U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

SAND2015-2974C

Building detection in SAR imagery

Ryan M. Steinbach
Mark W. Koch, PhD
Mary M. Moya, PhD
Jeremey Goold

April 20, 2015

LDRD
LABORATORY DIRECTED RESEARCH & DEVELOPMENT

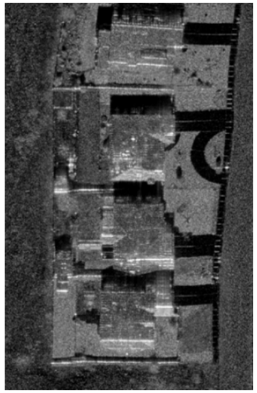
Sandia National Laboratories

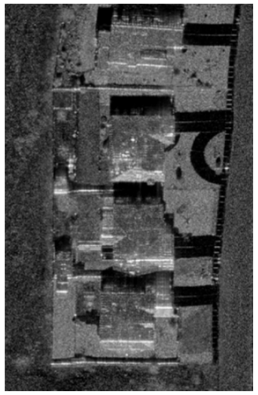
Exceptional service in the national interest

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2013-4147P

What is PANTHER?

- ***Pattern ANalytics To support High-performance Exploitation and Reasoning (PANTHER)***



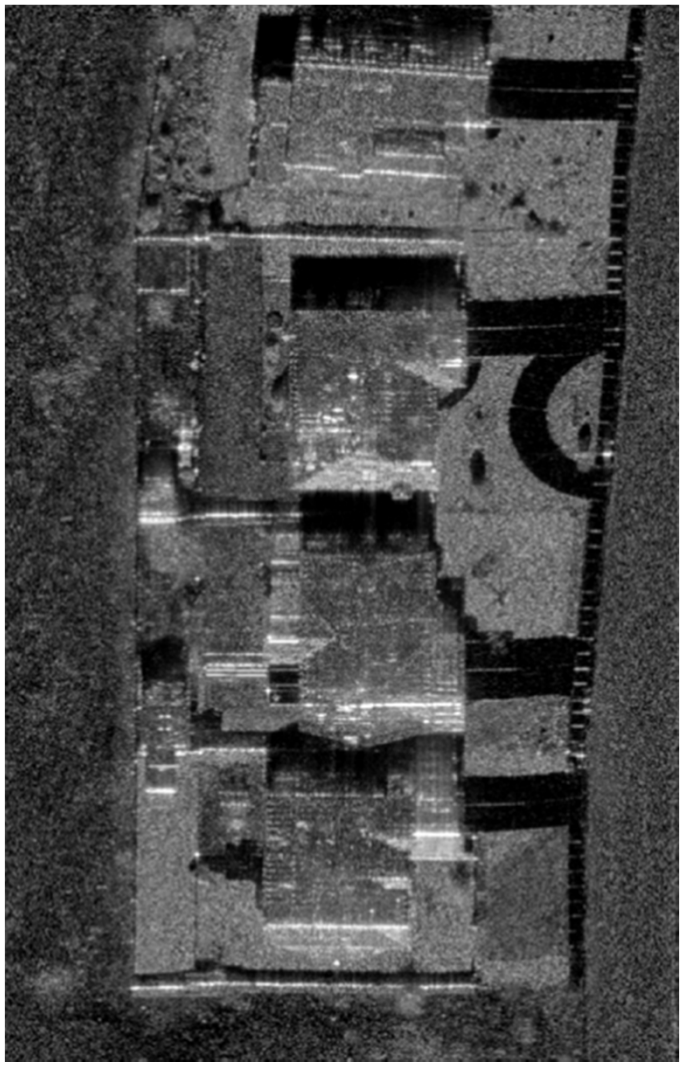


Why care about building detection?

