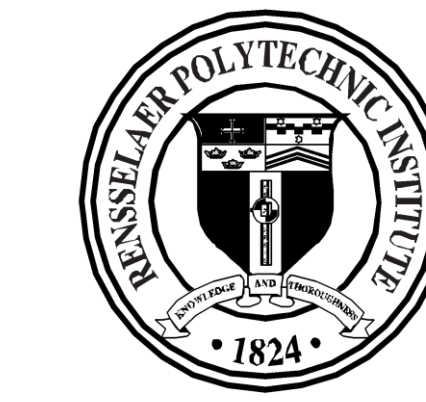




# Real-Time Airport Security Checkpoint Surveillance

Ziyan Wu<sup>1</sup>, Keri Eustis<sup>2</sup>, Eric Ameres<sup>1</sup>, Richard J. Radke<sup>1</sup>  
<sup>1</sup>Rensselaer Polytechnic Institute, <sup>2</sup>Asbury University  
 wuz5@rpi.edu, rjradke@ecse.rpi.edu



Rensselaer

## Abstract

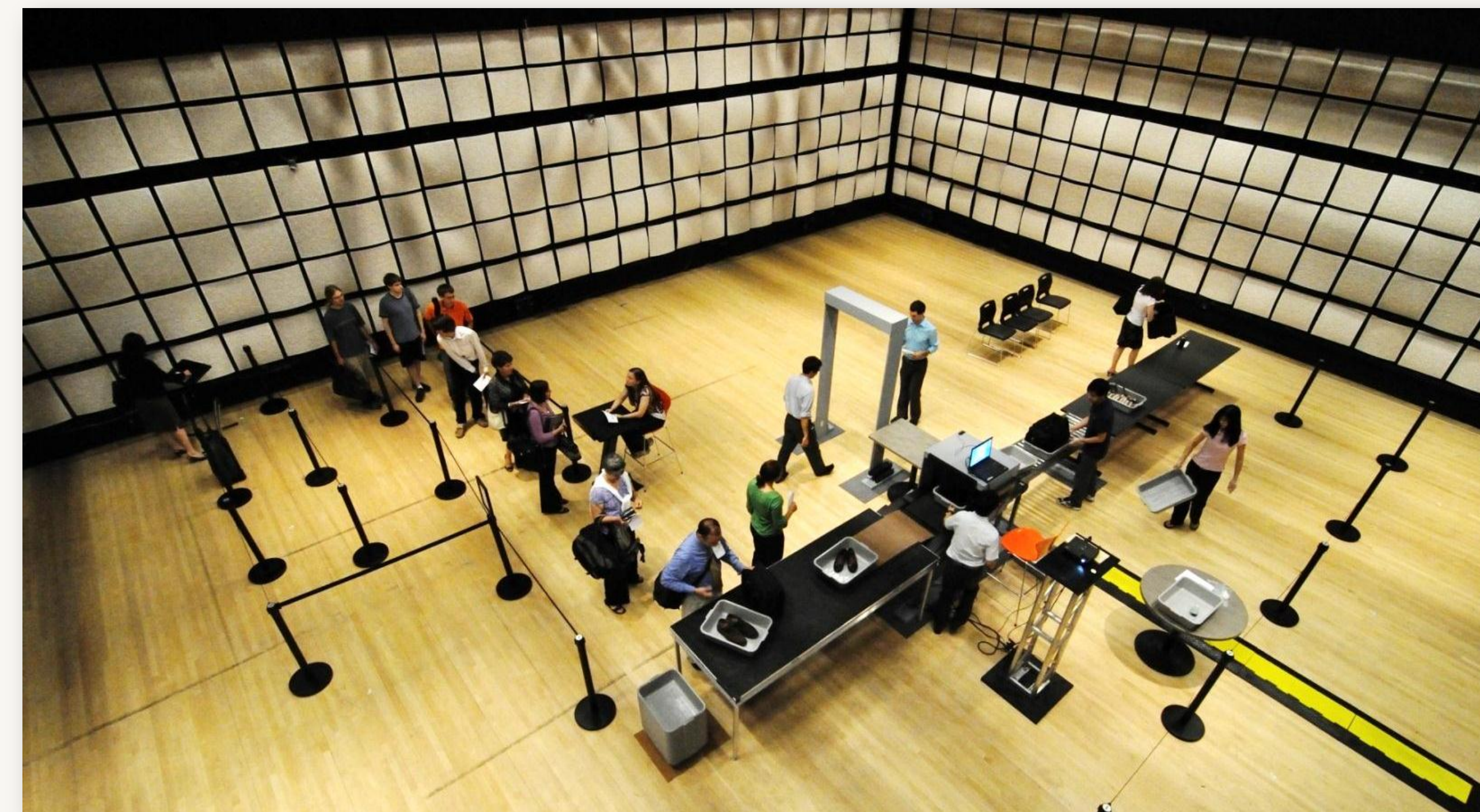
We designed a real-time airport security checkpoint surveillance system using a multi-camera network. The system tracks the movement of each passenger and carry-on bag, continuously maintains the association between bags and passengers, and verifies that passengers leave the checkpoint with the correct bags. We investigated methods for calibrating the camera network and tracking the many moving objects in the environment in real time.

