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MOVING JAVA FORWARD

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Java, Kinect and Gestural interfaces

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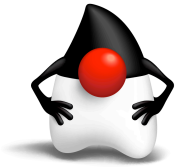


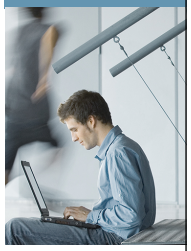
The Man-Machine Interface

How we interact with computers is changing
(and will continue to do so)

Gone are the days of the keyboard and mouse

Behold! The rise of the gestural interface

Program Agenda



- The Man Machine Interface
- Building Interfaces: JavaFX and JMonkeyEngine
- Using the Wiimote with Java
- Data gloves and head tracking
- Using the Kinect with Java
- Putting it all together
- Conclusions and further information

THE MAN MACHINE INTERFACE

How It All Started

Progress was made…

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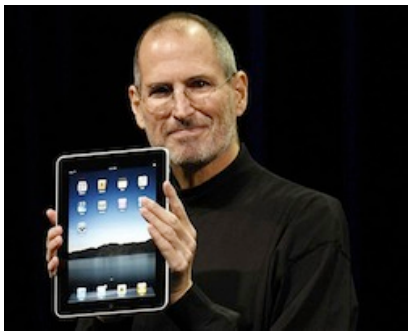
Multi-touch has become popular



Gaming Has Driven Several Interfaces

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Now It's About Gestures

KINECT for XBOX 360.

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BUILDING INTERFACES: JAVAFX AND JMONKEYENGINE

Building An Interface: JavaFX 2.0

- Continuation of JavaFX product line
  - Now a Java API, no scripting language
  - Most APIs ported directly across
  - Things like binding and animation needed more thought
- Embrace more web technologies
  - Use of CSS for all JavaFX controls
  - Follow web spec for Drag-and-Drop
- Developers use scenegraph, not DOM

JavaFX and Gestural Interfaces

- Pro
  - Built in features like data binding and animations
  - Relatively simple Java API
  - Able to build rich, visually appealing interfaces
- Con
  - Currently limited to 2D environment
  - Engineering team working on 3D support
  - Some pseudo-3D support through perspective transform

Building An Interface: JMonkeyEngine

- A software system designed for the creation and development of video games
  - a game engine
- Built on top of OpenGL
  - Higher level constructs, rather than individual polygons
  - Camera, light sources, objects, quarterions, etc

JMonkeyEngine and Gestural Interfaces

- Pro
  - Full 3D support
  - Game engine facilities like collision detection, physics engine, etc
- Con
  - Hard to program (highly changeable APIs, poor backwards compatability)
  - Games focused rather than generic interfaces

USING THE WIIMOTE WITH JAVA

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Nintendo Wiimote

Java Interface

- Wiimote communicates using Bluetooth
  - Bluetooth stack needs to support L2CAP
  - JSR-82 Java Bluetooth API implementation
  - Wiimote specific Java APIs (IR sensors, accelerometer, etc)
- Mostly free and open source
  - Native Bluetooth stack (Windows, Linux, MacOS)
  - Avetana JSR-82 lib (free trial, €25 license)
  - Wiiremotej or motej Wii specific library

Wiimote Interface Code

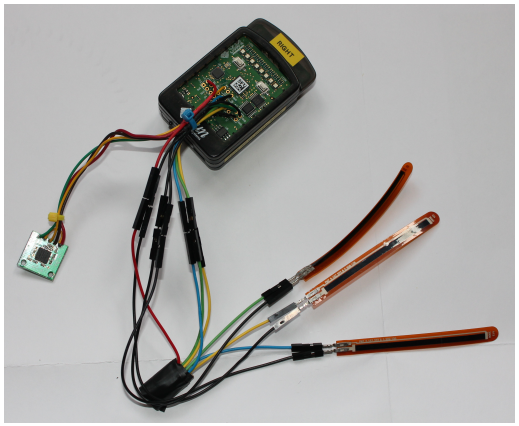
```
WiiMote implements WiiRemoteListener {
  public Wiimote() throws IOException {
    WiiRemote remote = WiiRemoteJ.connectToRemote("001CBE3C3E8B");
    remote.setIRSensorEnabled(true, WRIREvent.BASIC);
    remote.setLEDIlluminated(2, true);
    remote.addWiiRemoteListener(this);
  }

  public void buttonInputReceived(WRButtonEvent evt) { ... }
  public void statusReported(WRStatusEvent evt) { ... }
  public void accelerationInputReceived(WRAccelerationEvent(evt) { ... }
  public void IRInputReceived(WRIREvent wire) { ... }
  // Other methods for extensions (balance board, nunchuk)
}
```