- Data analytics allow a bridge between raw data and humans
- Raw data must be preprocessed to perform data analytics
  - Image needs to be broken into “chunks”
  - Builds are one of the “chunks”

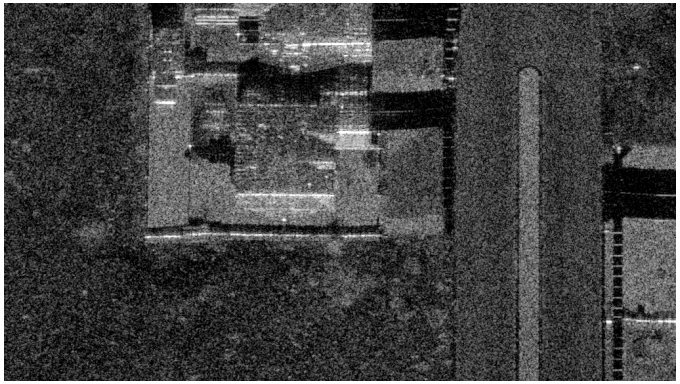
Why is building detection hard?

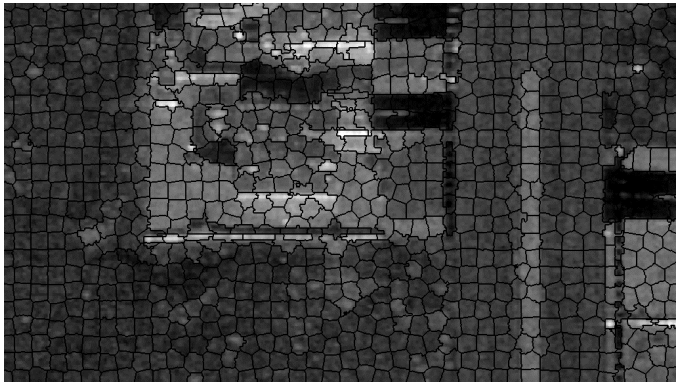
- Buildings are not uniform
  - Size
  - Shape
  - Material
  - Orientation
- Only leading edge of building are defined in SAR
- Edge and shadow are disconnected
  - Difficult to associate



Assumptions required for success

- Superpixel segmentation has been performed
- Superpixels have been classified
  - Bright regions
  - Shadow regions

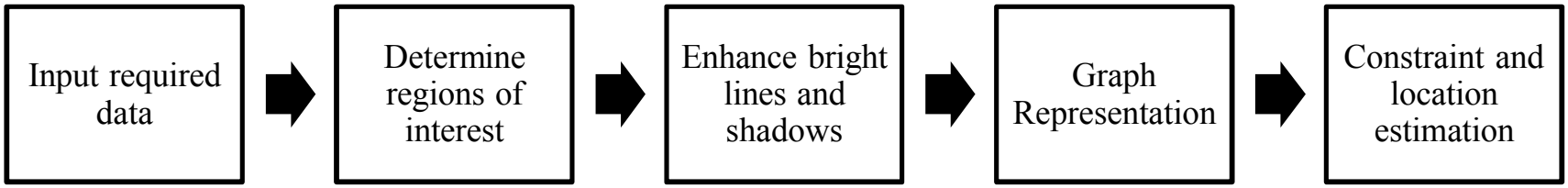




Outline

- Technique Overview
- Preprocessing
- Region of Interest
- Shadow Enhancement
- Bright line Enhancement
- Graph representation
- Graph reduction
- Results
- Conclusion

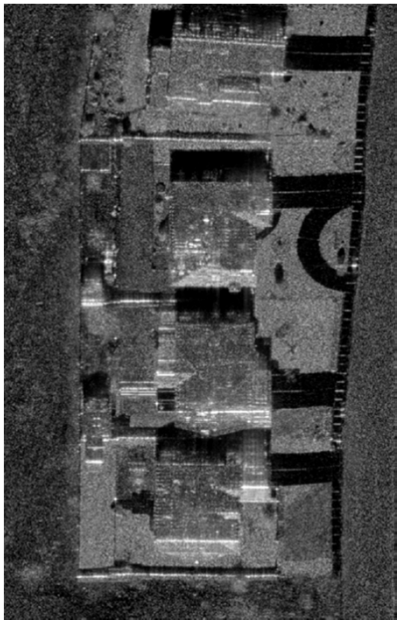
Technique Overview



- Data preprocessing
- Region of Interest
- Shadow enhancement
- Bright line enhancement
- Graph representation
- Graph reduction

