Discussion & Next Steps

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Executive Summary

- Project has achieved its goals
  - Developed new reconstruction methods for single- and dual-energy CT-based explosive detection equipment
  - Developed methods (clouds) to assess improved imagery using surrogates for tuned end-to-end ATRs
  - Developed simulation tools and standardized phantoms that will allow comparisons of algorithms and faster/cheaper development of new products
  - Created a public domain database of raw and scanner meta data so that work on reconstruction continues after this project ends
  - Trained new people to work in the explosive detection field

How Good Did They Do?

- Clouds generally shrunk in area and objects more clustered
- Should reduce regions in classifiers leading to
  - Increased PD or decreased PFA
  - Room to lower minimum mass
- Still a conjecture
- Useful to have extensible ATR and take TSL Certification test

Common Strengths

- Understood problems caused by CT artifacts such as finite resolution and streaks, leading to merging and splitting of objects
- Helped to develop metrics based on image quality and segmentation
- Potential for future improvements

Opportunities for Improvements

- Researchers have done excellent work.
- Domain experts applaud all their efforts
- Next slides discuss opportunities for improvements
  - Should not be considered to be criticism of their work
- We bear some responsibility for weaknesses
  - Corollary of Heisenberg's Uncertainty Principle is that we could not observe without affecting

How Far Did They Go?

- Groups were told to mainly concentrate on streak artifact reduction (mainly caused by metal)
- Other artifacts less explicitly addressed
  - Low frequency shading
  - Blurring
- Causes
  - Beam hardening, scatter
  - Finite source/detector apertures

Areas of Concern

- Artifacts reduced with image smoothing could lead to texture being modified
- Only showed that PD/PFA improvements may be possible
- Some algorithm paths recreated aspects of known methods

Algorithmic Futures

- New data
  - Cone beam CT
  - Multi-bin projections
- More time to work on algorithms
- Combine methods
  - Example: iterative + sinogram processing
- Improve metrics
  - Correlate with PD/PF (difficult)

Researchers

- Publish, patent, present
- Seek additional funding from
  - Vendors, DHS, TSA, ALERT
- Revise algorithms
- Address computational expense

Program Management

- Complete final report
- Database and problem statements into public domain
- Facilitate community and networking

Lesson Learned

- Database creation
  - More specification and documentation
  - Different object sets (e.g. single sheets)
  - More and earlier validation
  - Frustratingly hard to get this entirely, perfectly right. Much time needs to be given to boring things (like record keeping)
- Research teams
  - Fewer
  - More work before end of project

Recommendations to DHS/TSA

- Fund additional research by researchers, national labs and vendors
- Encourage vendors to engage third parties
- Choose more representative unclassified problems
  - AIT, AT2, cargo

Recommendations to National Labs

- Execute reconstruction algorithms on scans of threats and stream of commerce data
  - Use DHS image database at LLNL
- Predict improvement on PD/PFA

Recommendations to Vendors

- Compare proprietary reconstruction algorithms to researcher algorithms
- Hire researchers, students and their colleagues
- Contribute to specification of more unclassified problems! Share your ideas for what is valuable and what is not.

Thank you!

- Thank you to
  - DHS
  - Researchers
  - Vendors
  - Meeting participants

The Structure of Scientific Revolutions
Thomas Kuhn

Kuhn has made several notable claims concerning the progress of scientific knowledge: that scientific fields undergo periodic "paradigm shifts" rather than solely progressing in a linear and continuous way; that these paradigm shifts open up new approaches to understanding that scientists would never have considered valid before; and that the notion of scientific truth, at any given moment, cannot be established solely by objective criteria but is defined by a consensus of a scientific community. Competing paradigms are frequently incommensurable; that is, they are competing accounts of reality which cannot be coherently reconciled. Thus, our comprehension of science can never rely on full "objectivity"; we must account for subjective perspectives as well.

Look forward to paradigm shifts in the near future