IED Prevention and Forensic Video Analysis

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The Economist

FEBRUARY 27TH–MARCH 5TH 2010 Economist.com

The data deluge

AND HOW TO HANDLE IT: A 14-PAGE SPECIAL REPORT

NPS Vision Lab

- decompose problem of information discovery into information *parts*
- learn the relationship between *parts*
- detect *parts* probabilistically
- hypothesize information presence based on co-occurrence of *parts*

Credits

Work performed at the ***NPS Vision Lab*** and MOVES Institute

in collaboration with the

- Remote Sensing Center at NPS
- Unmanned Systems Lab at NPS

Student collaborators:

- Rich Morrison
- Justin Jones
- Rob Zaborowski

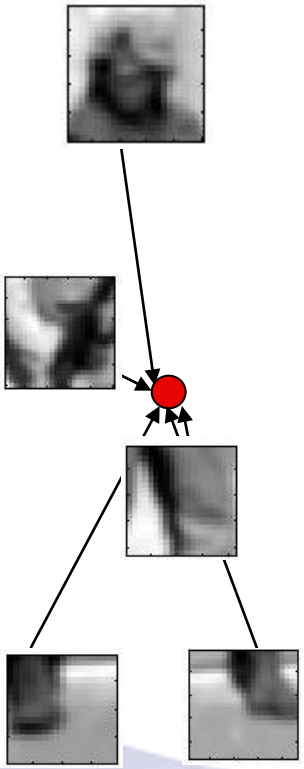
Faculty collaborators:

- Simson Garfinkel
- Chris Olsen
- Amela Sadagic

NPS Vision Lab

Decomposition

Example: detect US Marines and their posture

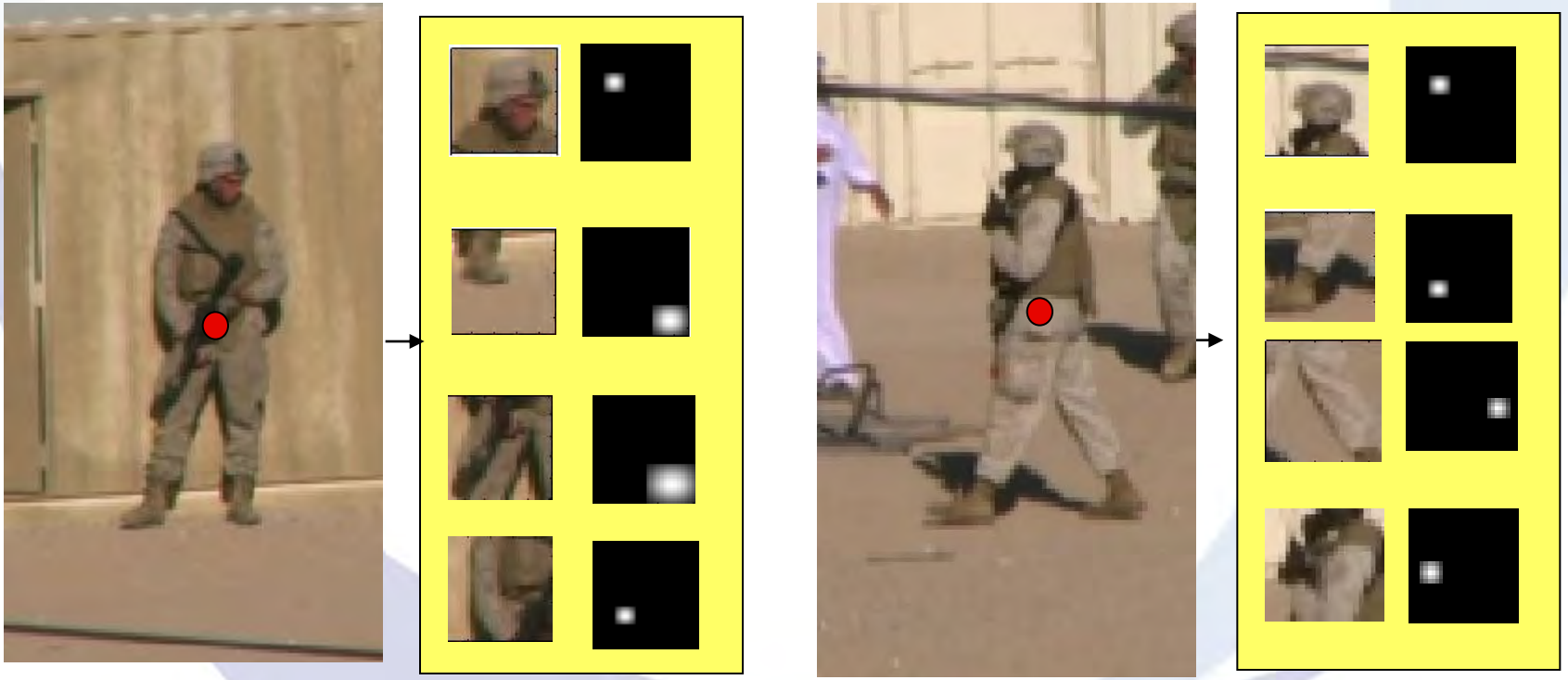


methods to determine parts:

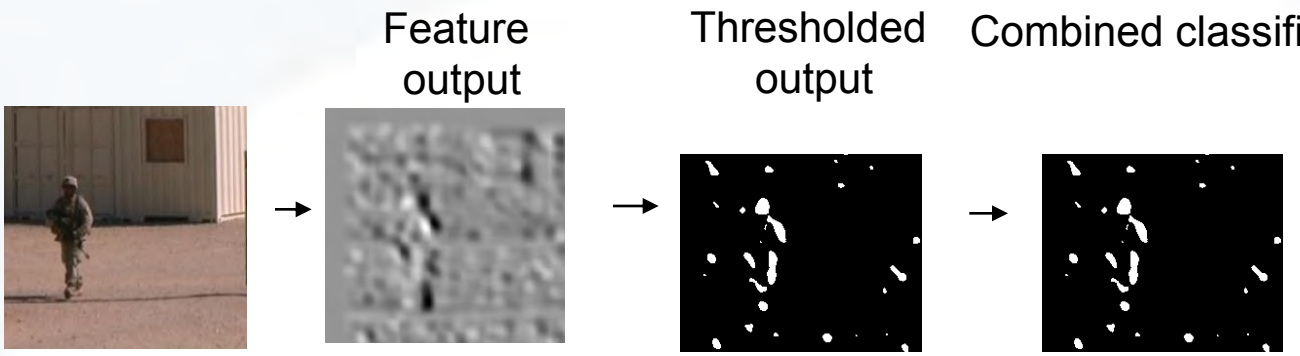
- manual designation
- random patches, clustered
- random patches, learned
- …

