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Machine-learning Classification of Aerial Photogrammetric 3D Point Clouds

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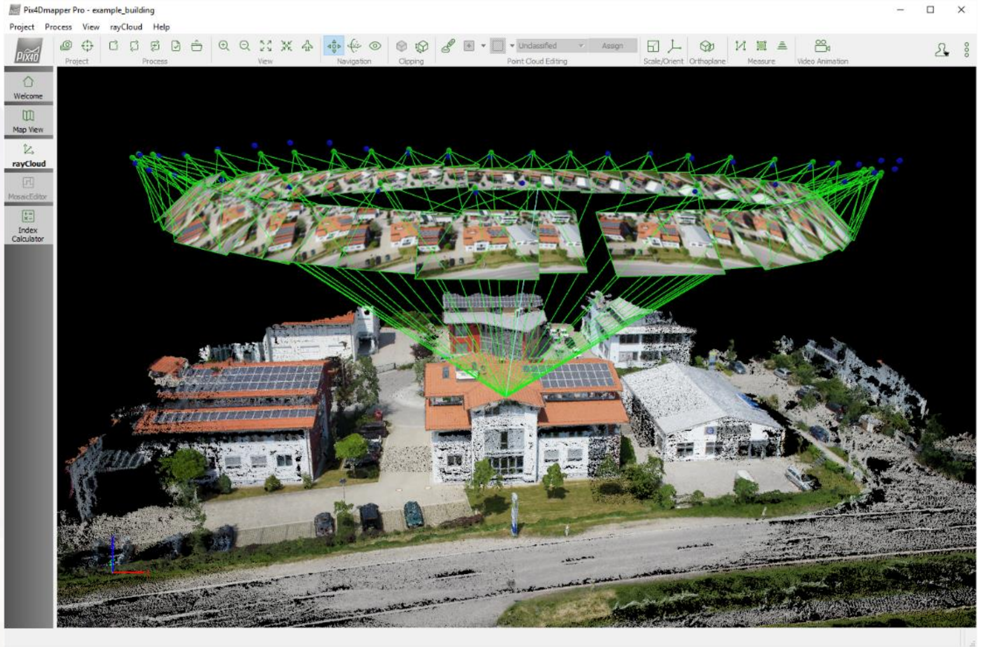
Point Cloud Classification & Photogrammetry Data

