



IED Prevention and Forensic Video Analysis

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13 July 2010

Report Documentation Page

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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



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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

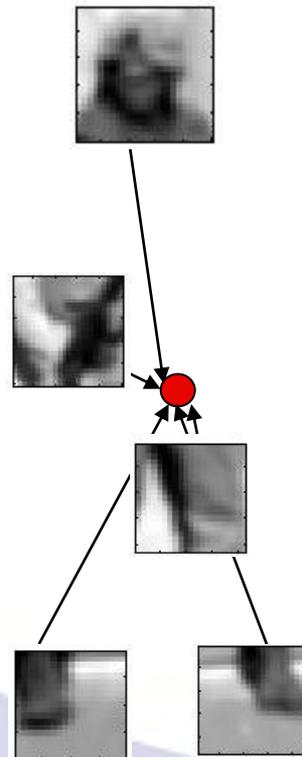
Chris Olsen

Amela Sadagic

NPS Vision Lab

Decomposition

Example: detect US Marines and their posture

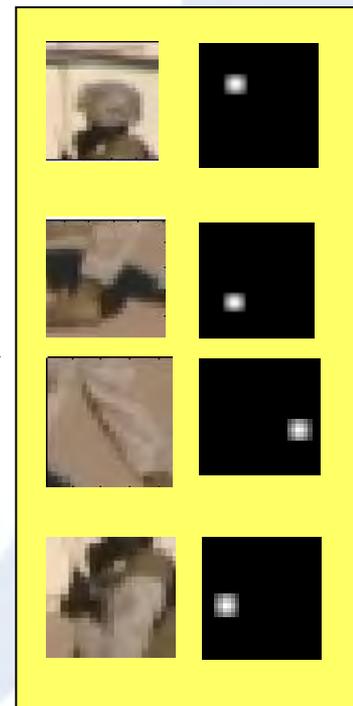
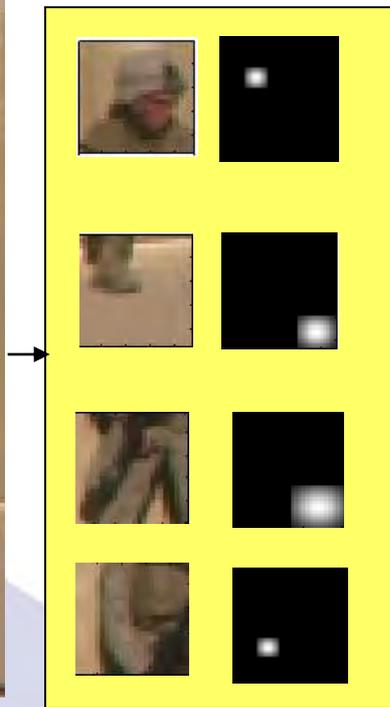


methods to determine parts:

