Quality-Based Multimodal Biometric Authentication Systems for Consumer Mobile Devices

Nicholas Smith

Security Day 2015

California State University, Fullerton

What are Biometrics?

Biometrics are *metrics* that pertain to human features such as the voice, face, or fingers.

Examples:

Biometric Authentication Systems

Biometric authentication

- Verify identity using *unique physical traits*
- No passwords necessary

Example: Hand geometry scanner

Target Application

Targeting: *Consumer Mobile Devices*

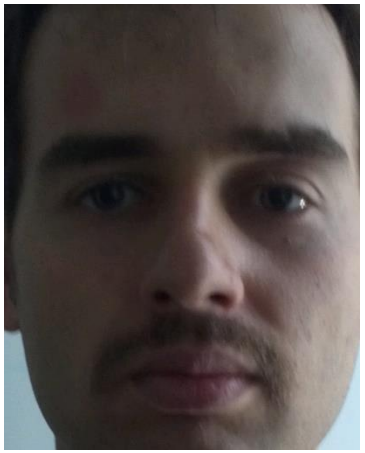
Benefit:

- Improve **device security**
- **Less burden** to user

Modern Issues

Mobile biometric authentication suffers from:

- Poor quality **mobile hardware**
  - *Camera*, *Microphone*
- **Environmental conditions**
  - *Lighting*
  - Background Noise
- **User error**
- Use of **unimodal biometrics**



Research Objectives

Purpose of Research:

- Improve robustness of mobile biometric authentication systems
- Reduce FRR and FAR
- Prevent *spoofing attacks*

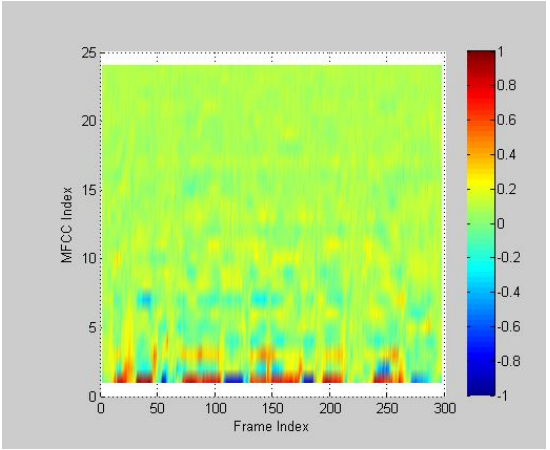
Modalities Used:

- *Facial* and *Voice Recognition*

Approach

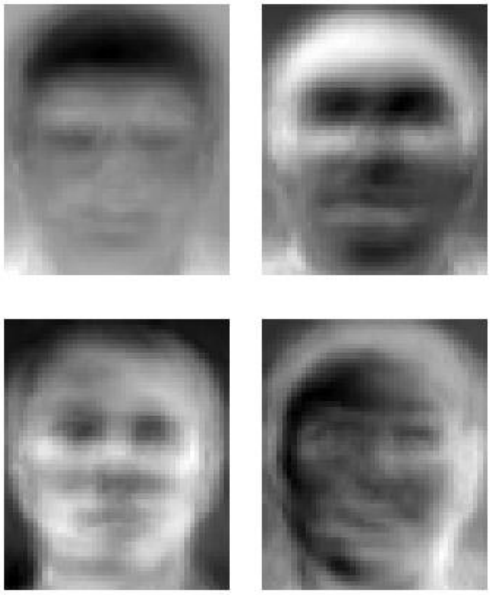
Voice: Record voice with built-in microphone

- Features: *MFCCs*



Face: Capture face with built-in camera

- Features: *Eigenfaces* [6]

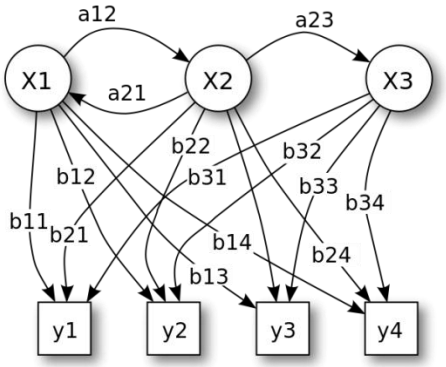


[3]