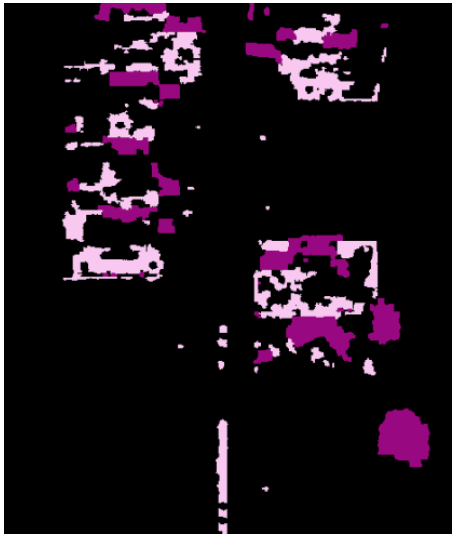
Preprocessing

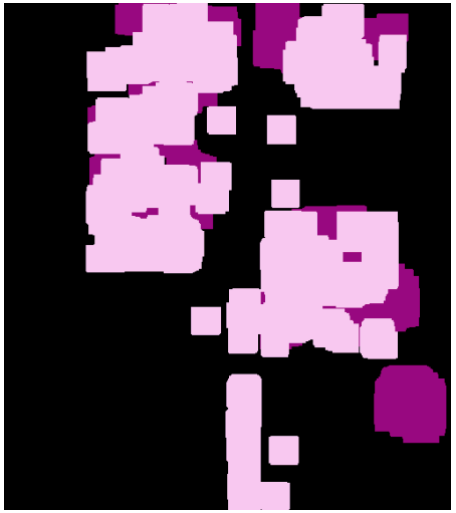
- SAR data segmented into Superpixels
- Classified using Kolmorogov Smirov test and probabilistic fushion



Region of Interest (ROI)

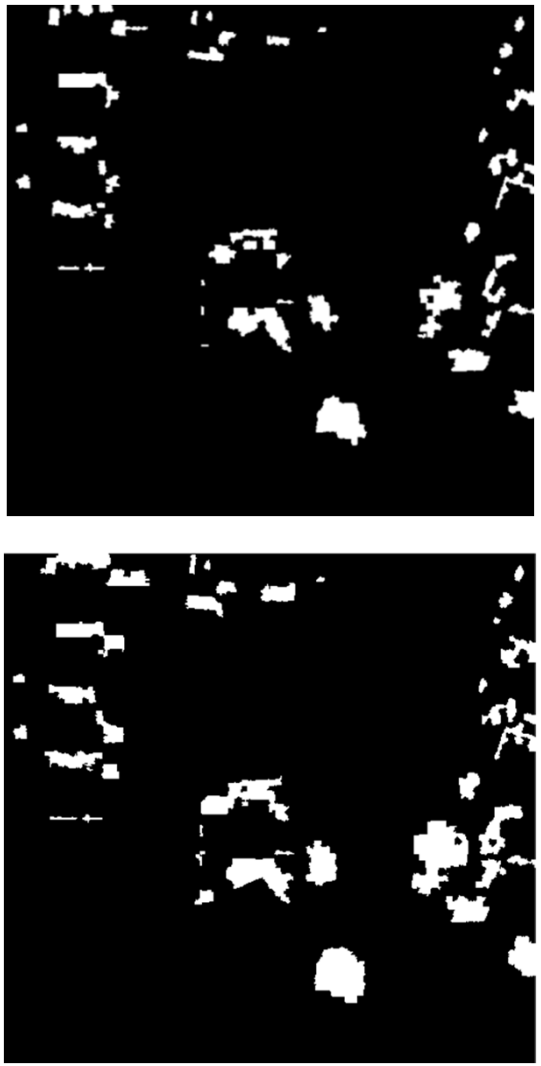
- ROI's are subimages that could contain one or more buildings
- Bright line and shadow labels are dilated with no regard to class label
- Grouped using 4 pixel connection





Shadow Enhancement

- Shadow-labeled pixels are conditionally dilated
  - Conditioned on p-values
- Pixel accepted if its p-value is greater than some threshold

