



Video Analytics (and Homeland Security)

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Why Video?



- **Because it is there, and it is cheap**



Networked Cameras are Everywhere

- **And there is much technology in development that may transfer to DHS**



Why Not Video?



- **Because there is so much of it!**



“30 million cameras produce 4 billion hours of video footage each week in US ” Pop. Mech. 08
Most video footage stored but rarely analyzed

Requires lots of personnel!

Potential answer:

Video Analytics!



DOD Experience



- **Remote Surveillance**



- **Q: How many persons to operate this “unmanned” aircraft?**
- **Q: How many aircraft can operate simultaneously?**



Some DHS Potential Applications



- **Biometrics: Who is there**
 - Automatically recognize individuals in watch lists, ...
- **Anomaly Detection: Something unusual**
 - Activities that raise concerns
- **Tracking: Maintain continuity of ID, fuse temporal information**
 - Associate activities, data over time
- **Forensics: find past activities by person or type**
 - Review old video with new perspective



Biometrics: Face Recognition



- **Used in portals – image sufficient**

- Much work on feature selection, robust identification
- Harder problem: on the move, uncontrolled pose and lighting, etc

“Face recognition devices failed in test at Logan” (‘03) *The Boston Globe*



- **Where video helps...**

- Diverse views, collect features over time
- Can also look at additional features: gait analysis, others
- Interesting, but not current focus of ALERT work





Interesting Problem: Storage



- **Most video has little of interest**
 - Should we store it?
 - Approach: video condensation – lossless compression

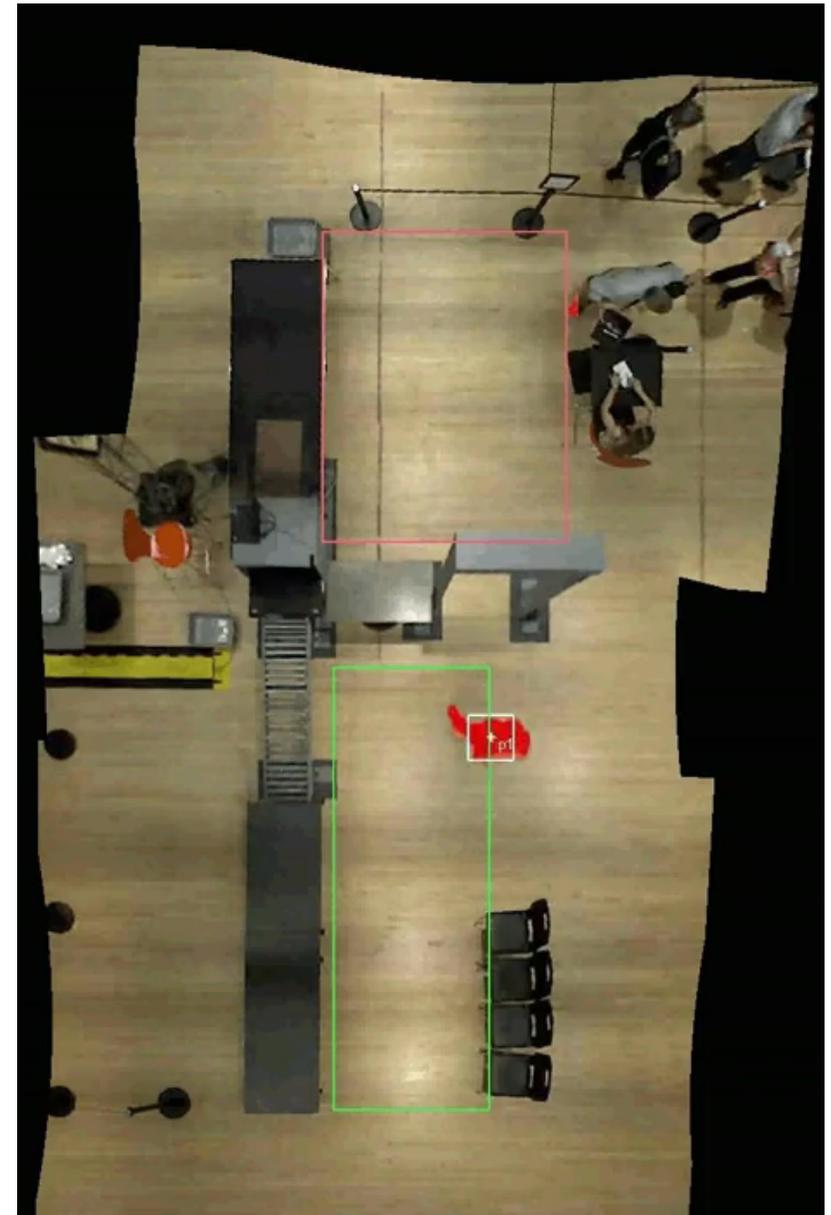




Anomaly Detection: Security Lane



- **Maintain relationship between luggage and persons, groups, others...**
 - Similar to Logan overhead cameras, Terminal C
 - Anomalies: change of bag/person association

