Identifying Windows in Building Facades

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Problem and Motivation

- Uses:

1. 3D city modeling
2. Better visual scene understanding
3. Surveillance

Background

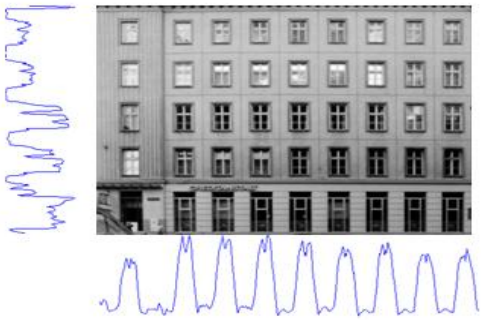
- Two approaches:
  - Single image analysis
  - Statistical machine learning based
- We limit our scope to frontal facades
- Focus on single image analysis of the facade

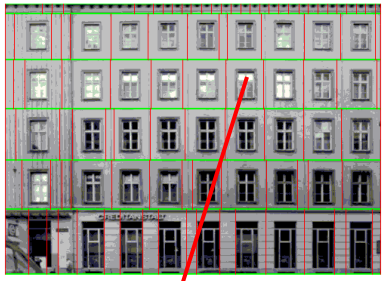
Workflow

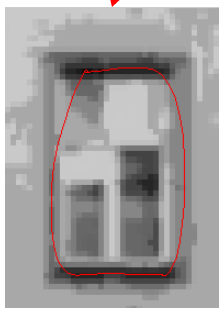
Projection Profiles

Mutual Information

Active Contours or Snake Algorithm

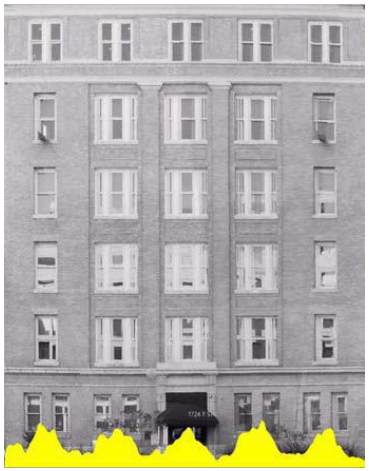


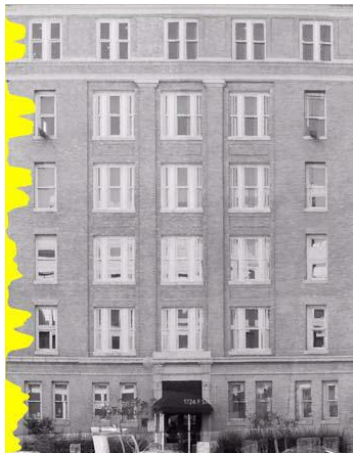




Projection Profile

- Projection profile: Summation of gradients in a row/column
- Get horizontal projection profile and vertical projection profile





- Choose threshold values to get approximate height of each floor

Mutual Information

- In this stage, we split an image into floors and tiles
- MI serves as a measure of similarity between regions of an image

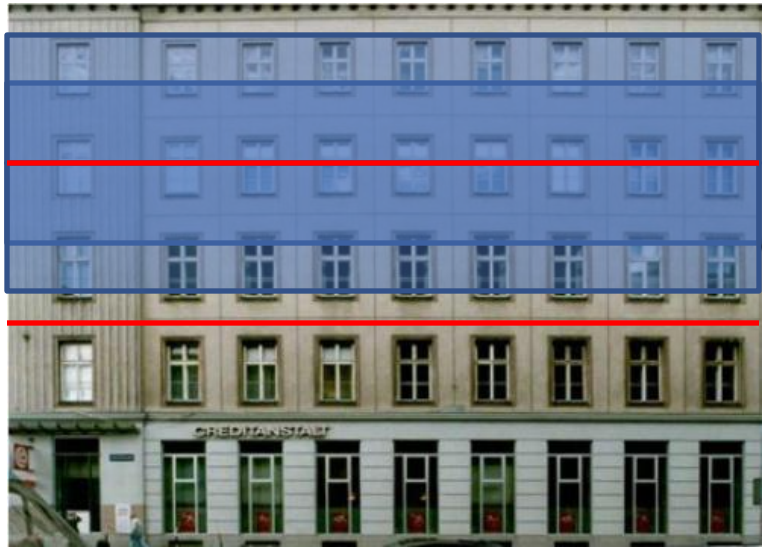
$$MI(A,B) = \sum_{a,b} P(a,b) \log \frac{P(a,b)}{P(a) \cdot P(b)},$$

