Quantization in Relative Gradient Angle Domain For Building Polygon Estimation

Yuhao Chen, Yifan Wu, Linlin Xu,

Alexander Wong

Vision and Image Processing Lab (VIP)

Systems Design Engineering Department

University of Waterloo

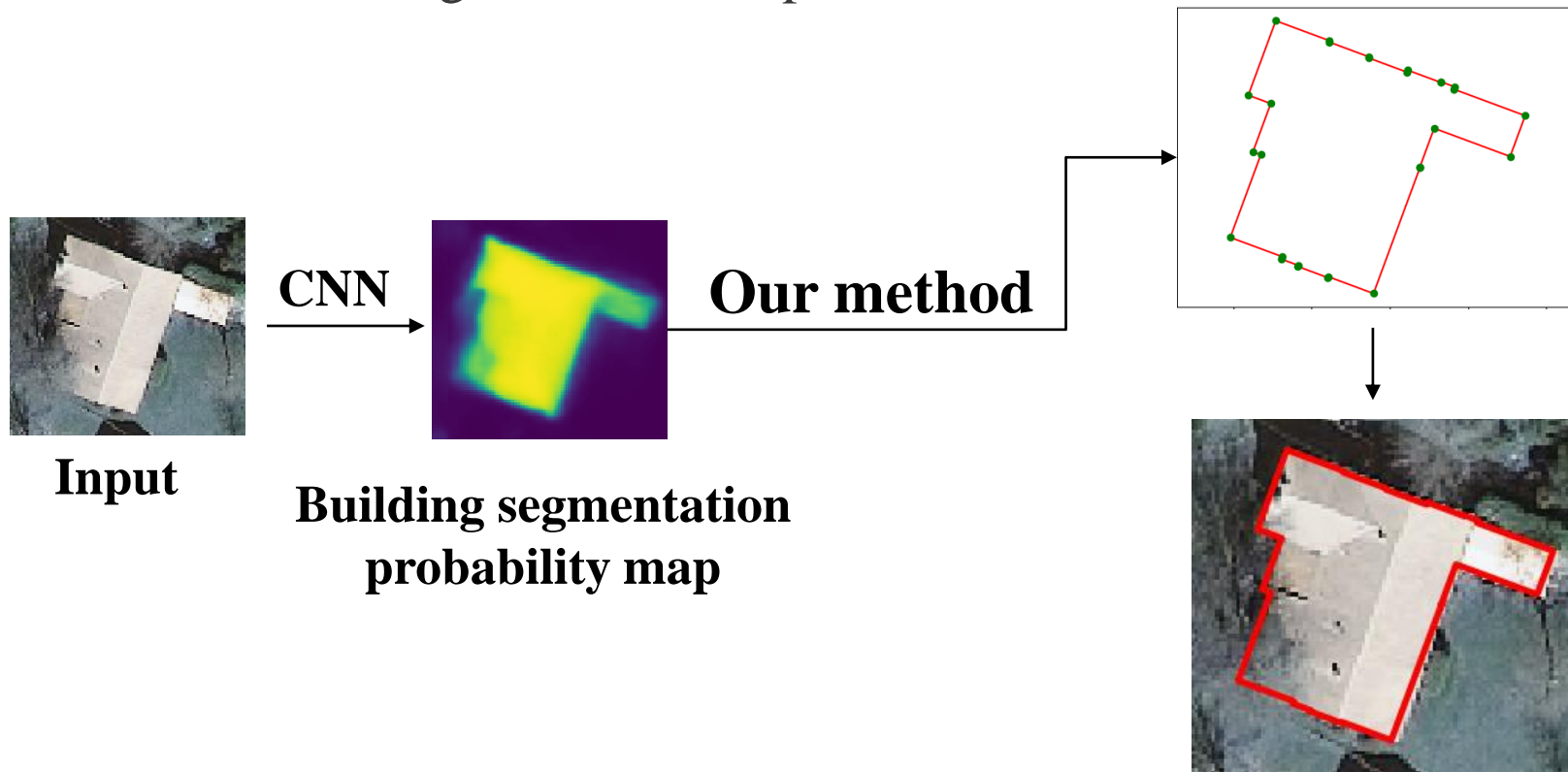Waterloo, Ontario, Canada

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
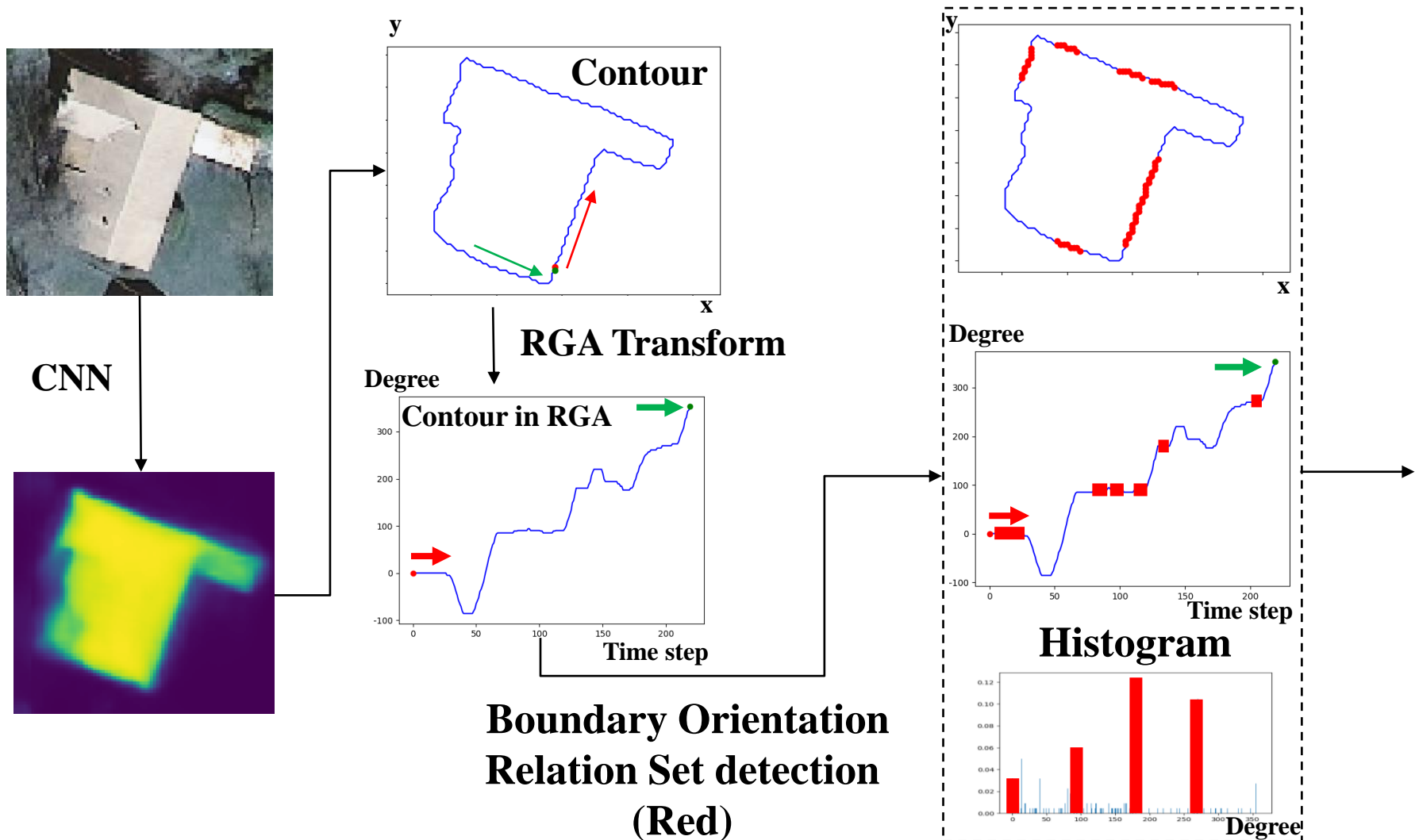