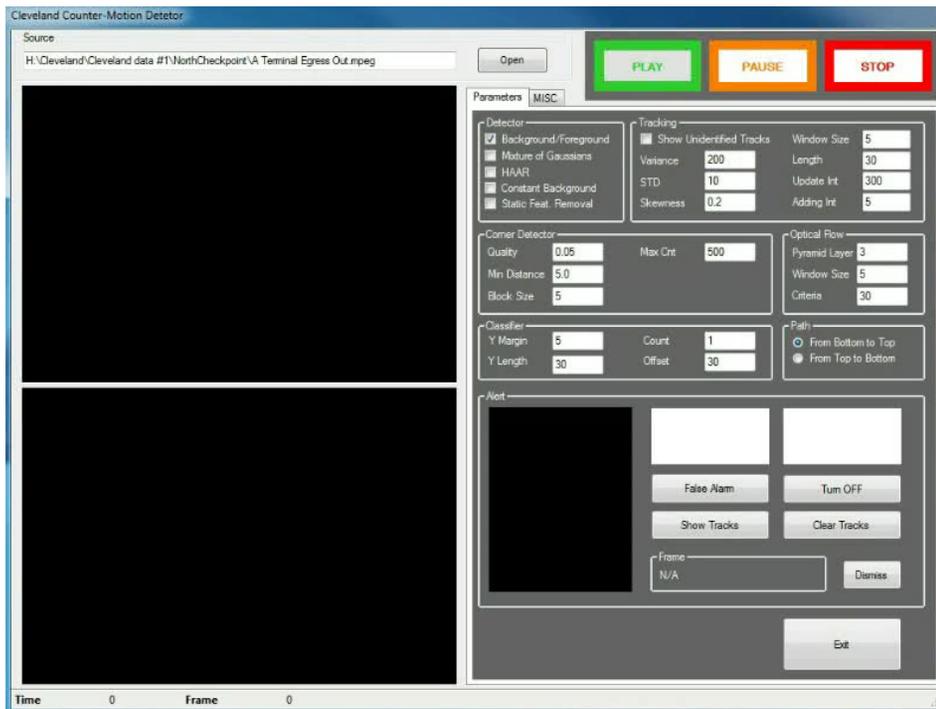




Anomaly Detection: Exit Lane



- Look for individuals moving against normal flow
 - Known type of anomaly





Anomaly Detection: Unknown Anomalies?

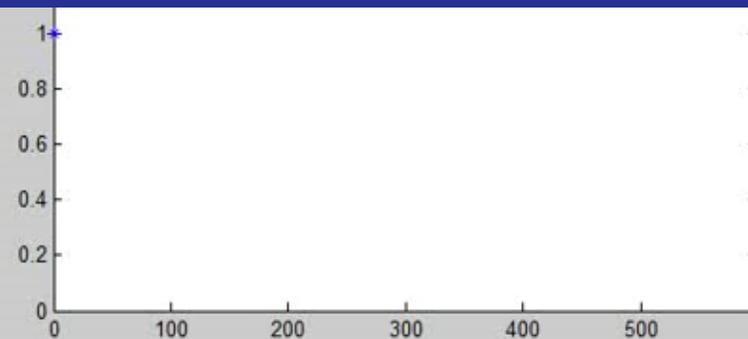


- **Harder problem: Find something unusual**
 - Something different, worth investigating



Video Anomaly Detection
Based on Local Statistical Aggregates

Created with Flip4Mac WMV Demo
www.Flip4Mac.com





Forensic Search



- Detecting motion patterns in stored video

Section: Seq 1 [Load section]

Target Query:

Start Frame	Type	Size	Color	Speed
1	All	All	All	All
End Frame	Cars			Fast
300	Human			Medium
				Slow

Statistics Query:

- Find video segments with similar motion
- Find time and location that plane fly over the ocean
- Find time and location that people move on the beach
- Find # of cars passing the chosen area

Query Results:

	Start Frame	End Frame	Similarity Score
Result 1	25	294	257
Result 2	30	46	47

Target/Event Query:

Target Info:

- Type: All
- Size: All
- Color: All
- Speed: All
- Start Time: 1
- End Time: 300
- ROI Info:
- Path Info:
- x(1): 383 y(1): 174
- x(2): 374 y(2): 186
- x(3): 347 y(3): 186
- x(4): 317 y(4): 188
- x(5): 301 y(5): 220
- x(6): 292 y(6): 247
- x(7): 300 y(7): 347

4 hours
processed in
12 seconds!