Classifiers: A High-Level View

Classifier: Compares Input to Training Sample

- *Hidden Markov Model (HMM)* per [1] and [2]



[4]

Idea:

- **Input:** Face Features/Voice Features
- **Output:** Percent Similarity Score

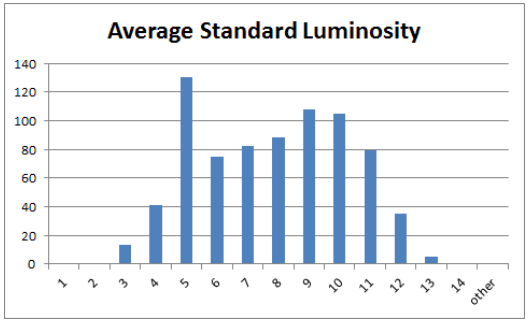
Methodology

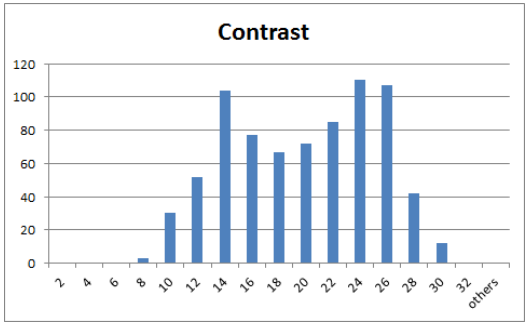
Image quality metrics:

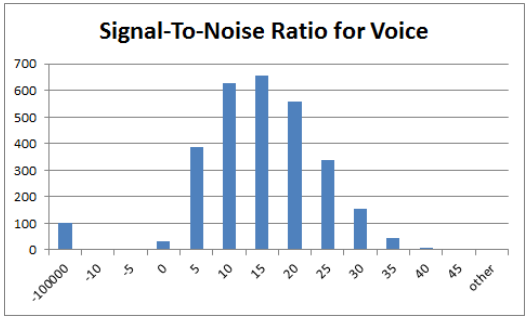
- Luminosity
- Orientation
- Contrast
- Sharpness

Voice quality metric:

