Locating Crop Plant Centers From UAV-Based RGB Imagery

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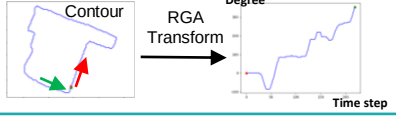
Introduction

- Building footprint extraction in remote sensing data benefits many important applications, such as urban planning and population estimation.
- Recently, rapid development of convolutional neural networks (CNNs) and high-resolution satellite building image datasets have pushed the performance boundary further for automated building extractions.
- However, CNN approaches often generate imprecise building morphologies including noisy edges and round corners.
- We propose a method uses prior knowledge of building corners to create angular and concise building polygons from CNN segmentation outputs.

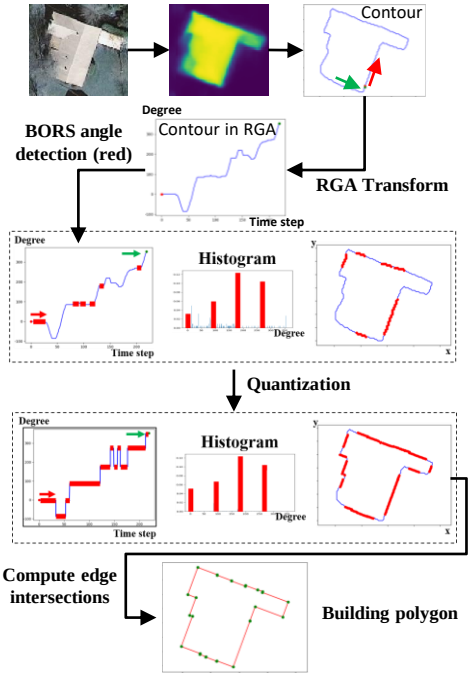
Contours of segmentation mask generated by CNN

Relative Gradient Angle Transform

- The goal of Relative Gradient Angle Transform (RGA Transform) is to describe object boundary shapes with gradient angles.
- However, similar angles may have large numerical differences. For example, we may have two neighboring angles, A=1° and B=359°, but their smallest angle difference $|D_{smallest}(B,A)|$ is 2°, where $D_{smallest}(B,A)$ finds the smallest angle of B subtract A.
- Instead of using the numerical angle value, we compute the relative gradient angle.
- The relative gradient angle of B with respect to A is $A + D_{smallest}(B,A) = -1°$.
- RGA Transform iterates through angles along a contour and sequentially computes relative gradient angles with respect to previously computed angle.



Block Diagram



Boundary Orientation Relation Set

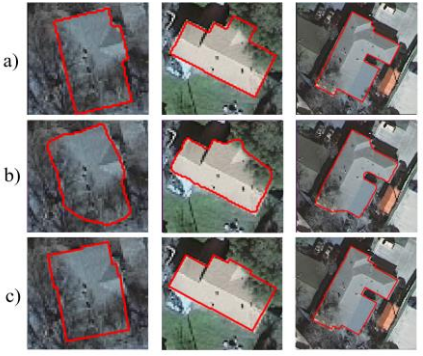
- Edges in a building contour can be orthogonal or parallel, and this property creates angle relationships in RGA domain, for example, the angle between building edges are 0°, 90°, 180°, and 270°.
- We name the set of angle relationships a Boundary Orientation Relation Set (BORS).
- For a given RGA signal, we detect angles that best fit the angle relationships described by a BORS

Quantization and Polygon Estimation

- By quantizing contour angles to the detected angles, we straighten edges and replace round corners with sharp corners
- Building polygon is then estimated by computing the intersections between edges with quantized angles.

Experimental Results

- We evaluate our method on the Inria Aerial Image Labeling Dataset



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

Conclusions

- We presented a method to extract building polygons from CNN segmentation outputs.
- We described a new transform, Relative Gradient Angle Transform that converts object contour signals into time vs. angle domain.
- We proposed a quantization framework to straighten edges and reconstruct sharp corners based on the gradient angle relationships between object edges.
- Experimental results demonstrate our method refines CNN output from a rounded approximation to a more clear-cut angular shape of the building footprint.