Segmentation CNN

- 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
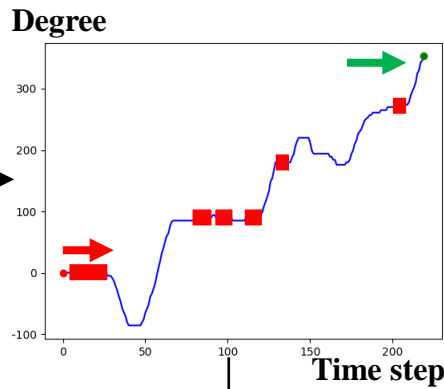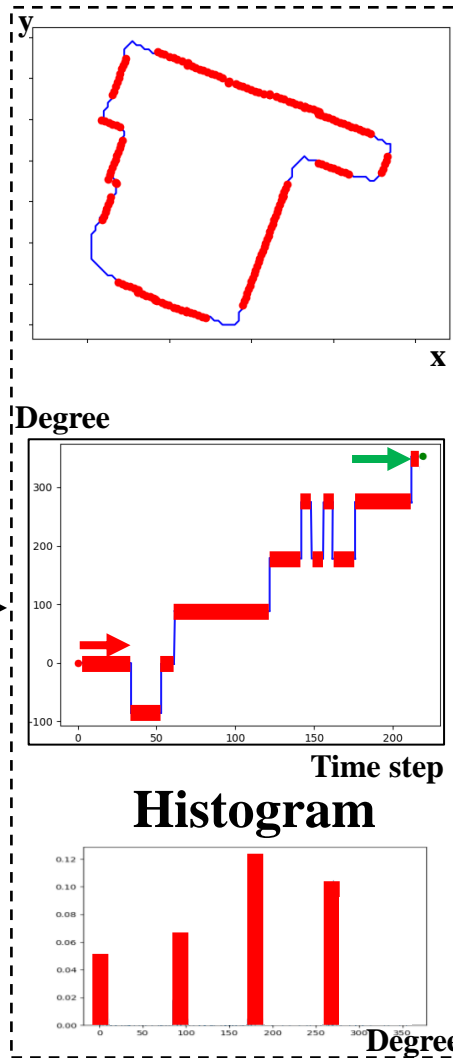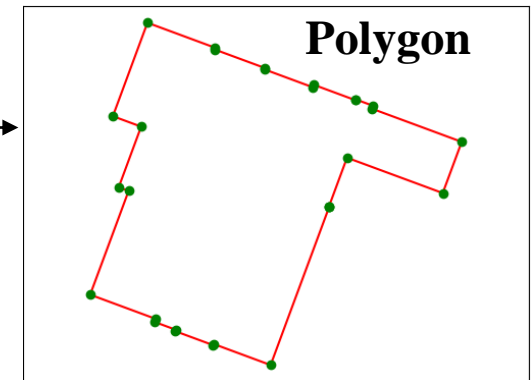

CNN

Our method

Input

Building segmentation probability map

Block Diagram

CNN

Contour

RGA Transform

Contour in RGA

Boundary Orientation Relation Set detection (Red)

Histogram

Block Diagram

Contour in RGA

Find Edge Intersections

Polygon

Quantization

Histogram
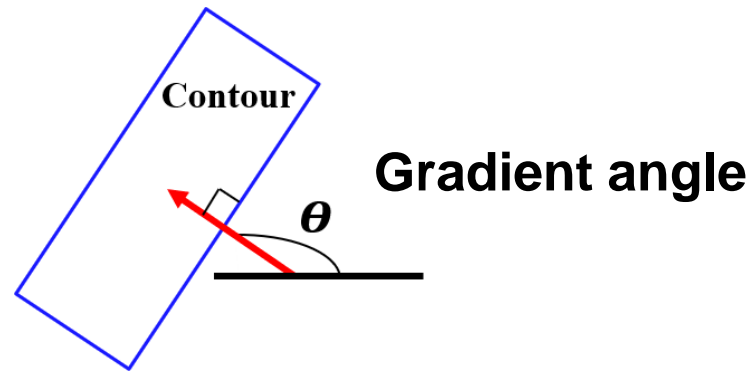
Relative Gradient Angle Transform