DATA GLOVES AND HEAD TRACKING

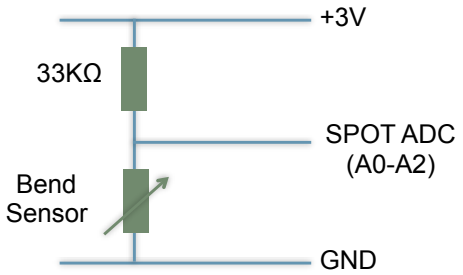
DIY Data Gloves

Hardware

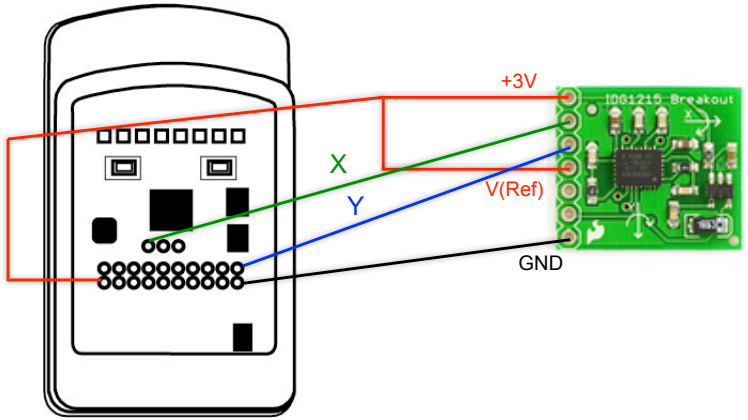
- Sun SPOT controller
- Gyro sensor for more precise rotation data
- Three bend sensors for finger movement



Data Glove Architecture (Bend Sensor)



Data Glove Architecture (Gyro Sensor)



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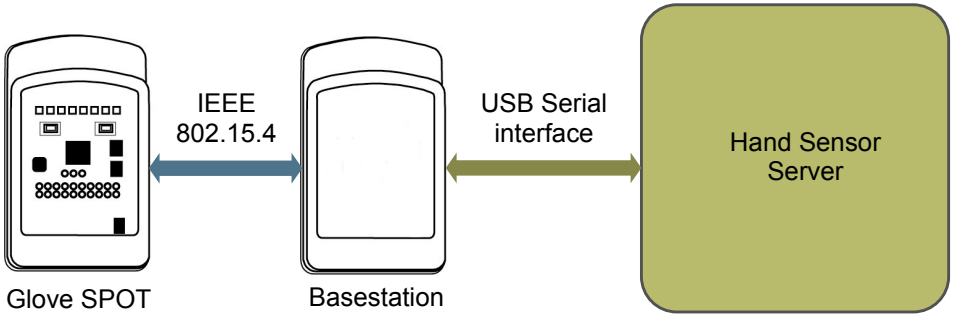
Hand Sensor Architecture



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Data Glove

Data Format

- Hand Identifier (left or right)
- Thumb bend value
- Index finger bend value
- Middle finger bend value
- Raw tilt (x and y)
  - From built in accelerometer
- Gyro compensated tilt (x and y)
  - Computed on SPOT

Hand Tracking Code (SPOT)

```
EDemoBoard demoBoard = EDemoBoard.getInstance();
thumb = demoBoard.getScalarInputs()[EDemoBoard.A0];
indexFinger = demoBoard.getScalarInputs()[EDemoBoard.A1];
middleFinger = demoBoard.getScalarInputs()[EDemoBoard.A2];
gyroX = demoBoard.getScalarInputs()[EDemoBoard.A3];
gyroY = demoBoard.getScalarInputs()[EDemoBoard.A4];
accelerometer = demoBoard.getAccelerometer();

currentPkt.writeInt(thumb.getValue());
currentPkt.writeInt(indexFinger.getValue());
currentPkt.writeInt(middleFinger.getValue());
currentPkt.writeInt((int)(accelerometer.getTiltX() * RADIANS_TO_DEGREES));
currentPkt.writeInt((int)(accelerometer.getTiltY() * RADIANS_TO_DEGREES));
currentPkt.writeInt(getTiltX());
currentPkt.writeInt(getTiltY());
```

Head Tracking Hardware

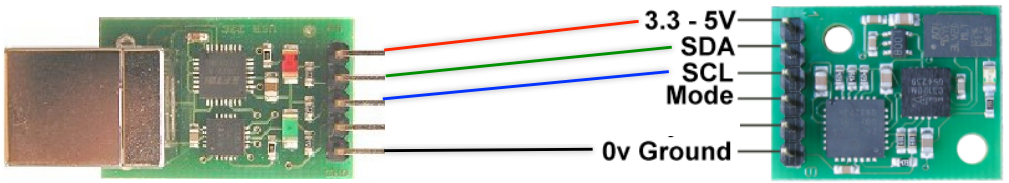
I2C to USB interface

Tilt-compensated compass

Also provides tilt and roll data

Head Tracking Hardware

I2C to USB Adapter



Compass Sensor

Mode unconnected to operate in I2C mode

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Head Tracking

Data

- Use simple I2C protocol to read data
  - Start bit, module address, read/write bit, register number
- Compass value as a word
  - Direction returned as an integer angle in degrees
- Tilt of sensor (x axis)
- Roll of sensor (y axis)
- Serial interface is used to send bytes to I2C

