Algorithm Development for Security Applications (ADSA) Workshop 8:

Automated Threat Recognition (ATR) Algorithms for Explosion Detection Systems

Workshop Objectives

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Conclusions / Questions

- How to get *better* ATRs developed and deployed?
- What does *better* mean?
- How are features chosen?
- How are classifiers developed?
- How should requirements be set?
- How are ATRs trained & tested?
- How do testing and requirements affect development?
- How to involve third parties?
- How to use risk-based screening and deterrence?

ATR Definition

Sensor → ATR → Go No-go

- Sensor: CT, XBS, MMW, Trace, QR, XRD, fused system
- ATR
  - In: sensor data
  - Out: Red or green light
  - Fully automated (no human)
- Requirements (classified)
  - N classes of explosives with minimum mass
  - PD > x , PFA < y
- Conops requires human review in real world

ProVision
ATD

SmartCheck   AS&E

smiths
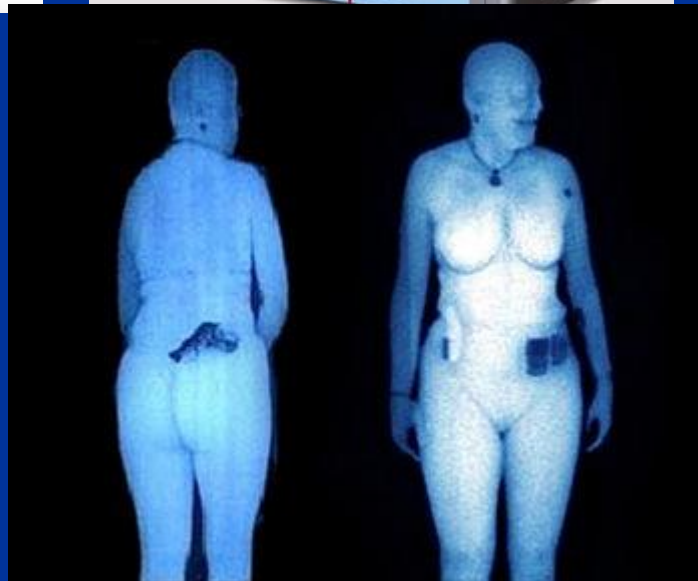
All images from the Internet.
Pictures not to scale.
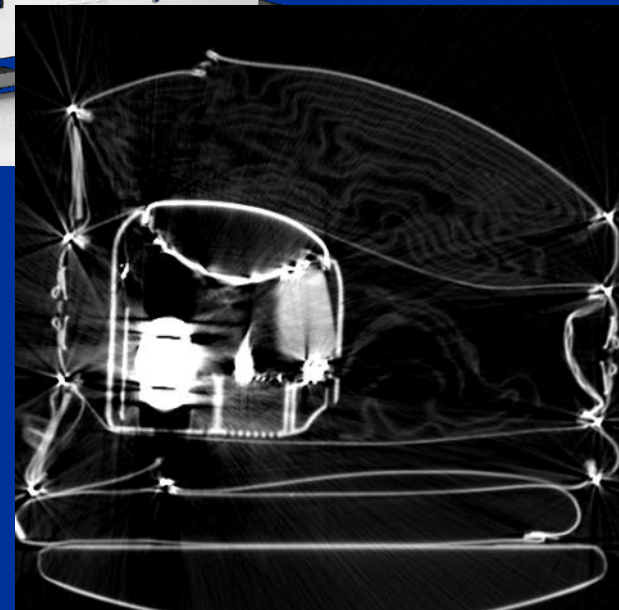
Image provided by Telesecurity Sciences.
Pictures not to scale.

Pictures not to scale.