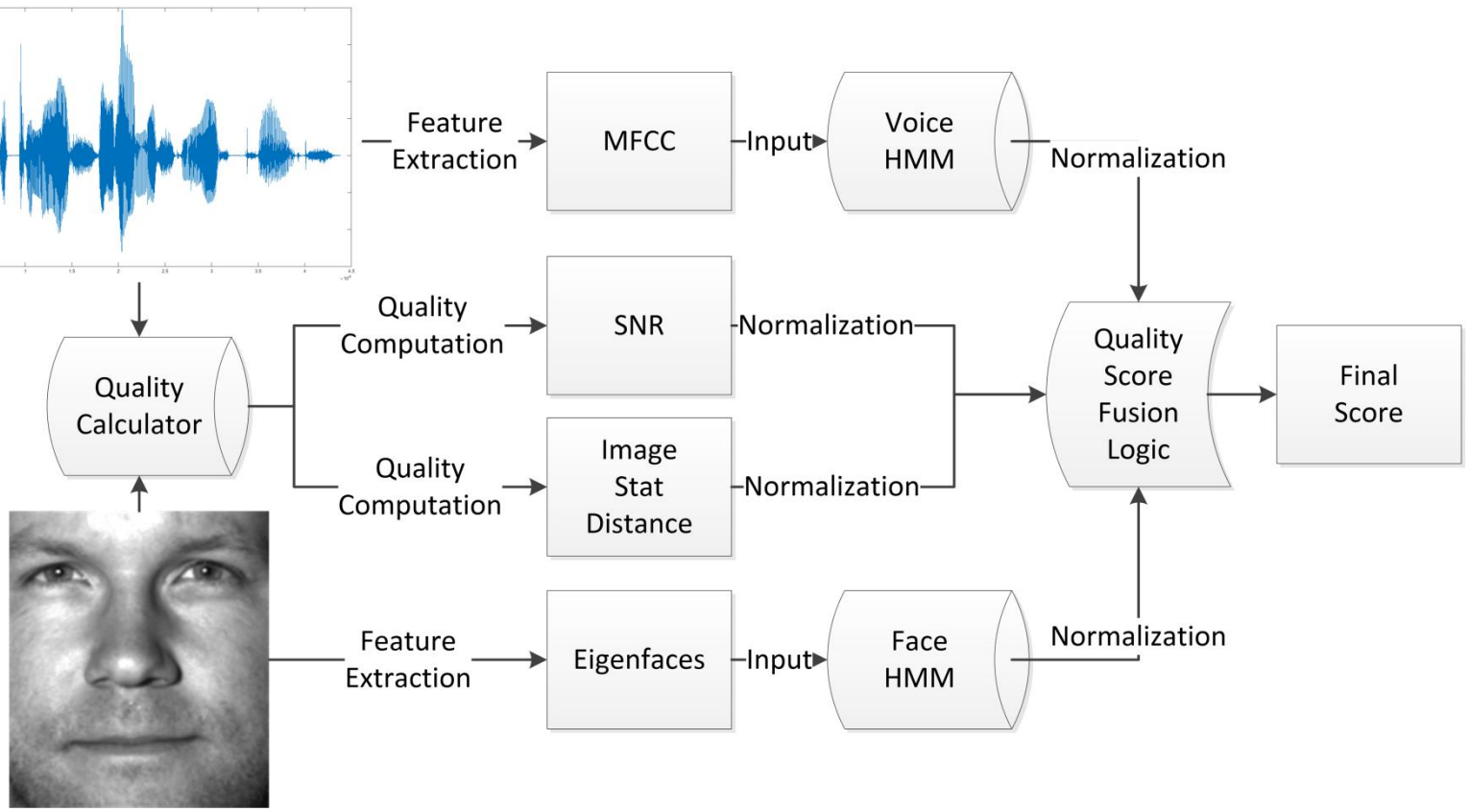
- Signal-to-noise ratio







System Overview



[5]

Methodology

- Modalities combined using score-level fusion

$$S = \sum_{i=i}^{m} w_i s_i$$

- Weight of modality determined by quality

$$w_i = \frac{c-1}{mc} + \frac{q_i}{c\sum_{j=1}^{m} q_j}$$

Dataset

Our team created mobile biometric database.

- Over **54 people**
- Different genders and ethnicities
- Captured using *Samsung Galaxy S5*
- Video Recordings

Results

Modality	EER	Training Time (s)	Auth. Time (s)
Face	16.93%	24.50	0.0645
Voice	22.21%	104.07	0.0448
Fusion	12.61%	141.37	0.1079

Future Work

Next Steps:

- Incorporate **More Modalities**:
  - Fingerprint, Ear, etc
  - Prevent Spoofing
- Improve **performance**:
  - Speed
  - *Equal error rate (EER)*

References and Citations

•[1] Rabiner, Lawrence, and Biing-Hwang Juang. "An introduction to hidden Markov models." ASSP Magazine, IEEE 3.1 (1986): 4-16.

•[2] Kohir, Vinayadatt V., and Uday B. Desai. "Face recognition using a DCT-HMM approach." Applications of Computer Vision, 1998. WACV'98. Proceedings., Fourth IEEE Workshop on. IEEE, 1998.

•[3] "Eigenfaces". Licensed under Attribution via Commons - https://commons.wikimedia.org/wiki/File:Eigenfaces.png#/media/File:Eigenfaces.png

•[4] "HiddenMarkovModel" by Tdunningvectorization: Own work - Own work. Licensed under CC BY 3.0 via Commons - https://commons.wikimedia.org/wiki/File:HiddenMarkovModel.svg#/media/File:HiddenMarkovModel.svg

•[5] Georghiades, A. "Yale face database." *Center for computational Vision and Control at Yale University, http://cvc. yale. edu/projects/yalefaces/yalefa* (1997).

•[6] Turk, Matthew, and Alex P. Pentland. "Face recognition using eigenfaces." *Computer Vision and Pattern Recognition, 1991. Proceedings CVPR'91., IEEE Computer Society Conference on*. IEEE, 1991.