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

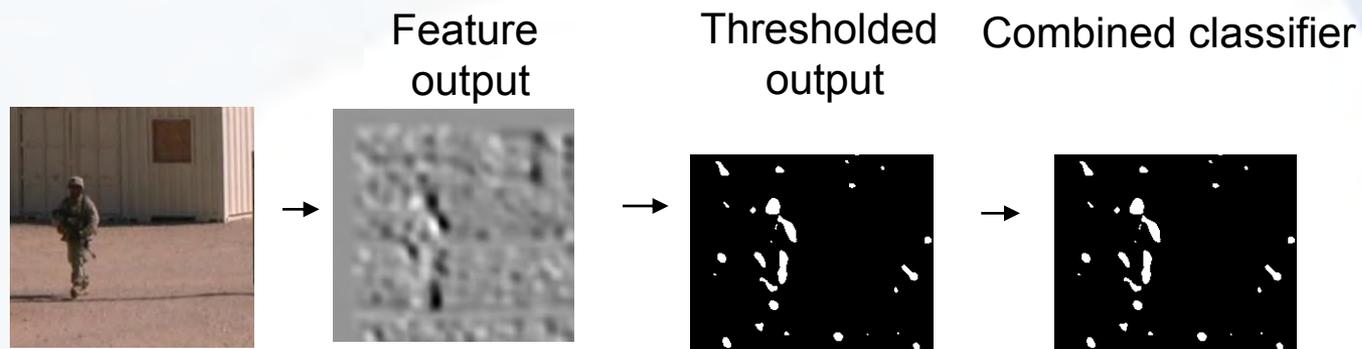
Parts' Relationships

Learn from training data; statistics determine the distribution

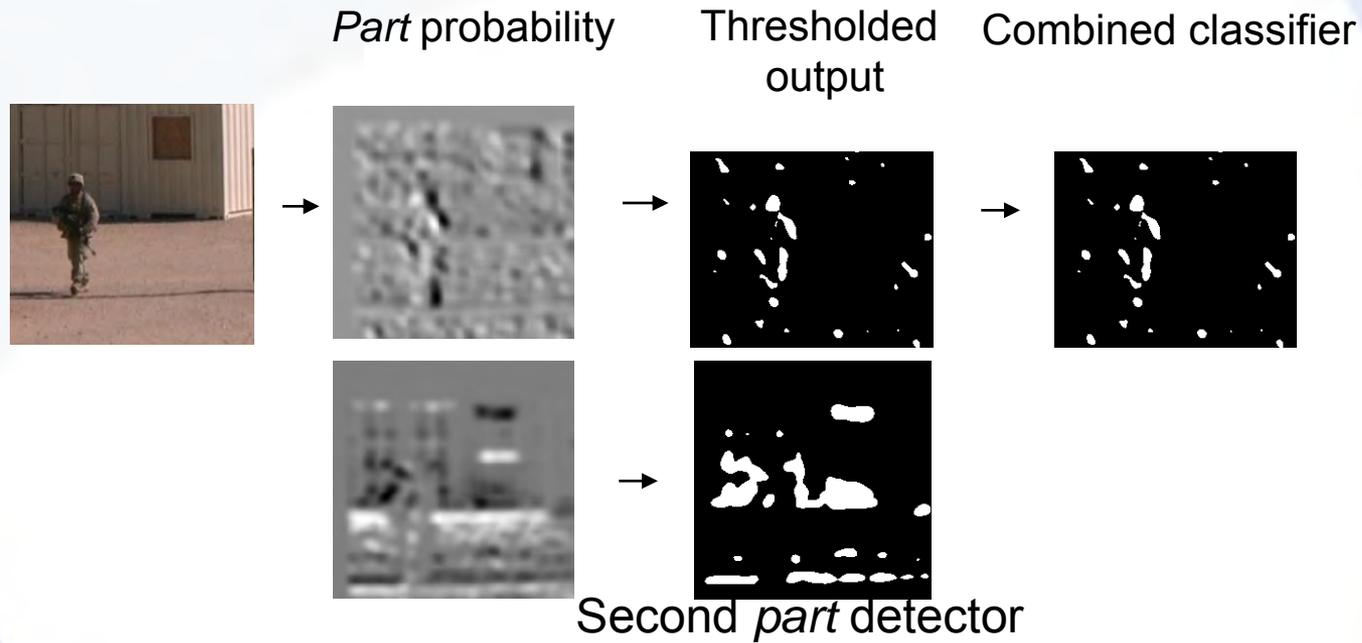


...