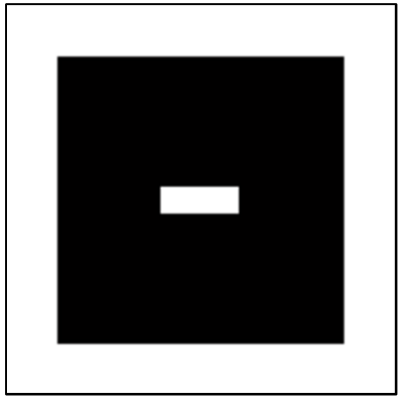


Bright Line Enhancement

- Mean and standard deviation of bright labels are calculated
  - Calculated in ¼ power domain
- Pixels greater than 2 times the standard deviation are bright lines

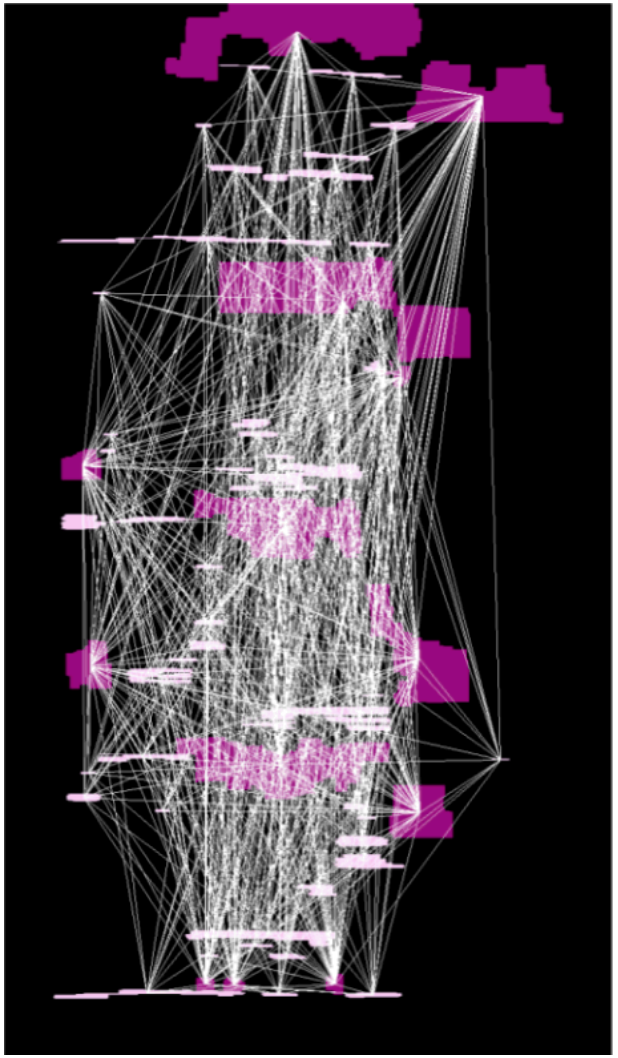
Bright Line Enhancement

- Bright lines can be farther enhanced using the power ratio test
- Ratio test compares the mean of the target region to the clutter region