- Generating point clouds from imagery is easy and available

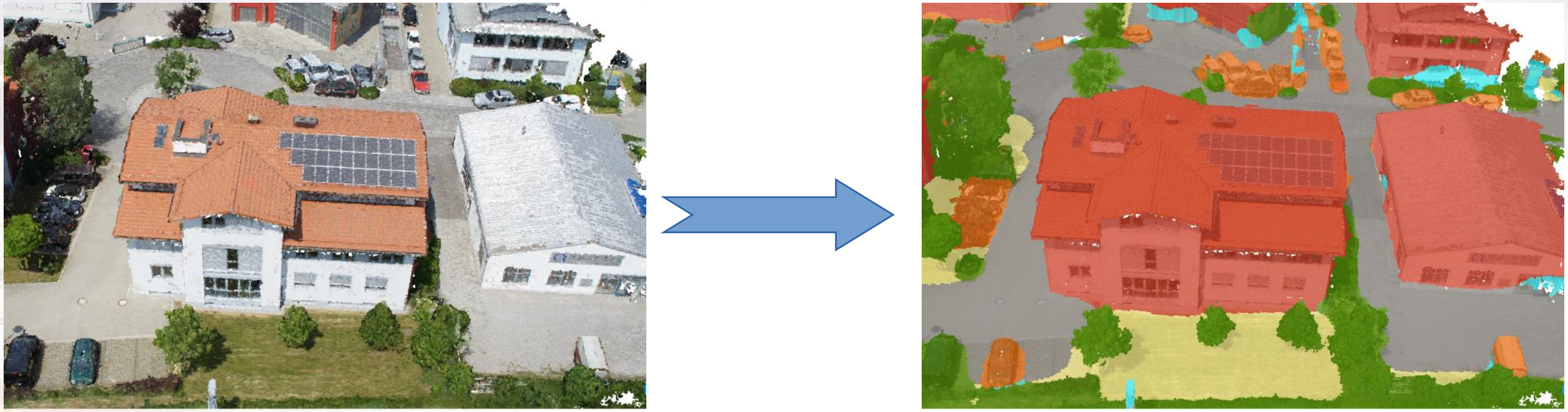

Pix4Dmapper Pro - example_building
Project Process View rayCloud Help
Project
Process
View
Navigation
Clipping
Unclassified
Assign
Point Cloud Editing
Scale/Orient
Orthoplane
Measure
Video Animation
Welcome
Map View
rayCloud
MosaicEditor
Index Calculator

Point Cloud Classification & Photogrammetry Data

- DTM generation
- Vectorization/shape extraction
- Roads, trees, cars detection&counts

The problem

Manual labeling is impractical and unfeasible for large datasets → need for automated machine learning approaches

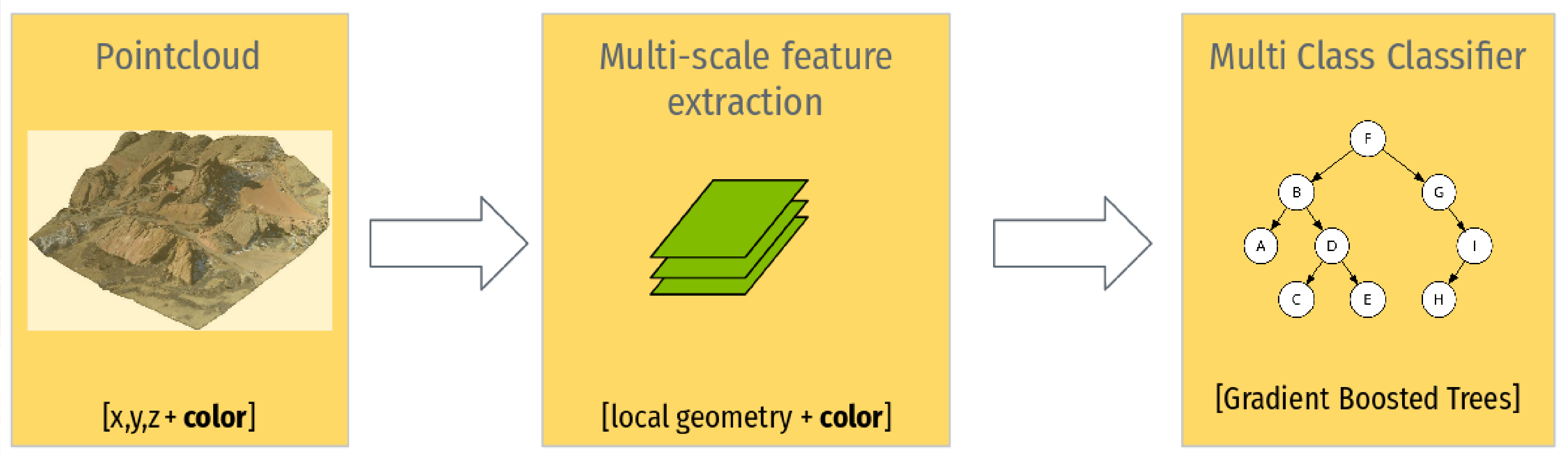


Our goals

Propose and evaluate an automatic classification approach that

- is computationally efficient to be run **interactively**
- runs on **large** photogrammetry point clouds
- Exploits **color information** from photogrammetry data

Overview of the proposed method



Pointcloud

[x,y,z + **color**]

Multi-scale feature extraction

[local geometry + **color**]

Multi Class Classifier

[Gradient Boosted Trees]