Probabilistic Part Detections

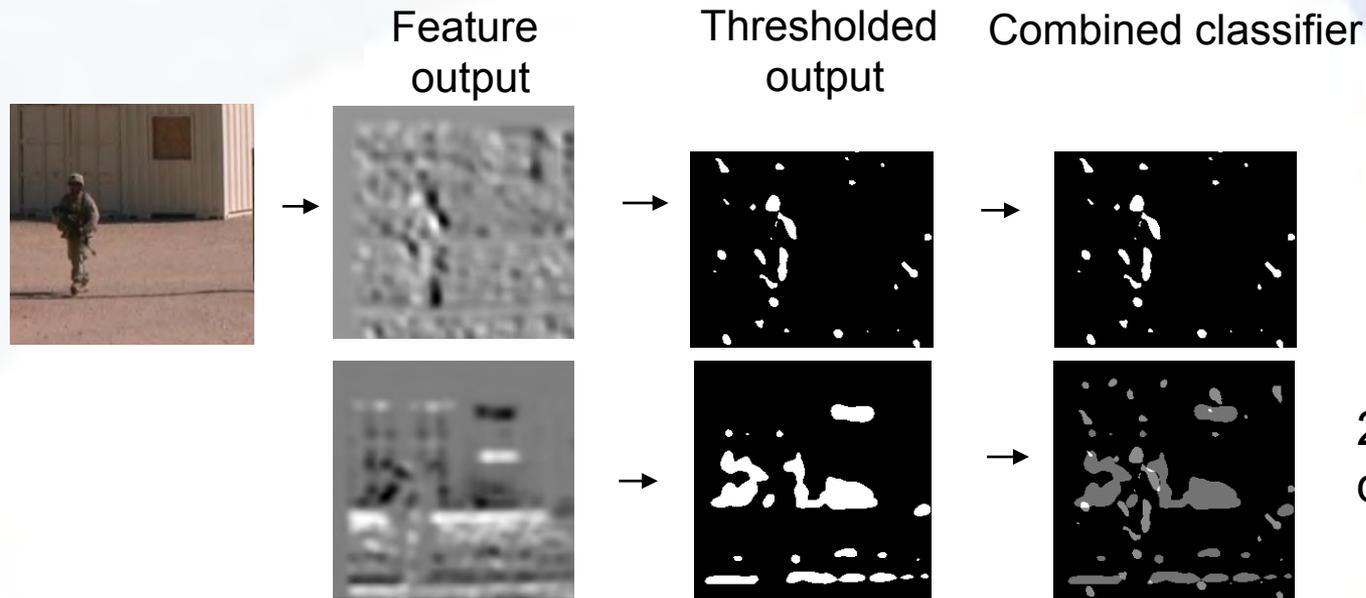


Probabilistic Part Detections



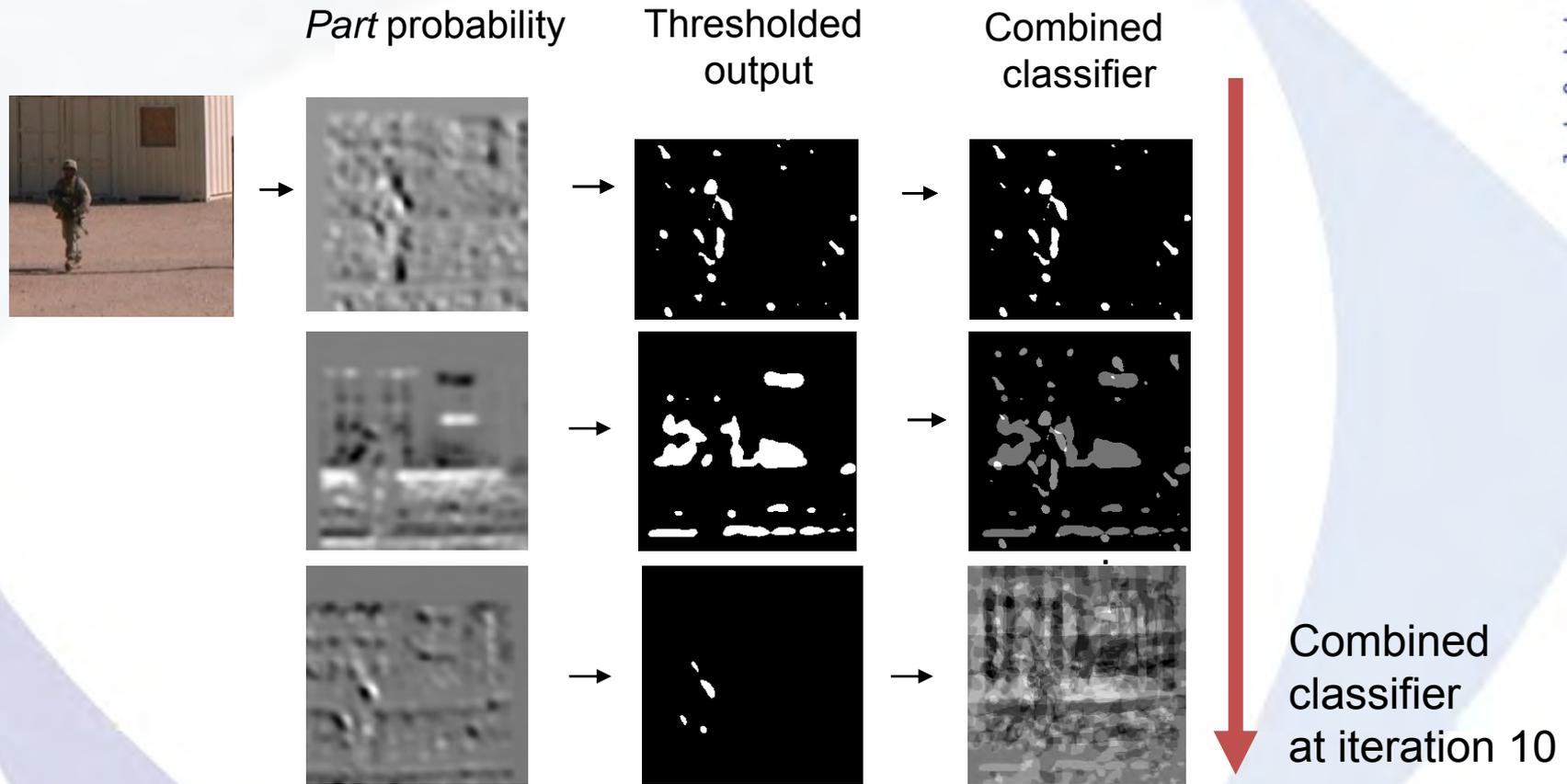
Produces a different set of detections.