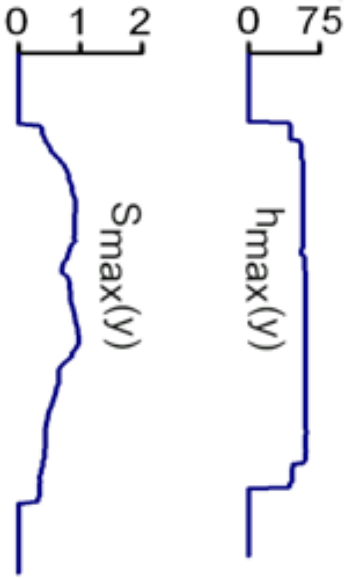
Mutual Information (cont.)

- Similarity between two adjacent regions:

$$S(y,h) = MI(I(\mathscr{R}_{y,h}), I(\mathscr{R}_{y-h,h})).$$

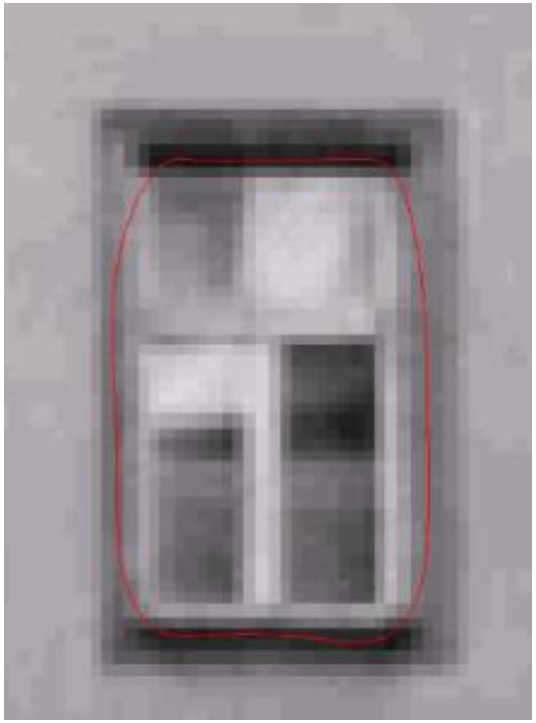
- Compute S(y,h) for all positions of y and a range of values for h given by our projection profile algorithm.





Snake Algorithm

- Detect window boundaries within a tile
- Works like a stretched elastic band being released