Multi-scale feature extraction

Geometry information

- Voxelize point cloud at different scales (from 20 cm to 50 m) to capture spatial information

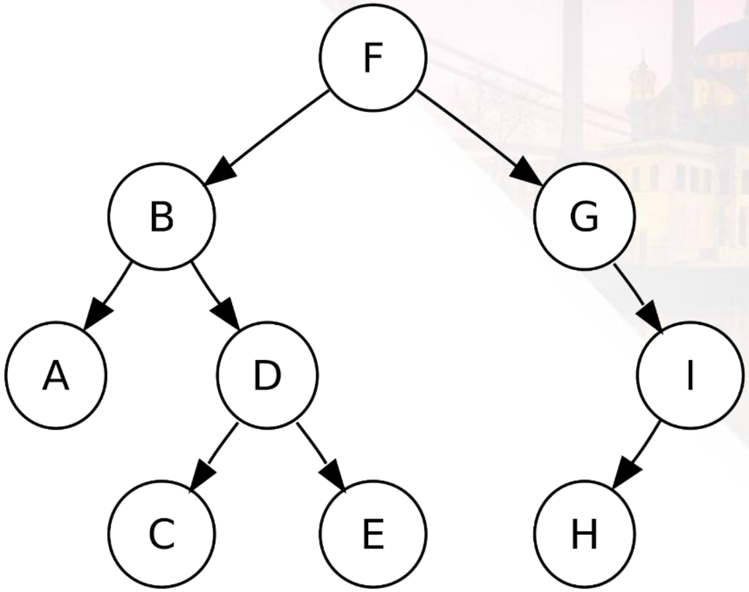
Color information

- Color of the point of interest
- Average color of neighboring points within radius **r**

Multi class classifier

We used Gradient Boosted Trees (GBT)

- fast to train and predict
- early stopping scheme gained 3x speed-up



Our datasets

Ankeny (9M points)

Buildings (3.4M points)

Cadastre (5.8M points)