- We want to describe object boundary shapes with gradient angles
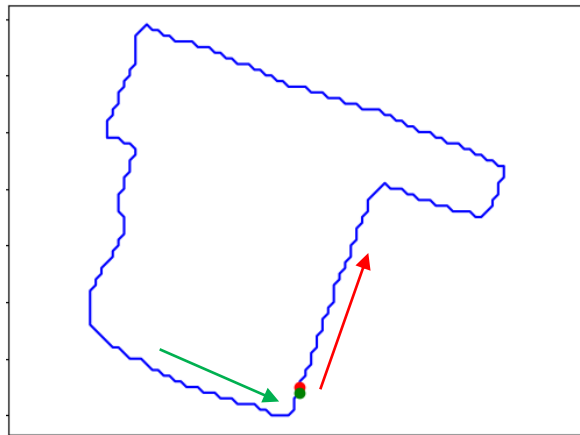

- Similar angles may have large numerical differences
  - For example, we may have two neighboring gradient angles, A=1° and B=359°, but their smallest angle difference is 2°
  - The relative gradient angle of B with respect to A is $A + (B - A) = -1°$

- 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
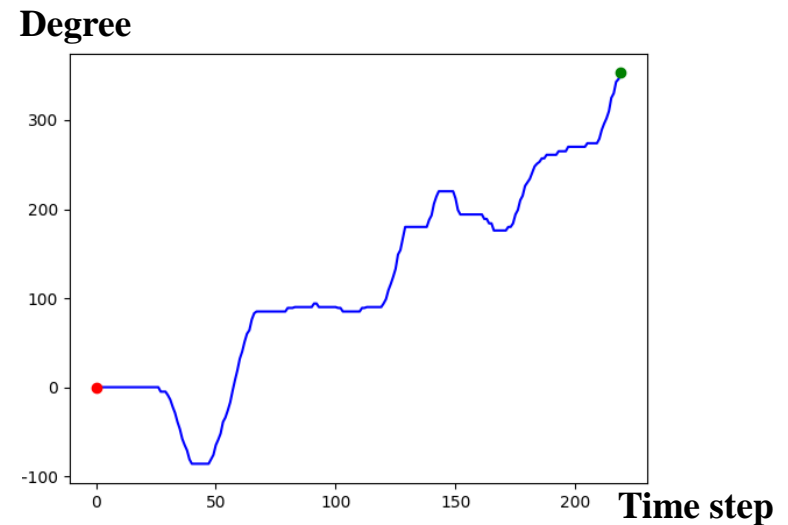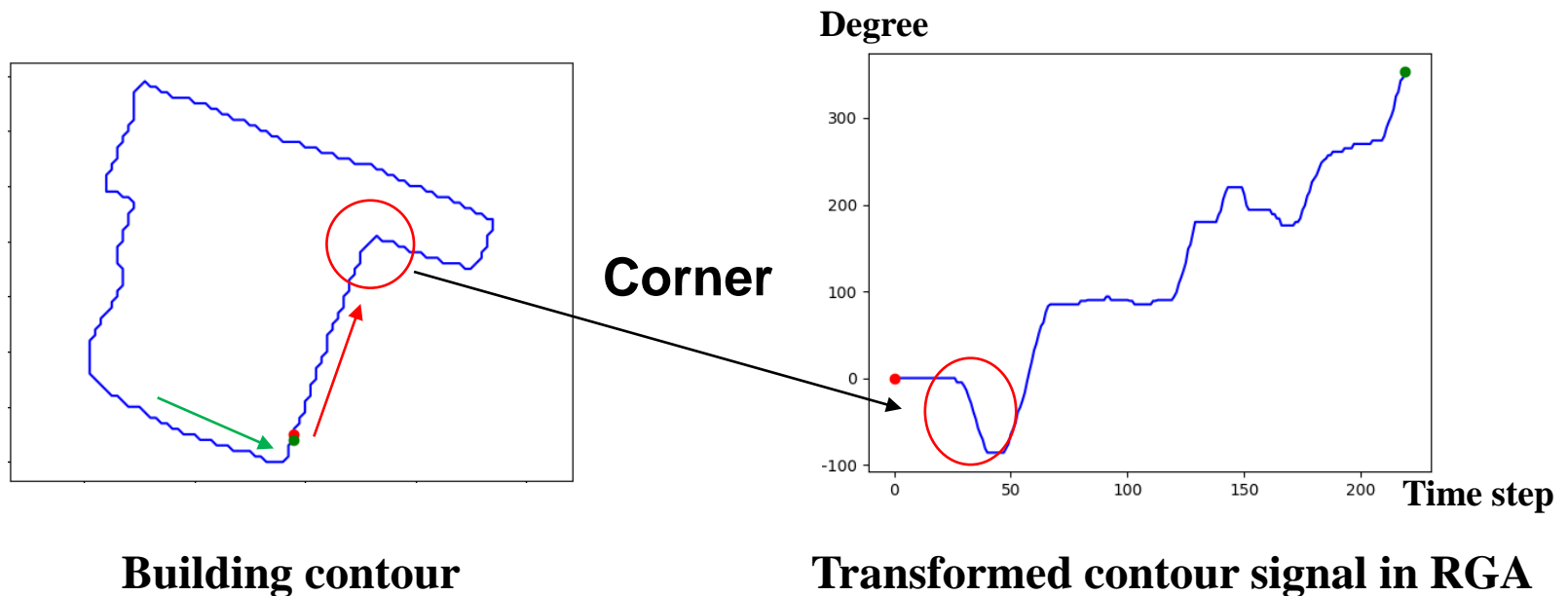
Transformed contour signal in RGA
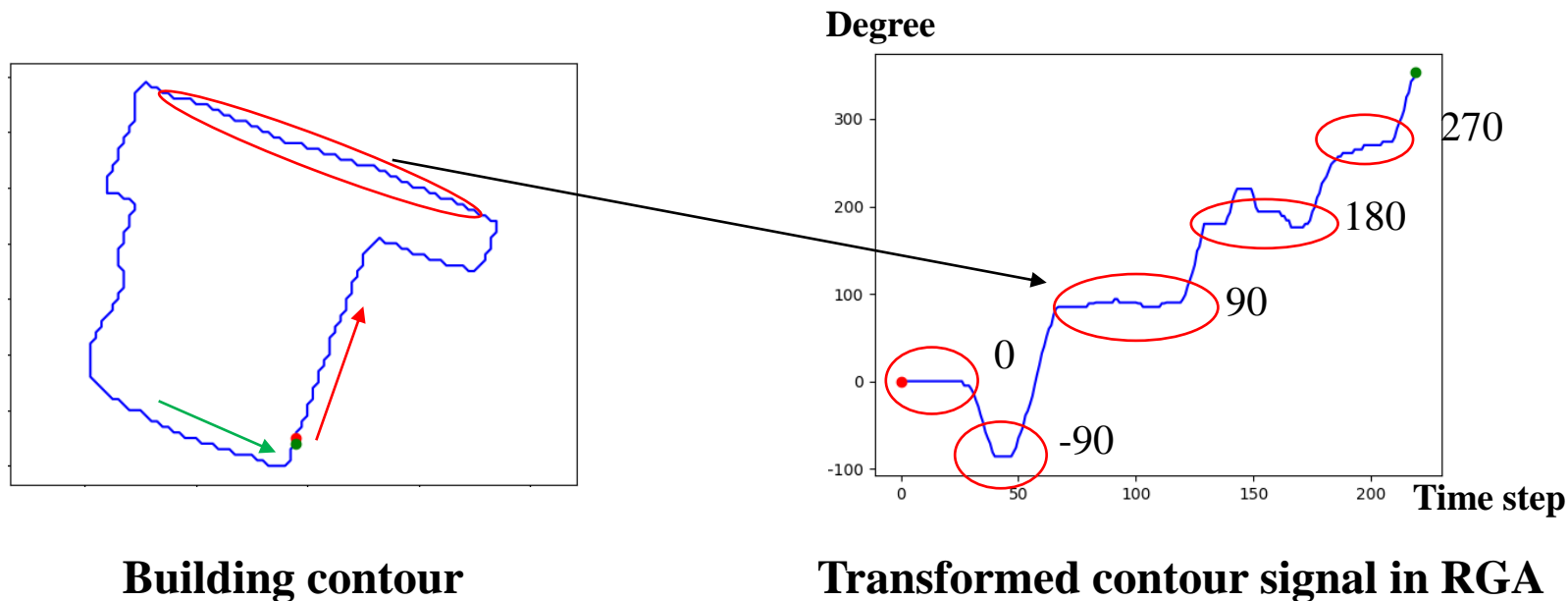
Relative Gradient Angle Transform

