BUILDING EXTRACTION FROM POLARIMETRIC INTERFEROMETRIC SAR DATA USING BAYESIAN NETWORK

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1. INTRODUCTION

Many researches have been done to extract buildings from high resolution Synthetic Aperture Radar (SAR) data. The extraction problem is far from solved due to many constraints, e.g. SAR side-look imaging, speckle, and lack of object extent in SAR images. Building detection algorithms usually use intensity information or textures. Layovers and shadows can be discriminated from other objects since they have distinct appearances. The detection is hindered by the small geometric extent of buildings in SAR images and the orientation dependency of reflections. Many buildings are occluded with surrounding environments. The interactions between radar and various buildings are hard to model. Polarimetric SAR data can resolve some ambiguities because polarimetry can be used to analyze physical scattering properties. Scatterers formed by buildings have strong double-bounce reflections. Polarimetric SAR data also allow us to extract rich features for object detection. Polarimetric interferometric SAR (PolinSAR) data are more promising since they are able to provide object height information. Furthermore, coherent scatterer and permanent scatterer analysis using interferometric SAR (InSAR) data are powerful in urban change detection applications. As to building localization, a height map retrieved from PolinSAR data is very advantageous. PolinSAR data are expected to further resolve ambiguities in building detection problems.

For meter-resolution PolinSAR data, however, it is hard to retrieve phases of building roofs from interferometric phase because of complex scattering mechanisms and building geometries. Building height image was derived from InSAR digital elevation model (DEM) in [1]. DEM map was rank-filtered to produce digital terrain model (DTM). The difference of the DEM and DTM maps represented elevations of buildings. This method worked well for a rather flat terrain, however, was not suitable for urban areas. Building height was estimated from interferometric phase of L-band PolinSAR data using ESPRIT algorithm in [2]. ESPRIT generated two estimated phases of dominant scattering mechanisms. The phase corresponding to the top of a building was recovered to give height information. The retrieved height map helped to localize buildings.

In this paper, we address the problem of integrating building detection and height estimation. State-of-the-art object detector is adopted to generate building evidences. The height map generated from PolinSAR data is expected to resolve occlusions and interactions among different objects. Our proposed system integrates appearance-based detection and height information using a Bayesian network, which is a type of directed graphical models. Both evidences of buildings have some faults. A graphical model is efficient in that the evidences will be incorporated in a robust manner [3]. Scene geometry from phase information helps to resolve interactions between objects. On the other hand, the appearance-based detecting result can remove inaccurate height estimates. We are able to jointly estimate scene geometry and object localization. Inferences of the two sources can be done simultaneously.

2. BAYESIAN NETWORK

The proposed Bayesian network consists of object hypotheses, height, coherence and geometric surface. The inference will be performed on these graph elements. We adopt the classification framework presented in [4] to generate local layover identities. A rich set of features are extracted for detecting, including intensity, texture, geometric clues, polarimetric and interferometric features. The object hypotheses in the model are the probabilistic output of the layover detector. The algorithm proposed in [2] is applied to retrieve height information with uncertainty from PolinSAR data. Coherence is a measure of the quality of interferometric products. Here coherence is used to evaluate the quality of height information. Geometric surface maps are obtained by classifying the data into several surface types, e.g. layover, tree, shadow, field and water. These elements are integrated in the graphical model. Graphical model can tolerate errors in the input evidence sources, and the inference among all elements can achieve a global optimization. We can infer final building identities using Belief propagation.

3. EXPERIMENTS

Polarimetric interferometric ESAR data are used in the experiments. The data were acquired in Dresden in 2000. Resolutions are 3.0m in azimuth and 2.2m in range.

4. REFERENCES

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