In 25 minutes of real video from volunteer groups, our algorithms flawlessly tracked 47 passengers, and correctly detected 67 of 71 bags with 3 false alarms. 66 of the 67 detected bags were correctly associated with passengers, including 2 “wrong bag” events that we introduced.

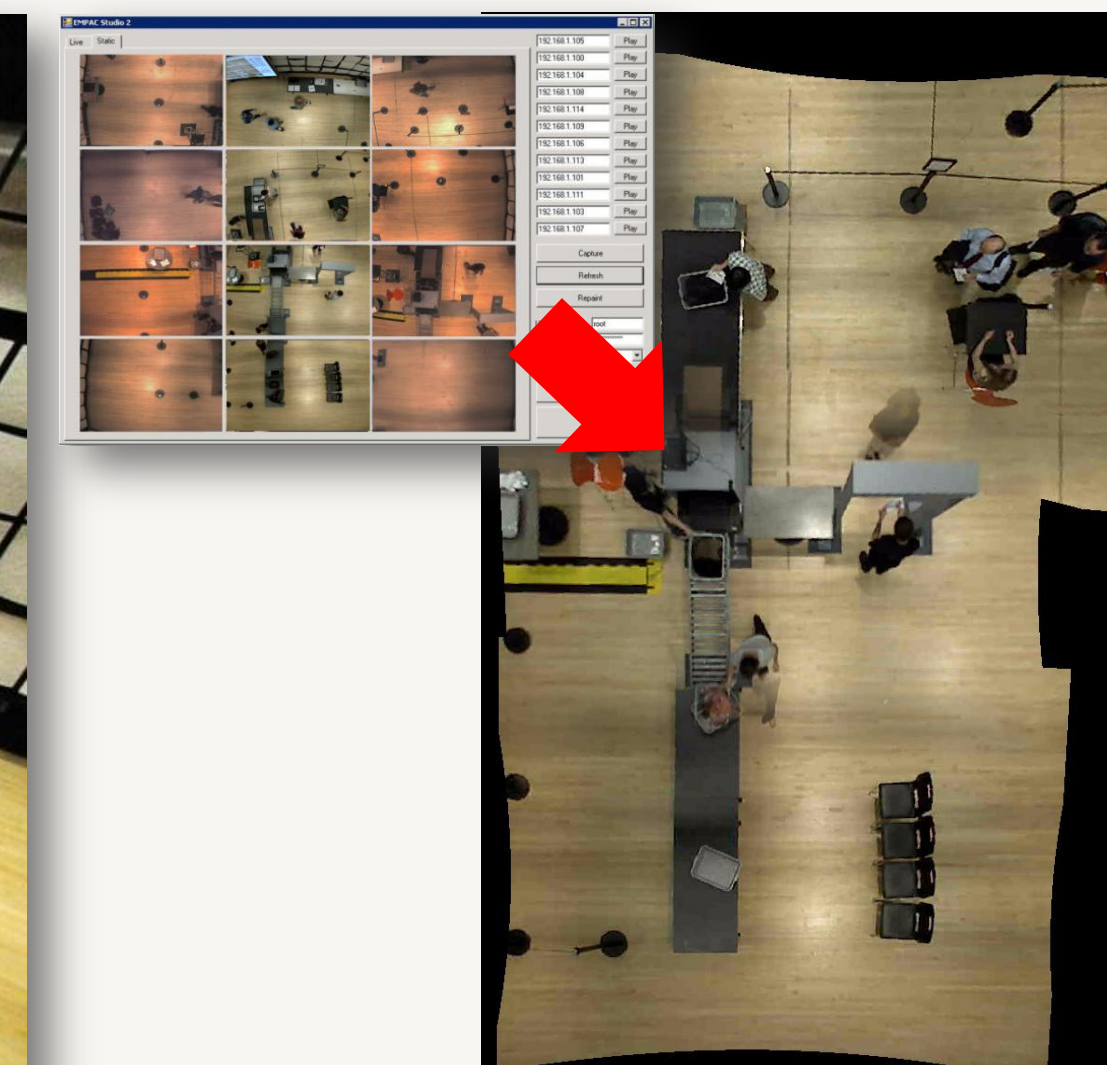
## Relevance

Airport security is a critical issue for defense and homeland security applications. Every day, millions of passengers pass through airport security screening checkpoints. However, to our knowledge there are no automatic methods in place for tracking passengers and bags as they pass through such checkpoints, or for automatically maintaining the association of each item on the conveyor belt to the correct passenger. We developed a robust, real-time computer vision system to solve these problems, using data from a wide-area camera network containing both fixed and pan-tilt-zoom (PTZ) cameras.

