The Center for Security Technologies
Technology Review

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Outline

• WUSTL
• CST Scope
• Intellectual Research Thrusts
• Integrated Demonstration Testbeds
• CST Collaborations
Washington University
Center for Security Technologies

• Washington University:
  - USNWR: 12, top ten in endowment
  - 8 Schools: Medical, GWBSSW top 3
  - SEAS: 6 departments including ESE and CSE

• CST
  - Interdisciplinary Academic Research Center
  - Formed early 2002
  - Foundations

• Funding
  - Individual investigator, groups, and Center level

• External Collaboration
CST Mission

To advance research in basic science, mathematics, and engineering in those areas which can most directly improve security including:

- physical aspects of security (intrusion detection, biological and chemical substance identification)
- information aspects of security (networking, searching of massive databases, and information theory)
- law
- economics
- public policy
CST Coverage

- Broad spectrum of applications
  - Not just focused on information assurance
  - 40 faculty from five schools
  - Integrated research testbeds

- Security is not only terrorism
  - A variety of ‘attacks’ including natural disasters

- Synergy between technology and policy
  - Privacy/public policy as ‘design criteria’
Faculty Breadth

14 Electrical and Systems Engineering
13 Computer Science and Engineering
5 Arts and Science (Chem, Math, EPS, Phil, Econ)
1 Medicine
5 Law
2 Social Work
Technology Expertise and Enablers
devices, design, analysis, computation, electronics, systems ...

- Cheap, even disposable sensors
- Inexpensive mass data storage
- Fundamental advances in imaging science
- Reconfigurable, fast electronics
- Affordable, rapid computational processing
- Economical, pervasive networking, including wireless
Application: Fingerprints

• Court ruling
  - fingerprint recognition not a science
  - Need new scientific foundations for biometrics-based recognition and object recognition

• Consider complete security system
  - optical or ultrasound image
  - computational algorithms
  - hardware implementation
  - management/transmission of data
  - performance prediction
S & T Intellectual Thrusts

- Sensors: Indeck
- Advanced Electronic Systems: Lockwood
- Information-Theoretic Signal and Image Processing: Snyder
- Recognition Theory and Systems: O’Sullivan
- Vision for Security: Pless
- Distributed and Mobile Systems: Gill
- Network and Information Security: Hegde
- Detection, Isolation, and Accommodation of Faults: Isidori
- Privacy, Public Policy, and Ethics: Kieff
Sensors

- Optical Cameras: custom, high-end, off-the-shelf, frame-rates
- Infrared, Multispectral, Hyperspectral Sensors
- Biological and Chemical Sensors
- X-ray, ultrasound, MRI
- Custom sensors such as fingerprint, retinal
- Magnetic
- Radar
- Active, passive

Indeck, Brownstein, Fritts, Fuhrmann, Hayes, O’Sullivan, Pless, Smith, Snyder

Center for Security Technologies
Washington University in St. Louis
Advanced Electronic Systems

- Reconfigurable electronics
- Embedded processing
- Signal processing and VLSI design
- Novel electronics including random number generation

Lockwood, Chamberlain, Franklin, Fritts, Morley, Richard, Rode, Shrauner
Information-Theoretic Signal and Image Processing

- Signal and image processing, deterministic and stochastic
- Data modeling, algorithm development, performance prediction
- Signal and information representation, compression, coding

Snyder, Fuhrmann, Grimm, Hegde, Mukai, O'Sullivan, Pless, Wickerhauser, Xu
Recognition Theory and Systems

- Biometrics-based recognition including face, fingerprint, retinal, DNA, etc.
- Physical signature recognition including magnetic signatures
- Fast database searching and recognition system implementation
- Data and model compression, signal representation
- System implementation considerations: processors, computation, communication, database design
- Data mining, intelligence extraction, situational awareness

O'Sullivan, Byrnes, Chamberlain, Franklin, Indeck, Martin, Grimm, Pless, Wickerhauser, Washington University in St. Louis
Vision for Security