Probabilistic Part Detections

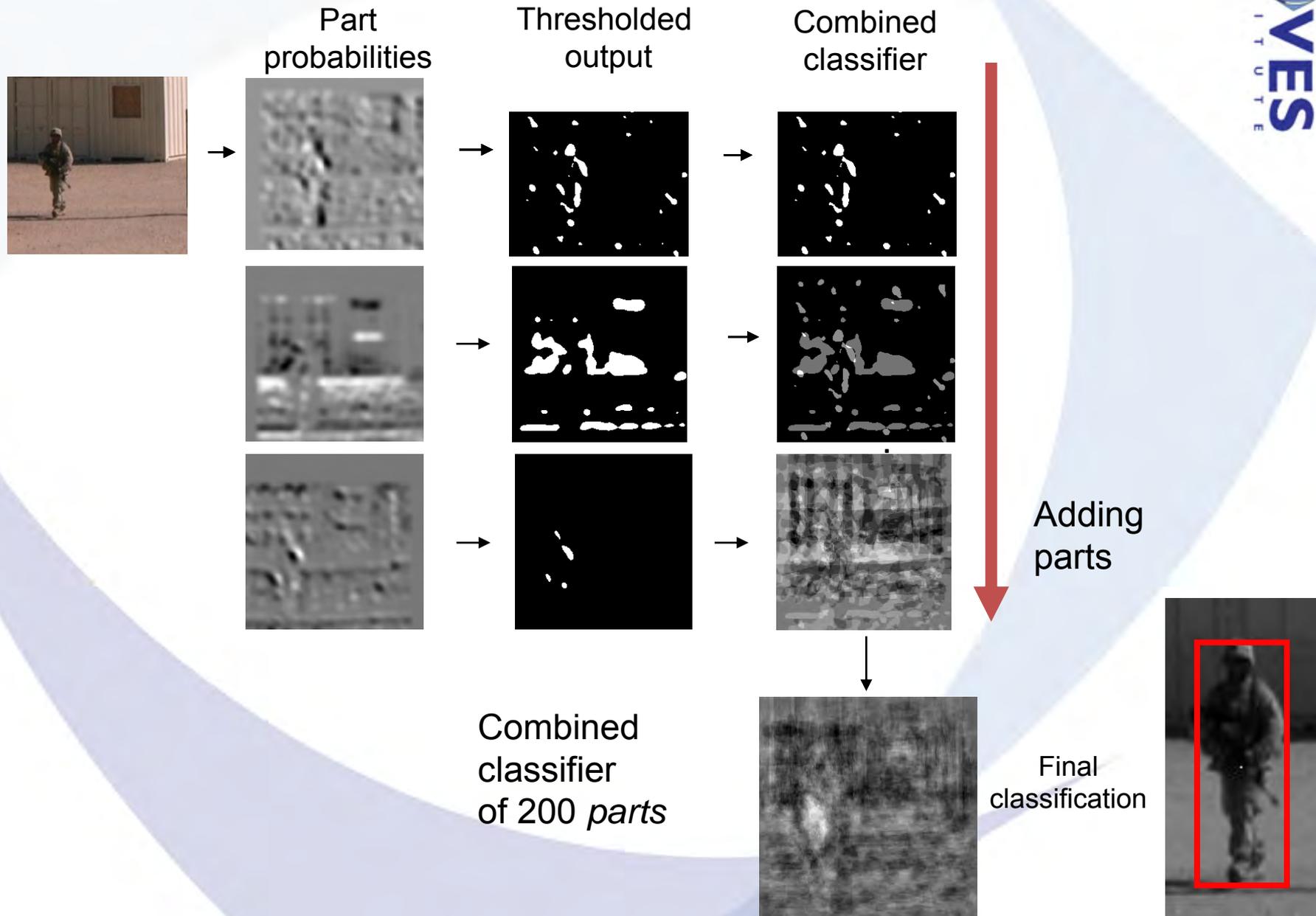


2 combined part detectors

Probabilistic Part Detections



Probabilistic Part Detections



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, ...

