Cubic Hand

Kevin Albers, Robert Bui, José Oyola, Naren Vasanad
Objective

Create an LED cube with lighted squares that can be controlled by hand gestures sensed by a data glove.
Focus Areas

- Real time networks
- Classification of gestures
- Model-based design of systems
Real Time Networks

Data Glove
- Bend sensor data
- Quaternion data

Computer
- Bend sensor data
- Quaternion data

LED Cube
- Size of LED square
- Movement of square
- Color changing

TCP/IP Socket Communication

CubeNet™ Network
# Modeling Gestures

<table>
<thead>
<tr>
<th>Sensor Data Specifications</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Precision</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger Sensors</td>
<td>0</td>
<td>1000</td>
<td>1</td>
<td>0.1%</td>
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<tr>
<td>Roll</td>
<td>-90.00</td>
<td>90.00</td>
<td>0.01</td>
<td>degrees</td>
</tr>
<tr>
<td>Pitch</td>
<td>-90.00</td>
<td>90.00</td>
<td>0.01</td>
<td>degrees</td>
</tr>
<tr>
<td>Yaw</td>
<td>-90.00</td>
<td>90.00</td>
<td>0.05</td>
<td>degrees</td>
</tr>
<tr>
<td>Gesture Recognition Thresholds</td>
<td>Unbent</td>
<td>Bent</td>
<td>Units</td>
<td></td>
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<tr>
<td>-------------------------------</td>
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</tr>
<tr>
<td>Fingers 0-3</td>
<td>&lt; 350</td>
<td>≥ 350</td>
<td>ADC unit</td>
<td></td>
</tr>
<tr>
<td>Finger 4 (Thumb)</td>
<td>&lt; 200</td>
<td>≥ 200</td>
<td>ADC unit</td>
<td></td>
</tr>
<tr>
<td>Roll, Pitch, Yaw</td>
<td>&lt; -10</td>
<td>&gt; 10</td>
<td>degrees</td>
<td></td>
</tr>
<tr>
<td><strong>Neg. Movement</strong></td>
<td></td>
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<tr>
<td><strong>Pos. Movement</strong></td>
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</tbody>
</table>
Gesture Classification: Size & Color

Neutral

Increase Size

Change Color

Decrease Size
Gesture Classification: Movement
Design Methodologies
Design Methodologies
Design Methodologies

Diagram showing the process of data flow from a Glove, through Correction, Tilt Detection, Gesture Recognizer, and Update Cube, with inputs and outputs labeled accordingly.

Additional diagram for Glove, Wifi Socket, Raw Data, Parse Packet, angles, fingers, filteredAngles, filteredFingers, Tilt Detection, Δ positions, Δ size, color, Train, Filter, count, and trainLength.
mbed Libraries Used

- CC3000: cc3000_hostdriver_mbedsocket
  
  *By: Martin Kojtal*

- NeoPixel LEDs: Multi_WS2811
  
  *By: Richard Thompson*
Acknowledgements

- Professor Edward Lee
- Professor Sanjit Seshia
- John Finn, Antonio Iannopollo and Ben Zhang
- Embedded Systems Laboratory
- Invention Lab
- Virtual Realities
- TerraSwarm Research Center

TerraSwarm
Questions?
Materials

Embedded Platform: Freescale FRDM-KL25Z
Wi-Fi Module: CC3000
Neo Pixel LED Strips: 300 for 10x10 LED Cube
Data Glove: VirtualRealities DG5

<table>
<thead>
<tr>
<th>Data Glove Sensor</th>
<th>Action</th>
</tr>
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<tbody>
<tr>
<td>Accelerometer</td>
<td>Movement of Square</td>
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<tr>
<td>Gyro</td>
<td>Change Color</td>
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<tr>
<td>Flex Sensor</td>
<td>Change Size of Square</td>
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Demo Video