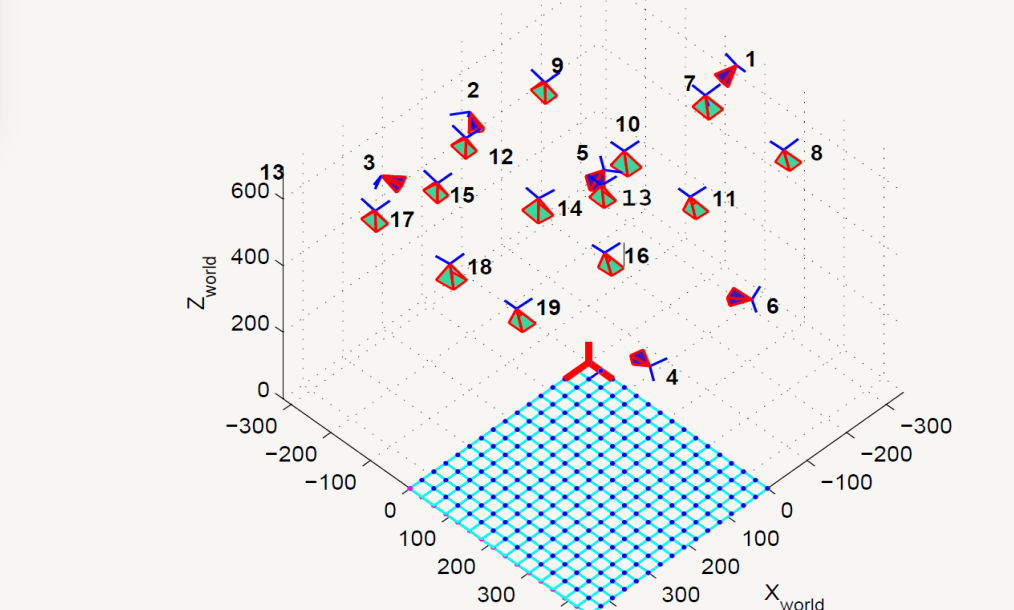
## Technical Approach



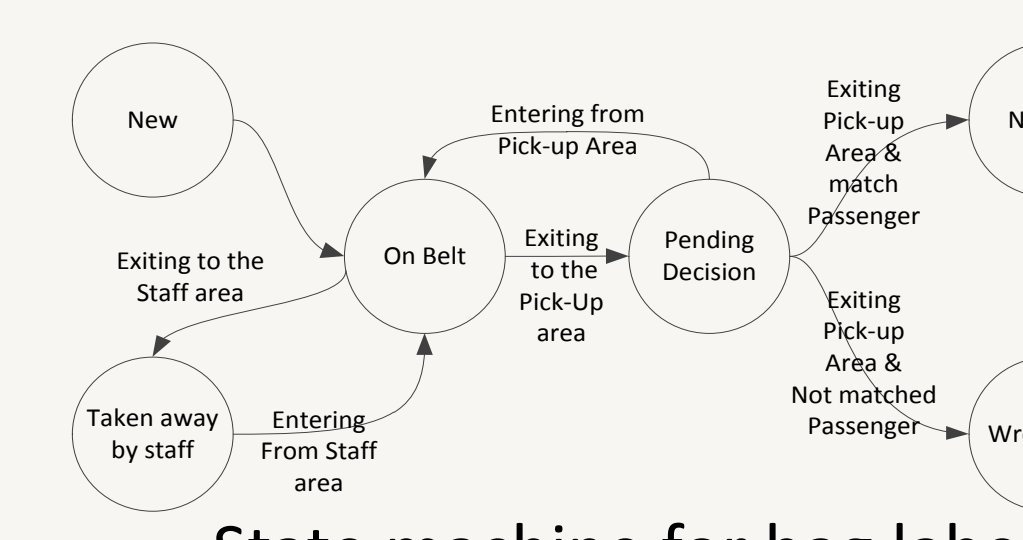
Simulation Environment



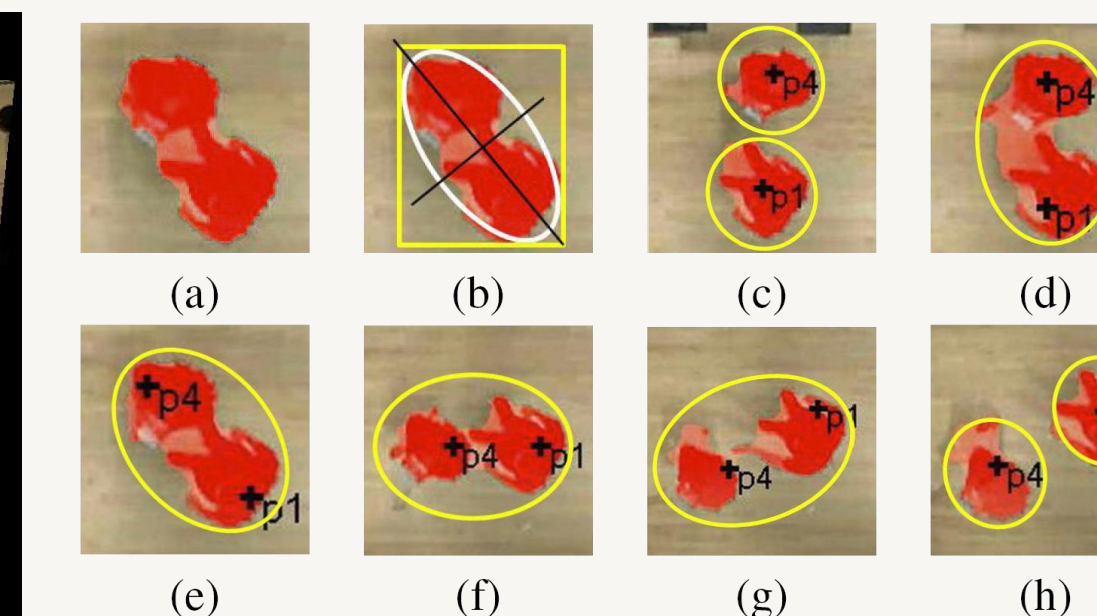
Stitching Images from Cameras



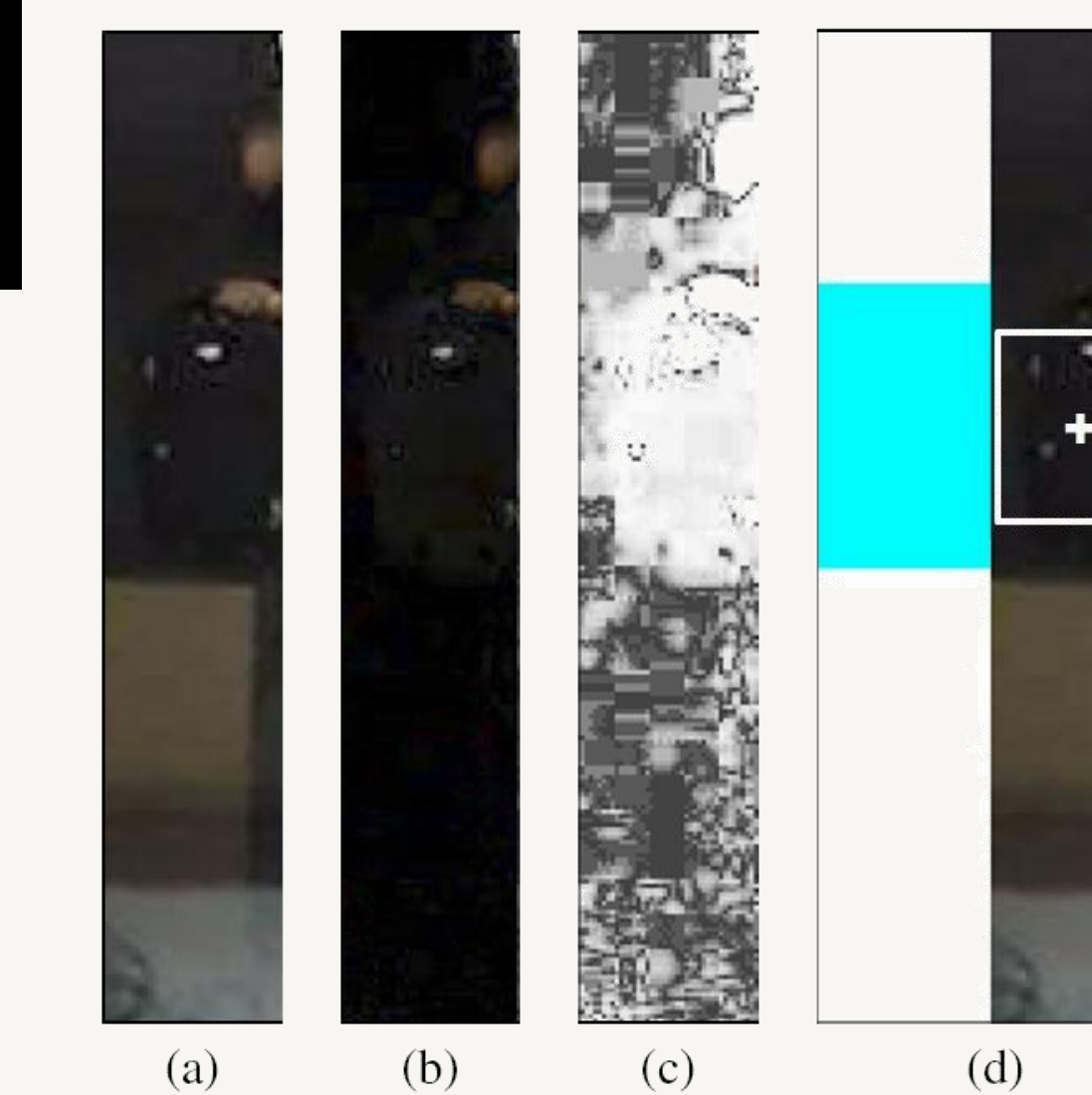
Camera Network Calibration



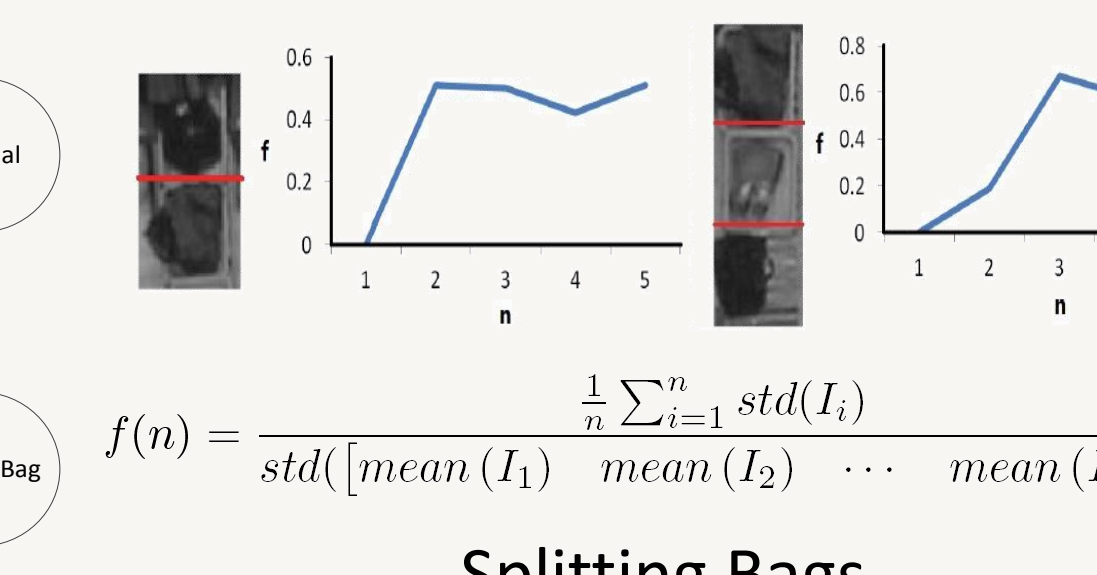
State machine for bag labels



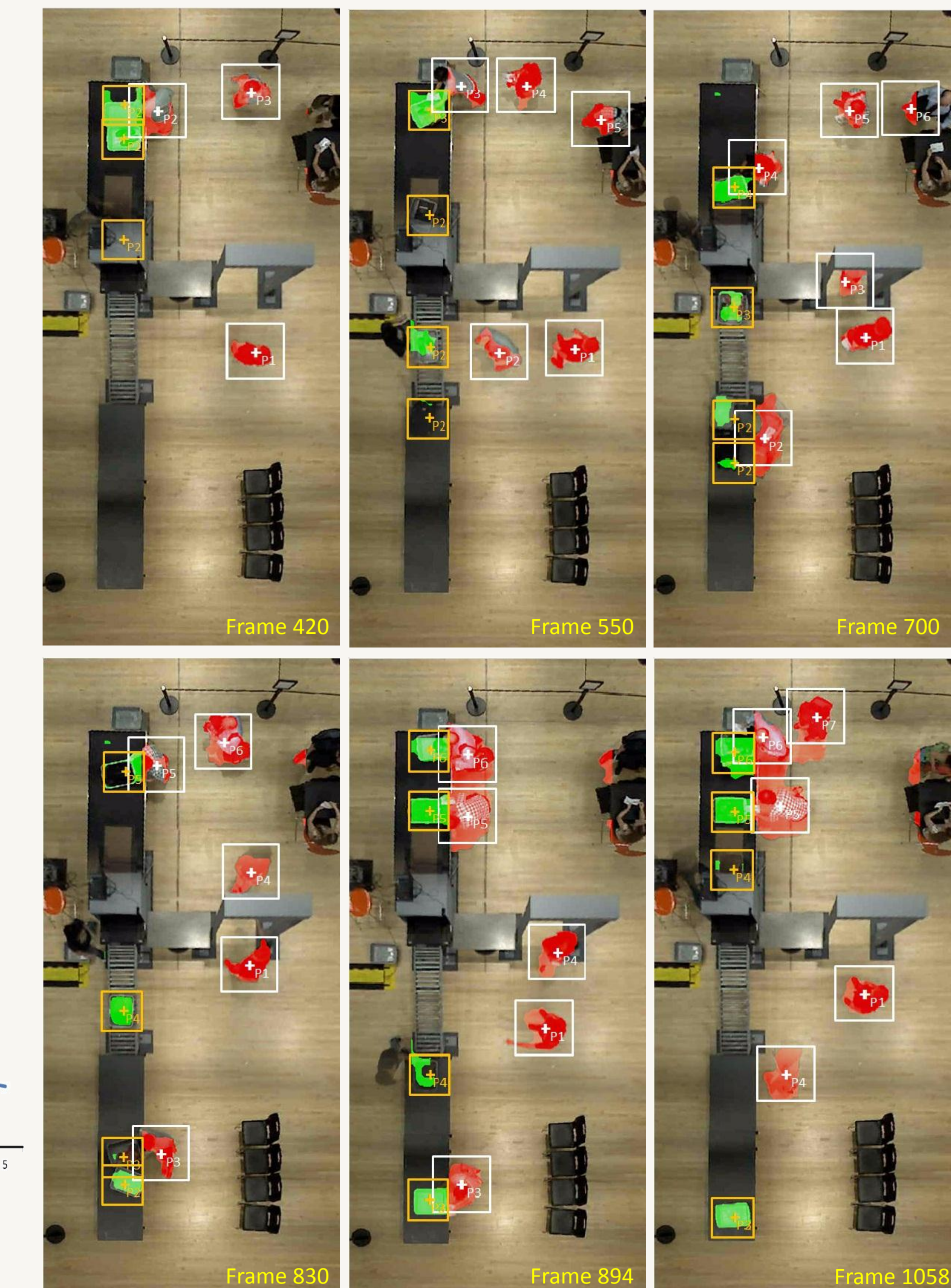
Passenger Tracker



