Panel-Segmentation: A Python Package for Automated Solar Array Metadata Extraction using Satellite Imagery

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Background

• Rise in solar investments $\rightarrow$ rise in solar acquisitions [1]
• Data lost during transference between owners
• Metadata: tilt, azimuth, module type, and mounting configuration
• Manual entry **OR** costly site inspections

**Why is having accurate metadata important?**

• Expected energy yield and degradation rates
• Mounting configuration type affects system degradation rate

Approach

- **NREL Panel-Segmentation package**
  - Example model pipeline [3]

- **New Goal**: Identify mounting configuration
  - Fixed tilt or tracking
  - Carport, ground, or rooftop mount

Methods

• **Data Sets**
  • 862 satellite images
  • Label mounting configuration:
    • Rooftop-fixed
    • Ground-fixed
    • Carport-fixed
    • Ground-single-axis-tracker

• **Object Detection Model**
  • Backbone: Faster-RCNN Resnet-50 FPN [6]
  • Model specifics available in our full paper

Measuring Object Detection Model Performance

- Average Precision (AP) score
- Mean Average Precision (mAP) score
- Intersection-over-Union (IoU)
  - Used to calculate precision and recall
  - Vary IoU score to build precision-recall curve
  - AP score: Area under the precision-recall curve
- mAP score: Average of all AP scores

Image courtesy of [7]

Results

• Precision-recall curve and AP score by class
• Overall mAP score: 77.79%
• How does this compare to the state-of-the-art?
  • Direct comparison not available
  • Previous literature for detecting solar arrays ONLY: 95.66% mAP [8]
  • Easier object detection task (1 class vs. 4)

Panel-Segmentation Pipeline Integration

- Updated model pipeline
  - Input: Google Maps API Key, lat-long coordinates
  - Output: Azimuth and mounting configuration

- Labeled data sets publicly available via the DOE DuraMAT DataHub
  - Only satellite images, no identifying info
Continued Research

• Panel-Segmentation updates
  • Array size/energy output
  • Ground coverage ratio (GCR)
  • Tilt estimations

• What is the actual cost of incorrect metadata?
  • This research heavily leveraged by PV Fleets
  • Quantifying the financial cost of incorrect metadata


LiDAR is used to estimate rooftop solar potential via Google’s Project Sunroof.
Thank you!

www.nrel.gov

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