Snake Algorithm

Idea: Minimizing energy

$$E^*_{\text{snake}} = \int_0^1 E_{\text{snake}}(\mathbf{v}(s))\, ds$$

$$= \int_0^1 E_{\text{int}}(\mathbf{v}(s)) + E_{\text{image}}(\mathbf{v}(s))$$

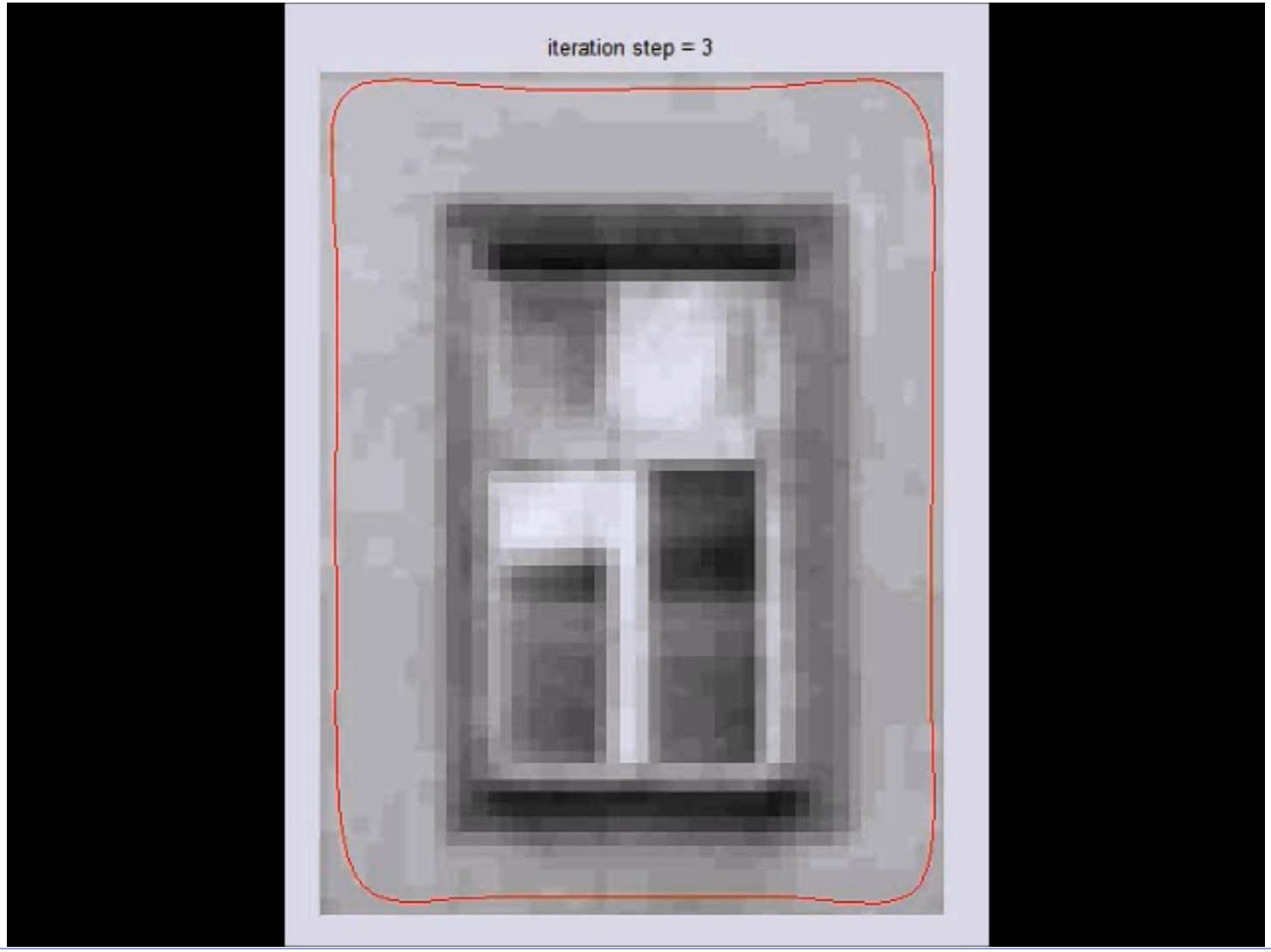
$$+ E_{\text{con}}(\mathbf{v}(s))\, ds$$

$$E_{\text{int}} = (\alpha(s)|\mathbf{v}_s(s)|^2 + \beta(s)|\mathbf{v}_{ss}(s)|^2)/2$$

Shrink

Smooth

Results

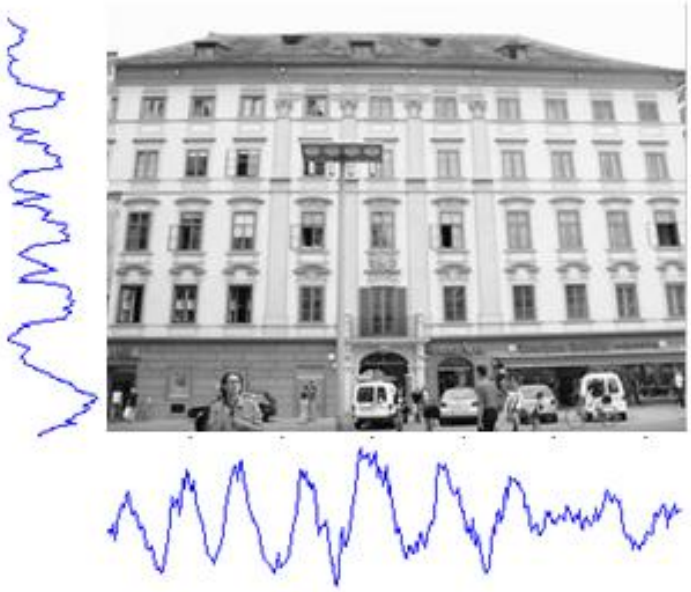


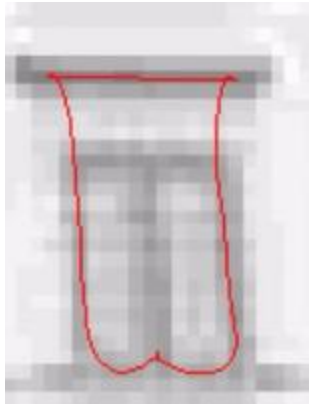
Results

Projection Profiles

Mutual Information

Active Contours or Snake Algorithm





Future Work

- Irreducible Facade (IF) is a stack of original, similar image fragments

Future Work

- Angular shots
- Arch windows / irregular windows

Thank You !

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