State of Research, Development and Evaluation at NIJ

William A. Ford
Division Director, Information and Sensor Technologies Division
william.ford@usdoj.gov
202-353-9768

Who is the National Institute of Justice?
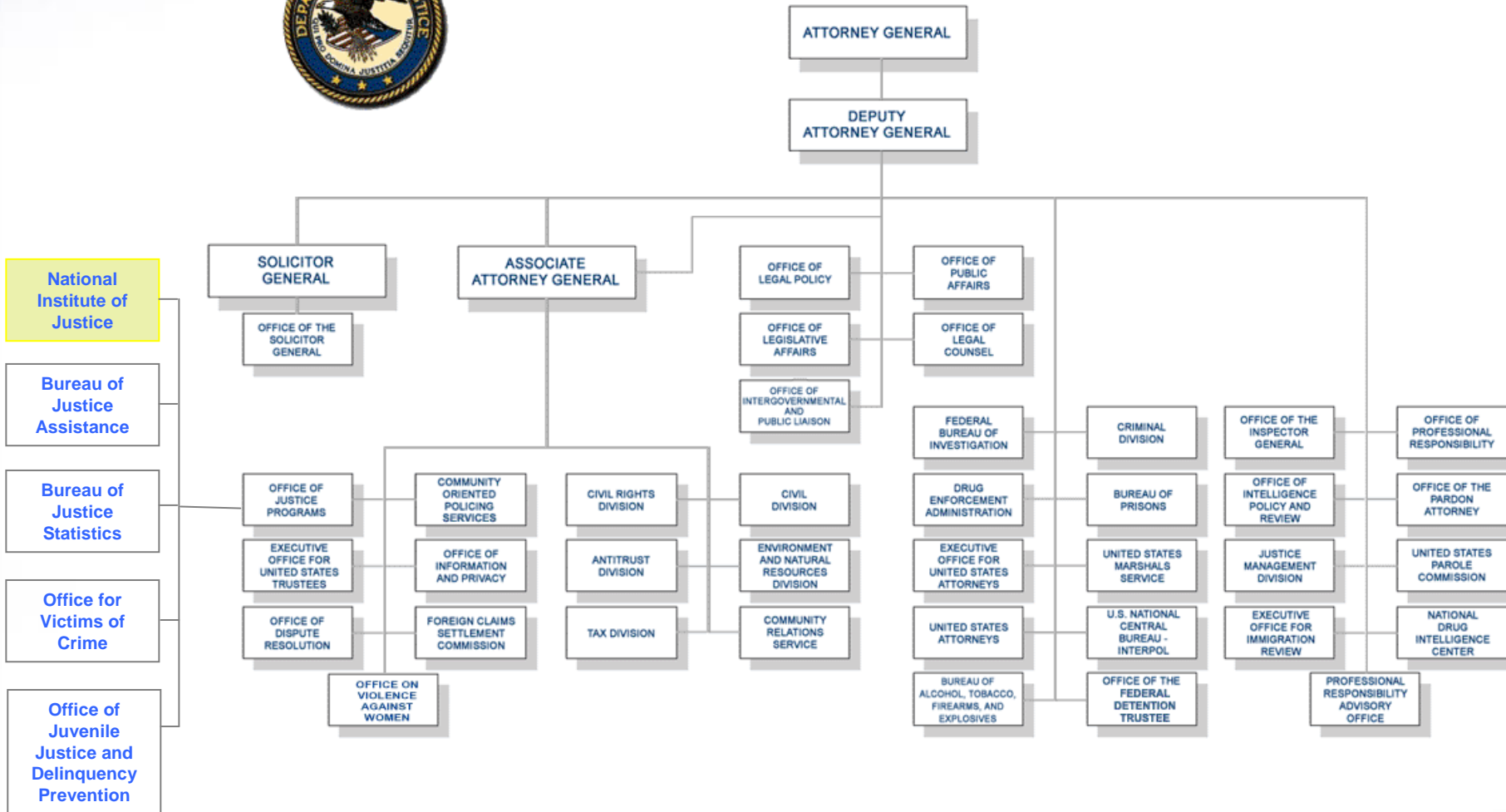
NIJ's Location Within the Department