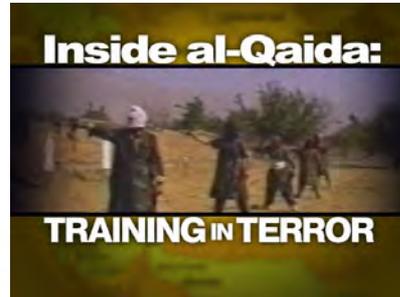
الجموعس كرتدريب

al qaeda, 10,200,000 text hits

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

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

jihad recruiting, 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.

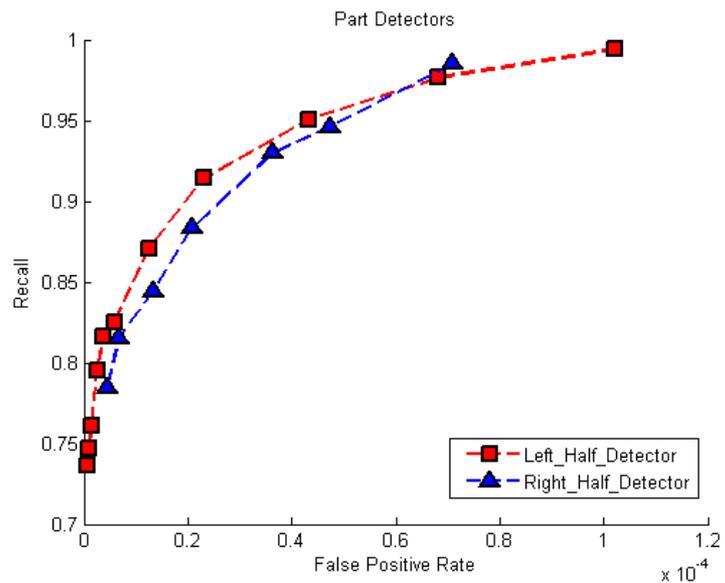
Left Detector



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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NPS Vision Lab

The NPS Vision Lab is a research and education lab in the [MOVES Institute](#) and the [Computer Science Department](#) at the Naval Postgraduate School in Monterey, CA. Our expertise is at the crossroads of computer vision, computer graphics and human-computer interaction. We collaborate with NPS-wide efforts on training systems, robotics and autonomous systems, sensor networks and embedded systems. We strive to accomplish projects with educational goals while incorporating and advancing current research into prototype systems.

News updates

MOVES Director CDR Joe Sullivan gave an interview for the [Experiential eLearning](#) blog, talking about some of the technologies developed here in the NPS Vision Lab.

The Velodyne LIDAR that was purchased by the NPS Physics Dept. and the MOVES Institute in a joint effort has enjoyed plenty of attention. We mounted it on a truck and drove it through urban areas. Here are a few images:

[Our data capture truck](#) [Lidar scan of an urban scene](#)