Parts' Relationships

Learn from training data; statistics determine the distribution



Probabilistic Part Detections

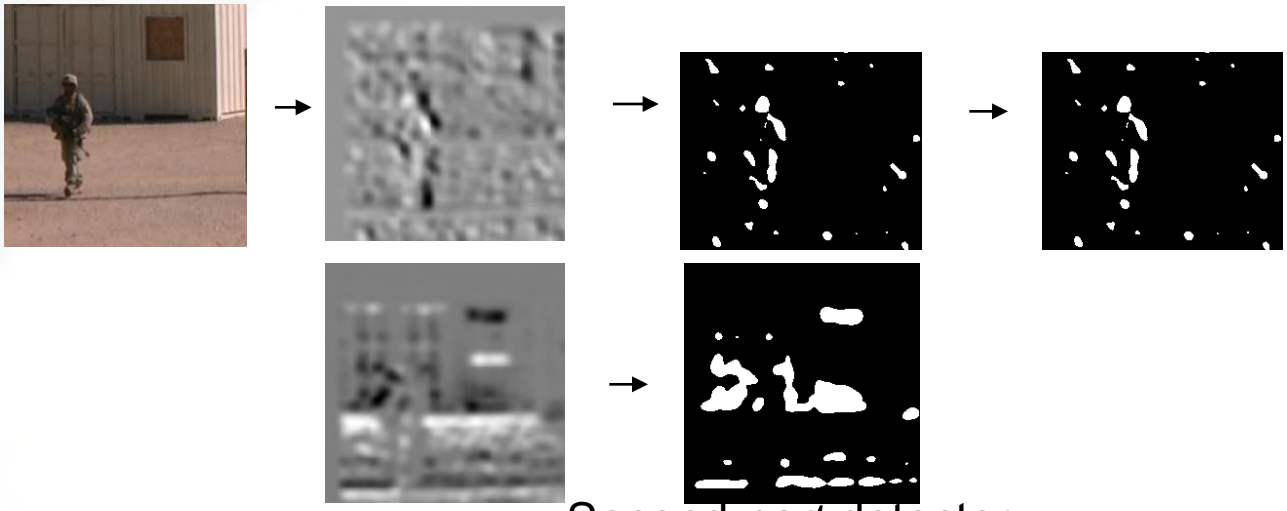


Probabilistic Part Detections

Part probability

Thresholded output

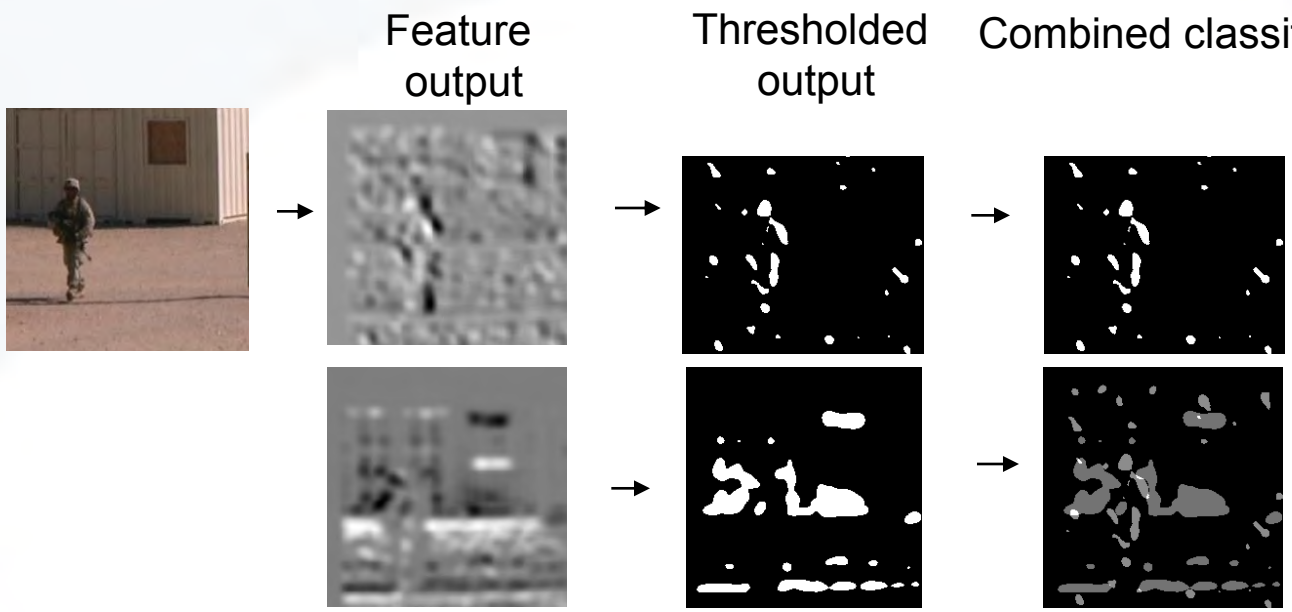
Combined classifier



Second *part* detector

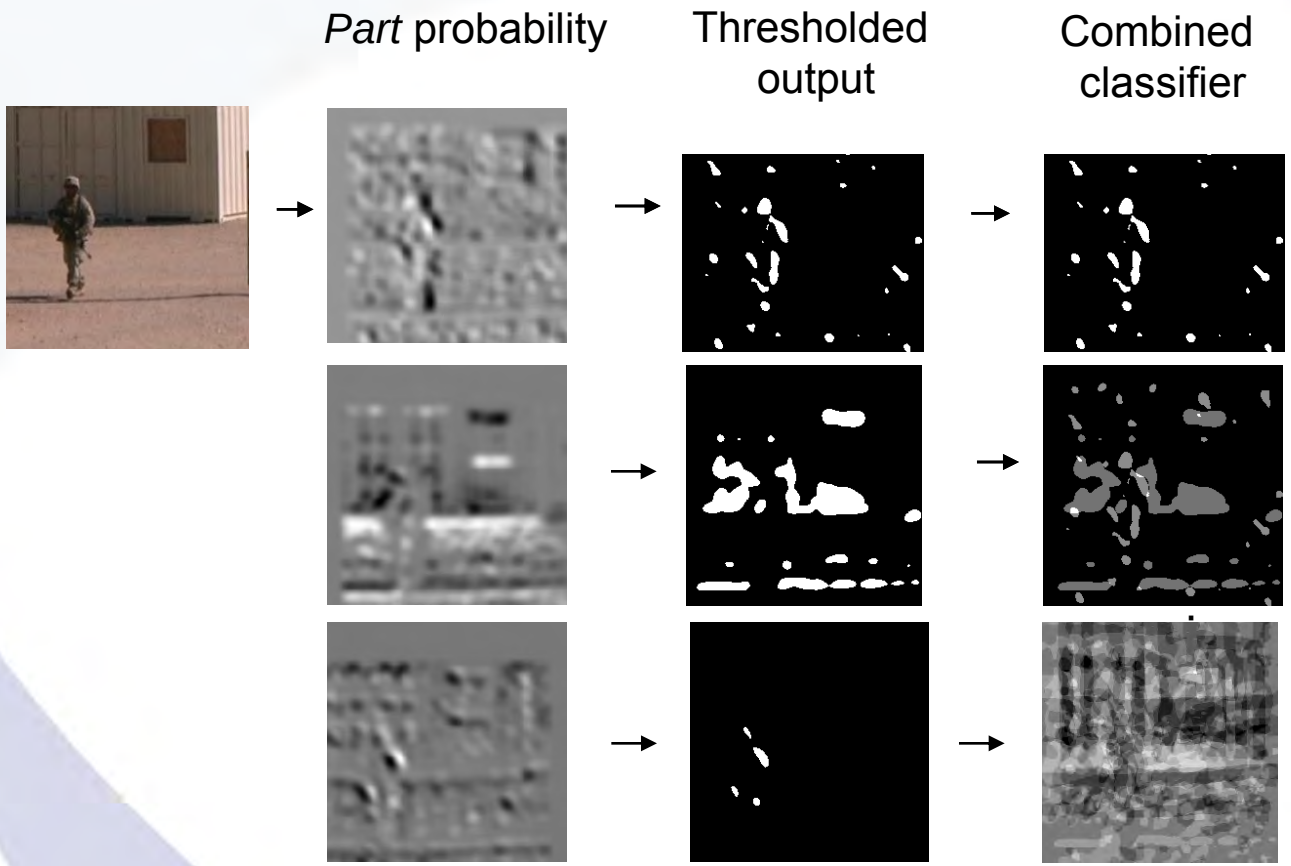
Produces a different set of detections.

