Face Recognition
Grand Challenge

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NIST
Face Recognition Grand Challenge

Systematically pursue two methods (2D and 3D) to reduce the error rate in face recognition by an order of magnitude.
Verification - HCInt

![Graph showing verification rates for different systems with bars and lines indicating performance across different false accept rates (%).](image)

- Cognitec
- Eyematic
- Identix
- C-VIS
- Imagis
- Viisage
- VisionSphere
- Dream MIRH

Legend:
- Cognitec
- Eyematic
- Identix

Verification rate (%): 0.1 1 10

False accept rate (%): 0.0001 0.0010 0.0100 0.1000 1.000
Select Point to Measure

• Verification rate at:
  - False accept rate = 0.1%

• Current:
  - 20% error rate (80% verification rate)

• Goal:
  - 2% error rate (98% verification rate)
Measuring Accuracy w/Error Rate of 2%

- **Non-match scores:**
  - Sufficient

- **Match scores:**
  - Need to design collection for sufficient number

<table>
<thead>
<tr>
<th>Match Scores</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>~ 20</td>
</tr>
<tr>
<td>10,000</td>
<td>~ 200</td>
</tr>
<tr>
<td>50,000</td>
<td>~ 1,000</td>
</tr>
</tbody>
</table>

- Allows for error ellipses
- Minimal demographic analysis
Data Collection

Fall Semester
(Gallery)
15 Weeks

Spring Semester
(Probes)
15 Weeks

200 People

All match scores ~ 50,000

200 People
Modes Examined

Single Still

Multiple Stills

Outdoor/Uncontrolled

3D Single view

3D Full Face
Measure Progress on:

- Indoor cooperative face recognition
- Outdoor cooperative face recognition
- Comparison of still & 3D face recognition
- Effect of multiple images
- Effect of High Dynamic Range cameras on outdoor face recognition
- Comparison between human and machine performance
Programmatic

• **Series of Challenge Problems**
  - Facilitate development
  - Systematically measure progress

• **FR Challenge Grand Challenge Evaluation**
  - Independent measure
## Experiment Design
### FRVT 2002 versus Grand Challenge

<table>
<thead>
<tr>
<th>FRVT 2002</th>
<th>Grand Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat design</td>
<td>Combinatorial design</td>
</tr>
<tr>
<td>Process all data</td>
<td>Process subset of data</td>
</tr>
<tr>
<td>Blind data</td>
<td>Transparent data</td>
</tr>
<tr>
<td>Black box</td>
<td>Transparent box</td>
</tr>
<tr>
<td>Single mode</td>
<td>Multiple modes</td>
</tr>
<tr>
<td>Fixed design</td>
<td>Adaptive design</td>
</tr>
<tr>
<td>Central analysis</td>
<td>Distributed and central analysis</td>
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</table>
## Grand Challenge Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
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<tbody>
<tr>
<td>Aug-Sep '05</td>
<td>Face Recognition Grand Challenge Evaluation</td>
</tr>
<tr>
<td>Sep '04</td>
<td>Release challenge problem v2.0</td>
</tr>
<tr>
<td>Aug-Sep '04</td>
<td>Baseline performance determination for v2.0</td>
</tr>
<tr>
<td>April '04</td>
<td>Release challenge problem v1.0</td>
</tr>
<tr>
<td>April '04</td>
<td>First challenge problem workshop</td>
</tr>
<tr>
<td></td>
<td>- Explain challenge problem in detail</td>
</tr>
</tbody>
</table>
Challenge Problem Infrastructure

- Based on HumanID gait challenge problem
  - Design set of experiments
  - Baseline algorithms
  - Infrastructure for running experiments

- Documented progress
  - Forced researchers to concentrate on a problem
BEE Architecture

- BEE-core
  - Algorithm/System
  - Analysis tools
  - Results

- Experimental Data sets
  - Training
  - Galleries
  - Probe sets

- Data sets
  - hbase
  - hbase lite
  - hbase superlite
BEE: Biometric Experimentation Environment

- **Flexible Framework for Biometric Algorithms**
  - Plug & play algorithms
  - Mix & match modular components
- **Provides Universal XML-Based Interfaces**
- **Facilitates Biometric Evaluations**
- **Uses a Non-Proprietary Open Source Design**
Experiments

- Evaluate single system using multiple datasets
- Evaluate multiple systems with uniform data
- Complete audit trail
- Audit trails are portable and can be used as inputs to subsequent runs
- Similarity matrices offer a portable representation of raw results
- Rerun trial using intermediate results
- View graphs/reports on experiments performance
- Supports independent advanced post analysis
Reproducibility via XML

Datasets (inputs)

Similarity Matrix (raw results)

Audit Trail (output)

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  <Recording id="hgfR00001"/>
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  <Query file="DataSet2.xml"/>
  <BioBox module="hFace 1.2"/>
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  <Target file="DataSet1.xml"/>
  <Query file="DataSet2.xml"/>
  <BioBox module="hFace 1.2"/>
</Audit>

...
Cross Institution Experimentation

- Execution of multiple algorithms at multiple institutions with a common experiment definition
- Transmission of raw results
- Uniform reporting of results
- Cross institutional analysis
Cross Institutional Experiment Replication

- Independent replication of results
- Transmission of experiment definitions
- Uniform reporting of results
Grand Challenge Evaluation Team

- **Jonathon Phillips—NIST**
  - Director Face Recognition Grand Challenge
- **Notre Dame (Prof. Kevin Bowyer and Prof. Patrick Flynn)**
  - Data collections
  - Baseline algorithms
- **SAIC (Dr. Todd Scruggs)**
  - Design and implement BEE
  - Maintain hBase
- **Mitre (Joe Marques)**
  - Analysis
  - Assist with Grand Challenge
- **University of Texas at Dallas (Prof. Alice O'Toole)**
  - Human performance
Conclusion

• **Face Recognition Grand Challenge**
  - Order of magnitude increase in performance
  - Systematically investigate still and 3D
  - Formulate series of challenge problems
  - Final Grand Challenge evaluation

• **Biometric Experimentation Environment (BEE)**
  - Infrastructure for Grand Challenge
  - Uniform structure for challenge problem