Graph Representation

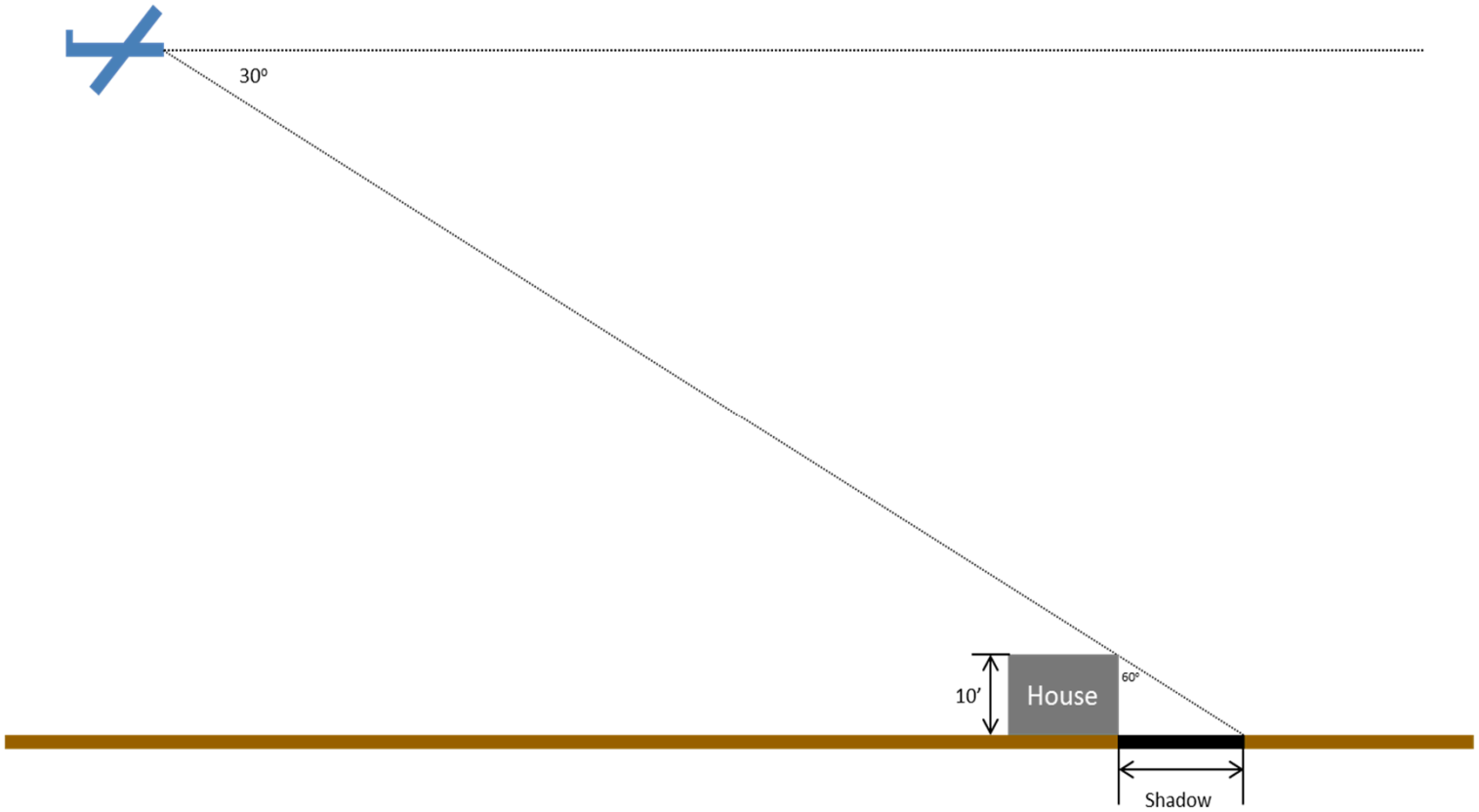
- Bright lines and shadows are the nodes of the graph
- All of the bright lines are connected to all of the shadows
  - Fully connected
  - No need to connect bright lines to bright lines or shadows to shadows