generated with Pix4D Mapper Pro and fully labeled. Publicly available now at

https://pix4d.com/research

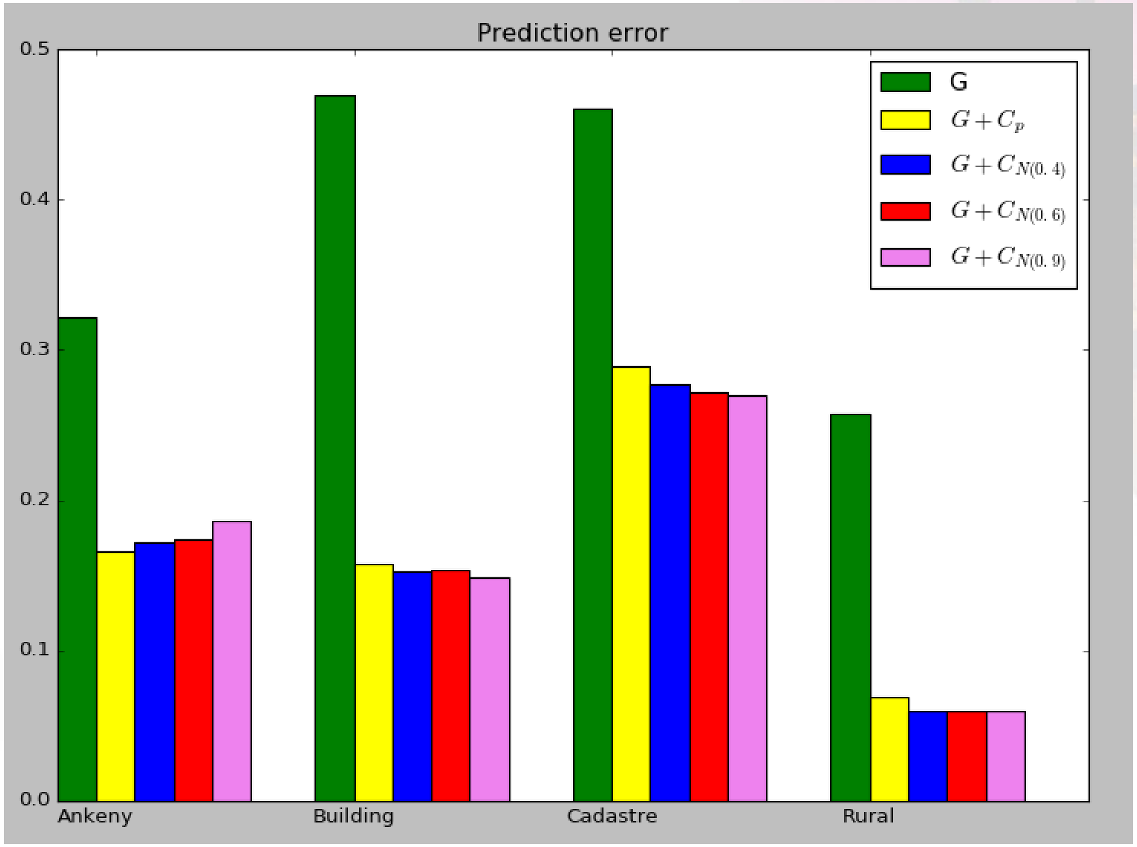
Experimental setup