Head Tracking Code

```
portId = CommPortIdentifier.getPortIdentifier("/dev/ttyUSB0");
serialPort = (SerialPort) portId.open("compass", 500);
serialPort.setSerialPortParams(19200,
    SerialPort.DATABITS_8,
    SerialPort.STOPBITS_2,
    SerialPort.PARITY_NONE);
portInput = serialPort.getInputStream();
portOutput = serialPort.getOutputStream();

private void sendReadCommand(byte command, byte readSize {
  byte[] readCommand = new byte[4];
  readCommand[0] = I2C_AD1;           // I2C one byte access
  readCommand[1] = CMPS09_ADDR + 1;   // Sets write bit
  readCommand[2] = command;
  readCommand[3] = readSize;
  portOutput.write(readCommand);
}
```

Head Tracking Code

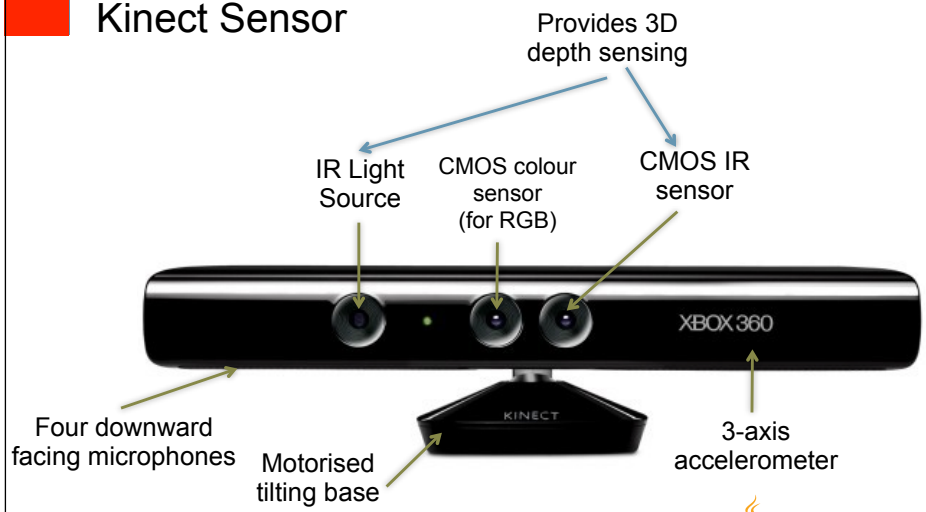
```
public int getBearing() {
  sendReadCommand(READ_BEARING_WORD, (byte) 2);
  int bytesRead = portInput.read(data);
  int hi = (int) data[0] & 0xFF;
  int lo = (int) data[1] & 0xFF;
  int b = (hi << 8) + lo;
  currentBearingInt = b / 10;
}

public int getTilt() {
  sendReadCommand(READ_TILT, (byte) 1);
  int bytesRead = portInput.read(data);
  currentTilt = data[0];
}
```

Demo

USING THE KINECT WITH JAVA

Kinect Sensor



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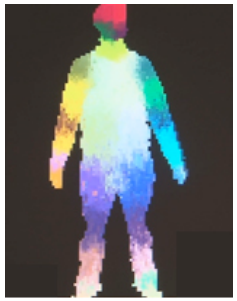
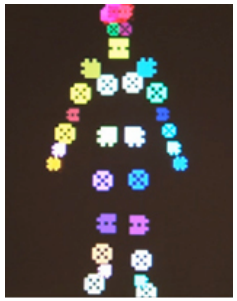
Kinect Sensors

RGB Image

Depth Sensor Image



Body parts inferred by algorithm



3D body part data

Images from Microsoft Research: research.microsoft.com/en-us/projects/vrkinect/

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OpenNI (Natural Interaction)

Kinect Java Interface

- Native C++ library in modular form (nodes)
  - Device
  - Depth generator
  - User generator
  - Image generator
  - IR generator
  - Scene analyser
- Java wrapper library using JNI
  - Required some bug fixing to make it work
  - These bugs have now been fixed