Generic System Diagram

Sensor → Recon* → ATR → Display → Decision

Divested – Objects People → Sensor

Operator → Display

Recon Output → Segmentation → Feature Extraction → Classifier → Binary Decision & Annotated Image to Display
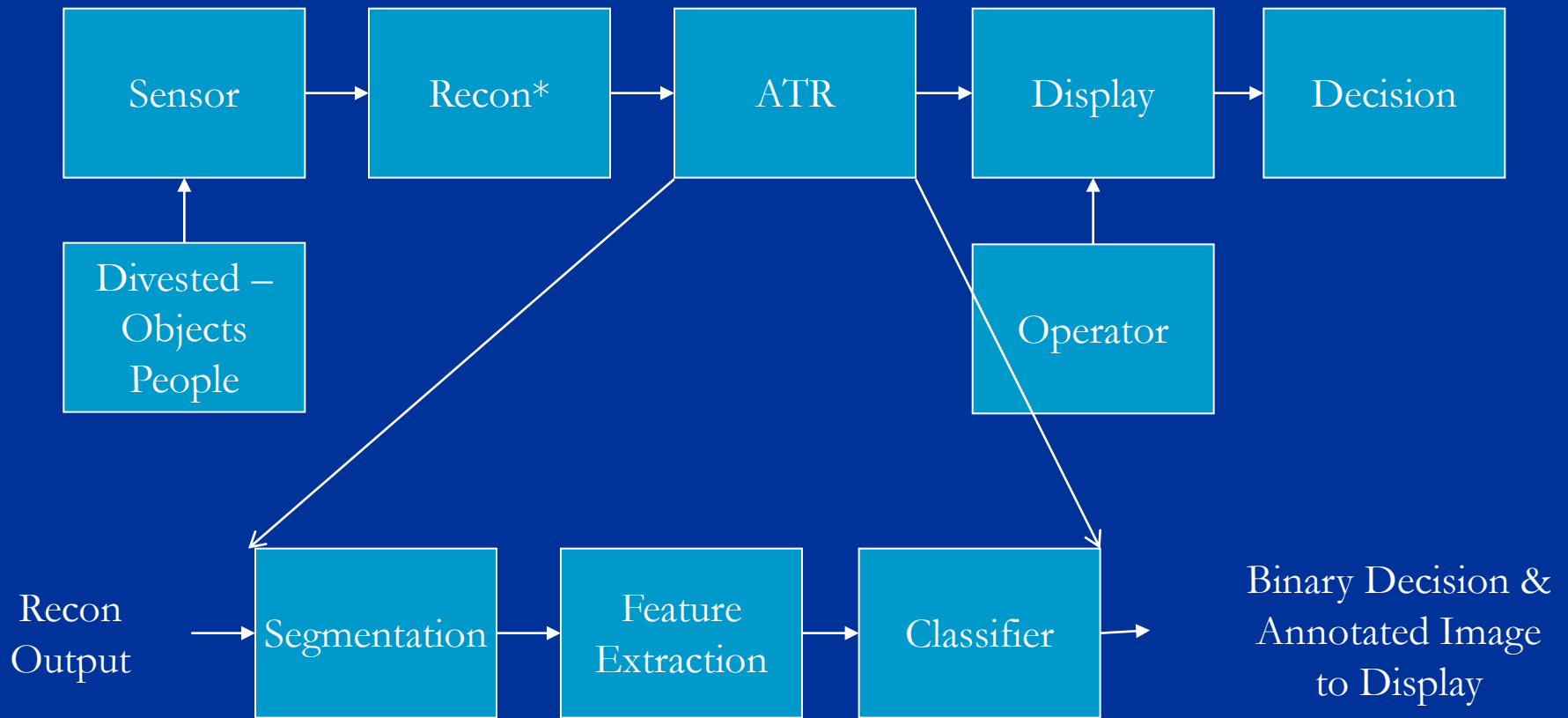
Notional ATR

*Recon is optional or integrated with ATR or denoted pre-processing.

