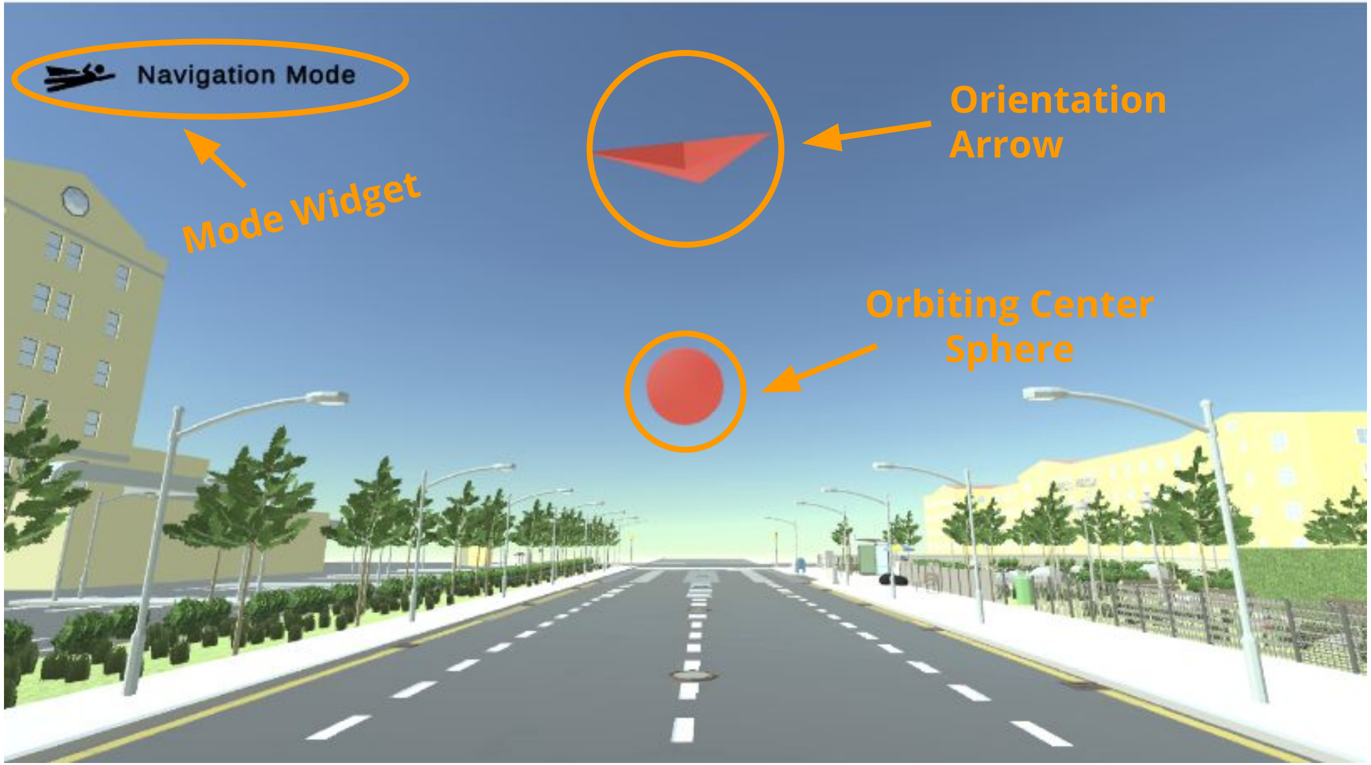
**Operation in Navigation Mode**:

- **Left Hand**: Tilting movement controls left/right and forward/backward translation.
- **Right Hand**: The palm is used to control camera rotation.

**Operation in Orbit Mode**:

- **Left Hand**: Raising or lowering the hand facilitates vertical translation.
- **Right Hand**: The palm controls camera rotation, similar to Navigation Mode.

# WeLeap - User Interface



# WeLeap - Implementation Details

**Incorporation of 'Deadzones'**: The method includes 'deadzones' for each degree of freedom, making it easier to achieve a neutral state where there's no movement or rotation.

**Neutral Stance Adjustment**: The neutral stance is set slightly away from the 0 value to match the natural tilt of relaxed hands.