NIJ's Organization

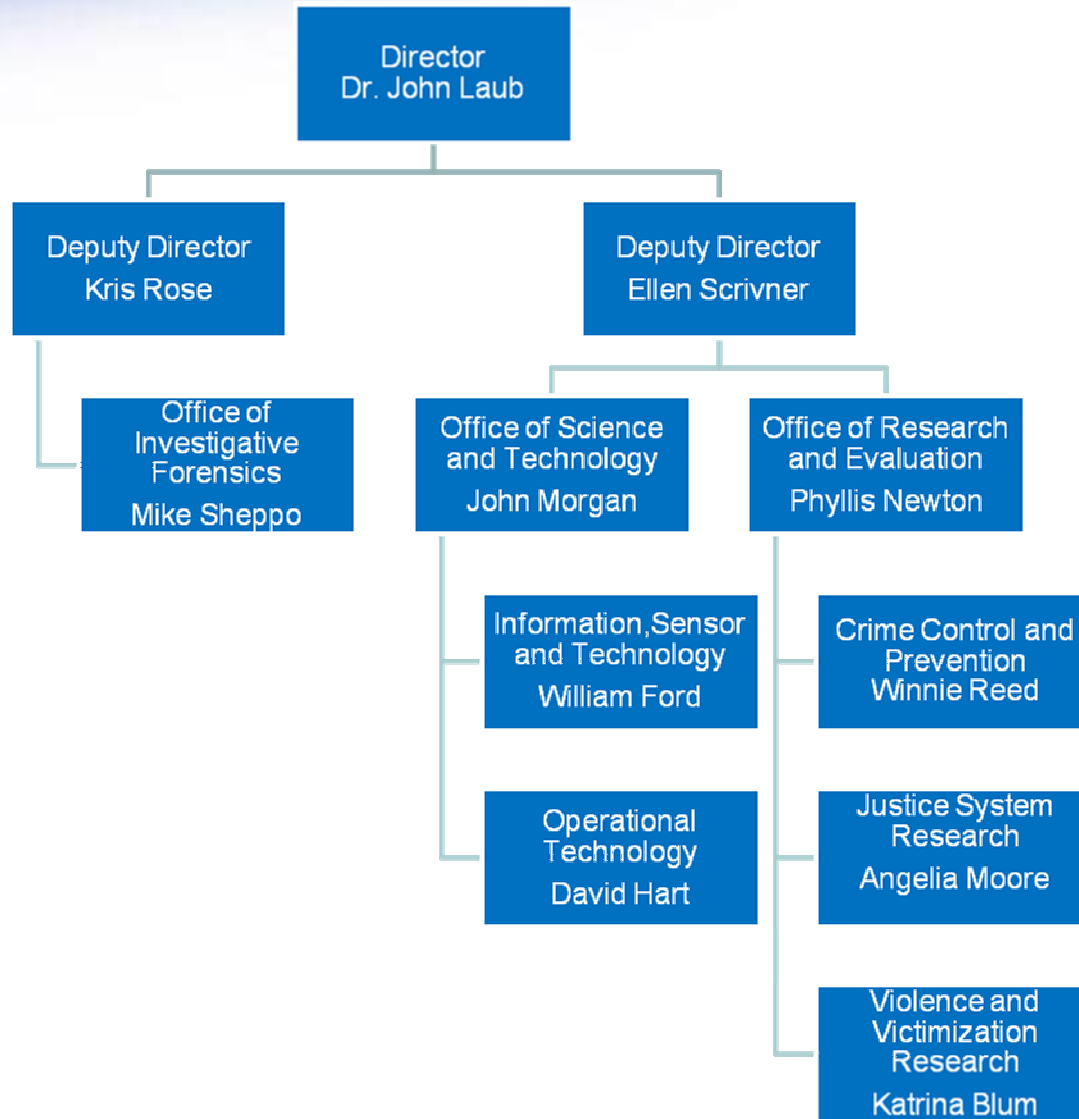# NIJ Biometrics Research Program and Advances
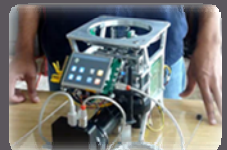
William A. Ford
Division Director, Information and Sensor Technologies Division
william.ford@usdoj.gov
202-353-9768
September 2010

Establishment of the Office

- NIJ's principal authorities are derived from the Omnibus Crime Control and Safe Streets Act of 1968, as amended (see 42 USC § 3721-3723) and Title II of the Homeland Security Act of 2002.
  - Title II of the Homeland Security act as it relates to NIJ's Office of Science & Technology
- Research, development and evaluation arm of the Department of Justice

NIJ'S MISSION

Advance scientific research, development and evaluation of technologies to improve efficiency and effectiveness of the criminal justice community and public safety.

Information and Sensor Technologies Division

We develop innovative solutions to the next generation of technology through:

