Interaction Devices and Sensors

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Outline

• 3D Interaction Tasks

• Action Capture System
  – Large range
  – Short range

• Tracking System
  – With markers
  – Markerless
  – Orientation sensor
3D interaction tasks

• Navigation
• Selection and manipulation
• System control
• Symbolic input
• Two-handed interaction
Action capture system

- **Oculus Touch**
  - 4* Digital buttons
  - 1* Joystick
  - 3* Passive buttons
  - Haptic vibration motor
  - Ring of infrared LEDs (24 IR LEDs)
  - Gyroscope and Accelerometer

- **Constellation**
  - Infrared sensor (IR camera + filter)
  - USB 3.0
Action capture system

- Actions tracking in VR:
  - Oculus touch
    - Object manipulation
      → partial “finger tracking” (thumbs/forefinger)
      → Grabbing object
    - Hand position (6 DOF)
    - Target-based (using Trigger)
    - Navigation (joystick)
Action capture system

- Data sent to headset
- Proprietary Protocol

Data streaming

- IR filter on the Camera
- Triangulate its position in the tracking space

Positional Tracking
Action capture system

• Vive Controller
  – 6* Digital Buttons
  – 1*Tactile Pad
  – Haptic vibration motor
  – Ring of photodiodes (24)
  – Gyroscope and Accelerometer

• Lighthouse
  – 2*Laser emitters
Action capture system

• Actions tracking in VR:
  – Vive Controller
    • Object manipulation
      → Grabbing object (Grip button)
    • Hand position (6 DOF)
    • Target-based (using Trigger)
    • Navigation (Pad)
    • Tactile interaction (Pad)
Action capture system

- Data sent to headset
- Proprietary Protocol

Data streaming

- Laser Emitter
- Triangulate its position in the tracking space

Positional Tracking

[Image of an action capture system]
Action capture system

• Motions Controller
  – 4* Digital Buttons
  – 1*Tactile Pad
  – 1*Joystick
  – Haptic vibration motor
  – Ring of visible LEDs (32 LEDs)
  – Gyroscope and Accelerometer

• Inside-out Tracking
  – 2*low-resolution black and white cameras
Action capture system

• Actions tracking in VR:
  – Motions Controller
    • Object manipulation
      → Grabbing object (Grip button)
    • Hand position (6 DOF) (limited to the front cameras FOV) / (3DOF) if not.
    • Target-based (using Trigger)
    • Navigation (Joystick)
    • Tactile interaction (Pad)
Action capture system

- Data sent to headset
- Proprietary Protocol

Data streaming

- Visible light Cameras
- Identify features in your environment in visible light.

Positional Tracking
Actions capture system

• PlayStation Move for PSVR (PS3 Sony)
  • Motion sensing
    – 3-axis accelerometer
    – 3-axis angular rate
  • Location tracking
    – Magnetometer
    – Object recognition (via PlayStation Eye)
  • 1 * Analog trigger
  • 8 * Button

Range of distance: 25cm - ∞ (in wide angle view)
Field of view: 56° (standard view) - 75° (wide angle view)
FOV zoom lens

External dimension: Approx. 200mm × 46mm (height × diameter)
Best range: 0.6-3 meter from camera
Actions capture system

• PlayStation Move Navigation Controller:
  – Analog stick (for navigation)
  – D-pad (thumb-operated directional control)
  – 1 * Analog trigger
  – 5 * Buttons

• Connectivity:

  ![Bluetooth Logo]  ![USB Certified Logo]

  Class 2: ~10 meters

• Sony PlayStation Move trailer:
  – [http://www.youtube.com/watch?v=KywkIJJJoJ5s](http://www.youtube.com/watch?v=KywkIJJJoJ5s)

External dimension : Approx. 138mm × 42mm (height × diameter)
• Actions tracking in VR:
  – PS Move
    • Object manipulation/selection
  – PlayStation Move Navigation Controller
    • Navigation
**Actions capture system**