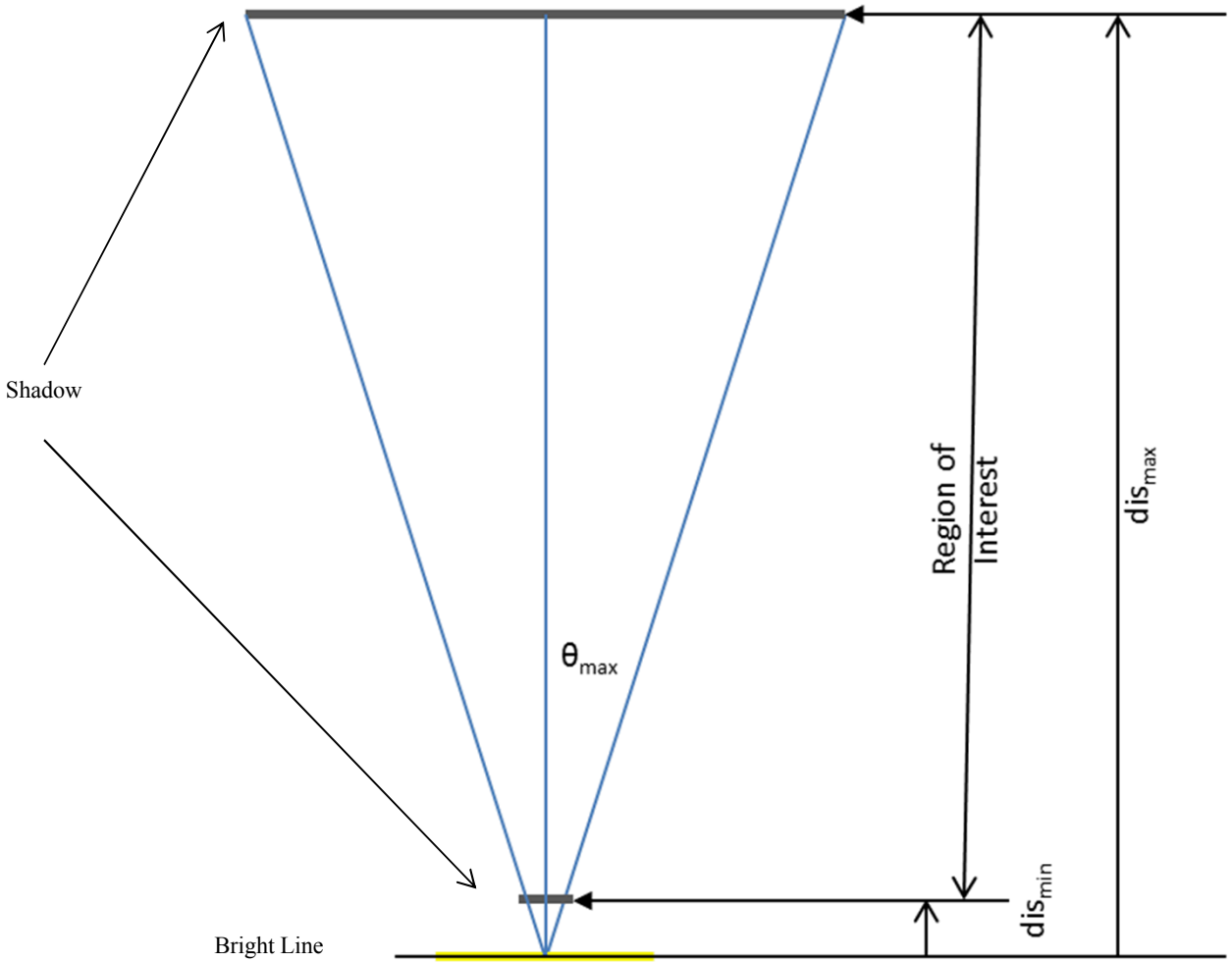
Graph Reduction

- Connections must be reduced in order to locate buildings
- Reduced using 3 constraints
  - Shadow length
  - Connection length
  - Connection Angle

