Navigation Input Devices

- Cubic Mouse, the trackball and the 3-D probe
- Perform relative position/velocity control of virtual objects
- Allow “fly-by” application by controlling a virtual camera
Trackballs

RS232

Sensing cylinder

Forearm support

Push buttons

LED

Dz

Dx

Dy

PSD ring

PSD
The Microscribe (Immersion Co.)
Gesture Input Devices

- Fakespace “Pinch Glove”
- 5DT Data Glove
- The DidjiGlove
- Immersion “CyberGlove”
- Have larger work envelope than trackballs/3-D probes
- Need calibration for user’s hand.
Finger Degrees of Freedom

- Palmar abduction
- Radial abduction
- Extension
- Flexion
- Retroposition
- Anteposition (opposition)
The Pinch Glove (Fakespace Co.)
- no joint measures, but contact detection
The Pinch Glove (Fakespace Co.)
One optical fiber per finger

Roll/pitch sensing

100 datasets/sec, 12 bit A/D flexion resolution, wireless version transmits data at 30 m, needs calibration
5DT Data Glove

Two sensors/finger plus abduction sensors

Two gloves use one Bluetooth 2.4 GHz transmitter on the user’s belt

The glove interface: a) 14-sensor version; b) wireless kit
The coupling of intermediate and distal finger joints

5DT Data Glove

Glove has less sensors than hand joints ... Needs to infer distal joint flexion angle

Joint Angle Coupling

θ₃ (deg)

40.0

35.0

30.0

25.0

20.0

15.0

10.0

5.0

10.0 20.0 30.0 40.0 50.0

θ₂ (deg)

Index finger

Middle finger

The coupling of intermediate and distal finger joints
5DT Data Glove
5DT Data Glove

Linear calibration method

\[
\text{out} = \frac{\text{raw}_{\text{val}} - \text{raw}_{\text{min}}}{\text{raw}_{\text{max}} - \text{raw}_{\text{min}}} \times 255
\]
The Didjiglove

- Inexpensive wired glove for computer animation
- Uses capacitive sensors (two per finger) and a 10-bit A/D converter (1,024 points)
- Can do 70 hand configuration reads/sec.
- Communicates with the host over an RS232 (19.2 k)
The CyberGlove

- Uses 18-22 linear sensors – electrical strain gauges
- Angles are obtained by measuring voltages on Wheatstone bridge
- 112 gestures/sec “filtered”
- Sensor resolution 0.5 degrees, but errors accumulate to the fingertip (open kinematic chain);
- Sensor repeatability 1 degree
- Needs calibration when put on the hand
- Is expensive (about $10,000)
The CyberGlove

VC 2.3 on book CD
## Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Pinch Glove</th>
<th>5DT Data Glove</th>
<th>Didjiglove</th>
<th>CyberGlove</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sensors</td>
<td>7/glove (2 gloves)</td>
<td>5 or 14/glove (1 glove)</td>
<td>10/glove (2 gloves)</td>
<td>18 or 22/glove (1 glove)</td>
</tr>
<tr>
<td>Sensor type</td>
<td>Electrical</td>
<td>Fiber-optic</td>
<td>Capacitive</td>
<td>Strain gauge</td>
</tr>
<tr>
<td>Record/sec</td>
<td>NA</td>
<td>100(5DT 5W), 200(5DT 5)</td>
<td>70</td>
<td>150(unfiltered)</td>
</tr>
<tr>
<td>Sensor resolution</td>
<td>1bit (2 Points)</td>
<td>8bit (256 Points)</td>
<td>10 bit (1024 points)</td>
<td>112(filtered)</td>
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<tr>
<td>Communication rate</td>
<td>Wired (19.2kb)</td>
<td>Wireless(9.600kb)</td>
<td>Wired (19.2kb)</td>
<td>Wired (115kb)</td>
</tr>
<tr>
<td>Wrist sensors</td>
<td>None</td>
<td>Pitch (5DT 5 model)</td>
<td>None</td>
<td>Pitch and yaw</td>
</tr>
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</tbody>
</table>
Tracking: Review

- **Classification of systems**
  - Physical medium
  - Geometric configuration of devices
  - Hybrid systems

- **Physical Medium**
  - Acoustic
  - Inertial
  - Magnetic
  - Optical
Tracking: Review

- **Sensor Configurations (Coordinate Frame)**
  - Laboratory Frame
  - User’s Frame

- **Hybrid Systems**
  - Inertial and Optical/Acoustic
Tracking: Review

- **Performance Characteristics**
  - Measurement rate – Readings/sec
  - Sensing latency
  - Sensor noise and drift
  - Measurement accuracy (errors)
  - Measurement repeatability
  - Tethered or wireless
  - Work envelope (working volume)
  - Sensing degradation
Tracking: Review

- **Suitability of Technology to Application**
  - Digitization of 3D object
  - Head-mounted display
  - Motion capture
  - Mouse control
  - Surgical instrument tracking