<http://vision.movesinstitute.org/>

Backup Slides

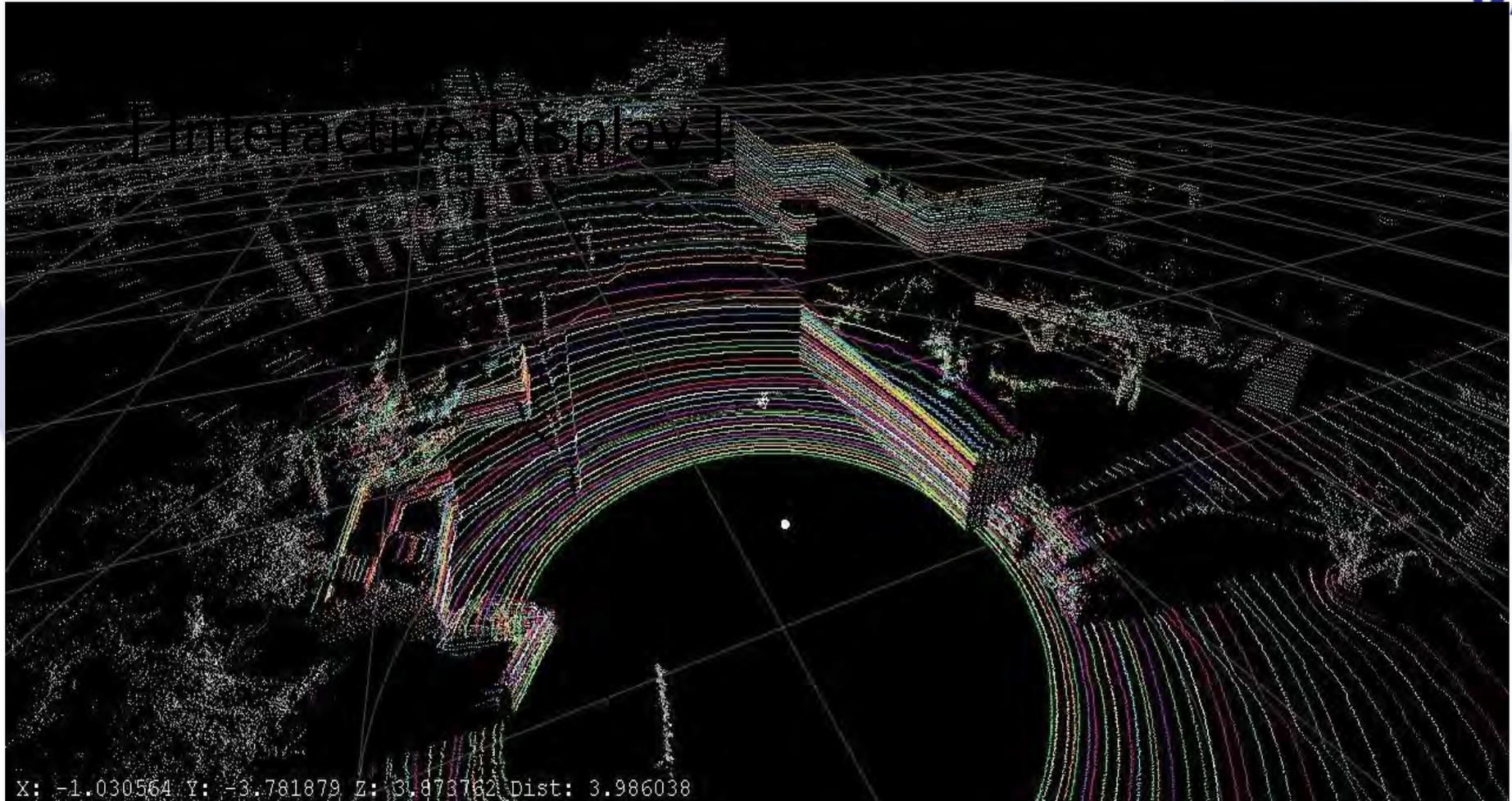
Technical Challenges

- 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