Use 1 dataset for testing, all remaining for training

Different set of features:

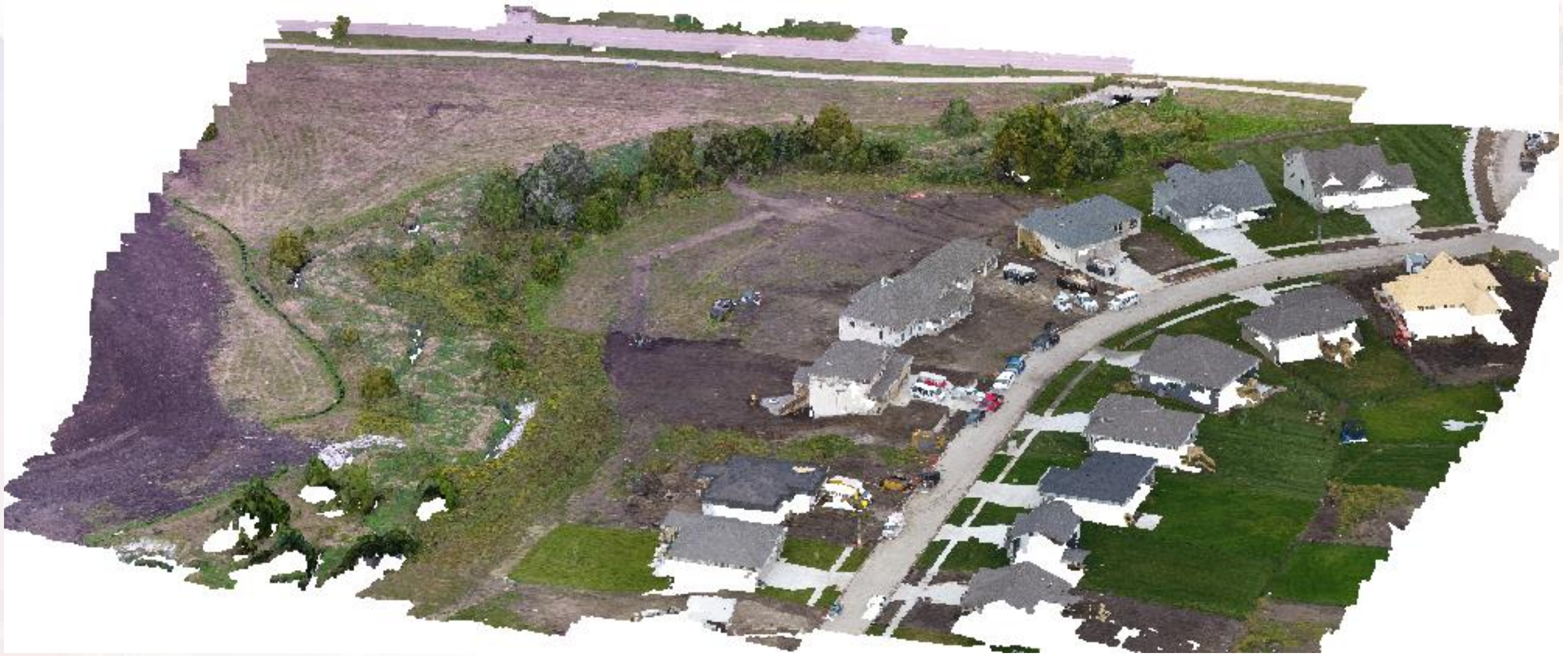
- Geometry only
- Geometry and point color
- Geometry, point color and neighborhood color