Problem

- Terrorists still trying to take down airplanes
- Terrorists are making home-made explosives (HME)
- Need better detection performance
    - More types of explosives
    - Lower masses
    - Increased probability of detection (PD)
    - Decreased probability of false alarm (PFA)

Bin Laden Dead, But …

His Followers Are Still There

- Plot to bomb airliner foiled, officials say

- A nonmetallic explosive device was recovered that had similarities to the one used in the failed attempt to bomb a Detroit-bound jet in 2009, a U.S. official said.

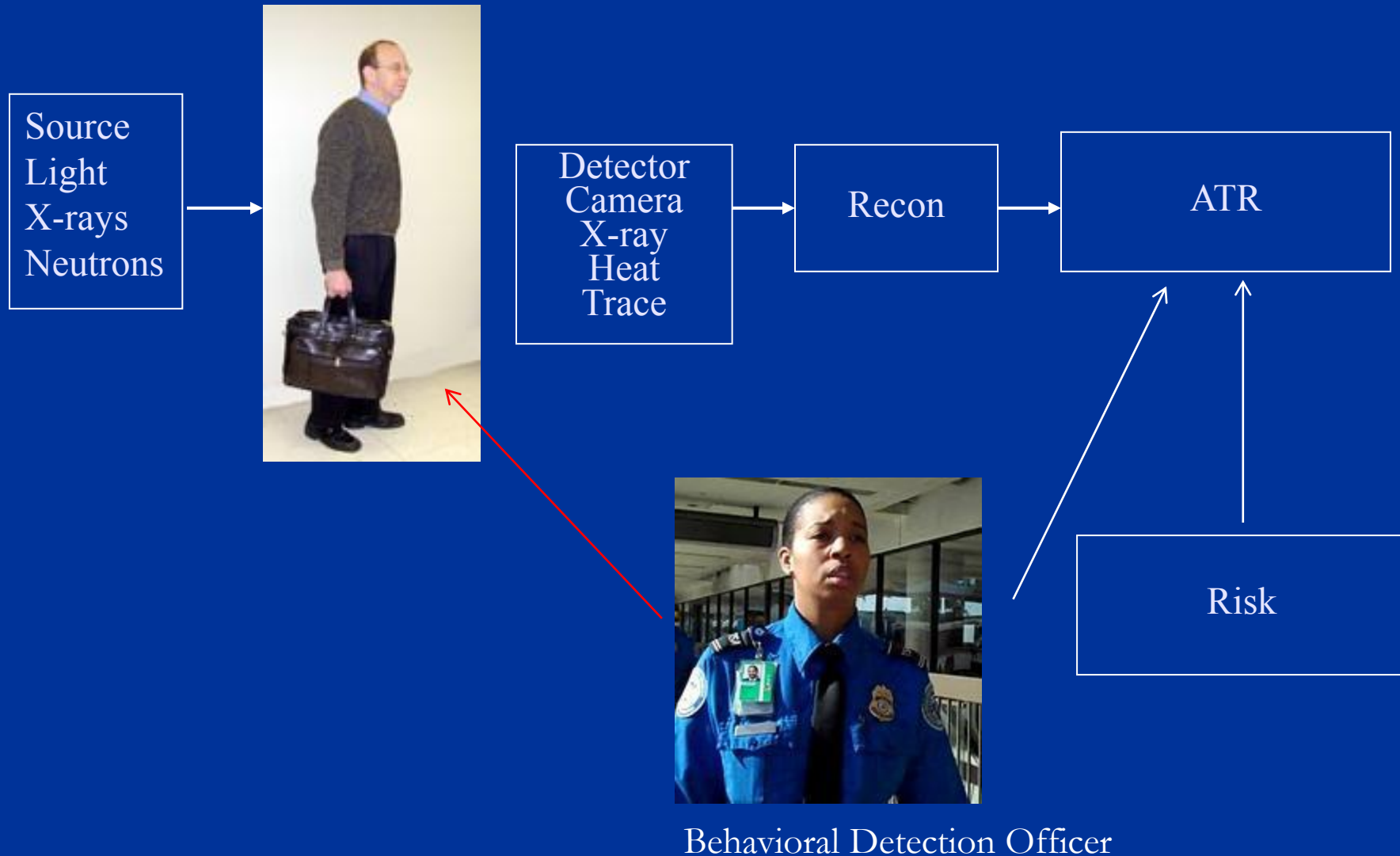# Man arrested after plotting Federal Reserve bomb, authorities say