Probabilistic Part Detections



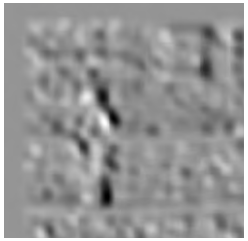
2 combined part detectors

Probabilistic Part Detections

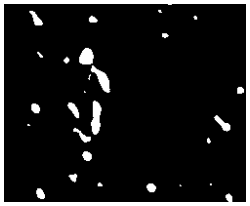


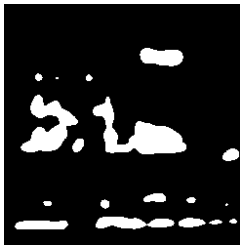
Probabilistic Part Detections

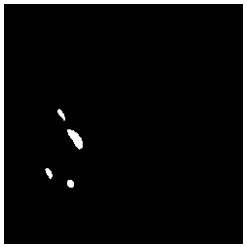
Part probabilities



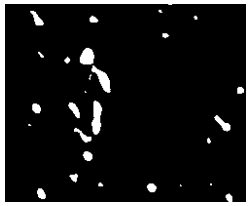
Thresholded output

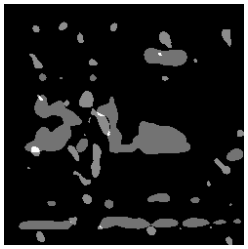


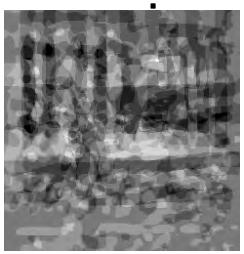




Combined classifier

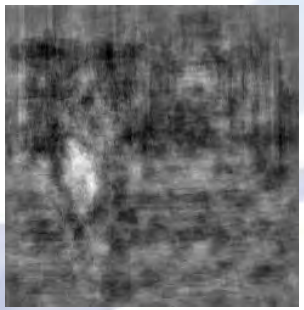






Adding parts

Combined classifier of 200 *parts*



Final classification

Posture Recognition for BASE-IT

http://www.movesinstitute.org/base-it/

Juan P. Wachs, Deborah Goshorn, Noah Lloyd-Edelman

Hierarchical Learning

- primate vision
- computer vision in the 70s (structural models)
- rediscovered now:
  - more powerful learning methods,
  - better local parts (“features”), more invariant
  - faster computers

At the NPS Vision Lab:

development of:

methods for automated object recognition in image and video data, of untypical objects, as opposed to face or pedestrian detection

Application to IED Prevention

Where is Waldo?*

Tools exist for:

- determination of approximate disk contents
- restoration of deleted files
- text analysis of emails, temporary internet files, etc

Lack of tools for:

- video and still image content analysis

*) Waldo, or: the wiring diagram, the photo of the chemical compound, the weapon, …

بيردت رکسعاجال

al qaeda, ةدعاقلاميظنت 10,200,000 text hits

al qaeda recruiting, ديجنتدعاقلا 578,000 text hits, 38 videos

jihad training camp, بيدتركسعامهجال, 254,000 text hits, 38 videos

jihad recruiting, ديجناهجال, 311,000 text hits, 9 videos

translations via
TranStar translator

Training an AK 47 Detector

Thesis work of Justin Jones

- 1146 Positive Images
- 5668 Negative images
- Normalized, Grey Scale
  - 20x40 for whole AK
  - 20x20 for Left and Right Half.