- **Comparison between above devices**

<table>
<thead>
<tr>
<th></th>
<th>Oculus Touch</th>
<th>PSMove</th>
<th>Mixed Reality</th>
<th>HTC Vive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sub controller cable</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Depth movement precision</td>
<td>Medium/High</td>
<td>Low</td>
<td>Medium/Low</td>
<td>High</td>
</tr>
<tr>
<td>Movement detection</td>
<td>Accelerometer Gyroscope</td>
<td>Magnetometer</td>
<td>Accelerometer Gyroscope</td>
<td>Accelerometer Gyroscope</td>
</tr>
<tr>
<td>Position detection</td>
<td>Yes With Constellation</td>
<td>Yes With PS eye</td>
<td>Yes (Partially) With Inside-out tracking</td>
<td>Yes With Lighthouse</td>
</tr>
<tr>
<td>Occlusion sensitive</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Actions capture system

• Software
  – Oculus Touch: Oculus Home
  – HTC Vive : SteamVR
  – PSMove : Sony official Move.Me
  – Mixed Reality : Windows 10
Actions capture system (gesture)

- Leapmotion
  - USB 2.0/3.0 connection

https://www.leapmotion.com/product/v2_video?yid=gby6hGZb3ww

<table>
<thead>
<tr>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 mm</td>
<td>13 mm</td>
<td>76 mm</td>
<td>45 grams</td>
</tr>
</tbody>
</table>
Tracking system

• With markers
  – Active
  – Passive
• Markerless
Tracking system (Head tracking)

- With markers: Active motion capture system
  - PhaseSpace optical motion capture
    - Motion tracking
    - Position sensing

LEDs
Dimensions: 20 mm x 14 mm x 3.2 mm
Weight: 4.5 grams
Each LED modulates at a unique frequency resulting in a unique digital ID. LEDs are available in Red visible and Infra-red versions.

Cameras
Dimensions: 108 mm x 92 mm x 57 mm
Weight: 380 grams
Each camera achieves an Optical Resolution of 3600 x 3600 (12 Megapixel) using two linear detectors with 16-bit dynamic range. Onboard processors produce an impressive Subpixel Resolution of 30,000 x 30,000 at 480 Hz.
Tracking system (Head tracking)

• Active motion capture system
  – Only Head Tracking
Tracking system (Head and hand tracking)

• Passive tracking system
  – Reflect incoming IR radiation back in the direction of the incoming light (ART tracking maxi distance = 7m)
Tracking system

• Passive tracking system architecture
Tracking system

• IMU motion capture
  – Xsens
  – Perception Neuron

https://www.youtube.com/watch?v=LtMfrkRqlRs
Tracking system

• Markerless Motion capture system
  – Kinect sensor
    • Natural user Interface using
      – Gestures
      – and Spoken commands
  – Connectivity: **USB**+ *power cable* (for PC)
Tracking system

• Kinect sensors:
  – RGB camera
  – Depth sensor (IR Emitter and IR Depth Sensor)
  – Multi-array microphone

• Functionality:
  – Full-body 3D motion capture
  – Facial recognition
  – Voice recognition
Tracking system

• Kinect sensor features :
  – Sensor outputs video at 30Hz
  – RGB video 8-bit VGA Resolution (640*480 pixels/HD)
  – Depth sensing in VGA resolution (320*240pixels/512*424pixels)
  – Ranging limit :
    • Distance 4.5m
    • Angular field of view :
      – 57° horizontally / 70°
      – 43° vertically / 60°
Tracking system

• New Kinect Sensor
  – Improved field of view results in much larger play space.
  – RGB stream is higher quality and higher resolution.
  – See in the dark
  – Biometric scanning
  – Muscle+force
  – Expression engagement

https://www.youtube.com/watch?v=NDTqx1Zi-n0
Tracking system

• Kinect motion tracking:
  – Head tracking
  – Hand tracking
  – Upper body
  – Full-body tracking
# Tracking system