ADSA08 Topics

- Topics:
    - How to get *better* ATRs developed and deployed?
    - What does *better* mean?
    - How are features chosen?
    - How are classifiers developed?
    - How should requirements be set?
    - How are ATRs trained & tested?
    - How do testing and requirements affect development?
    - How to involve third parties?
    - How to use risk-based screening and deterrence?
- Look at related fields (radiologic, video)
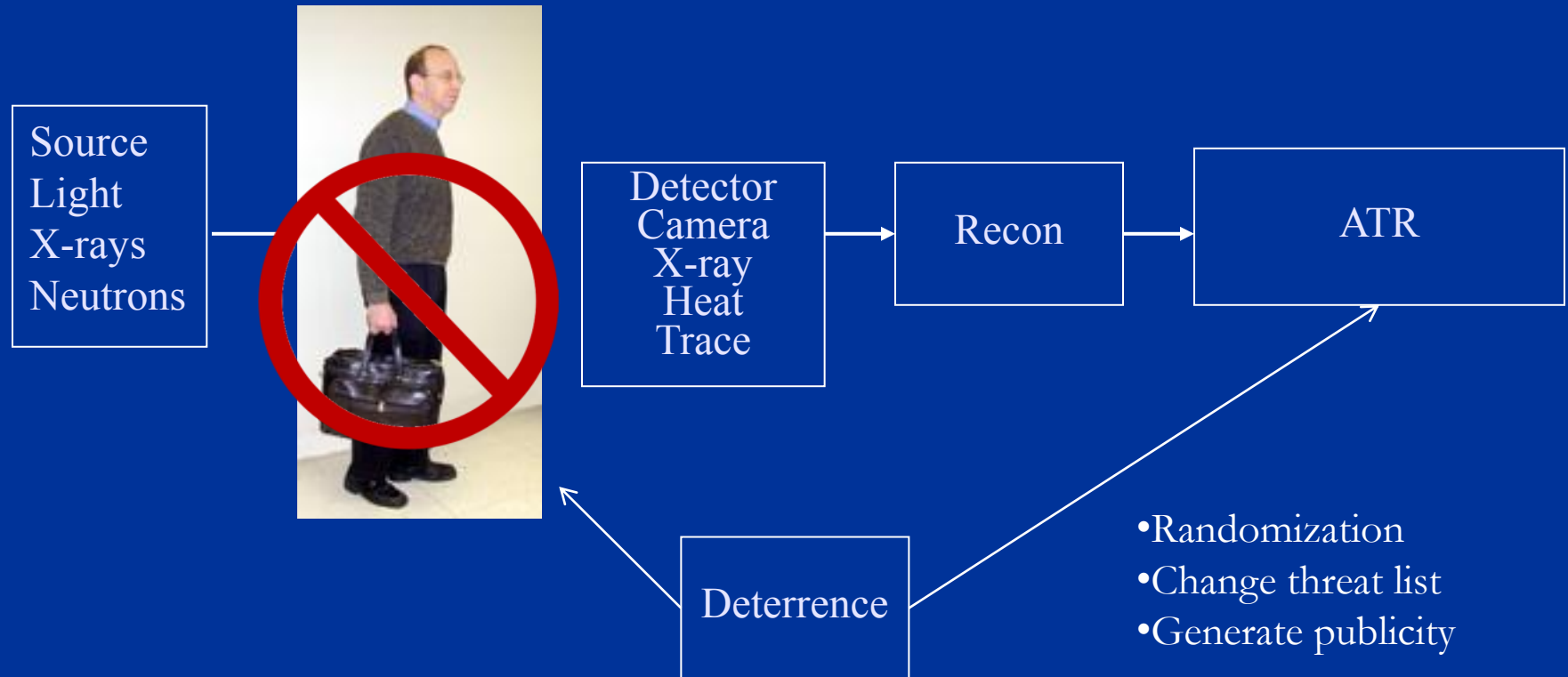- Introduce new topics: XBS dose, behavioral detection, terrorism risk

