Quantization in Relative Gradient Angle Domain For Building Polygon Estimation

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Introduction

- Building footprint extraction in remote sensing data benefits many important applications
  - Urban planning
  - Population estimation
- Convolutional neural networks (CNNs) is powerful but often generate imprecise building morphologies including noisy edges and round corners

Segmentation CNN
In this paper, we propose a method that uses prior knowledge of building corners to create angular and concise building polygons from CNN segmentation outputs.

**Input**

- Building segmentation probability map

**Our method**

- Our proposed method takes the building segmentation probability map as input and generates concise building polygons.
Block Diagram

CNN ➔ RGA Transform ➔ Contour in RGA ➔ Degree ➔ Time step ➔ Boundary Orientation Relation Set detection (Red) ➔ Histogram ➔ Degree ➔ Time step

Contour

Degree

Time step

Histogram
Block Diagram

Contour in RGA

Find Edge Intersections

Polygon

Degree

Time step

Quantization

Histogram

Degree

Time step
Relative Gradient Angle Transform

• We want to describe object boundary shapes with gradient angles

• Similar angles may have large numerical differences
  – For example, we may have two neighboring gradient angles, $A=1^\circ$ and $B=359^\circ$, but their smallest angle difference is $2^\circ$
  – The relative gradient angle of $B$ with respect to $A$ is $A + (B - A) = -1^\circ$
Relative Gradient Angle Transform

- We propose Relative Gradient Angle (RGA) Transform that iterates through gradient angles along an object’s contour and sequentially computes relative gradient angles with respect to previously computed angle.

![Building contour](image1)

![Transformed contour signal in RGA](image2)
We propose Relative Gradient Angle (RGA) Transform that iterates through gradient angles along an object’s contour and sequentially computes relative gradient angles with respect to previously computed angle.
Relative Gradient Angle Transform

- We propose Relative Gradient Angle (RGA) Transform that iterates through gradient angles along an object’s contour and sequentially computes relative gradient angles with respect to previously computed angle.
We name the set of angle relationships a Boundary Orientation Relation Set (BORS).

In this paper, we assume the angle relationships in building applications to be orthogonal or parallel.

- The BORS for building applications is \{90, 180, 270\}

We detect the relative gradient angles with angle relationships described by BORS.
By quantizing contour angles to the detected angles, we replace round corners with sharp corners.
Building Polygon Extraction

- Building polygon is obtained by computing the intersections between edges
Experimental Results

a) Ground truth contours
b) Contours of segmentation mask from PSPNet outputs
c) Polygons extracted by our method
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