- Capturing the technology needs of the criminal justice community.
- Strategic planning of a research agenda.
- Supporting research, development and evaluation via the competitive award process.
- Demonstrating and testing of emerging technologies.
- Dissemination of research and evaluation results
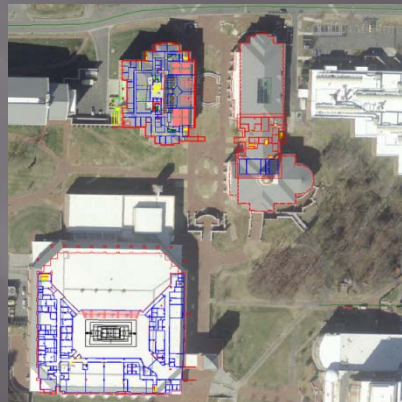
RDT&E Process
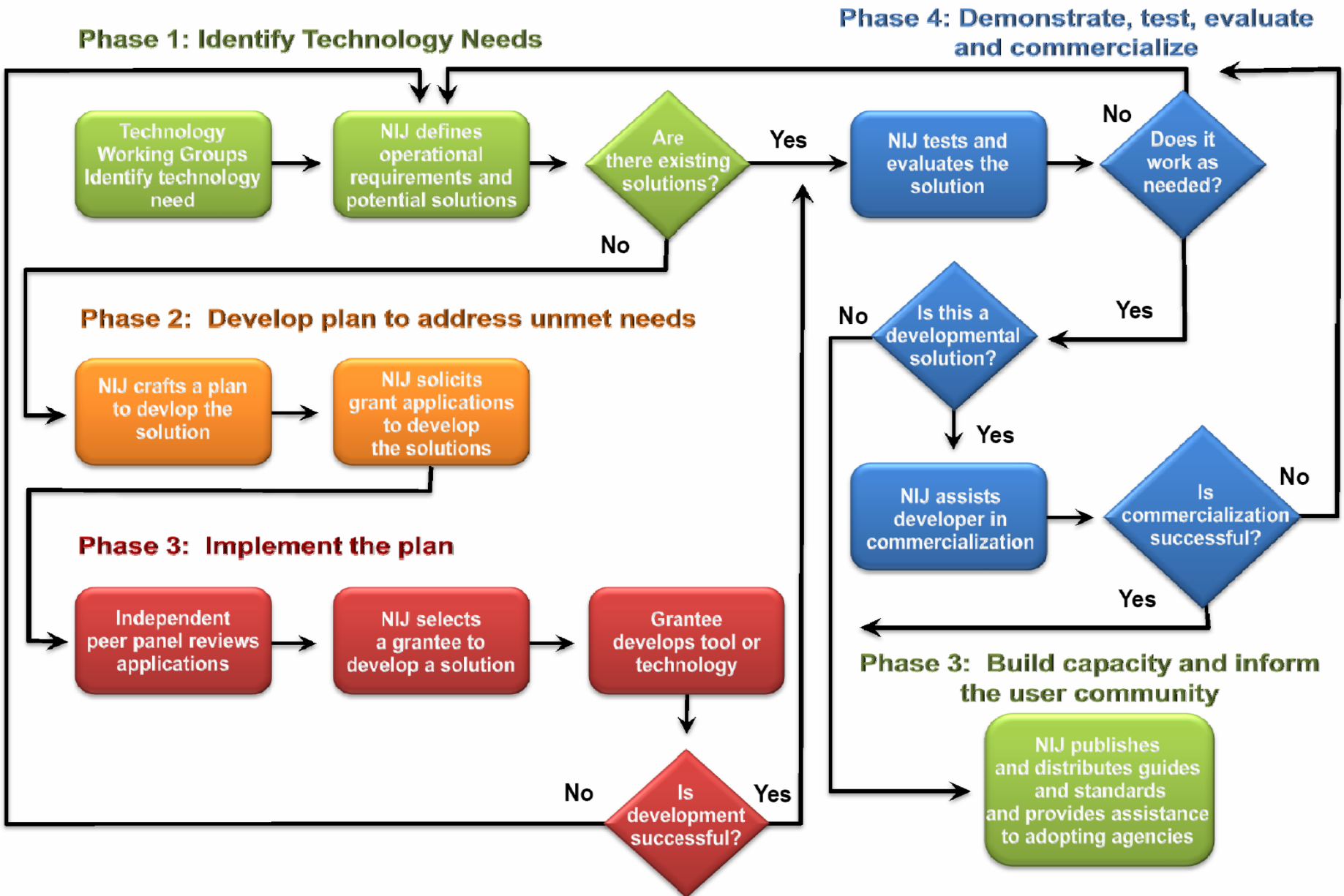
Solicitation Process

- Seeded with TWG identified needs
- Competitive; peer reviewed
- Peer panels with practitioners and technologists
  - TWG representatives as well as representatives from Federal R&D agencies

U.S. Department of Justice
Office of Justice Programs
National Institute of Justice

The U.S. Department of Justice, Office of Justice Programs, National Institute of Justice is seeking applications for funding to enhance the ability of law enforcement personnel to deal with the threat of Improvised Explosive Devices (IEDs) and Vehicle Borne Improvised Explosive Devices (VBIEDs).

This program furthers the Department's mission by sponsoring research to provide objective, independent, evidence-based knowledge and tools to meet the challenges of crime and justice, particularly at the State and local levels.

Solicitation:
Enhanced Tools for Improvised Explosive Device (IED) and Vehicle Borne IED Defeat

Eligibility

(See "Eligibility," page 3)

Deadline

All applications are due by April 30, 2007, 11:59 p.m. eastern time.

Contact Information

For assistance with the requirements of this solicitation, contact Chris Tillery, Deputy Assistant Director for Science and Technology, 202–305–9829, George.Tillery@usdoj.gov.

This application must be submitted through Grants.gov. For technical assistance with submitting the application, call the Grants.gov Customer Support Hotline at 1–800–518–4726.

Grants.gov Funding Opportunity No. 2007–NIJ–1441

SL# 000758

U.S. Department of Justice
Office of Justice Programs
National Institute of Justice

The U.S. Department of Justice, Office of Justice Programs, National Institute of Justice is seeking applications for funding research and development of sensor or surveillance technologies, or novel applications of those technologies, to address specific needs in the field of criminal justice. This program furthers the Department's mission by sponsoring research to provide objective, independent, evidence-based knowledge and tools to meet the challenges of crime and justice, particularly at the State and local levels.

Solicitation:
Sensors and Surveillance Technologies

Eligibility

(See "Eligibility," page 4)

Deadline

All applications are due by October 30, 2006, 11:59 p.m. eastern time

Contact Information

For assistance with the requirements of this solicitation, contact Chris Miles, Senior Program Manager, Research and Development Technology Division, 202–616–1110, Christopher.Miles@usdoj.gov.

This application must be submitted through Grants.gov. For technical assistance with submitting the application, call the Grants.gov Customer Support Hotline at 1–800–518–4726.

Grants.gov Funding Opportunity No. 2007-NIJ-1434
SL# 000757

Past Research

# Selective Feature Based Quality Measure Plug-in for Iris Recognition System

- Method to estimate the accuracy of the iris image preprocessing in the form of a plug-in