Shadow Length Constraint



Length and Angle Constrain



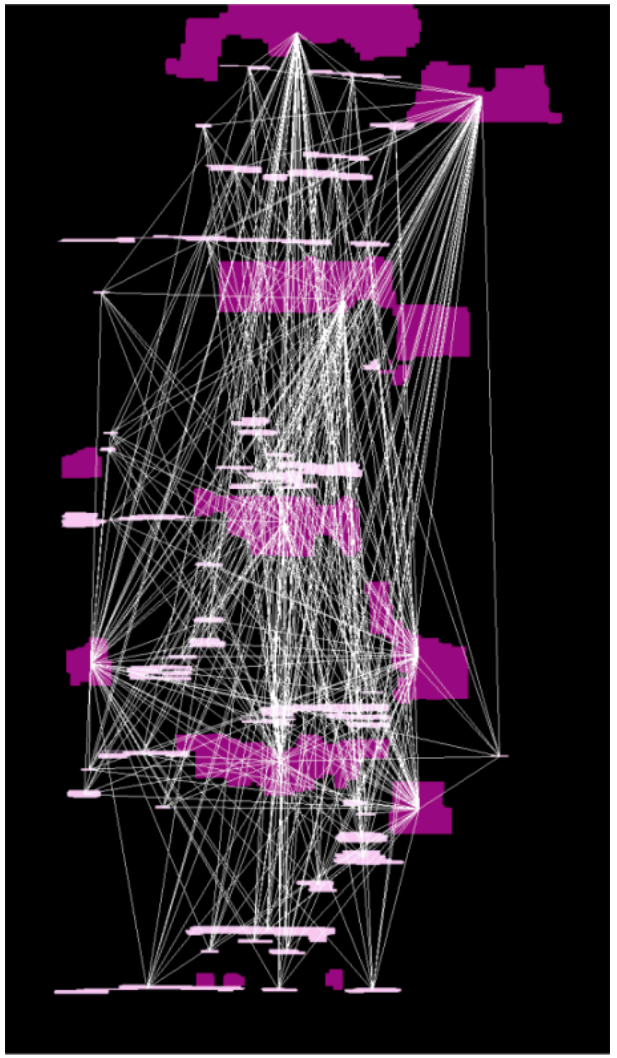
Results

- Building estimates found by:
  - Averaging Shadowing Centroids
  - Averaging Bright Line Centroids
  - Average the two Averages