Issues (TSA)

- ATRs are integrated with vendor equipment today
  - Exception is Optosecurity in Europe
- Not allowed to test an ATR independent of a vendor scanner
- Requirements are classified
- How to set up surrogate problems
  - Detect Coke in suitcases?
- How generic can an ATR be?
  - ATRs are present tuned to scanner output and acceptance testing
- Where to operate on ROC?
  - We don't know whether 90/20 (PD/PFA) or 80/5 is better (Ellenbogan, ADSA01)

Risk-Based ATR

Source
Light
X-rays
Neutrons

Detector
Camera
X-ray
Heat
Trace

Recon

ATR

Risk

Behavioral Detection Officer

Deterrence used in ATR

Source
Light
X-rays
Neutrons

Detector
Camera
X-ray
Heat
Trace

Recon

ATR

Deterrence

- Randomization
- Change threat list
- Generate publicity

Goal: Design system including ATR to keep terrorist out of airport.
Deterrence is more than an ATR.

Tools Versus Craft

- Need to fix my gas furnace
  - Can purchase tools and parts from Home Depot
  - Would not do it myself
- ATR
  - Segmentation, classification tools available on web
    - Feature extraction and domain expertise not available on web
  - Requirement specs not on the web
 - ADSA08 mainly interested in how to approach developing an ATR

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DHS Tactics

- *Augment* abilities of system vendors with 3rd party involvement
- 1st party = TSA/DHS
- 2nd party = incumbent vendors
- 3rd parties
  - Academia
  - Industry other than system vendors
- Create centers of excellence (COE) at universities
- Hold workshops to educate 3rd parties and discuss issues with involvement of 3rd parties
- Fund 3rd parties and deploy advances

Amateurs Discover Planet with Four Suns

- This week, reality trumped (science) fiction with an image even more enthralling: two amateur astronomers poring through data from deep, distant skies and discovering a planet with four suns.

- The discovery of the four-sun planet by amateur scientists takes crowd sourcing to new heights. The expression, coined by Wired magazine editor Jeff Howe, describes tasks that are outsourced to a disparate group of people to come up with a solution.

- In this case, the Planet Hunters group made data from NASA's $600 million Kepler telescope available to the public through its website and coordinates their findings with Yale astronomers.
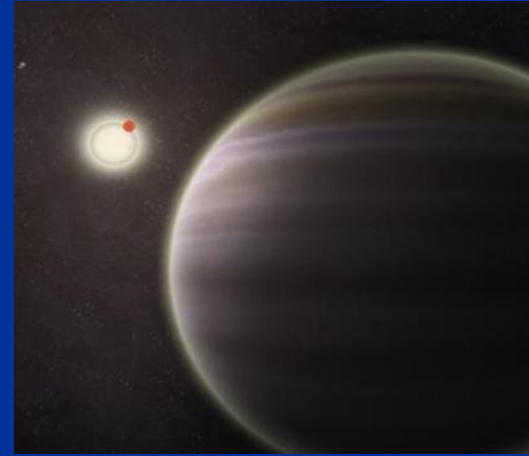
This is why DHS wanted to involve third parties.