Baggage Tracker



Splitting Bags



Example Results

## Accomplishments Through Current Year

- Constructed the airport security checkpoint simulation environment and collected 300GB of multi-camera video data for analysis.
- Developed new algorithms for calibration of a wide-area camera network, tracking and associating passengers and bags, and anomaly detection.

## Future Work

- Detecting and understanding further types of abnormal behaviors.
- Designing active vision systems in which the PTZ cameras adaptively focus on abnormal or difficult-to-process events.
- Combining video analytics with additional sensors (e.g., radiological, chemical)

## Opportunities for Transition to Customer

The calibration, tracking, and association algorithms can easily be adapted to actual security checkpoints or other situations of DHS interest.

The camera network tracking testbed can be used to investigate additional applications including security monitoring and anomaly detection, flow analysis in crowded scenes, and other large-scale environment simulations.

## Patent Submissions

None in current year.

## Publications Acknowledging DHS Support

Ziyan Wu and Richard J. Radke, Real-Time Airport Security Checkpoint Surveillance Using a Camera Network, Submitted to *Workshop on Camera Networks & Wide Area Scene Analysis*, in conjunction with *IEEE CVPR 2011*.

## Other References

- G. Brostow and R. Cipolla. Unsupervised Bayesian detection of independent motion in crowds. *CVPR 2006*, 594–601, 2006.
- C. Stauffer and W. Grimson. Learning patterns of activity using real-time tracking. *IEEE Transactions on PAMI*, 22(8):747–757, 2000.