Positive Image

Negative Image

Left Half

Right Half

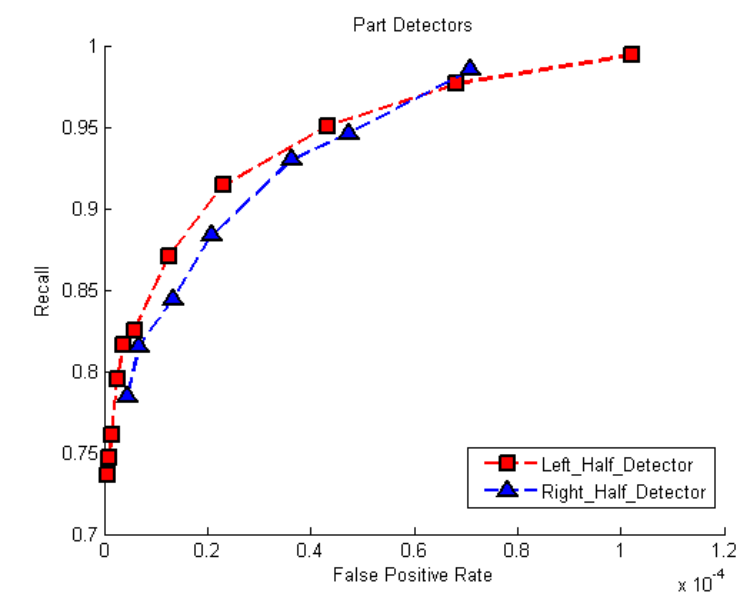
Structural Classification with a Support Vector Machine

- Left and Right Detectors were run over the training set.
- Detections in the annotated box are considered true detections.
- Detections outside the annotated box are false detections.
- Vector is Difference between Left and Right CenterX's, Y's, and Radii, all normalized by the mean radius of the 2 detections.

Left Detector

Right Detector

Performance



Parts-Based Object Detection

Benefits:

- smaller areas, speed, special hardware
- permits variability instead of a rigid whole object (wheels, for varying car wheelbase)
- reuse parts for multiple objects (wheels for cars, motorcycles, even clocks)

Basic research questions:

- what are ideal parts?
- how are they best combined?

Questions?

Contact:

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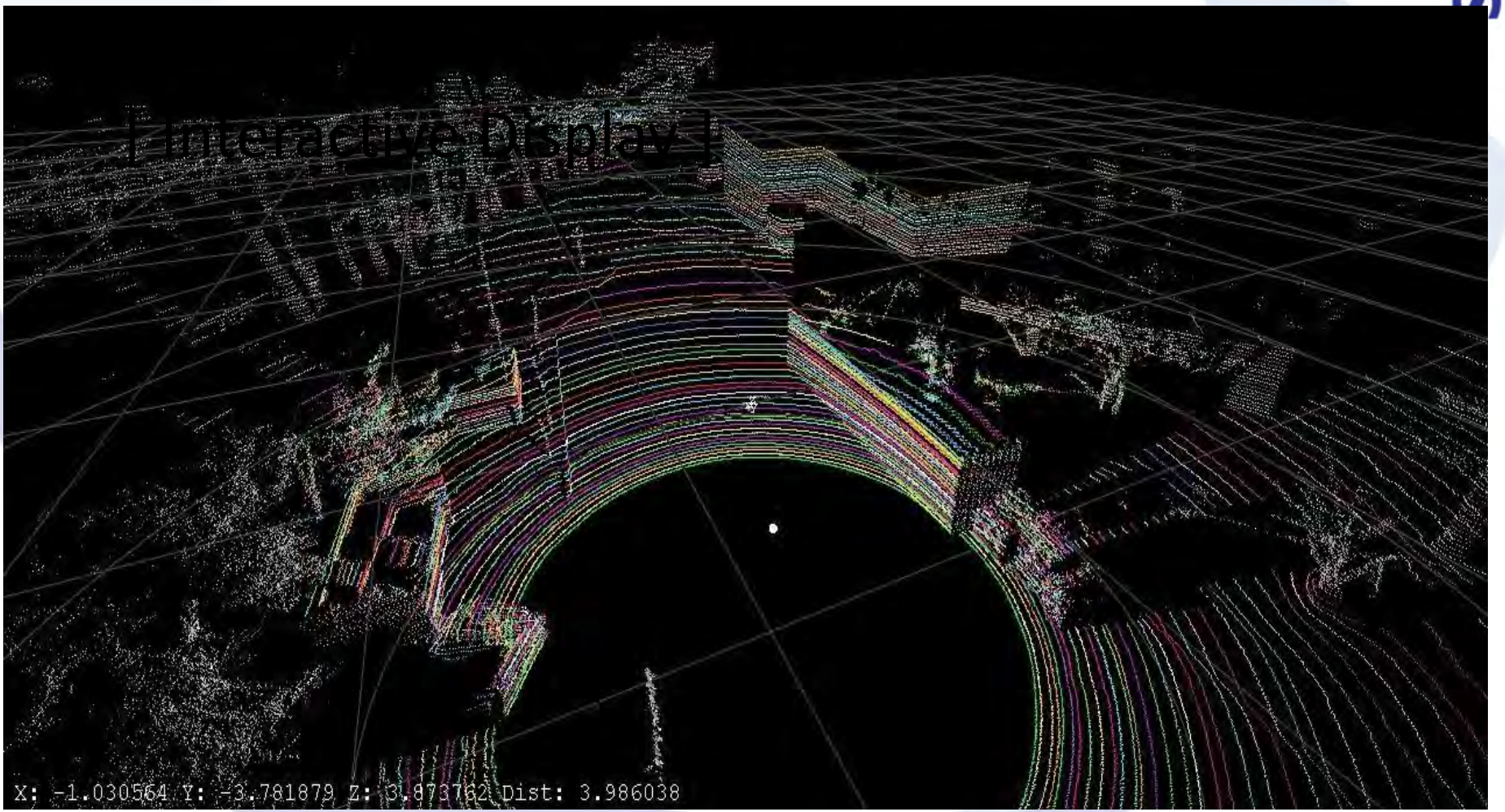
Backup Slides

Technical Challenges

- accurate overlay of geospatial information
  - GPS location information is not accurate enough in city streets and might even be jammed.
- acquire dynamic 3D model of the environment
  - location estimation of the own combat vehicle within a street
- extract sufficient building geometry
  - to place 3D annotations accurately on windows, doors, street corners etc.
  - Simultaneous Localization And Mapping (SLAM)
- suitable visualizations (icons, overlays, etc)
- field-feasible geo-registered input