- 3D Scene modeling
  - known or constrained scenes, unknown scenes
  - Texture, lighting, BRDF
  - Deterministic, stochastic
  - Natural scenery, man-made objects, known objects
- Scene and camera motion, known and unknown
- 3D registration
- Smart cameras, embedded processing
- Optical, infrared, hyperspectral, radar imaging systems

Pless, Fuhrmann, Fritts, Ghosh, Grimm, O’Sullivan, Smart, Smith, Snyder
Smart Borders – Smart Cameras
Privacy, Public Policy, and Ethics

- Societal issues, security-privacy perception and reality
- Economic issues, cost-benefit analysis
- Legal issues
- Technological solutions to privacy issues
- Facilitate discourse on technology and its implications
- Interact together as a group through common queries
- Bilateral interactions with technologists regarding technological enablers and systems design.
Selected Center Projects

- Forensics
- Sensing (optical, HSI)
- Object identification
- Voice/fingerprint recognition
- Airport screening
- Satellite imagery, vision
- Encryption/data security
- Network security
- Water/food supply
Engineering Demonstration Testbeds

- Connect all parts
- End-end demonstration
  - Biometrics/Physics-Based Recognition Systems  Morley
  - Searching Massive Databases for Critical Information  Franklin
  - Networks of Video Cameras  Pless
  - High Speed Network Security  Hegde
  - Security of the Food and Water Supply  Smith
  ➢ Roles of Privacy and Policy  Kieff
Humanoids have produced 12 Exabytes over the past ~30,000 years (12,000,000,000,000,000,000 Bytes)
We will generate next 12 Exabytes in just over a year!
US intelligence collects data equaling the printed collection of the US library every day!
- email, telephone, satellite, . . .
To find what we’re looking for most effectively . . .

. . . push the request to the data!
Intelligent Searching of Massive Databases

Fast, inexpensive searches for changing databases

- 200 times faster than conventional searches
- Scalable, using conventional drives
- Search need not be exact

Wide applicability

- Intelligence
- Images
- Genomics

DataSearch Systems, Inc.

CST
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IBM
Washington University in St. Louis
The Case of Maury Travis

Suspect in over 20 murders
Sent map to Post-Dispatch
Contacted Expedia
ID’ed IP address
Contacted MCI-WorldCom
Apprehended suspect

Per Sgt. Muffler
Data Transmission

- 120 TBytes/sec internet peak rate
- 120 PBytes/month Internet
- 100 PBytes/month telephone
Network Watchman

- Electronic postmen
  - direct packets to destination via headers
- Secure network
  - search headers
  - view payload
  - copy/redirect/stop packets
Networks of Distributed Sensors

- Existing or future sensor networks
- Networks of sensors
  - **Waterway**: detect pollution, bioterrorism, chemical spills
  - **Building**: fire, temperature, other agents
  - **Cameras**: dynamically reconfigure
  - Communicate problems, identify source
  - Real-time response to evolving situations

BECS Engineering
Digital Array Scanning Interferometer (DASI)

**Food Supply, Mail, Currency**

- **Diagram**: Diagram showing the components of the DASI system, including collimator lens, 45° polarizers, reimaging lens, Wollaston prism, and spatial interferogram (falls on 2D FPA).

- **2D Scene at Wavelength λ₀**: Diagram illustrating a 2D scene at wavelength λ₀, showing the radiant spectrum at position (a,b).

- **Scene Cube**: Conceptual representation of the scene cube, indicating polarization, propagation effects, and time evolution.

- **Logos**:
  - MEDECO
  - FDA

- **Images**: Images showing various scenes from the DASI system.
CST Funding/Collaborations

- NSF, DoEd
- DARPA, ARO, ONR
- CIA, FBI, NSA, Secret Service
- NIST – ATP
- Battelle
- Boeing, CSFB, Monsanto, SBC . . .
CST External Advisory Board

Mr. Earle Harbison (retired President and COO, Monsanto), Chair
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Dr. Don Ross (Chairman, Ross and Baruzzini: Cernium)
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Center for Security Technologies

- Critical mass in security technologies
- Many complementary projects
- Widespread applications
- Fundamental scientific issues
- Guiding standards
- Uniquely integrating privacy issues
- Synergy between WUSTL & region
Center for Security Technologies

International Scientific and Engineering Resource