3D User Interfaces for Games and Virtual Reality

Lecture #3: The Wii Remote

Spring 2010

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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

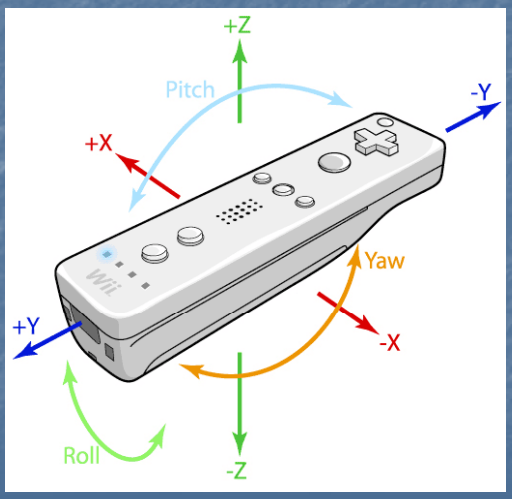


Image courtesy of www.osculator.net

The Wiimote – Optical Data

- 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

Sensor Bar

The Wiimote – Motion Data

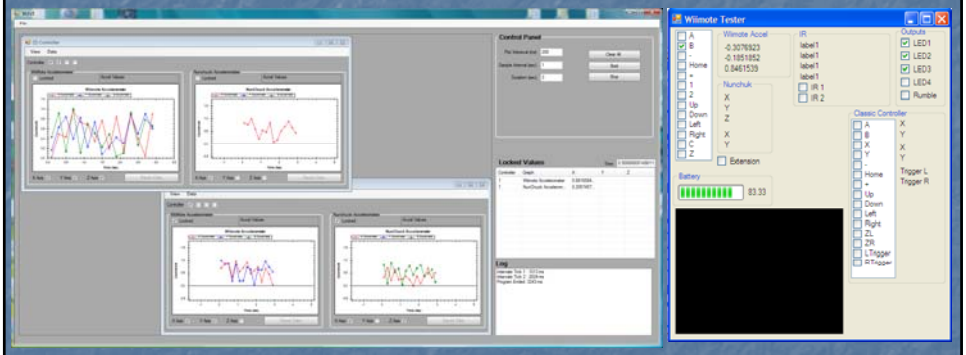
- Data from 3-axis accelerometer
  - senses instantaneous acceleration on device (i.e., force) along each axis
  - arbitrary units (+/- 3g)
  - always sensing gravity
    - at rest acceleration is g (upward)
    - freefall acceleration is 0
  - finding position and orientation
    - at rest – roll and 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

```
public GestureGame() { // constructor

  mWiimoteComponent1 = new WiimoteComponent(this, Bespoke.Common.Wiimote.PlayerIndex.One);

  Services.AddService(typeof(WiimoteComponent), mWiimoteComponent1);
  Components.Add(mWiimoteComponent1);
}

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


Example Code – Bespoke XNA 3DUI Framework – II

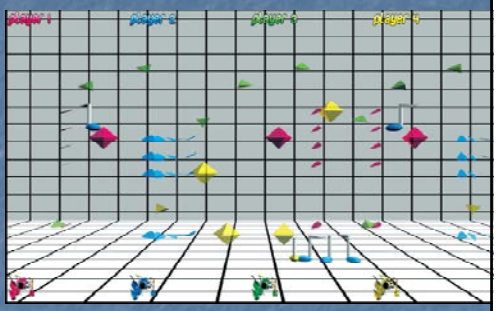
```
private void UpdateWiimoteState() {
  mCurrentWiimoteState = mWiimoteComponent1.Wiimote.WiimoteState;

  if (mWiimoteComponent1.WasButonPressedThisFrame(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.WasButonReleasedThisFrame(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

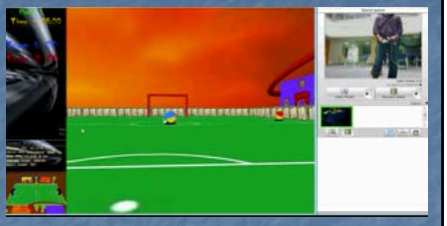
Navigation in Sports Games – I

- 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...