- Evaluates and produces quality metrics/score for segmentation

- Assessment of feature information

- Assigns quality score for feature extraction based on feature characteristics

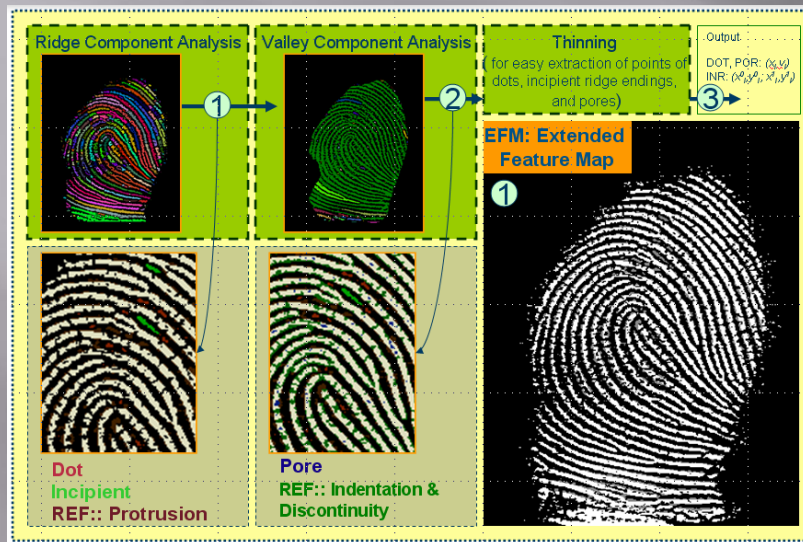- Developed a score fusion method to calculate the confidence level of possible match
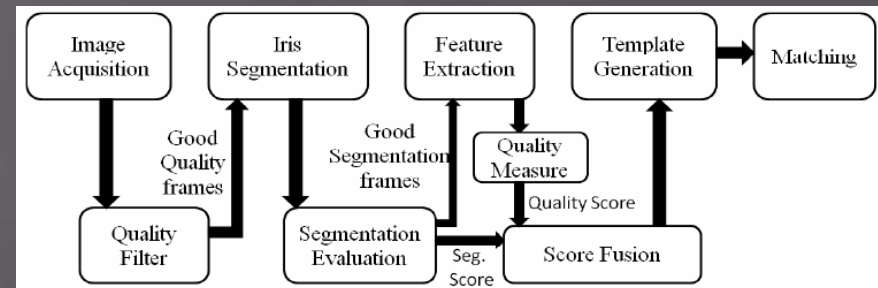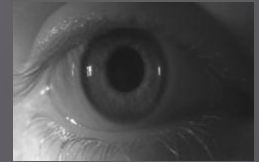
Algorithmic Fusion of Face and Iris

- Single image capture for face-iris recognition

- Iris technology to process images within the conditions and resolutions of face acquisition

- Face acquisition near infrared illumination (usual for iris)

- Improved iris feature extraction for off axis acquisition and uneven illumination

- Designed algorithm for mode selection: iris-iris and face-iris
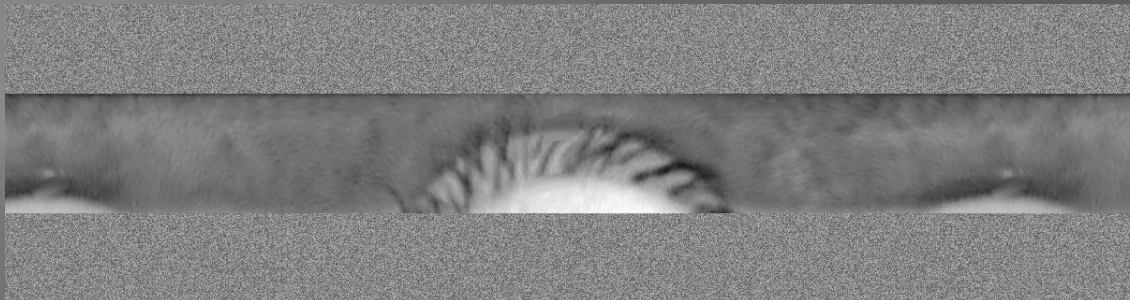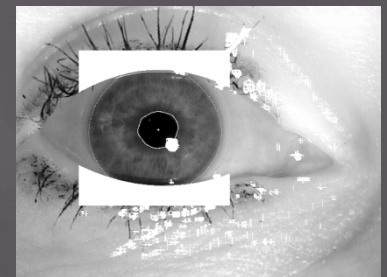
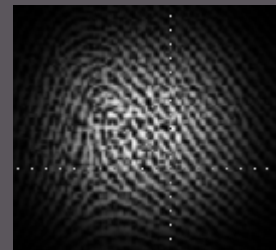# Application of Level 3 Matching to Latent Finger and Palm Prints

| Matcher Subsets	BE7 (level-2)	BE7+BYT (texture)	BE7+BYT +HCP
L5 (minutiae only)	49.80%	N/A	56.08% (no BYT)
L1 (image only)	57.68%	62.24%	N/A
L2 (image+minutiae)	70.98%	74.12%	74.51%
L3 (image+extended feature set)	81.18%	86.27%	N/A

Table 1.1: Rank-1 Performance with data subset of 240 mates on 4180 exemplars ordered in by increasing effectiveness of feature set used.

* HCP = Hausdorff Distance matcher

- **Fuse various Level 3 feature matchers with Level 2 minutiae matcher for latent fingerprints.** (Level 3 features include ridge shape, sweat pores, incipient ridges, scars, permanent creases, and other distinguishable marks)

- **NIST-EFS data set**

- **Automated level 3 feature extraction for gallery . Manual level 3 feature extraction of latent probes**

- **Candidates from level 2 matcher will invoke level 3 matching.**

- **SDK deliverable**

Site Adaptive Face Recognition at a Distance

pittpatt

- Designed to recognize low quality facial images from video surveillance

- System to locate 26 pose specific landmarks on the human face

- Site adaptive training method has been developed for the major components of the PittPatt face recognition training algorithm

- Improved precision of face alignment by extending Boosted Ranking Model (BRM)

- Semi-supervised face alignment which can propagate the manual labeling from a few images to a large image ensemble