- 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

Corner

Building contour

**Transformed contour signal in RGA**

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

Transformed contour signal in RGA

Boundary Orientation Relation Set

- 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

Histogram

Degree

Degree

y

x

Time step
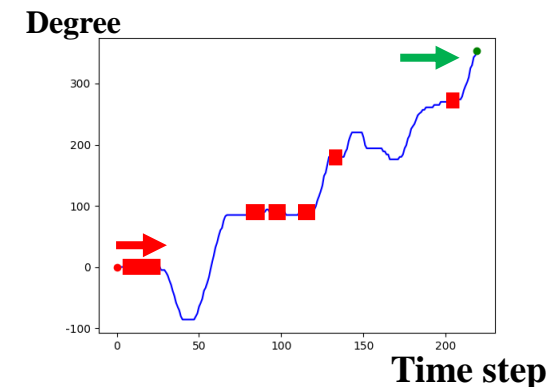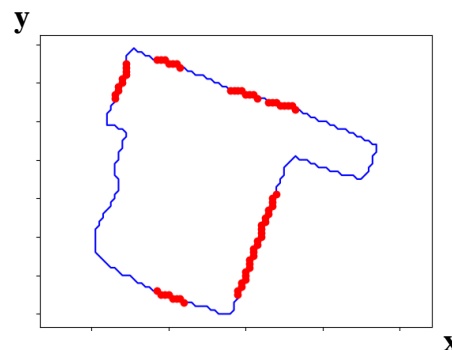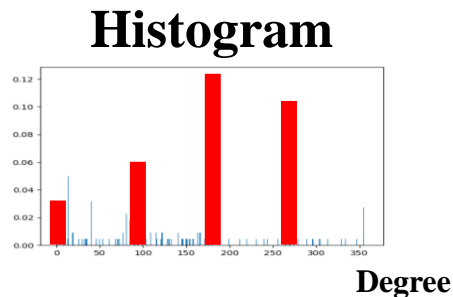
Red: detected relative gradient angles

Quantization

- By quantizing contour angles to the detected angles, we replace round corners with sharp corners

