Biometrics: A Personal Journey

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Who is This Person?
Who is This Person?
My First Encounter With Biometrics

• ser·en·dip·i·ty noun \ˌser-ən-ˈdi-pə-tē\: 
  Luck that takes the form of finding valuable or pleasant things that are not looked for (Merriam-Webster)

• 1992: Project from IDA Supercomputing Research Center & NSA to port “image processing” operations on Splash-2, a reconfigurable custom parallel processor

• Two generic operations
  – Image filtering (Gabor filters)
  – Point matching (fingerprint matching)
Fingerprint Matching on Splash 2

- Sequential matcher on the host: 70 matches/sec
- Parallel version on Splash 2 @1 MHz clock: ~ 6,300 matches/sec

N. Ratha, D. Rover and A.K. Jain, "An FPGA-Based Point pattern Matching Processor with application to Fingerprint Matching", CAMP '95, Italy
Fingerprints

“Perhaps the most beautiful and characteristic of all superficial marks (on human body) are the small furrows with the intervening ridges and their pores that are disposed in a singularly complex yet even order on the under surfaces of the hands and feet.”  

Francis Galton, Nature, June 28, 1888
Latent Segmentation and Enhancement

True mate retrieved at rank 2 with (latent + “new template”) as input to COTS matcher
3D Fingerprint Phantom

2D fingerprint image

Electronic 3D phantom
Outline

• What I learned?
  – Many facets of biometrics
  – Application & system requirements
  – Progress in sensing & computing technology
  – Game changers
  – What’s next?

• Summary
Biometrics

Here, we are extracting the biometrics of the subject!

Prof. Tyfun Agkul, Istanbul Technical University
Many Facets of Biometrics

Image & signal processing

Human factors

Security & privacy

Sensor design & embedded system

Machine learning

Cryptography

Biometrics

What does it mean to say we work in biometrics?
System is More than the Recognition Algorithm

Biometrics is a small embedded component

http://www.britannica.com/EBchecked/media/95649/The-components-of-an-automated-teller-machine
Designing a Biometric System

• Purpose, target population, system requirements

Texas Health hospital system uses palm scans to ID patients

Recognition of coal mine workers, China
Sensing Technology

- **Identix**
  - Dimensions: 12.5cm x 18cm x 6cm
  - Weight: 1 lb
  - Cost: ~$1,500 (1995)

- **Digital Persona (Optical)**

- **Lumidigm (Multispectral)**

- **Authentec, Swipe sensor (Capacitive)**

- **Morpho “Finger on the Fly” (Contactless)**

- **Goodix (Capacitive)**
New Sensors Bring New Challenges

U.are.U 4500 fingerprint reader

392x257 pixels (500PPI)

Touch fingerprint reader from Goodix

96x96 pixels (500PPI)
Mobile Unlock With Iris
Enrollment of 724K; average of 400 tenprint search/day @\(15K\) comparisons/sec. Courtesy Scott Blanchard, MSP
Michigan AFIS (2014)

3M enrollment; 2K tenprint search/day, 35 latent search/day, 5 latent palm search/day @25M comparisons/sec
Game Changers

Game Changers

Walt Disney Theme Park (2005)
Game Changers

FBI Next Generation Identification (2008)

FBI installed the first AFIS in 1980; IAFIS launched in 1999

http://www.fbi.gov/about-us/cjis/fingerprints_biometrics/ngi/ngi2/
Game Changers

India’s Aadhaar Project (2009)

~700 million unique ID numbers have been issued

https://portal.uidai.gov.in/uidwebportal/dashboard.do
Game Changers

Apple’s Touch ID (2013)
Game Changers

Apple Pay (2014)

Worldwide mobile payments to total ~ $1 Trillion by 2014
What’s Next?

• Biometrics + non-biometric sensing
• Biometrics forever
• Forensics → biometrics → forensics
• Privacy
Biometric Sensors in a Mobile
Biometric + Non-biometric User Data
Inertial Measurement Unit (IMU)
Beyond Identity

“Over-Sensitive” Camera
An Afghan woman shows her inked finger after casting her vote at a polling station in Bamiyan, Afghanistan, on June 14. (Photo: Kamran Shefayee, AP) USA Today, Sep. 22, 2014
Back to Forensics

• “Strengthening Forensic Science in the United States: A Path Forward”, NRC report, 2009

• Need for statistical underpinning for forensic procedures
Dr. Levine, a dental expert, testifying at Ted Bundy’s trial, linking Bundy’s crooked teeth to a bite on a 20-year-old victim in Florida, 1979; obscure field of “forensic dentistry” became respectable

Eddie Lee Howard, Jr. on death row for two decades

Mold of Howard’s teeth used to link him to crime

Eddie Lee Howard Jr., 61, has appealed his conviction to MS Supreme Court
“Doubtful” Forensic Evidence

- Shoeprint
- Shell casing
- Fiber
- Latent palmprint
- Tire mark
- Saliva
- Latent fingerprint
- Hair
- Blood stain
- Bite mark
Security vs. Privacy

ARE YOU WILLING TO TRADE CIVIL LIBERTIES FOR GREATER SECURITY?

POLL

THAT DEPENDS ON THE EXCHANGE RATE.
Summary

• Technical depth and domain knowledge is necessary to make a contribution
• Choice of right problem at the right time
• Don’t lose sight of “why biometrics?”
• Be familiar with state of the art
• The best part: training & mentoring students
WITHOUT DEVIATION FROM THE NORM, PROGRESS IS NOT POSSIBLE

– FRANK ZAPPA