- Eleven white papers published
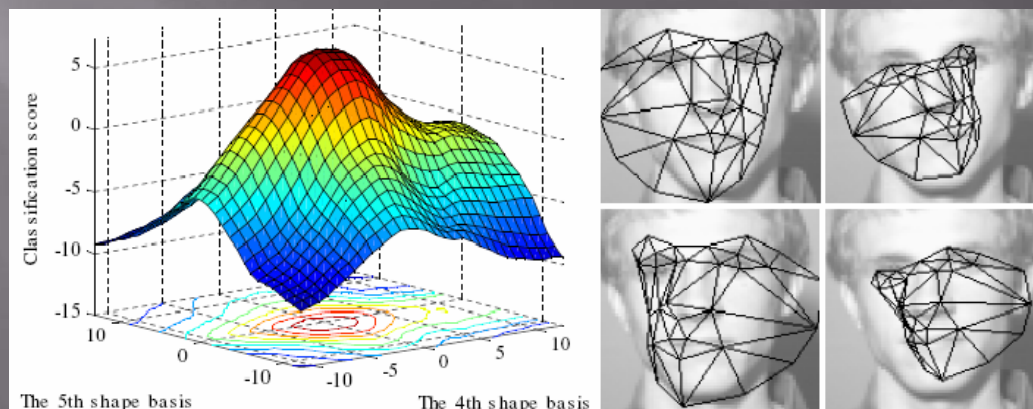
Current Research

3D Hand-Held Surveillance and Real Time Remote Multi-Modal Facial Recognition Device

Status: OPEN

- Develop a hand-held wireless 3D binocular/camera capable of face acquisition up to 1000 meters capable of real time face recognition.

- Wireless transmits 3D video clip to server via encrypted wireless upload. Server performs quality assessment

- Field testing with LA Sheriff Dept. & subsequent delivery of two devices to NIJ.

- L1 matcher

- Super resolution and speckle processing
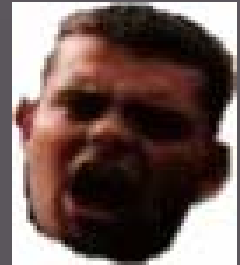
Mobile Fingerprint Capture

- Optical based fast four fingerprint scanner Acquisition time approx 1 sec per finger

- Rotational contactless 180 degree scan area or "rolls"

- Liveness test with IR scan of blood vessels

- Mobile unit with wireless encrypted WiFi and Bluetooth upload

- Will include adaptive lighting system. Camera provides real time feedback of lighting conditions of 6 areas of each finger
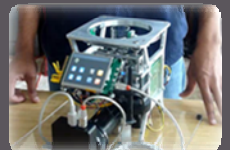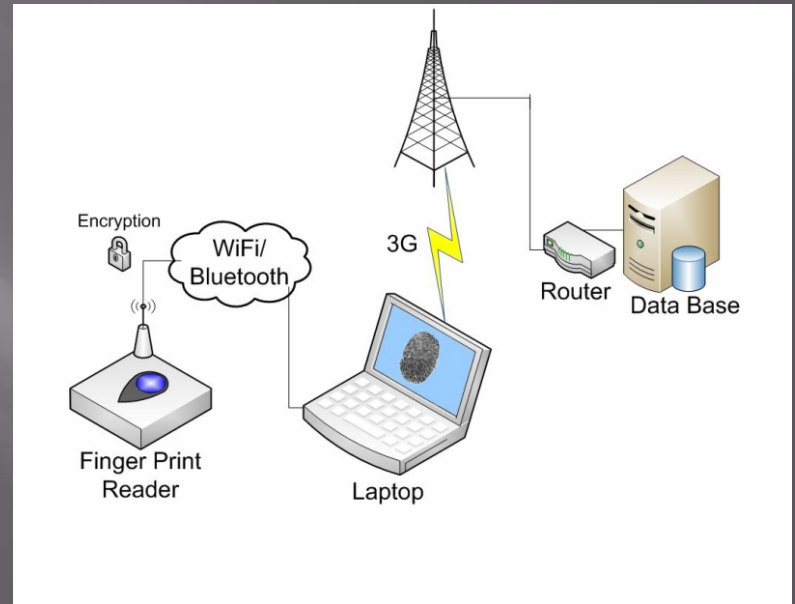
Automatic Fingerprint Matching Using Extended Feature Set

MICHIGAN STATE UNIVERSITY

Status: OPEN

- Improve match performance with automated extraction and matching of extended features singular points, pores, dots, ridge flow (orientation field) and minutiae shape

- Ten prints and latent prints

- Combine minutiae and extended features using various fusion schemes

- Study the statistical properties of extended features and demonstrate the performance gain by combining minutiae and extended features using various fusion schemes
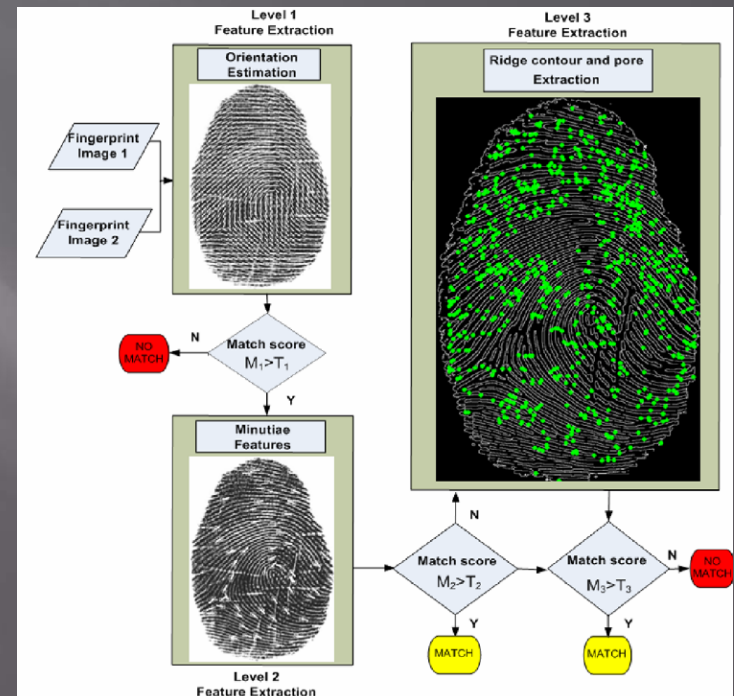
WVU Identification Technology Research and Transition Center