**Established Boundaries for Control**: Boundaries have been set for the controllable degrees of freedom, improving the system's controllability.

**Observations in Implementation**:

- Challenges with Hand Recognition: Long sleeves often interfere with hand recognition.
- Inconsistent Gesture Detection: The detection of pointing gestures is not always reliable.

**Dependence on Environmental Conditions**: The system functions optimally in specific environmental lighting conditions.

# WeLeap

Demo

# WiiFly - Technical Specifications

**Overview**:

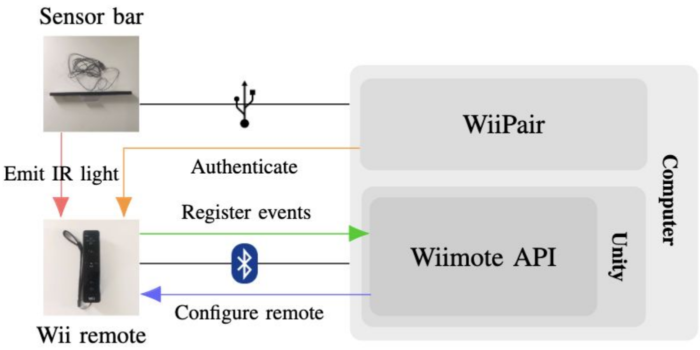
- Wii remote to navigate 3D navigational systems
- Capable of capturing distance and movement
- Sensor bar used to determinate remote's orientation and distance

**Hardware Components**:

- Wii remote that uses Bluetooth connection
- Sensor bar that uses USB-A port for connection