Velodyne HDL-64E
+ Point Grey Ladybug

Lidar Data – X3D Rendering



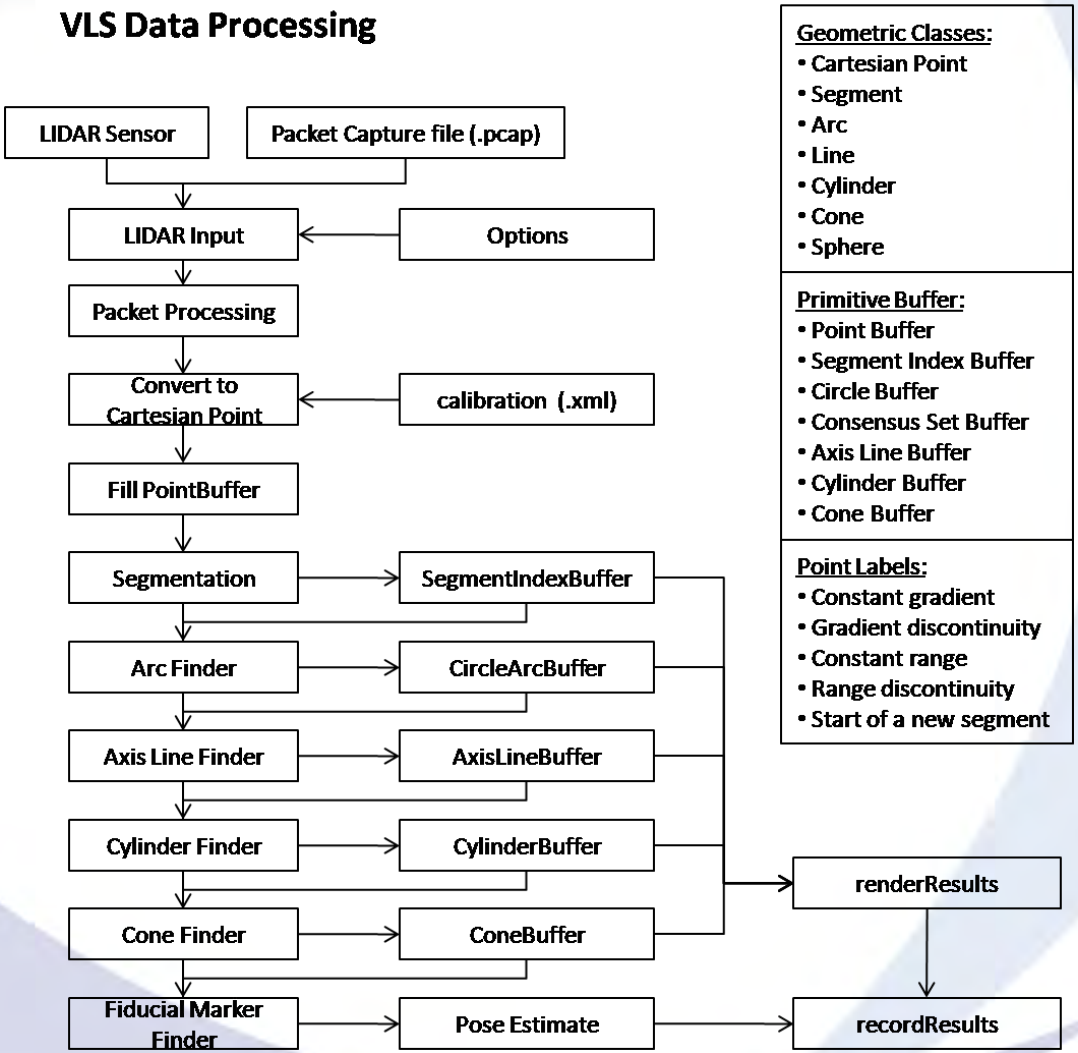
LidarPointCloud.x3d

Calibration Research

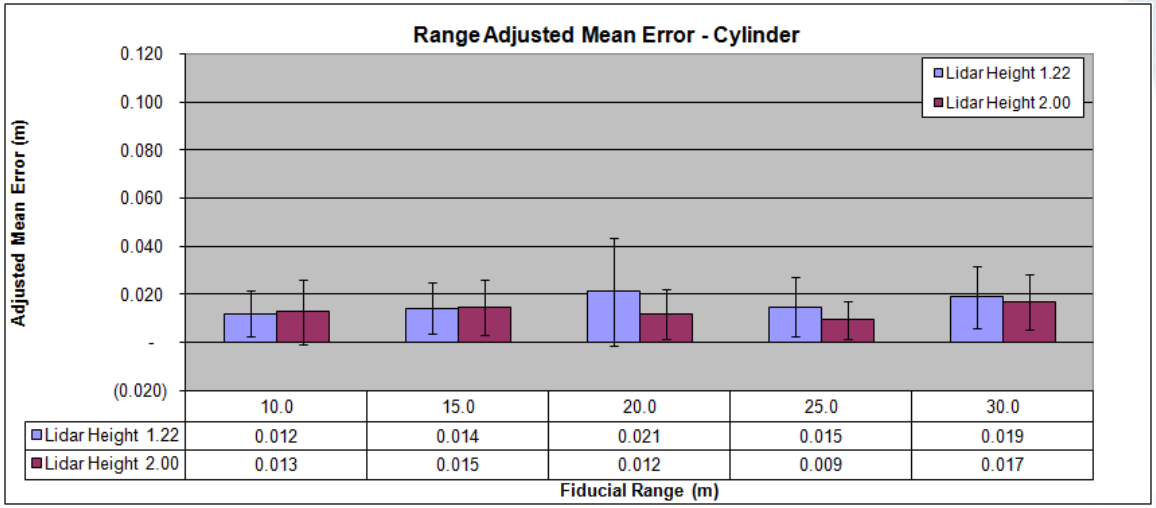
GPS resolution: 1000mm or…?
LiDAR resolution: 2-10mm

what about accuracy?