- Create the Research Transition Center Enterprise within the Center for Identification Research (CITeR) at West Virginia University (WVU)

- Host cooperative operation-based research with direct involvement of academic, industry, and government to assess readiness of biometric technologies that specifically address government needs.

CITeR

CENTER FOR IDENTIFICATION TECHNOLOGY RESEARCH

Face Annotation at the Macro-scale and the Micro-scale: Tools, Techniques, and Applications in Forensic Identification

UNIVERSITY OF NOTRE DAME

MICHIGAN STATE UNIVERSITY

Status: OPEN

- Formulate the characterization and representation of macro and micro facial features

- Previous categorizations overlap and are ambiguous

- Form and propose a standard for localized facial features

- Develop and evaluate methods for automatic and/or semi automatic extraction of such facial features in high resolution digital imagery

- Definitions of marks are now based on three different morphologies (i.e., Point, linear and Irregular) and two color characteristics, (i.e., light or bright)

- Currently designing automatic mark extraction and classification with medium resolution images to eventually be used on high resolution images
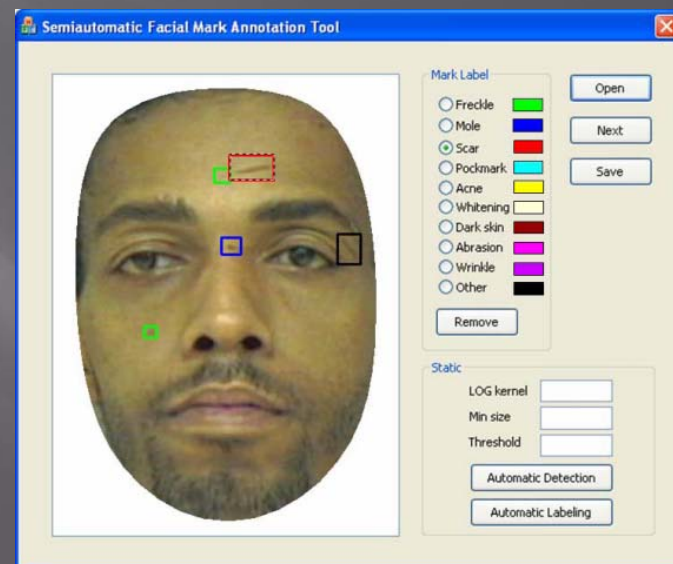
DNA Solicitations

- DNA backlog reduction - Make funding available to states and local LE for DNA analysis of cold cases (CODIS)
- Using DNA to find the missing (CODIS)
- Convicted Offender and/or Arrestee DNA Backlog Reduction Program
- Post conviction DNA Testing Assistance
- Forensic DNA Unit Efficiency Improvement
- Forensic DNA Research and Development - robust, more informative, less costly, or less labor-intensive identification
- Solving cold cases with DNA

DNA Backlog

Figure 1: DNA Casework: Supply, Demand, Backlogs

Legend: Backlog from previous year | New cases
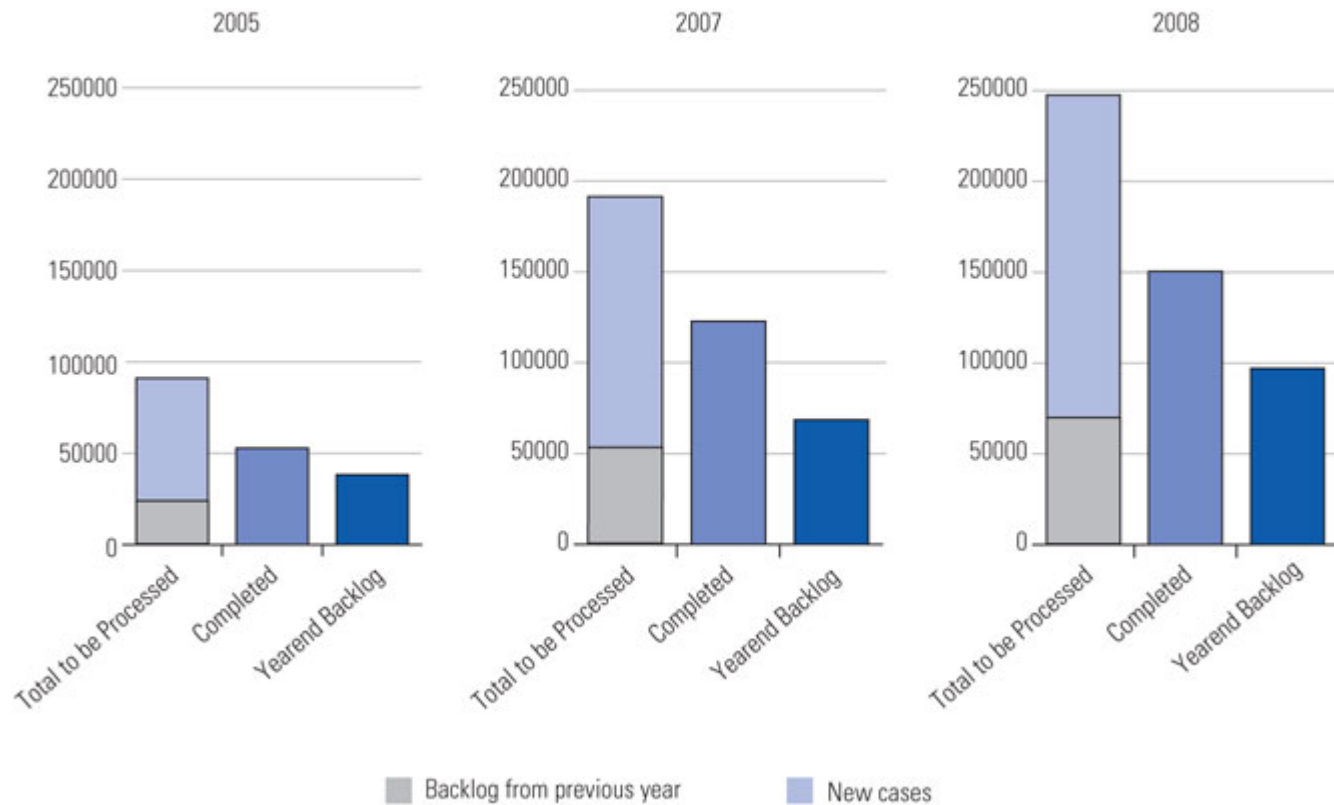
The Fingerprint Source Book