**Software Components**:

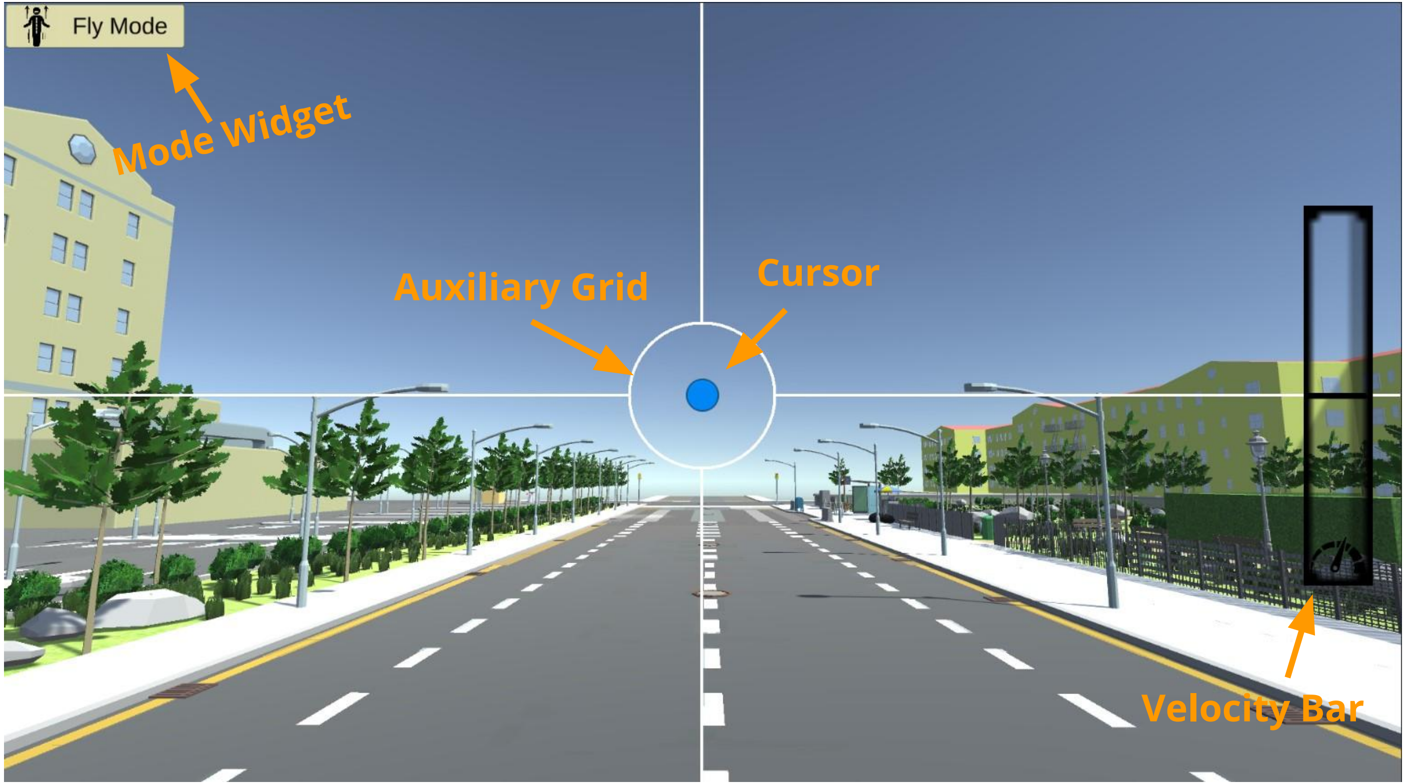
- Wiimote API
- Wii Pair



# WiiFly - Navigation Control

1. **Two Modes of Operation**:
    - **Navigation Mode**: Focuses on moving through space.
    - **Orbit Mode**: Centers around rotating or orbiting around a point.
2. **Mode Switching**:
    - Accomplished by pressing the “A” button on the Wii remote
3. **Camera Orientation**:
    - Controlled by the remote’s orientation, with a visible cursor on the screen
    - Position of the cursor impacts the camera’s angular speed
4. **Camera Translation**:
    - Relative to its orientation
    - Forward and backward directions
    - Velocity controlled by distance between the remote and the sensor bar

# WiiFly- User Interface



# WiiFly - Implementation Details

1. **Cursor Position**:
   - Exponential Moving Average (EMA) technique to get a more stable and accurate representation of the cursor’s position
   - Virtual zoom technique to adjust the remote’s sensitivity
   - When signal is lost the cursor is positioned towards the center
2. **Remote Distance**:
   - Distance to the sensor bar is determined by analyzing the intensity of the emitted IR light
   - EMA technique allows a more consistent depiction of the distance
   - When signal is lost the distance is adjusted so the velocity remains zero
3. **Established Boundaries for Control**:
   - Boundaries have been set for the controllable degrees of freedom, improving the system's controllability
4. **Movement Stability**:
   - Deadzones allow a degree of tolerance
5. **Mode Switching**:
   - Ray cast to obtain the orbit point

# WiiFly

Demo

# User Evaluation

# User Evaluation - Aim

**Gather user feedback on various aspects:**

### Usability

Assessing the ease and intuitiveness of the solution

### Precision

Evaluating whether the solution enables accurate motion

### Reliability

Examining the consistency between real world input and virtual input

### Speed

Determining if the solution facilitates swift motion and effectively controls speed

# User Evaluation - Experiment Protocol

**Experimental Protocol Structure**

Participants are involved in intra-group testing, engaging with both approaches.

**Participant Allocation**

The participants are divided into two halves. One half tests one system first, and the other half begins with the alternative system.

**Supervisor Requirement**

Each system requires at least one supervisor to be present during the testing phase.

# User Evaluation - Experiment Protocol

**Gathering Personal Information (First Phase)**:

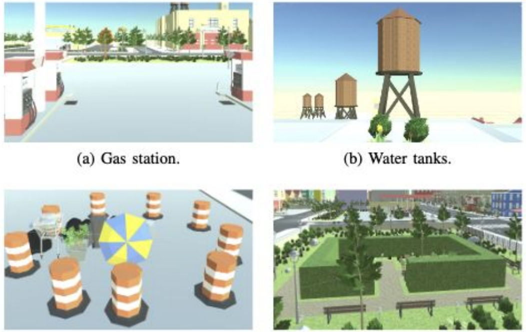
- **Informed Consent Form**
- **Personal Information Form**

**Assisting Users in System Utilization (Second Phases)**:

- **Video Tutorial**
- **Unrestricted Exploration**
- **Guided Navigation**

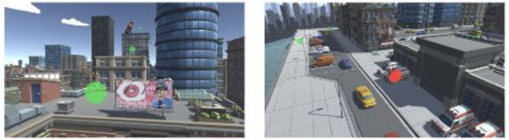
**Data Collection and Evaluation (Final Phase)**:

- **Execution of Tasks**
- **Circuit Challenge**
- **Post-Test Questionnaire**.