Results

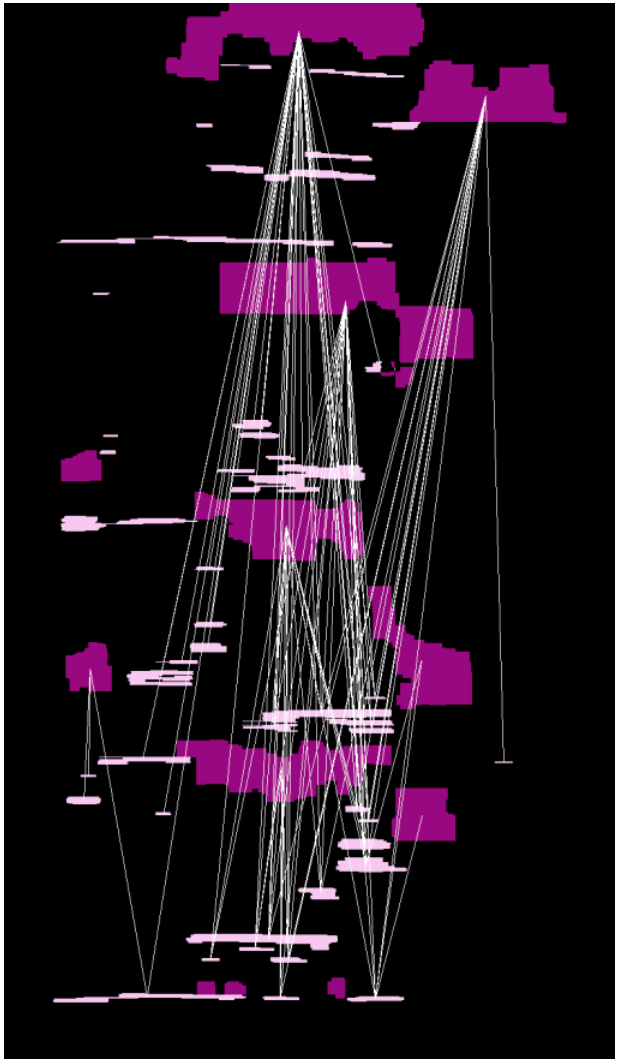
Completely Connected

Shadow Length Constraint



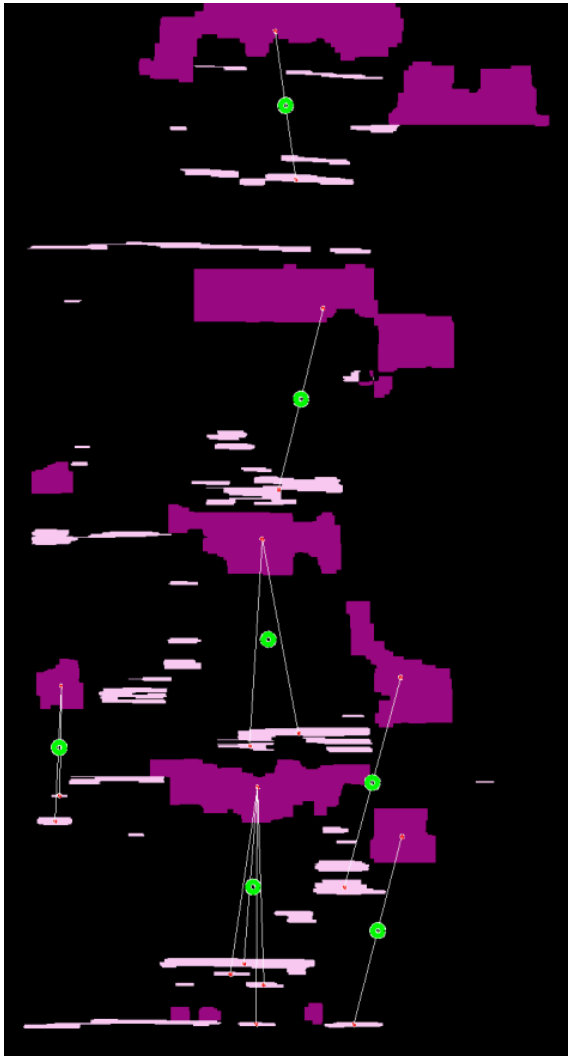
Results

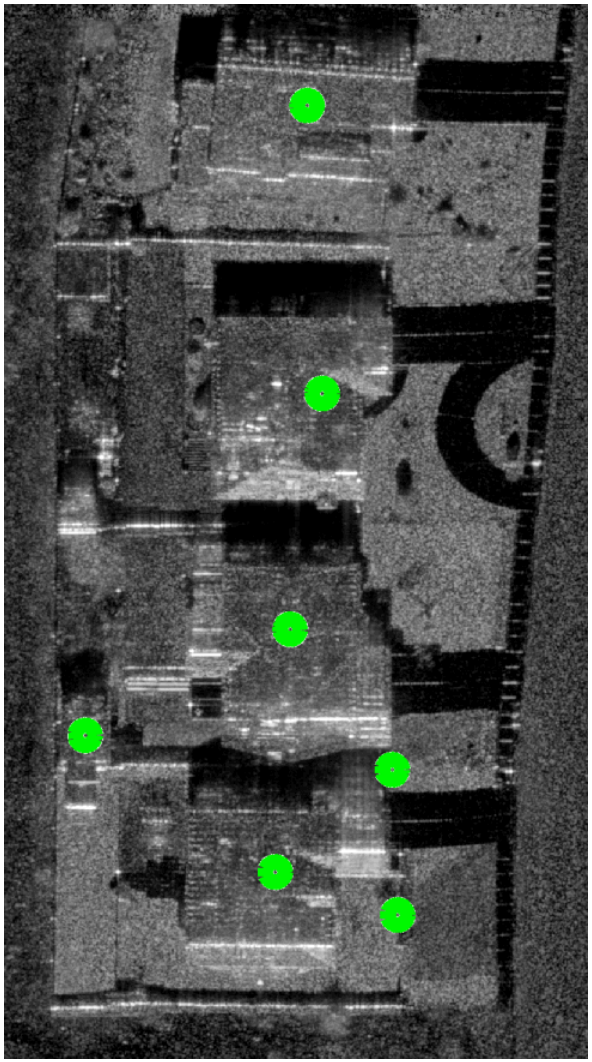
Angle Constraint



Distance Constraint

Results





Results

- 24 buildings in 4 images
- 17 buildings were detected
- 7 buildings were missed
- 5 false alarms
- 1 building detected twice

Conclusion

- Developed a focus of attentions that save computations
- Recognize buildings even though their components are not directly connected
- Used graphs and constraints as a way of grouping components together.

Acknowledgements

- This work was supported by PANTHER, a Laboratory Directed Research and Development (LDRD) Project at Sandia National Laboratories. For additional information about PANTHER, please contact Kristina Czuchlewski, PhD, krczuch@sandia.gov.
- Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.