- Invaluable resource for the forensic community

- Topics such as: History, Anatomy of friction ridges, Processing, Equipment, Quality Assurance, Research and Challenges

- Chapters will appear online at the NIJ website as they are completed

- A hardcover print version will be available when all chapters have been completed
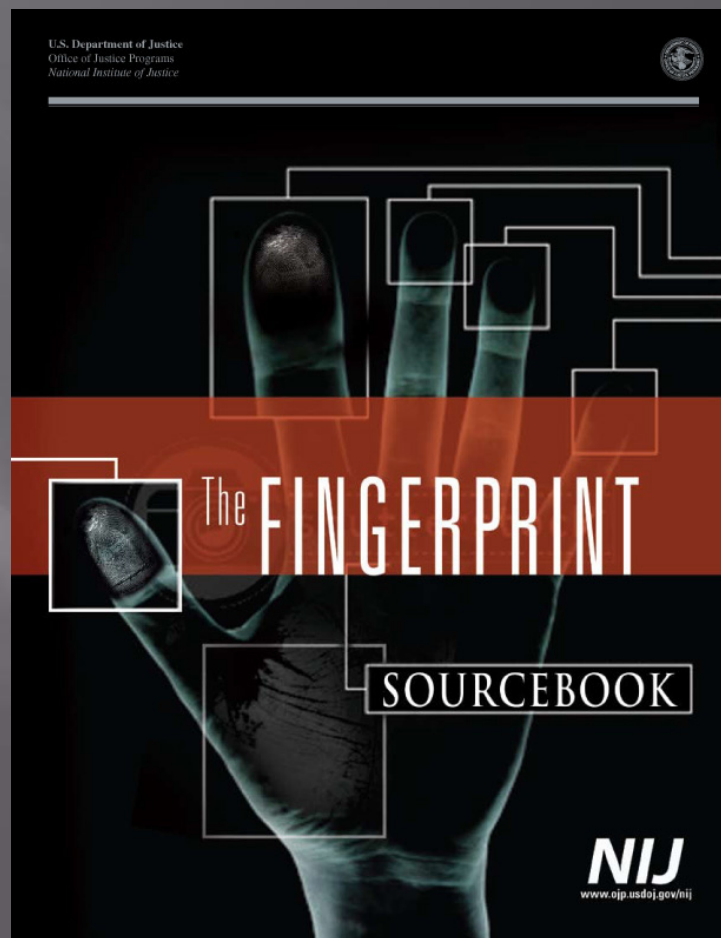
Other ancient artifacts have been found that have ridge patterns on them that were clearly carved rather than left as accidental impressions. It is important to note, however, that ridge designs similar to human friction ridge skin also occur in animal species other than humans, in some plants, and even in natural inanimate formations such as sand moved by wind or water. Therefore, it cannot be conclusively determined that all friction ridge-like artwork in ancient artifacts was produced as a representation of human friction ridge skin. Examples of ancient artifacts with friction ridge-like designs include megalithic artworks in the tomb of Gavr'inis on an island just off the west coast of France (Figures 1–3) and in the tomb at Newgrange on the coast of Ireland (Figures 4–6).

1.3 221 B.C. to 1637 A.D.

The Chinese were the first culture known to have used friction ridge impressions as a means of identification. The earliest example comes from a Chinese document entitled "The Volume of Crime Scene Investigation- Burglary," from the Qin Dynasty (221 to 206 B.C.). The document contains a description of how handprints were used as a type of evidence (Xiang-Xin and Chun-Ge, 1988, p 283).

Additionally, in India there are references to the nobility using friction ridge skin as signatures:

> In 1637 AD, the joint forces of Shah Jahan and Adil Khan, under the command of Khan Zaman Bahadur, invaded the camp of Shahuji Bhosle, the ruler of Pona (in the present day Maharashtra). The joint army defeated Shahuji, who was compelled to accept the terms of peace:
>
> > Since the garrison (of Shahuji) was now reduced to great extremities ....[,] Shahuji wrote frequently to Khan Bahadur in the most humble strain, promising to pay allegiance to the crown. He at the same time solicited a written treaty... stamped with the impression of his hand. (Sodhi and Kaur, 2003a, p 126–135)

The above text is an example of the nobility's use of palmprints in India to demonstrate authenticity when writing a document. The use of prints on important documents was adopted from the Chinese, where it was used generally, but in India it was mainly reserved for royalty (Sodhi and Kaur, 2003a, p 129-131). The use of friction ridge skin as a signature in China, Japan, India, and possibly other nations prior to European discovery is thus well-documented.

