Motivation

- Wiimote controller
  - provides 3D UI in the home
  - 3DUI in mobile environments
- Makes games accessible to casual users
  - great competitive edge over Xbox 360 / PS3
- Need to understand the device
  - advantages and disadvantages
  - how to develop 3DUIs
The Wiimote Device

- Wiimote features
  - uses Bluetooth for communication
  - senses acceleration along 3 axes
  - optical sensor for pointing (uses sensor bar)
  - provides audio and rumble feedback
  - standard buttons and trigger
  - uses 2 AA batteries
- Supports two handed interaction
  - can use 2 Wiimotes simultaneously
- Easily expandable

Wiimote Attachments

- Nunchuk
- Steering Wheel
- Zapper
- Wii Helm
- Boxing Gloves
- Sports Pack
- Fishing Reel
The Wiimote – Coordinates

Wiimote Coordinates

- Data from optical sensor
  - uses sensor bar
    - 10 LED lights (5 of each side)
    - accurate up to 5 meters
  - triangulation to determine depth
    - distance between two points on image sensor (variable)
    - distance between LEDs on sensor bar (fixed)
  - roll (with respect to ground) angle can be calculated from angle of two image sensor points

- Advantages
  - provides a pointing tool
  - gives approximate depth

- Disadvantages
  - line of sight, infrared light problems
  - only constrained rotation understanding

The Wiimote – Optical Data
The Wiimote – Motion Data

- Data from 3-axis accelerometer
  - senses instantaneous acceleration on device (i.e., force) along each axis
  - arbitrary units (+/- 3g)
  - always sensing gravity
    - at rest acceleration is g (upward)
    - freefall acceleration is 0
  - finding position and orientation
    - at rest – roll and pitch can be calculated easily
    - in motion – math gets more complex
    - error accumulation causes problems
    - often not needed – gestures sufficient

Advantages
- easily detect course motions
- mimic many natural actions

Disadvantages
- ambiguity issues
- player cheating
- not precise (not a 6 DOF tracker)

The Wii Motion Plus

- Current Wiimote device
  - gives user a lot of useful data
  - not perfect
    - ambiguities
    - poor range
    - constrained input
- Wii Motion Plus
  - moving toward better device
  - finer control
  - uses dual axis “tuning fork” angular rate gyroscope
  - true linear motion and orientation
Visualizing Wiimote Data

- Important to see data to understand device

Programming with the Wiimote

- Connect to computer
  - does not work for every bluetooth device
- Obtain Wiimote software
  - many variations and APIs (C, C++, C#, Java, Flash)
    - Brian Peek’s API (www.coding4fun.com)
      - low level API
    - Paul Varcholik’s XNA 3DUI Framework (www.bespokesoftware.org)
      - contained within larger framework
      - include gesture recognizer
- Write code and enjoy
  - heuristics
  - gesture analysis
Example Code – Bespoke
XNA 3DUI Framework – I

```csharp
public GestureGame() { // constructor
    mWiimoteComponent1 = new WiimoteComponent(this, Bespoke.Common.Wiimote.PlayerIndex.One);
    Services.AddService(typeof(WiimoteComponent), mWiimoteComponent1);
    Components.Add(mWiimoteComponent1);
}
```

```csharp
protected override void Update(GameTime gameTime) {
    UpdateWiimoteState();
    base.Update(gameTime);
}
```

Example Code – Bespoke
XNA 3DUI Framework – II

```csharp
private void UpdateWiimoteState() {
    mCurrentWiimoteState = mWiimoteComponent1.Wiimote.WiimoteState;
    if (mWiimoteComponent1.WasButtonPressedThisFrame(Bespoke.Common.Wiimote.Buttons.B)) {
        // Start collecting a new set of points.
        mCurrentWiimoteSamplePoints = new WiimotePointCollection();
        mHelpLabel = "Release B Button to End Gesture";
    } else if (mWiimoteComponent1.WasButtonReleasedThisFrame(Bespoke.Common.Wiimote.Buttons.B) &&
               mCurrentWiimoteSamplePoints.Count > 1) {
        // Create a gesture sample out of the collected points.
        mCurrentSample = new Gesture(mCurrentWiimoteSamplePoints);
        mHelpLabel = "Press B Button to Begin Gesture";
        if (mStatisticalClassifier != null) {
            ClassifiedGestureCollection classifiedGestureSet =
                mStatisticalClassifier.ClassifyGesture(mCurrentSample);
            UpdateClassifiedGestureOutput(classifiedGestureSet);
        }
    } else if (mWiimoteComponent1.IsButtonHeldDown(Bespoke.Common.Wiimote.Buttons.B) {[
        DateTime timestamp = DateTime.Now;
        if (mCurrentWiimoteSamplePoints.ContainsKey(timestamp) == false) {
            mCurrentWiimoteSamplePoints.Add(new WiimotePoint(mCurrentWiimoteState, timestamp));
        }
    }
```
Case Studies

- Wiimote used in many different ways
  - most famous – Johnny Chung Lee
- Two main approaches
  - wear sensor bar, use Wiimote as camera
  - hold/wear Wiimote
- Games
  - music
  - dance
  - navigation
- Robotic control

One Man Band

- Goal
  - provide musical interfaces using a single device
  - easy to use, powerful, and expressive
  - mimic real instruments
- Features
  - guitar, violin/bass, drums, trombone, theremin
  - MIMI – Multi-Instrument Musical Interface
    - heuristic recognition
    - exponential smoothing

Bott et al., 2009
Real Dance

- **Goal**
  - full body experience that feels like real dancing
  - untethered: no need to stand in one place or position
  - increasing amount of recognizable movements
  - preventing cheating by inaccurate movements

- **Approach**
  - attach Wiimotes to arms and ankles
  - heuristic evaluation of motion signals

- **Visual Interface**
  - timeline of icons
  - score feedback with avatars
  - animated instructor figure
  - user based figure

Charbonneau et al., 2009

Navigation in World of Warcraft

- **Work at V. Tech – Silva and Bowman**

- **Goal**
  - reduce interaction complexity in WoW
  - improve navigation
  - help player concentrate on other tasks

- **Approach**
  - leaning metaphor
  - use Wiimote as camera
  - wear IR sensor bar
Navigation in Sports Games – I

- **Goal**
  - more natural interface in American football
    - maneuvering
    - navigation
    - evasion
- **Approach**
  - IR head tracker
  - Wiimote/gyroscope
    - gesture recognition
    - integration

Williamson et al., 2010

Navigation in Sports Games – II

- **Work at Brown University – Wilson, Reddy, and Jenkins**
- **Goal**
  - explore exergaming
    - wiisoccer
    - natural locomotion
- **Approach**
  - track players foot motion
    - sensor bar attached to leg
    - Wiimote used as camera
  - kick, pass and player speed detected

http://www.cs.brown.edu/people/awilson/exergaming-home.html
Robot Control

- **Goal**
  - explore robot control using Wiimote

- **Approach**
  - use rest orientation for driving robot (tilt sensing from accelerometers)
  - gestures with simple classifier
    - forward, back, turn left, turn right, stop

Varcholik et al., 2008

On to XNA...