Divide and Conquer

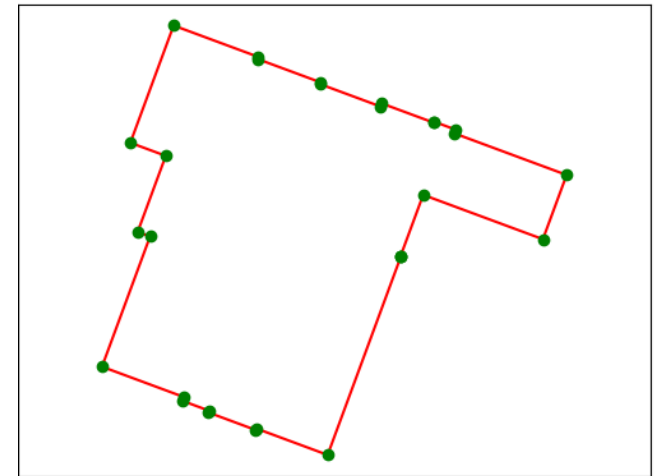**Histogram**

Quantize

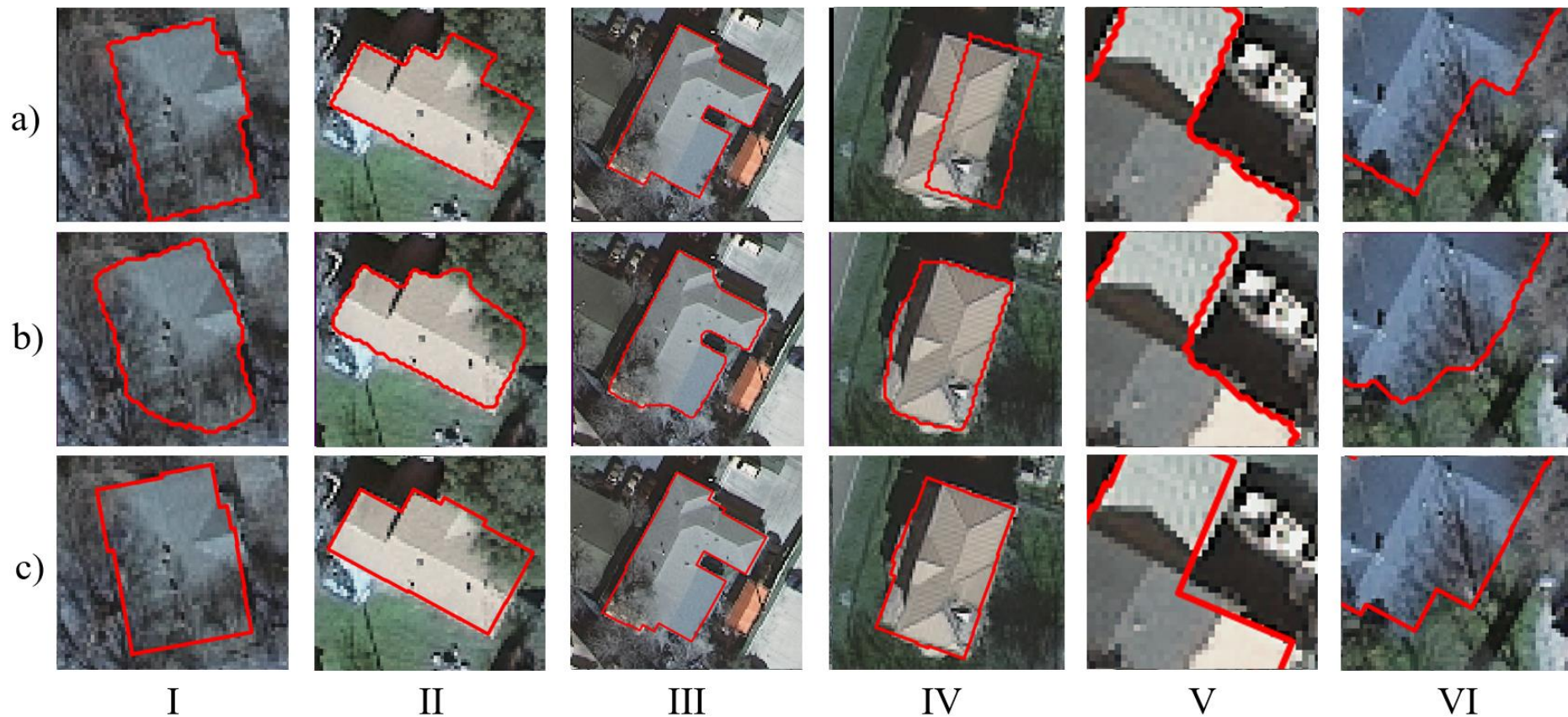**Remove**
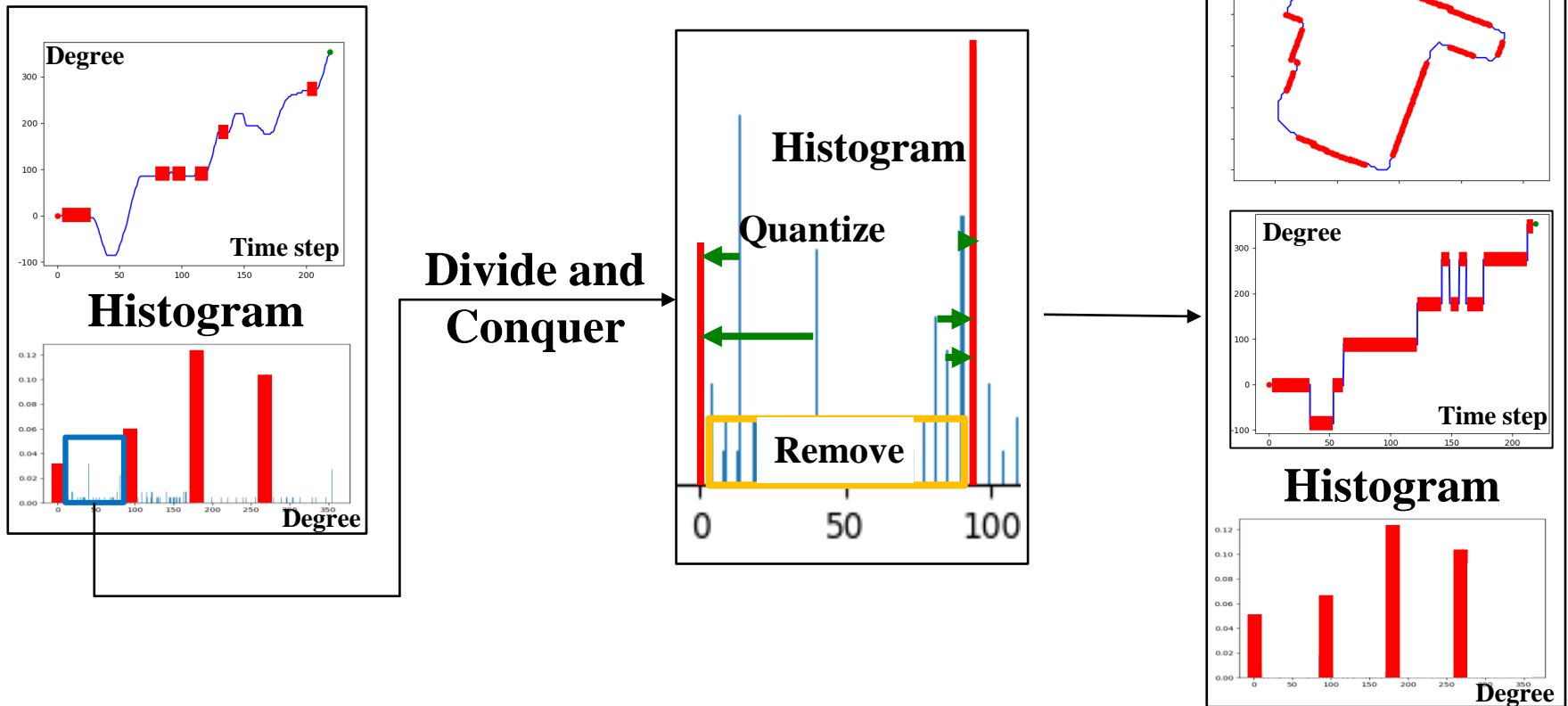
Building Polygon Extraction

- Building polygon is obtained by computing the intersections between edges
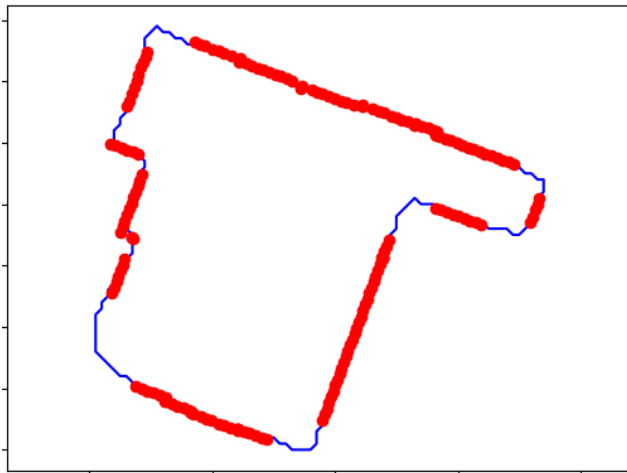
Compute intersections

Experimental Results

a) Ground truth contours

b) Contours of segmentation mask from PSPNet outputs

c) Polygons extracted by our method

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