(a) Gas station. (b) Water tanks.

(c) Circular barrels. (d) Garden's main entrance.



(a) Start region. (b) Finish region.

# User Evaluation - Experiment Requirements

**Technical Specifications Reference**: Already mentioned on previous slides for each approach

**Unity Scenes Setup (2 Scenes)**:

- **First Map**: Necessary for the second phase (Assisting Users in System Utilization), and executing the "simple tasks."
- **Second Map**: Specifically designated for the circuit task.

**Initial System State Prerequisites**:

- **WeLeap Approach**: Participants should position their hands to minimize movement and camera rotation.
- **WiiFly Approach**: Participants must start with the Wii remote positioned 50 centimeters perpendicular from the sensor bar to achieve zero camera velocity.

# User Evaluation - Participants

- **Summative** Testing with **10** participants:
  - 5 Started with WiiFly
  - 5 Started with WeLeap

# Results - Task Performance

Observations on **Simple Tasks**

**WeLeap Approach Observations**:

1. **Technical Demand**
2. **Mastery and Task Difficulty**:
    - Majority struggled with precision tasks.
    - A small group (2 participants) could master it and found tasks easier.
3. **Challenges in Stopping**
4. **Inconsistent Gesture Recognition**

**WiiFly Approach Observations**:

1. **Concept Understanding**
2. **Tendency to Over-Rotate**
3. **Max Speed Adjustment**
4. **Difficulty in Speed Mapping**
5. **Sensor Bar Position**

# Results - Task Performance

Observations on **Circuit**

| | WeLeap | WiiFly |
|---|---|---|
| Success Rate | 0.8 | 0.9 |
| Mean | 189.75 | 187.2(2) |
| Standard Deviation | 67.273 | 56.907 |
| Median | 181.5 | 200.0 |