ADSA History

- ADSA01: Check point
  - Recommend: grand challenges (GC) on segmentation and reconstruction
- ADSA02: GC for segmentation for CT-based EDS
- ADSA03: Body scanners (AIT)
- ADSA04: CT reconstruction
- ADSA05: Fusion of orthogonal systems – general
- ADSA06: Fusion for body scanners
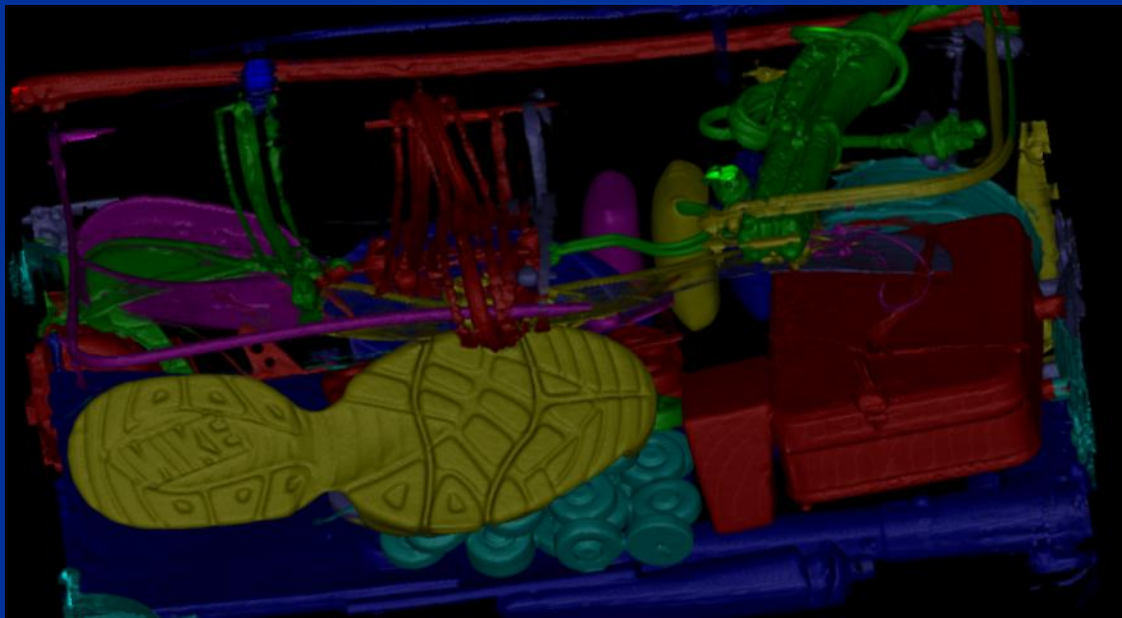- ADSA07: Reconstruction for CT-based EDS
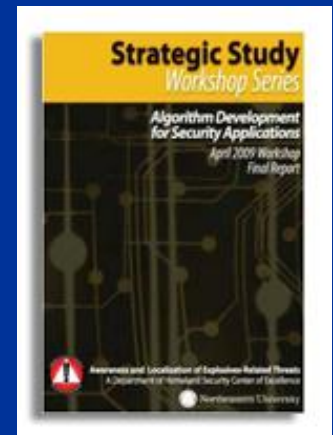
Final reports available at:

www.northeastern.edu/alert/

transitioning-technology/strategic-studies/

Segmentation Grand Challenge

- Five groups developed segmentation methods using scans of non-threats on medical CT scanner
- Two (randomly selected) groups to present at this workshop
- All to discuss how to optimize reconstruction for segmentation
- Final report available at site with ADSA final reports

Reconstruction Initiative (Grand Challenge)

- In progress
- CT-based EDS
- Algorithms
  - Iterative reconstruction
  - Improved filtered back-projection
  - Sinogram processing
  - Metal artifact removal
- Projection data
  - Imatron cardiac CT scanner
  - Simulations
- Metrics

Review meeting 7-10 PM tonight after the dinner session.
Everyone welcome to provide their insights.