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Passive</th>
<th>Markerless (Kinect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Invasiveness</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Measurement</td>
<td>Marker pos/ori(^1)</td>
<td>Marker pos/ori</td>
<td>Pos</td>
</tr>
<tr>
<td>Preparation</td>
<td>Complex</td>
<td>Complex</td>
<td>Easy</td>
</tr>
<tr>
<td>Battery</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Calibration</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Marker recognition</td>
<td>Yes</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>Price</td>
<td>High</td>
<td>Very High (e.g VICON)</td>
<td>Low</td>
</tr>
</tbody>
</table>

\(^1\): at least, 3 markers are needed for orientation measurement
Head Mounted Display (HMD)

• 3D display
Head Mounted Display (HMD)

• Oculus Rift
  – One Display
  – 2 IR Cameras
  – 2 wireless controllers
  – Active trackers
Head Mounted Display (HMD)

• HTC Vive
  – One Display
  – 2 Laser emitters
  – 2 wireless controllers
  – Active trackers
Head Mounted Display (HMD)

- Windows Mixed Reality
  - One Display
  - 2 Cameras
  - 2 wireless controllers
  - Active trackers
Head Mounted Display (HMD)

• Gear VR
  – One Display Wireless
  – No wireless controllers
  – No positional tracking
# HMD comparison

<table>
<thead>
<tr>
<th>Features</th>
<th>GearVR</th>
<th>Oculus</th>
<th>HTC Vive</th>
<th>Mixed Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PC requirements</strong></td>
<td>Smartphone Galaxy S7</td>
<td>Nvidia GTX970 AMD 290 I5, 8G+DDR3</td>
<td>Nvidia GTX970 AMD 290 I5, 4G+ DDR3</td>
<td>GPU Nvidia GTX 960 AMD RX 460 I5, 2G+ DDR3</td>
</tr>
<tr>
<td><strong>Connection</strong></td>
<td>HDMI+USB</td>
<td>HDMI 1.3 3USB 3.0</td>
<td>HDMI 1.3+ 2USB 3.0</td>
<td>HDMI 2.0+ USB 3.0</td>
</tr>
<tr>
<td><strong>Sensor Types</strong></td>
<td>Acc, Gyro, Mag</td>
<td>Acc, Gyro, Mag, Tracking Sensor Array</td>
<td>Acc, Gyro, Front-Facing Camera, Laser sensor</td>
<td>Acc, Gyro, Inside-out Tracking</td>
</tr>
<tr>
<td><strong>Field of View</strong></td>
<td>Appr. 90 degrees</td>
<td>Appr. 110 degrees</td>
<td>Appr. 110 degrees</td>
<td>Appr.105 degrees</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>1920*1080</td>
<td>2160*1200</td>
<td>2160*1200</td>
<td>2880*1 440</td>
</tr>
<tr>
<td><strong>Refresh Rate</strong></td>
<td>60hz</td>
<td>90hz</td>
<td>90hz</td>
<td>90hz</td>
</tr>
<tr>
<td><strong>$$</strong></td>
<td>99€ +699€</td>
<td>449 €</td>
<td>799 €</td>
<td>449 €</td>
</tr>
</tbody>
</table>
• Question?
TPs

- TP1: Navigation with active markers (CAVES and stereo server)
- TP2: Kinect character control and interactive scene
- TP3: Object manipulation
- TP4: Finger tracking
- TP5: Head tracking
- TP6: Google Cardboard
TP1 : Navigation with active markers

• CAVE/Stereo
  – 4-sided
    CAVE/Stereo Screen
  – Stereo glasses + emitters
  – 3D projectors
  – Motion capture system
TP2 : Kinect character control

– Projector if needed
– Kinect
– PCs
TP3 : Object manipulation

- PCs
- HTC Vive
- 2 Controllers
- Lighthouse
TP4 : Finger Tracking

- Leap Motion
- Oculus Rift CV1
- PC
TP5 : Google Cardboard

– Webcam
– PC
TP6: Google Cardboard

- Google Cardboard
- PC