Calibration Research



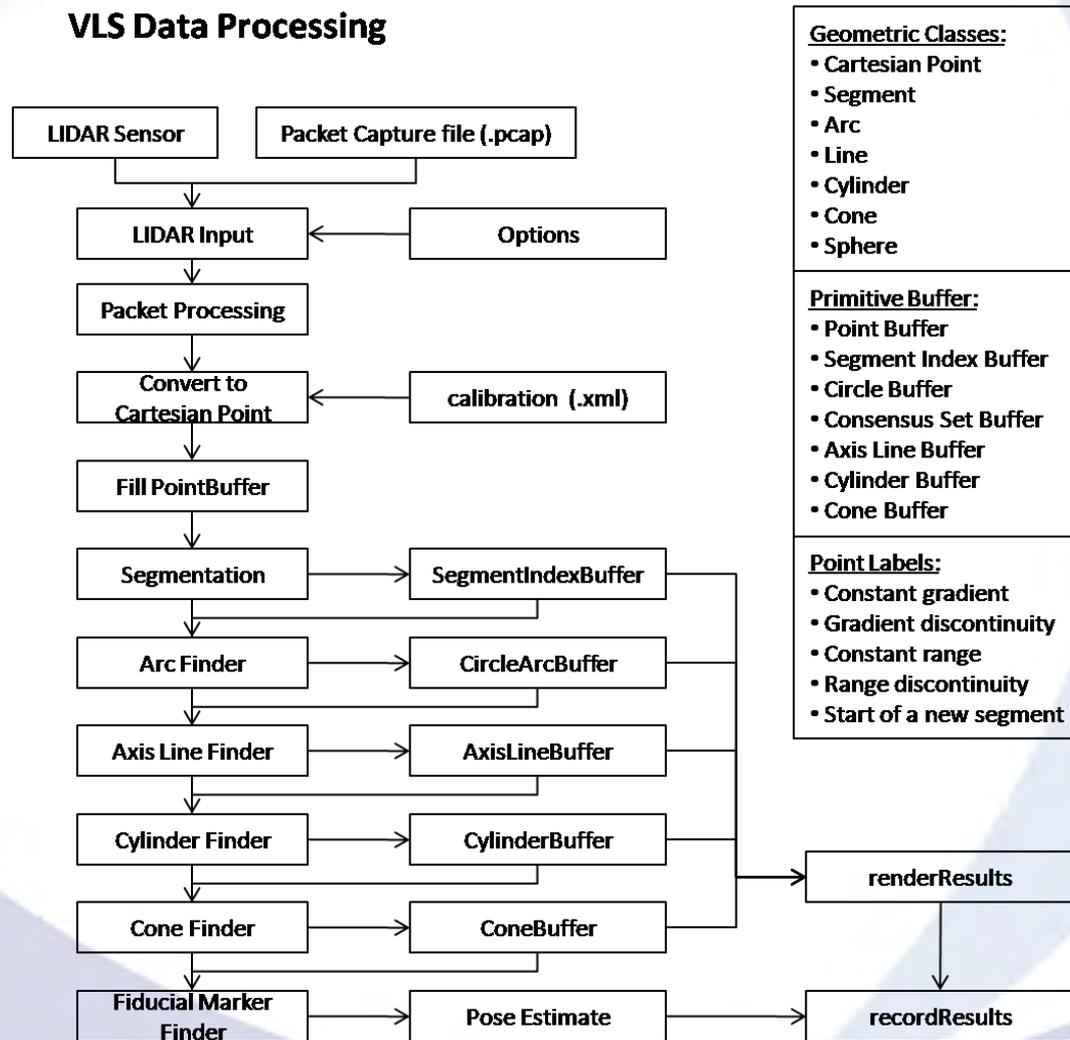
GPS resolution: 1000mm or...?
LiDAR resolution: 2-10mm

what about accuracy?

