EVOLUTION OF THE HBSI MODEL

IPBC 2012 CONFERENCE PRESENTATION
14:25-14:50
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PRESENTATION

- Evolution of the model
- HBSI v3.0
- Future roadmap
• The HBSI model is concerned with the data collection portion of the biometric model
  – Consistent and repeatable presentation to the sensor
HBSI MODEL

Conceptual model for HBSI

Human

Ergonomics

Sensor

Usability

Biometric System

Image Quality

Human-Biometric Sensor Interaction (HBSI)

Conceptual model for HBSI
UNDERLYING MODEL

Biometric System Ergonomic Design

Users

- Variables
  - Fixed
    - Uncontrolled
      - Measurable
      - Not measurable
    - Intentionally varied
      - Measurable
      - Not measurable

Environment

- Variables
  - Fixed
    - Uncontrolled
      - Measurable
      - Not measurable
    - Intentionally varied
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      - Not measurable

Algorithm

- Variables
  - Fixed
    - Uncontrolled
      - Measurable
      - Not measurable
    - Intentionally varied
      - Measurable
      - Not measurable
## MODALITY TESTING AND HBSI

<table>
<thead>
<tr>
<th>Year</th>
<th>Hand</th>
<th>Finger</th>
<th>Iris</th>
<th>Face</th>
<th>DSV</th>
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</thead>
<tbody>
<tr>
<td>2004</td>
<td></td>
<td>Age</td>
<td>Mobile iris</td>
<td>Illumination</td>
<td>Different devices</td>
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<tr>
<td>2005</td>
<td>Co-Rec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>Height /Placement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Habituation</td>
<td>Force</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>Initial HBSI Calc</td>
<td>Force Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td>Fixed iris</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td>Gender</td>
<td></td>
<td></td>
<td>Device (different sensors)</td>
</tr>
<tr>
<td>2012</td>
<td>Hand alignment</td>
<td>Force Finger interactions / Kinect</td>
<td>HBSI Training / Kinect</td>
<td>Detractors</td>
<td>Forgery</td>
</tr>
<tr>
<td>2012</td>
<td>Interaction Age</td>
<td>Interaction Age</td>
<td>Interaction Age</td>
<td>Interaction Age</td>
<td>Interaction Age</td>
</tr>
</tbody>
</table>
INCLUSION OF OTHER MODELS

- General Biometric Model
- Operation Times Model (Lazarick, Kukula, et.al)

Operational Times. Figure 1 Types of transaction times.
Metrics created and validated for:
- Iris
- Fingerprint
- Signature Verification
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- Iris
- Fingerprint
- Signature Verification

Video record the environment from different angles in order to watch the subject and to classify their presentation - typically 3 video angles and operator screen + (audio sometimes)
HBSI METRICS V2

Metrics created and validated for:
- Iris
- Fingerprint (different sensors)
- Signature Verification

Record the environment (video and sometimes audio) from different angles in order to watch the subject and to classify their presentation -typically 3 video angles and operator screen.
HBSI MODEL 3.0
UNDERLYING MODEL

Biometric System Ergonomic Design

Users
- Variables
  - Fixed
    - Uncontrolled
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      - Measurable
  - Intentionally varied

Environment
- Variables
  - Fixed
    - Uncontrolled
      - Not measurable
      - Measurable
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Algorithm
- Variables
  - Fixed
    - Uncontrolled
      - Not measurable
      - Measurable
  - Intentionally varied

RESPONSIVE  RELEVANT  RESULTS
More actors:
- Subject (typically the biometric donor)
- Operator
- Other people in the environment
Additional variables: Subject conditions
- moisture,
- elasticity,
- oiliness
Collected conditions such as:
- temperature
- humidity
EXAMPLES: HAND GEOMETRY
ACCESSIBILITY

Biometric System Ergonomic Design

Users  Environment  Algorithm

Biometric Sensor operator

Biometric Donor

Climate  Device

Test Administrator

Training

RESPONSIVE  RELEVANT  RESULTS
EXAMPLE METRIC CALCULATIONS

Biometric System Ergonomic Design

Users
- Biometric Sensor operator
- Biometric Donor

Environment
- Climate
- Device
- Test Administrator
- Training

Algorithm

Satisfaction

Ergonomics

Human Factors
- Anthropometry
- Impairments
- Demographics

HBSI Interaction
- Defective Interactions
- Concealed Interactions
- False Interactions
- Failure to Detect
- Failure to Extract
- Successful Acquisition

Training/Transfer

Efficiency
- Time on Task
- Number of Errors
- Number of Assists
- % Task Completion

Matching

FTA

Responsive Relevant Results
DETERMINATION OF ERRORS V1

- Process:
  - Recorded in real time as the study is underway
  - Interactions are coded
  - Metrics of the evaluation model are completed
  - Interaction errors are classified as HBSI terms
CURRENT WORK

- Generation of the errors is time consuming
- We notice other potential errors
  - Contribution of the operator to the error
  - Contribution of the test administrator to the error
- HBSI workflow
  - Semi-automatic coding of the model using Kinect
- New work
  - Accessibility study – hearing and sight impaired (started Jan 2012)
  - Contribution of cost to the model (started Jan 2011)
  - Examining the role of the impostor (thinking …. As this model only has been rested in a “genuine” environment)
  - Development of products that can help improve interactions
ASSIGNING A COST MODEL

• Identify interaction issues
• Classify where these errors are occurring – what is causing this
• Assign a cost to “retry” for example – based on:
  – Poor interaction
  – Sensor feedback
  – Operator not paying attention
• Assess the impact on fixing this error
BIOMETRICS LAB
Biometric Standards, Performance and Assurance Laboratory
Department of Technology, Leadership and Innovation