FIGURES 1–3

The stones at Gavr'inis (dated 3800 to 3500 B.C.). (Reprinted from Burl, Cunliffe.)

FIGURES 4–6

The stones at Newgrange, Ireland dated 3300 to 3000 B.C.). (Reprinted from Cunliffe.)

FIGURE 7

Dr. Nehemiah Grew (1641-1712).

FIGURE 8

Dr. Marcello Malpighi (1628-1694).

1.4 17th and 18th Centuries

In the late 17th century, European scientists began publishing their observations of human skin. Friction ridge skin was first described in detail by Dr. Nehemiah Grew (Figure 9) in the 1684 paper *Philosophical Transactions of the Royal Society of London*. Dr. Grew's description marked the beginning in the Western Hemisphere of friction ridge skin observations and characterizations (Ashbaugh, 1999, p 38; Lambourne, 1984, p 25). In 1685, Govard Bidloo, a Dutch anatomist, published *Anatomy of the Human Body*, which included skin and the papillary ridges of the thumb but failed to address individualization or permanence (Ashbaugh, 1999, p 39; Felsher, 1962, p 6–12). In 1687, the Italian physiologist Marcello Malpighi (Figure 10) published *Concerning the External Tactile Organs*, in which the function, form, and structure of friction ridge skin was discussed. Malpighi is credited with being the first to use the newly invented microscope for medical studies and, because of this, a layer of skin (stratum Malpighi) was named after him. In his treatise, Malpighi noted that ridged skin increases friction between an object and the skin's surface. Friction ridge skin thus enhances traction for walking and grasping (New Scotland Yard, 1990; Ashbaugh, 1999, p 40).

It would be 1788 before the uniqueness of this skin was recognized in Europe. J. C. A. Mayer, a German doctor and anatomist, wrote a book entitled *Anatomical Copper-plates with Appropriate Explanations*, which contained detailed drawings of friction ridge skin patterns. Mayer wrote, "The similarities are closer among some individuals. Differences are marked, yet in spite of their peculiarities of arrangement all have a certain likeness." (Cummins, 1943, pp 12–13).

1.5 19th Century

English wood engraver and ornithologist Thomas Bewick (1753-1828) published many books with wood engravings of birds and other animals. Three woodcuts (made in 1809, 1818, and 1826) included a fingermark, and the latter two had the legend "Thomas Bewick, his mark" (Herschel 1916, 32-33). The woodcuts (Figure 11) were very detailed, but it is unknown whether Bewick understood the value of friction ridge skin for individualization (Galton, 1892, p 26; Lambourne, 1984, p 26).

In his 1823 thesis titled "Commentary on the Physiological Examination of the Organs of Vision and the Cutaneous System", Dr. Johannes E. Purkinje (1787-1869), professor at the University of Breslau in Germany, classified fingerprint patterns into nine categories and gave each a name (Figure 12) (Lambourne, 1984, p 26; Galton, 1892, pp 85-88). Although Dr. Purkinje went no further than naming the patterns, his contribution is significant because his nine pattern types were the precursor to the Henry classification system (Herschel, 1916, pp 34-35; Galton, 1892, pp 67, 119).

German anthropologist Hermann Welcker (1822-1898) of the University of Halle led the way in the study of friction ridge skin permanence. Welcker began by printing his own right hand in 1856 and then again in 1897, thus gaining credit as the first person to start a permanence study. However, in the paper Welcker published in 1898, he sought no credit, but rather seemed only to offer assistance to prior claims of permanence in reference to friction ridge skin (Wilder and Wentworth, 1918, pp 339-340). Welcker

NIJ Partners

NIJ's Customers

- Federal, state & local criminal justice practitioners
  - 19,000 Law Enforcement Agencies
    - 750,000 Law Enforcement Officers
  - 4,451 Corrections Agencies (some overlap with law enforcement agencies)
    - 430,000 Corrections Officers
  - 351 Crime Laboratories
  - Courts, Probation & Parole, etc.
  - Public Safety Community at-large
- Department of Justice
  - Law enforcement components
  - OJP program offices, other Federal agencies
- Policymakers at all levels of government
- Researchers
- American public

Where to go........

www.ojp.usdoj.gov/nij

www.Justnet.org

www.ncjrs.gov

Biometrics Staff

William Ford – Division Director
202-353-9768
William.Ford@usdoj.gov

Mark Greene – Biometrics Portfolio Manager
202-307-3384
Mark.Greene@usdoj.gov

Steve Schuetz – Senior Program Manager
202-514-7663
Steve.schuetz@usdoj.gov

Back Up Slides

Past Solicitations
(Areas of Interest)

FY10 - Hand-held biometric acquisition and identification at a distance

FY09 - Mobile fingerprint capture

FY08

FY07
- Identification from video and audio surveillance
- Fast capture of latent and rolled-equivalent fingerprints and palm prints
- Expedited automation of legacy biometric information that is not yet shared electronically
- Acquisition of biometrics in field environments
- Access control

FY06
- Through-the-wall surveillance (TWS) for locating and/or tracking individuals within buildings
- Fast capture of rolled-equivalent fingerprints
- Identification from audio video
- Acquisition of biometrics in field environments
- Access control (weapons, communication devices)