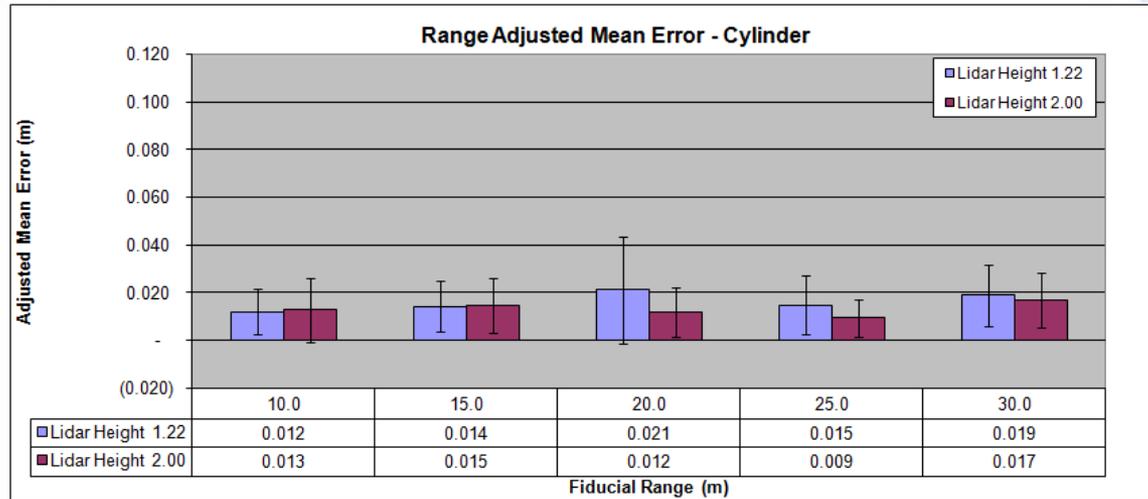


Finding the Markers

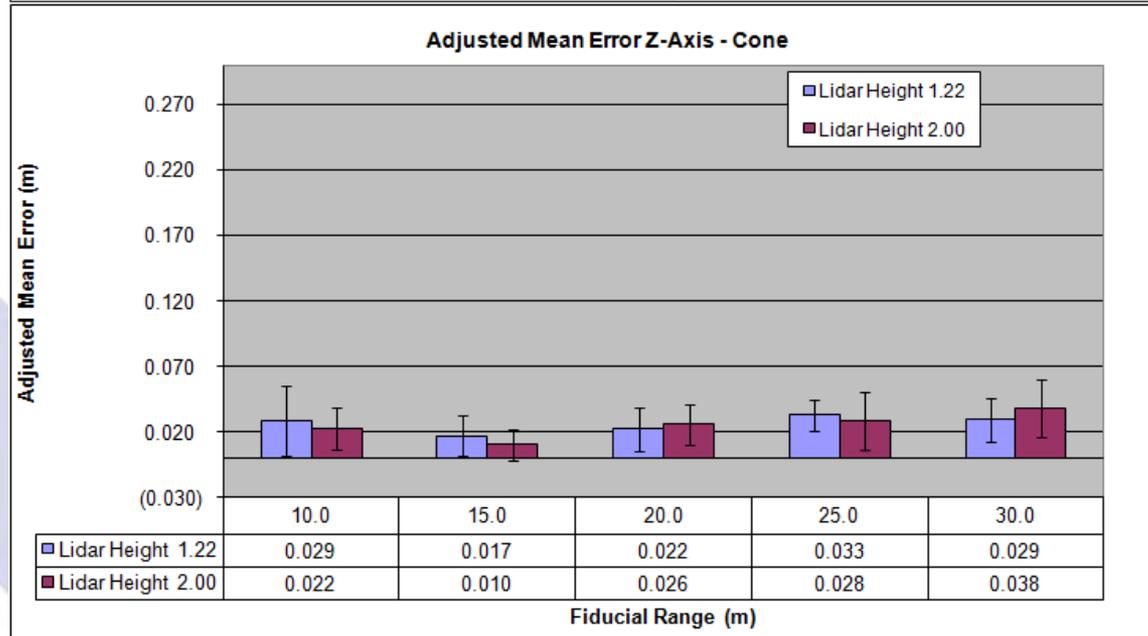
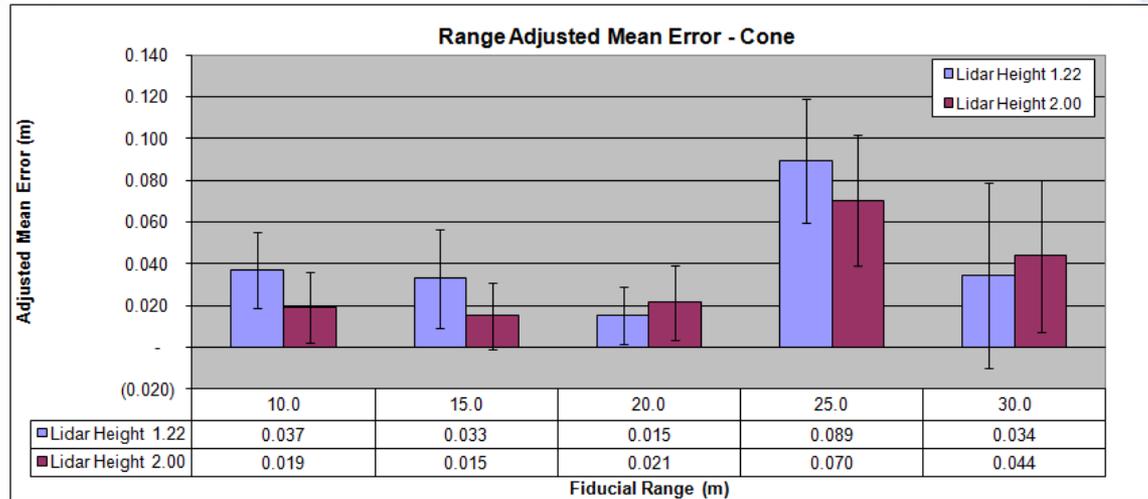
VLS Data Processing



Marker Position Estimation, Cylinder



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