TABLE I: Metrics Table

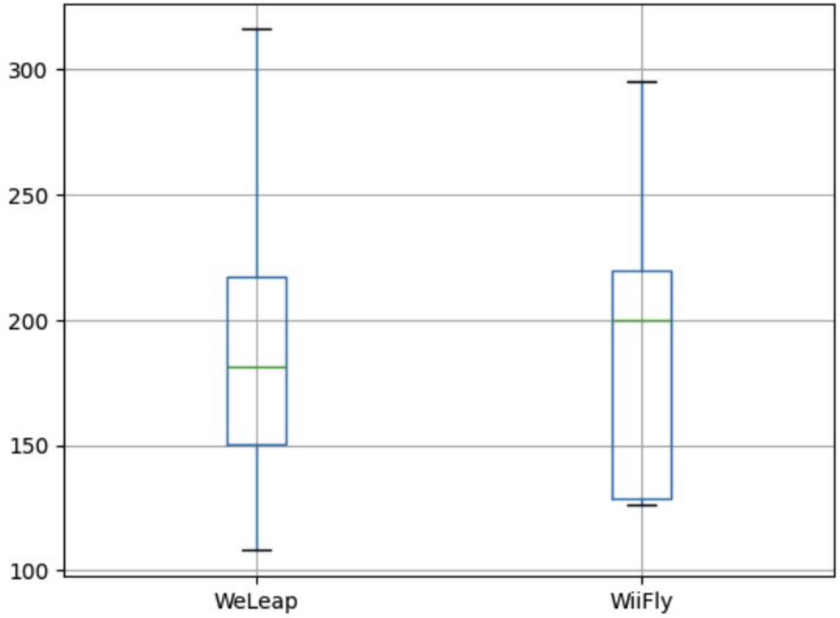



Fig. 10: Circuit Results

# Results - Task Performance

**Best Mean** for **Platforming and Simulation**

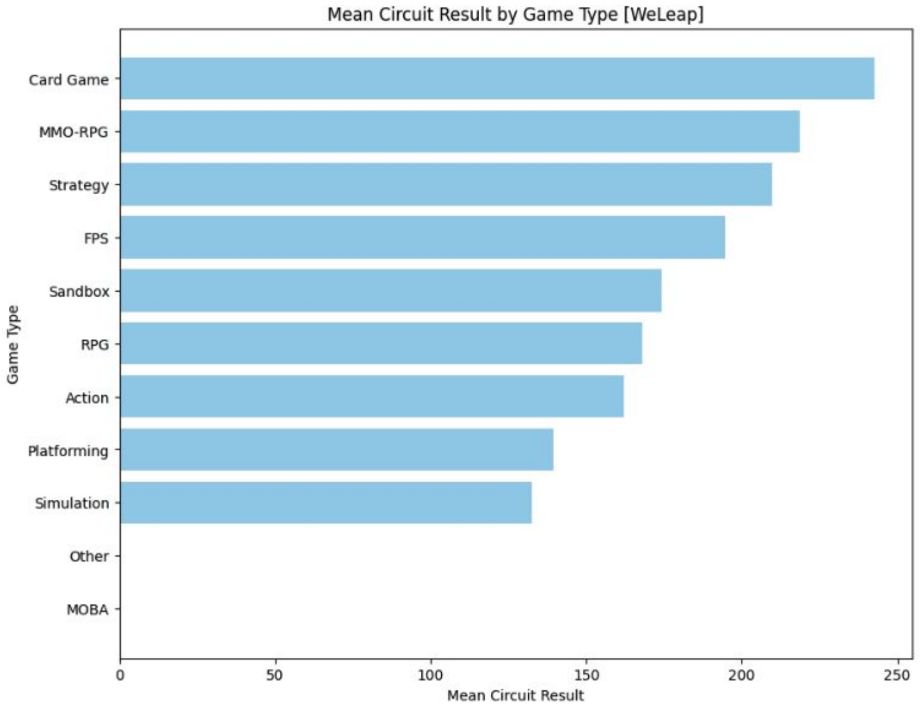



Fig. 11: WeLeap: Mean Circuit Time by Game Type

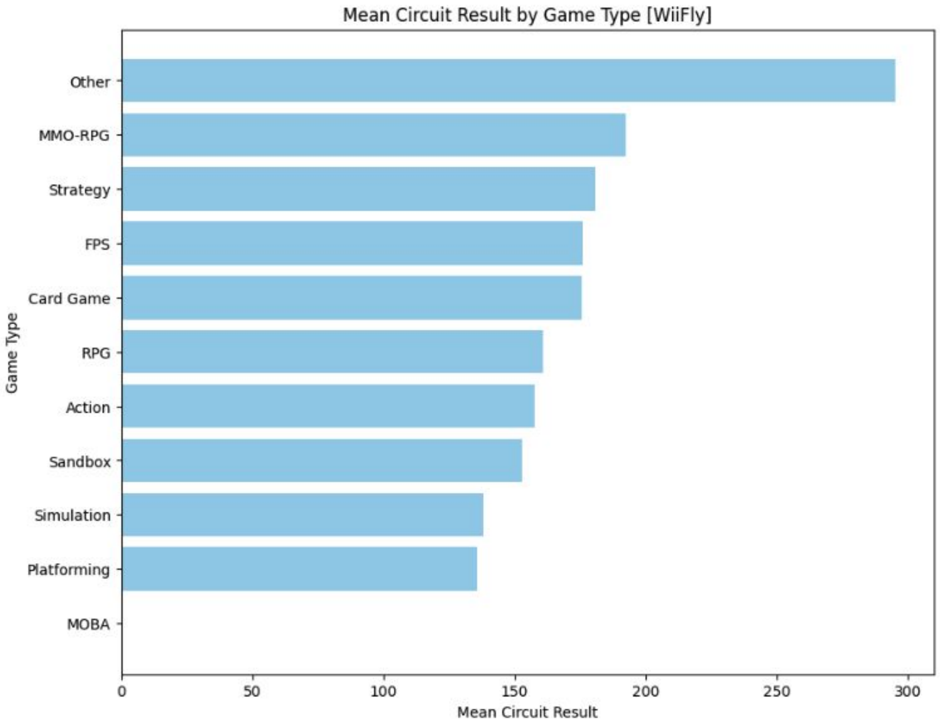


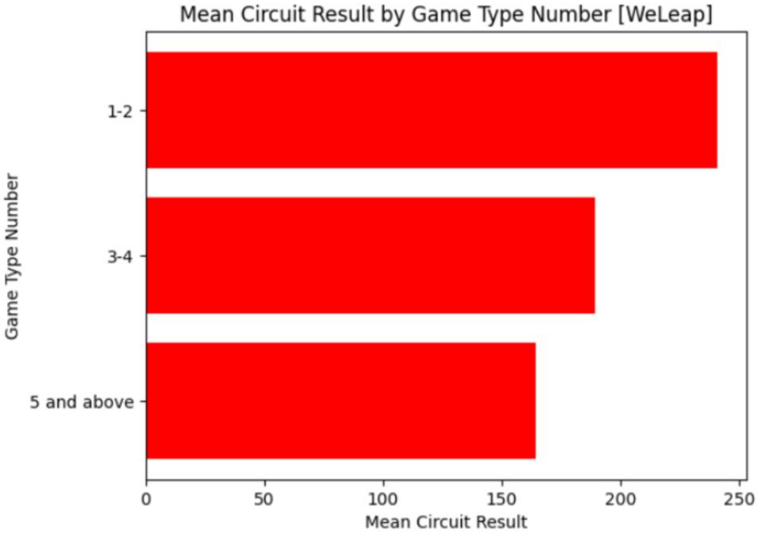

Fig. 12: WiiFly: Mean Circuit Time by Game Type

***Note: The lower the better**

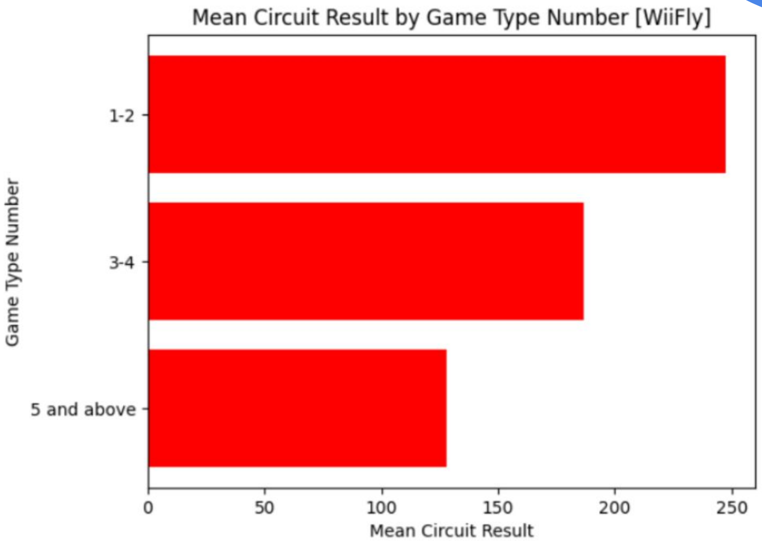
# Results - Task Performance

Observations on **Participant Characteristics and Performance**

The **more diverse** the types of games played by participants, the **better their performance.**




**WeLeap**




**WiiFly**

***Note: The lower the better**

# Results - User Preferences

Users find the **WiiFly approach** more intuitive, consistent and less cumbersome;

| Question | WeLeap mean | WiiFly mean |
|---|---|---|
| I think that I would like to use this system | 3.7 | **4.6** |
| I found the system unnecessarily complex | 2.4 | **1.5** |
| I thought the system was easy to use | 2.9 | **4.3** |
| I think that I would need the support of a technical person to be able to use this system | 3.2 | **1.3** |
| I found the various functions in the system were well integrated | 3.7 | **4.2** |
| I thought there was too much inconsistency in this system | 2.2 | **1.5** |
| I would imagine that most people would learn to use this system very quickly | 3.0 | **4.4** |
| I found the system very cumbersome to use | 2.7 | **2.0** |
| I felt very confident using the system | 2.8 | **4.0** |
| I needed to learn a lot of things before I could get going with this system | 2.8 | **1.8** |

TABLE II: User Preferences

# Conclusions

- **Interesting exploration** of unfamiliar technologies;
- **Pilot testing** would have been very valuable;
- The testing **circuit** was missing **player feedback**;
- **More participants** would help the quality of the results;