Resulting errors

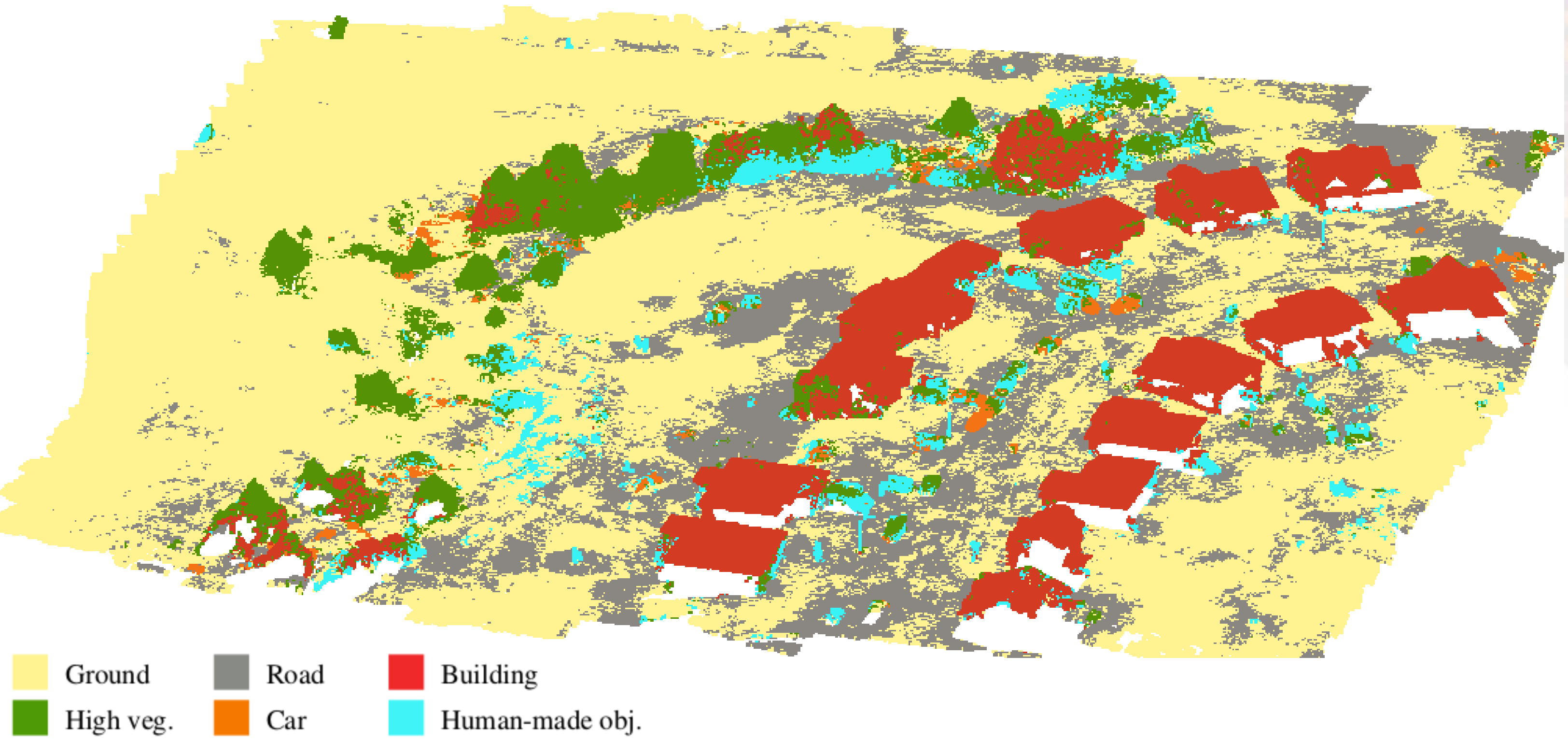


The lower – the better!