Tag and Track





Tracking: Geometry Matters



- **Many tracking algorithms exploit good vantage points**
 - Minimizes obscuration, facilitates coverage
 - See external video

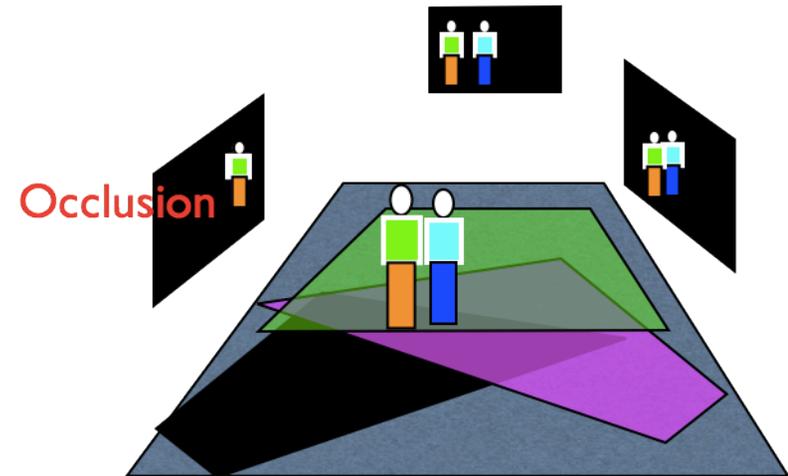




Multiple Cameras Assist Tracking



- If target is occluded in one view, the system should recover using the other cameras.
- Exploit geometrical and dynamical constraints





Tag and Track Made Easy...



- What \$300 hardware + clever algorithms do...

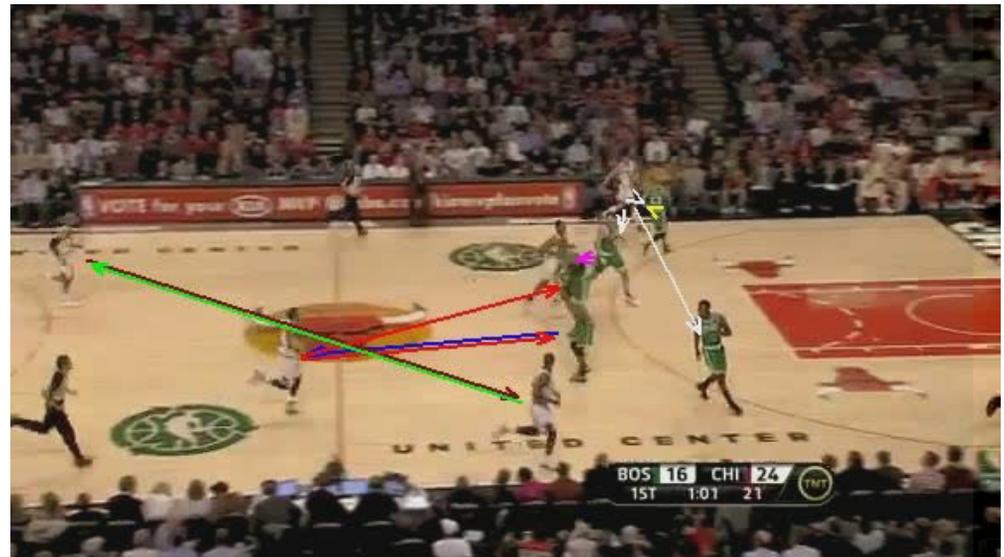
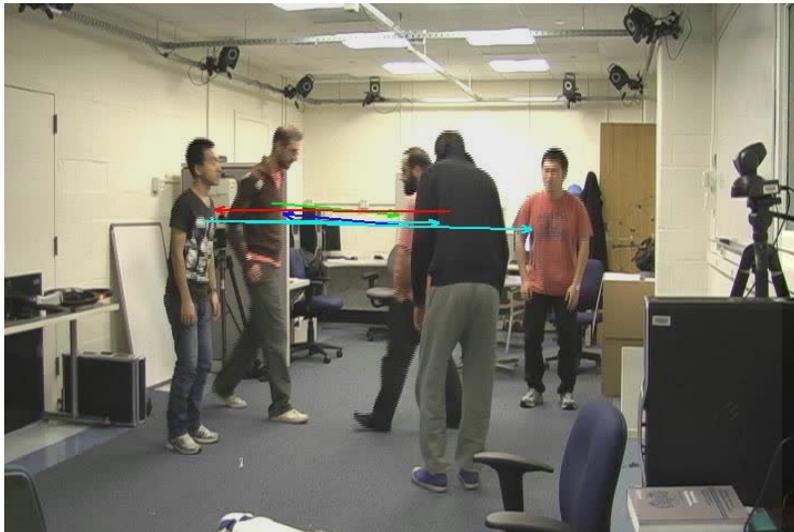




Detection of Team Behavior



- **Multiple agents acting in coherent fashion, potentially in crowds**
 - Look for time series of actions that have spatial correlation





Summary



- **Video sensors can provide useful information to assist in DHS/TSA missions**
 - Biometrics: recognition of individuals of interest
 - Anomaly detection: recognition of activities of interest and those of potential interest
 - Tracking: temporal linking of activities, information for individuals of interest
 - Forensics: rapid search for past activities/persons of interest
- **Without video analytics, tasks requires impossible levels of manpower**
- **ALERT and many others are working in translation of video analytics to DHS/TSA problems**
- **Such video analytic systems are precursors to alert human operators, simplify long-duration tasks**
- **Reliable, robust performance needs to be established**