Questionnaire

- Request for everyone to answer questions preferably during the workshop

- Hand in at end of workshop or email

- Typed or handwritten acceptable

- Name is optional

- Also available via Survey Monkey
  - https://www.surveymonkey.com/s/adsa08

Reception and Dinner

- Reception and dinner tonight part of workshop
- Student poster session during the reception before dinner
- Reconstruction meeting after dinner
- Sorry about conflict with World Series
  - Go Red Sox!

Mea Culpa - Agenda

- Forgot to include section headings

- Too many talks scheduled

- Moderator will provide glue during workshop

- Apologies to those people (~10) whose talks we could not accommodate or to others (~5) with shortened durations

Minutes & Participant Identification

- Minutes will be taken, but edited for final report
- Please identify yourself and institution first time you speak or ask questions

Acknowledgements

- Northeastern University (NEU)
- Awareness and Localization of Explosives-Related Threats (ALERT) Center of Excellence
- Department of Homeland Security (DHS)
- Presenters
- Participants
- Students

Logistics

- Deanna Beirne
- Kristin Hicks
- Brian Loughlin
- Rachel Parkin
- Melanie Smith

Let them know if you need support during or after workshop.

Rule #1 – Open Discussions

- This is a workshop
- Conversation and questions expected at all times, especially during presentations
- Moderator responsible for keeping discussions focused
- Not grip-and-grin

Rule #2 – Public Domain

- Do not present classified or SSI material
- Presentations, minutes and proceedings will be placed in the public domain after review for SSI and classified material

Rule #3 – Speaker Instructions

- 2nd slide has to be conclusions
  - Optimum presentation: stop at 2nd slide
- Expect discussion during presentation
- Allocate 50% of time slot for discussion
- Do not repeat material from prior speakers
- Delete math
- Concentrate on results
- Details into backup slides
- Delete slides now if necessary
- Put presentation on ALERT laptop in advance.

Beware of Moderator!

Logitech R800

- Slide advancer
- Laser pointer
- Count-down timer
  - Vibrate at 5, 2, 0 minutes left
- Explodes if 1 minute late!!

Vendors*

- **DO's**
  - Clearly communicate your expectations
  - Be Open: Accept new ideas
  - Share Data
  - Actively manage the project (find your 'Man from Milwaukee'). Invest more than money!

- **DON'T 's**
  - Don't be paranoid about protecting your IP, you're not that unique!
  - You're Not!
  - Don't expect 3rd parties code/design to work right out of the box, invest in learning and applying/improving the idea. There are no free lunches.

*Slide from Richard Bijjani's ADSA07 presentation

Academics/3ʳᵈ Party

- **DO's**
  - Research the Problem before you approach vendors
  - Communicate/Manage expectations
  - Insist on involving the vendor in your research group
  - Get approval for publications
  - Work on a schedule, deadlines are real!

- **DON'T 's**
  - Stop solving problems that are only problems because they make good papers but hold no practical merit.
  - Don't solve problems that don't need to be solved (Research)
  - Respect the vendors' experience. You really do not understand the problem better than they do. You really don't!
  - Under-promise and over-deliver
  - Talk to your technology transfer people, not every idea is worth $10M

    *Slide from Richard Bijjani's ADSA07 presentation

Disclaimers

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Takeaway – Material does not necessary reflect DHS and TSA policies.

Questions & Answers

- "Knowledge in general and self-knowledge in particular are gained not only from discovering logical answers but also from formulating logical, even though unanswerable, questions."*

- Framing problem is good start; need to do more over time.

*Soloveitchik, Joseph B. (2009-07-01). The Lonely Man of Faith (Kindle Locations 184-185). Random House, Inc.. Kindle Edition.

Final Remarks

- "Terrorism causes a loss of life and a loss of quality of life," Lisa Dolev, Qylur

- Need improved technology

- Thank you for participating