Finding the Markers

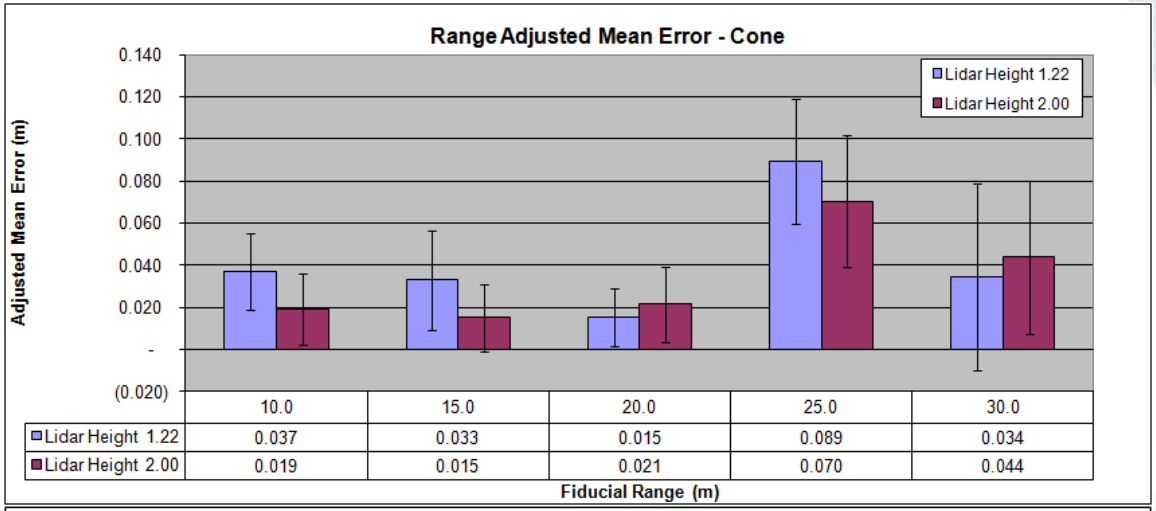


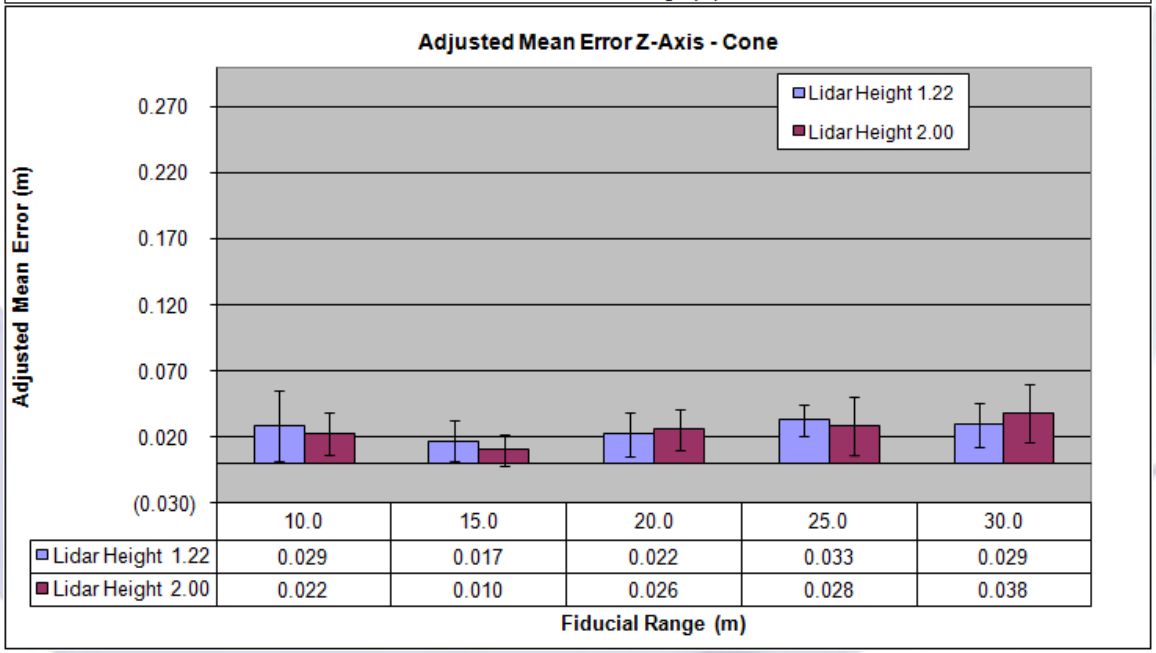
Marker Position Estimation, Cylinder



	10.0	15.0	20.0	25.0	30.0
Lidar Height 1.22	0.012	0.014	0.021	0.015	0.019
Lidar Height 2.00	0.013	0.015	0.012	0.009	0.017

Marker Position Estimation, Cone





Contributions

- Very accurate ground-truth (orders of magnitude better than GPS)
- Real-time panoramic video and depth fusion
- Vehicle-based Augmented Reality

  system prototype