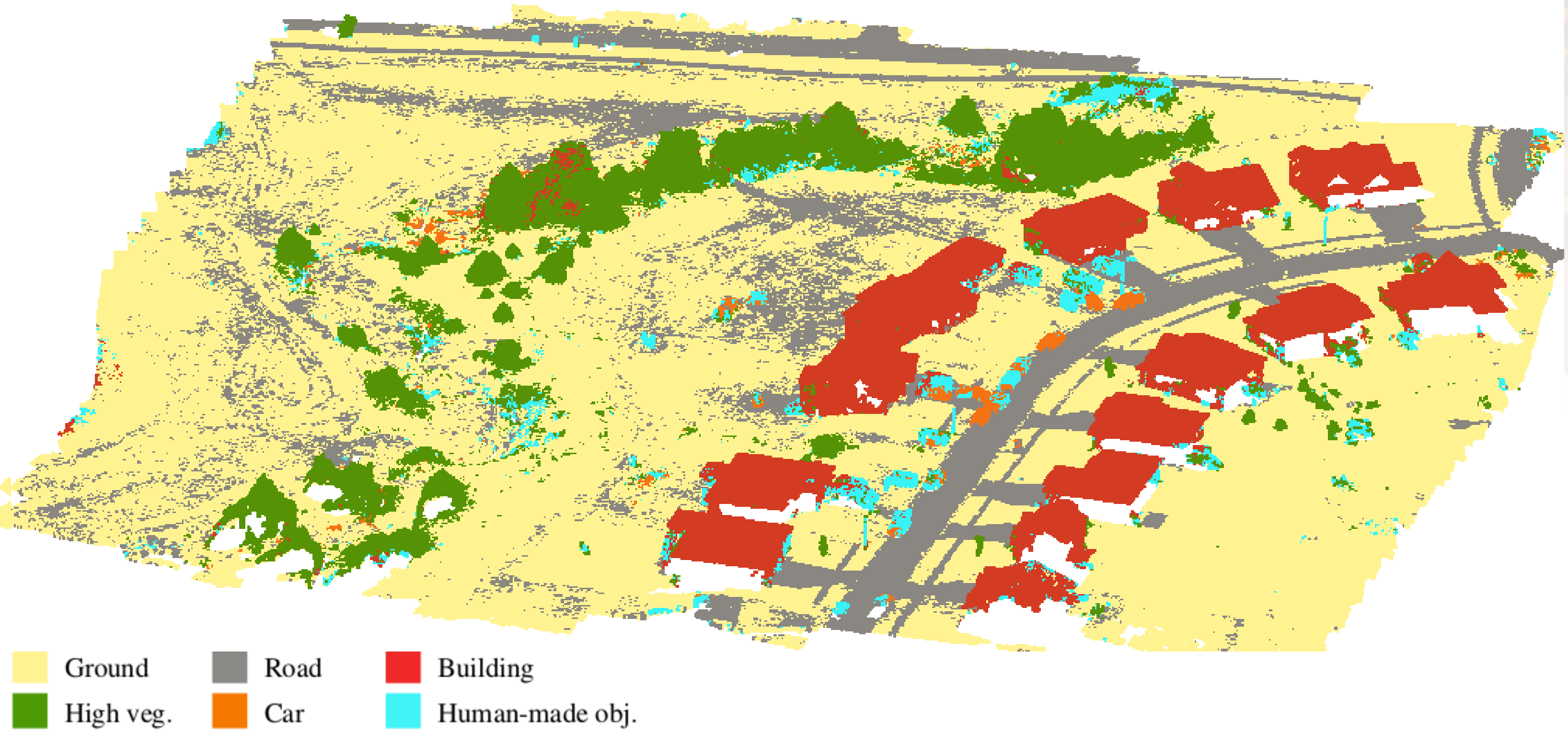
Visual results: original point cloud



Visual results: only geometry features


Ground
Road
Building
High veg.
Car
Human-made obj.

Visual results: geometry and color features


Ground
Road
Building
High veg.
Car
Human-made obj.

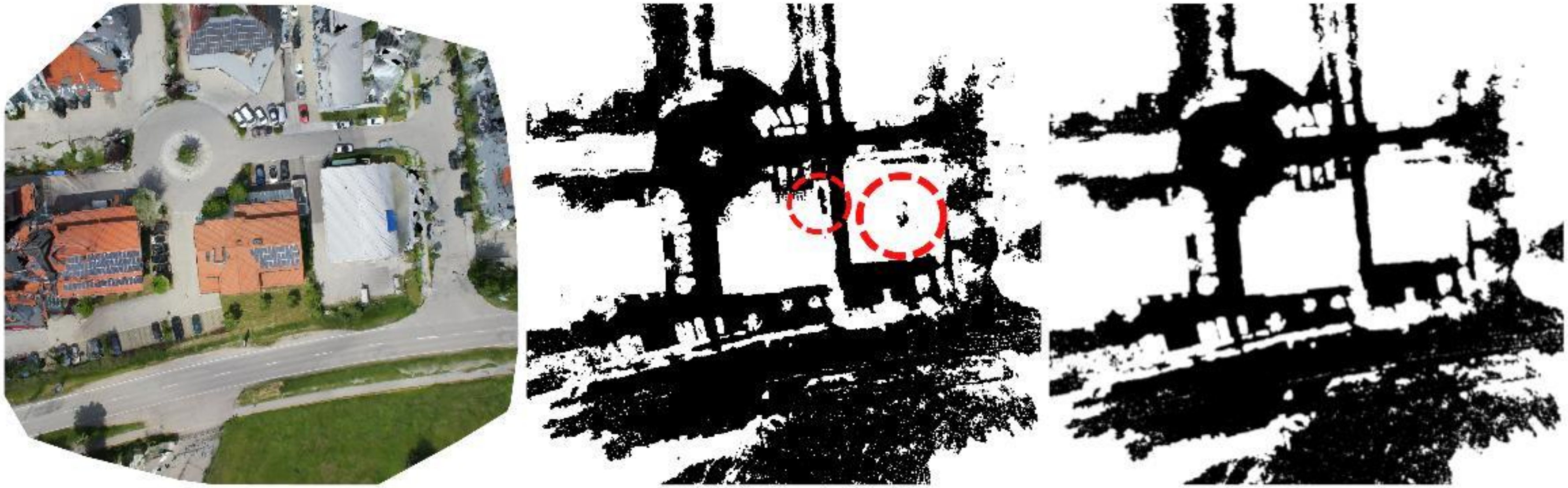
Classification based Digital Terrain Model (DTM)

Minimize an energy functional based on input DSM using a binary terrain mask

Generate the mask using classification results:

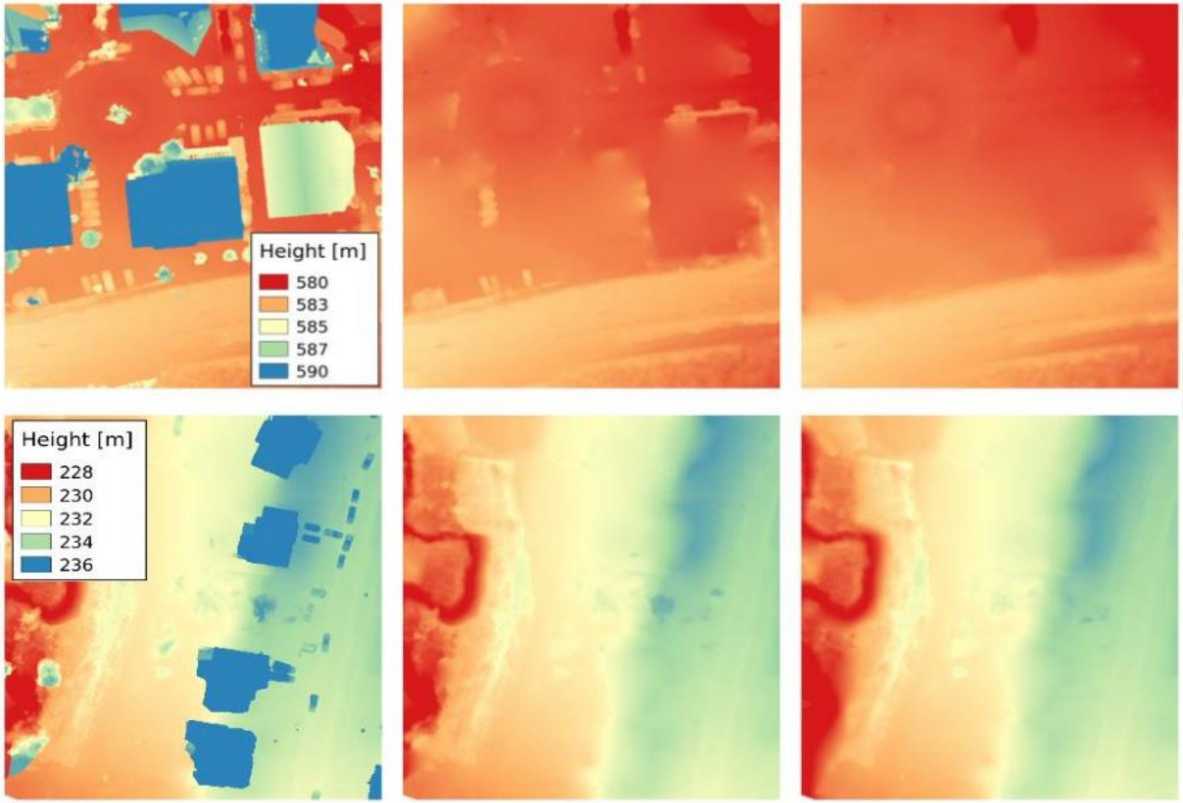
- Rasterize classified point cloud into an image
- Filter the image to remove artefacts

Examples



(a) Orthomosaic (b) Rasterization (c) Rasterization + Filtering

Results


Height [m]
580
583
585
587
590
Height [m]
228
230
232
234
236

(a) DSM (b) without classification (c) with classification

Conclusion

Evaluated a new classification approach for photogrammetric point clouds

- Computationally efficient (10M points in about 1 minute)
- Runs on large point clouds
- Exploits color information
- Available in Pix4D Mapper Pro
- Improved DTM generation

Photogrammetry datasets now available at pix4d.com/research

Thank you!

Visit Pix4D booth #D2

Resulting errors

Set of features			Set of features		
	G	G+C_p	G+$C_{N(0.4)}$	G+$C_{N(0.6)}$	G+$C_{N(0.9)}$
Ankeny	0.322	0.166	0.172	0.174	0.186
Building	0.47	0.158	0.153	0.154	0.149
Cadastre	0.461	0.289	0.277	0.272	0.27
Rural	0.258	0.069	0.06	0.06	0.06

The lower – the better!