

# Brief Description of the modified methodology used in ISPRS Test Project on Urban Classification and 3D Building Reconstruction

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## **Data Set Used:**

Vaihingen (area 1, area 2, area3)

## **Objects Targeted for classification:**

- Buildings
- Trees
- Natural ground covered by vegetation

## **Results File Format:**

Binary Geo-TIFF-file (tif) for each class individually along with World file (tfw) containing the georeferencing. Each file name is as shown in the next table with (x) indicate the area number.

Class	Name
Buildings	buildings_classification_area_x.*
Trees	trees_classification_area_x.*
Natural ground covered by vegetation	nature_classification_area_x.*

## **Methodology in brief:**

The used classification process is composed of several steps:

1. Calculate the normal vector of the LiDAR data surface at each point.
2. Segmentation of the derived normal vector layer using angle between normal vectors as the similarity measure for segmentation.
3. The largest segment is used as a candidate for the ground surface.
4. The pixels included in the candidate ground surface are used as

observations to estimate the ground surface as a polynomial surface of 5<sup>th</sup> order using least squares method.

5. The normalized SDM is calculated using the LiDAR data and the ground surface derived in the previous step.
6. Segmentation of the normalized DSM data into regions (segments) based on the vertical and horizontal gradient in a region growing fashion.
7. Small sized segments (which indicate very rough surface) at least 2 meters above the ground are grouped into larger objects that are primarily classified as trees.
8. The aerial images are used to construct an ortho-photo for each area under test.
9. The NDVI layer is calculated using the Red and Near Infrared bands.
10. The minimum NDVI value of the preliminary classified trees is used as a vegetation index threshold.
11. Segmentation of the normalized SDM and NDVI layers where adjacent pixels are within the same segment if height gradient is under 1 and both pixels greater or smaller than the vegetation threshold and also the two pixels are both above or under height of half meters.
12. Segments of area larger than 20 m<sup>2</sup> and mean height above 2 meters and under the vegetation index are classified as buildings.
13. Small segments within 3 pixels neighborhood of buildings are also classified as buildings.
14. Segments of mean height less than 2 meters and above the vegetation index are classified as natural ground.
15. Segments of mean height larger than 2 meters and above the vegetation index are classified as trees.
16. The positive NDVI of the dark (intensity less than quarter of maximum intensity) areas of the unclassified area indicates additional natural ground classified.
17. The obtained results are morphologically processed to reduce noise of the results.

18. The distance transform of the trees classes is used to find the deepest pixels (farthest from trees boundary), these deepest pixels are used as centers of circles with the distance transform value as radius. These circles are removed and the process iterates until only circles of less than radius threshold are found ( $r < 1.5$  m).