Kinect Java Code

```
scriptNode = new OutArg<ScriptNode>();
context =
    Context.createFromXmlFile(config.getKinectXMLConfig(), scriptNode);
depthGenerator = DepthGenerator.create(context);
DepthMetaData depthMetaData = getDepthGenerator().getMetaData();
userGenerator = UserGenerator.create(context);
width = depthMetaData.getFullXRes();
height = depthMetaData.getFullYRes();
skeleton = new Skeleton(depthGenerator, userGenerator);
SkeletonCapability skeletonCapability = skeleton.getSkeletonCapability();

// Add listeners for events

context.startGeneratingAll();
```

Kinect Java Code

```
joints.get(user).put(joint,
  new SkeletonJointPosition(
      depthGenerator.convertRealWorldToProjective(pos.getPosition()),
        pos.getConfidence()));

...

public SkeletonJointPosition getJoint(int user, SkeletonJoint joint) {
  return getJointsForUser(user).get(joint);
}

...

SkeletonJointPosition jointPosition1 =
    skeleton.getJoint(user, SkeletonJoint.LEFT_SHOULDER);
Point3D pos1 = jointPosition1.getPosition();
```

Demo

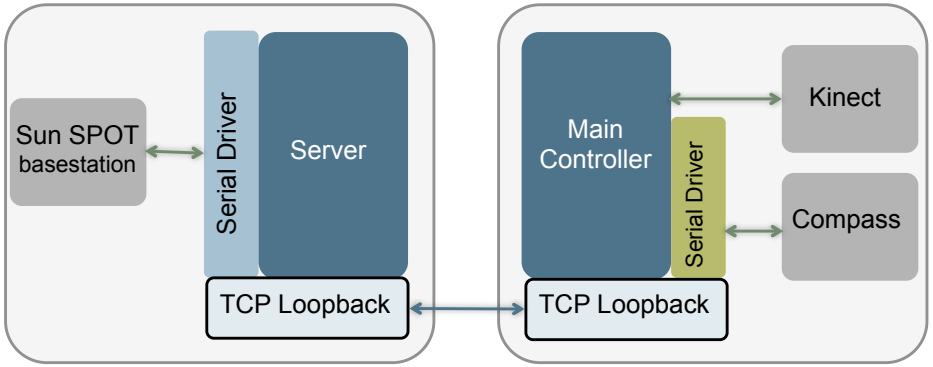
PUTTING IT ALL TOGETHER

All Drivers Are Not All Created Equal

Especially Serial Ones

- I2C to USB interface requires serial driver
- Sun SPOT basestation requires serial driver
- Unfortunately they are different drivers
- Proved impossible to configure the classpath, java.library.path and LD_LIBRARY_PATH to make both work from the same JVM

Loopback To The Rescue



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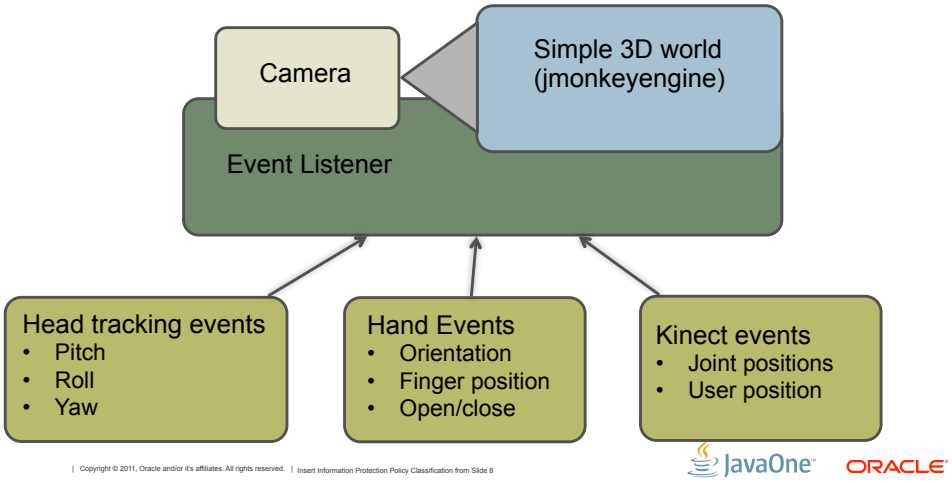
Demo Architecture



Demo

CONCLUSIONS AND FURTHER INFORMATION

Conclusions

- Java is still a really cool and powerful language
- Interfacing to exotic hardware is easy using free and open source libraries
- Modern hardware allows us to build some very interesting applications
- Be inspired, go out there and build more stuff!

Further Information

- wiiusej.googlecode.com
- javafx.com
- jmonkeyengine.com
- www.openni.org
- fivedots.coe.psu.ac.th/~ad/jg/ (Andrew Davidson at PSU)
- www.sunspots.com

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