KINECT

CRAIG HEBDA | ROB PINGRY | WENG KWONG CHAN | BRENT SHULER

RESPONSIVE RELEVANT RESULTS
MOTIVATION

• Video coding is time consuming
• Inter-rater reliability
  – Requires good robust definitions
<table>
<thead>
<tr>
<th>Movement Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slouched:</td>
<td>Subject is not standing up straight during fingerprint scan.</td>
</tr>
<tr>
<td>Head Movement:</td>
<td>Subject’s head is not still during fingerprint scan.</td>
</tr>
<tr>
<td>Body Movement:</td>
<td>Subject’s body is not still during fingerprint scan.</td>
</tr>
<tr>
<td>Upright:</td>
<td>Subject is standing up straight during fingerprint scan.</td>
</tr>
<tr>
<td>Labored Walking:</td>
<td>Subject has bag or other item on shoulder when approaching device.</td>
</tr>
<tr>
<td>Pivoting Palm:</td>
<td>Subject’s hand pivots on edge of device.</td>
</tr>
<tr>
<td>Rocking Fingers:</td>
<td>Subjects fingers rock from one finger to the next when hand is placed on device</td>
</tr>
<tr>
<td>Slapping Hand:</td>
<td>Subject slaps hand on to the device.</td>
</tr>
<tr>
<td>Angled Fingers:</td>
<td>Subjects fingers are at an angle other then 90 degrees from edge of the device</td>
</tr>
</tbody>
</table>
MICROSOFT ® SDK INTERFACE
MICROSOFT ® KINECT™ SKELETAL TRACKING SYSTEM


SLOUCHING

• Dictionary Definition
  • **Slouching**-A gait or posture characterized by an ungainly stooping of the head and shoulders or excessive relaxation of body muscles.

• Points of interest:
  • -Shoulders
  • -Head
  • -Spine
  • -Hips

SLOUCHING

- Tracking Points to be
  - Shoulder_Right
  - Shoulder_Left
  - Shoulder_Center
  - Head
  - Spine
  - Hip_Center
  - Hip_Right
  - Hip_Left
**SLOUCHING**

Highlight what is slouching
Break it into left right

- **Left Slouching:**
  - Left shoulder will be lower than the right shoulder.
  - All points on left arm will be lower than base image.
  - Head will be tilted to left.
  - Left hip will be lower than right hip.
  - Spine point will move slightly up and right.

=Movement Up
=Movement Down
SOLUTIONS TO THE CHALLENGES OF DEFINING

- A multi point approach can help solve the majority of the problems when describing what is slouching.
- Use a combination of how much each point moves to determine if the subject is slouching or just moving one part of their body.
HEAD DISPLACEMENT

• Definition of Head Movement:
• Voluntary or involuntary motion of head that may be relative to or independent of body.

http://www.medical-dictionary.cc/what-does/head-movement-mean
HEAD DISPLACEMENT

Critical Tracking Points (TPs):
1. Head (H)
2. Shoulder_Center (SC)

Associated Tracking Points (TPs):
1. Shoulder_Right (SR)
2. Shoulder_Left (SL)
### Definition of Head Movement Based on Tracking Points

<table>
<thead>
<tr>
<th>Head Movements</th>
<th>Tracking Points Definition</th>
<th>Changes in Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowering head</td>
<td>H approaches SC</td>
<td>X, Y, maybe Z too</td>
</tr>
<tr>
<td>Nodding</td>
<td>H moves back and forth from SC repeatedly</td>
<td>X, Y, maybe Z too</td>
</tr>
<tr>
<td>Head turning</td>
<td>Turn to the left: H moved to the left</td>
<td>X, Y, Z</td>
</tr>
<tr>
<td></td>
<td>Turn to the right: H moved to the right</td>
<td></td>
</tr>
<tr>
<td>Head tilted to one side</td>
<td>Tilt to the left: H moved to the left</td>
<td>X, Y</td>
</tr>
<tr>
<td></td>
<td>Tilt to the right: H moved to the right</td>
<td></td>
</tr>
<tr>
<td>Head bobbing</td>
<td>H moves in random direction with minimal distance</td>
<td>X, Y, Z</td>
</tr>
<tr>
<td>Head sliding forward</td>
<td>H moves forward</td>
<td>Z</td>
</tr>
<tr>
<td>Head wagging</td>
<td>H moves in left and right rapidly</td>
<td>X, Y</td>
</tr>
</tbody>
</table>

Source: [http://www.thefreedictionary.com/Head+Movements](http://www.thefreedictionary.com/Head+Movements)
HOW WILL THIS WORK?
A QUICK ROADMAP

Observation of error
Automatic identification and classification of error
Feedback to the user, customized to their interaction error
ACTIVITIES

• Link behavior and interaction to the image
• Understand the basic performance characteristics
• Relay back whether the interaction (or change in interaction) affects performance
The benefit is to examine the information associated with the sample, but also the video interaction of the image.

HBSI V3 has (will have):
- video and audio interaction
  - Watch the interaction
  - Understand who is contributing the error
  - Replay the interaction in real time as it was collected
- Metadata collected and searchable
QUESTIONS?

Get Involved in shaping these projects – contact elliott@purdue.edu to participate in the development of the model
Teleconferences over the summer 2012 period

- **Other actors**
  - Contribution of the operator to the error
  - Contribution of the test administrator to the error

- **HBSI workflow**
  - Semi-automatic coding of the model using Kinect

- **New work**
  - Accessibility study – hearing and sight impaired (started Jan 2012)
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ADDITIONAL SLIDES