Detecting regular patterns in urban PS sets

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PSI + Pattern Recognition

- Rows of façade structures → regular Patterns of PS along façade
- Use this information in PS processing
PSI + Pattern Recognition. Why?

- PS height can be estimated at best with a certain variance
- Cramér-Rao Lower Bound (Zhu & Bamler):

\[ \sigma_{\hat{h}} > \frac{\lambda \cdot r}{4\pi \sqrt{N} \cdot \sqrt{2 \cdot SNR \cdot \sigma_B}} \cdot \sin(\theta) \]

- PS are located on a horizontal row → redundancy
PSI + Pattern Recognition. Why?

- PS along lines manually defined
- Examination of corresponding height profiles
Facade 1

- Deviation from mean approximately 0.5 meters
- CRLB for PS with 20dB SNR would be 0.10 m

![Graph showing ground truth and PS results for facade 1](image)
Facade 2

- Three “blunders” visible → Layover
- Height has to be considered in grouping
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Automatic Pattern Recognition

- Bottom-up approach – Production System
- Group PS to horizontal/vertical lines
- Use of prior knowledge: building outlines
- Search for a regular pattern
Workflow – Pattern Recognition

PS-Analysis

Candidate Selection including Non-Maximum Suppression

Pre-selection based on maximum building height

Search for horizontal structures including PS Height
Search for horizontal structures excluding PS Height

Building Outlines
Primitive Objects

- PS selected by threshold on inter-image coherence (0.8)
- Non-Maximum Suppression
Prior Knowledge

- Building outlines: User defined in this case
- May be acquired from GIS or ALS-Data if available
Pre-selection of building PS

- Assumption: Building is not taller than certain threshold
- Defines buffer in range in front of radar-coded building outlines
Grouping of horizontal Lines

- Look for regular patterns of PS
- Search Lines parallel to building outlines $\rightarrow$ 1D search

- All possible triggering PS are tested
- Take biggest group as result (for now)
Result Grouping

- Grouping Results: Color indicates mean height of the group
- Result lacks completeness
Comparison with Ground Truth

- Ground Truth lines radarcoded from 3D-Building model
- Selection of base primitives seems to be a problem
Selection of base primitives

- PS may extents over several pixels
- Choice of appropriate pixel?
- Nearby PS induced by same scattering mechanism?
Scattering Mechanisms

- Different amplitude pattern ↔ different kind of windows
- Purple lines generated by shifting green lines to top of windows
Conclusion and Outlook

▪ Horizontal lines of PS can be used to improve height estimation

▪ Automatic Grouping gives incomplete results

▪ Selection of Base primitives; Interpolate PS positions?

▪ Different scattering mechanisms close together?