Object-based Classification Using Random Forest Method for Aerial Images with DSM

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This work develop an objected-based classification framework using Aerial images according with DSM. Our workflow is shown in Figure 1.

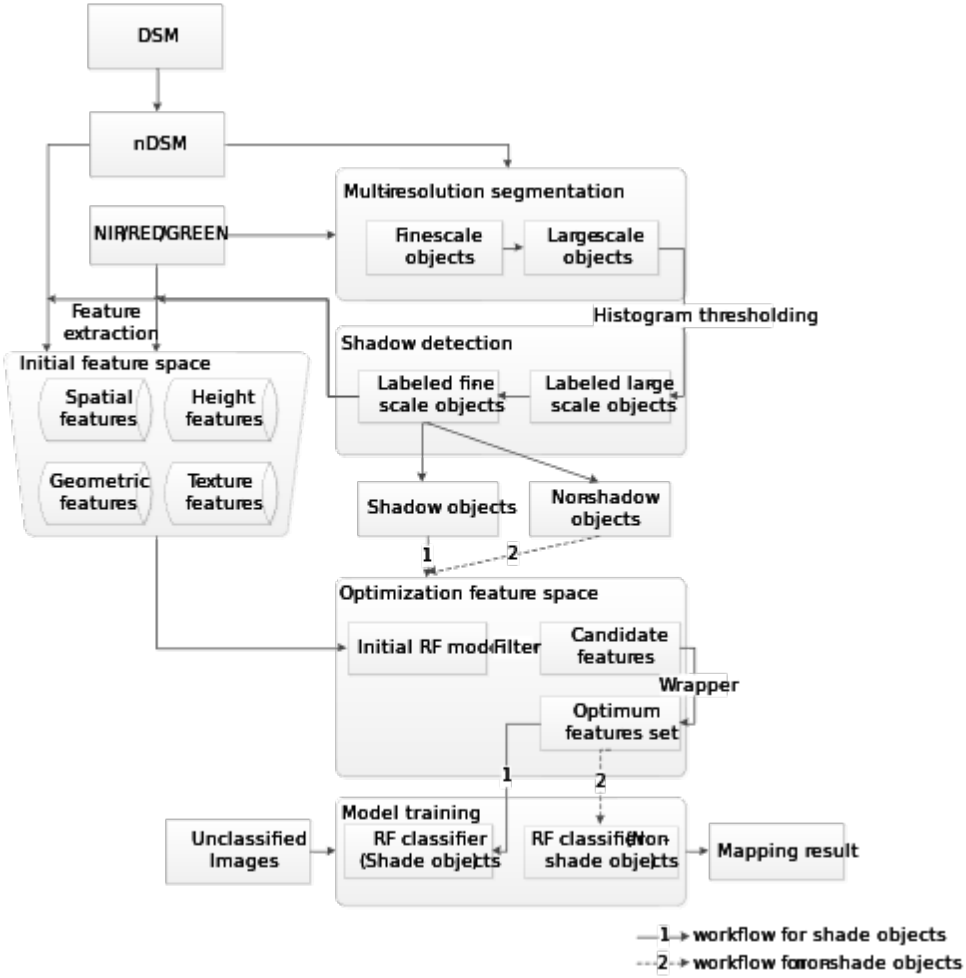

Figure 1. Flowchart of object-based urban LULC classification framework

1) DSM data is first used to obtain the nDSM data. We treat DSM images as point clouds regarding each pixel as a point. The ground points are obtained using a filtering algorithm and DEMs are interpolated by ground point interpolation. Then nDSM is subtracted by the DSM and the DEM
2) Multi-resolution segmentation algorithm is applied to generate objects of two scales. Shadow detection and labeling are applied to larger objects. Finer-scale objects are used for mapping the final results.

3) In the following step, a histogram thresholding method is applied to separate shadow and non-shadow objects and the results are mapped to finer scale objects.
4) Furthermore, feature extraction of finer scale objects are calculated on objects and the adjacent objects, including height features, spectral features, shape features and texture features. Besides we proposed three features to enhance the separate ability of height feature. Their definitions are as follows:

Mean difference of neighborhood objects base nDSM(diff_nDSM)

For each object C, calculates its mean difference from all adjacent objects based DSM, weights are assigned according to the length of the adjacent boundrary.

$$diff_n DSM = \frac{1}{l} * \sum_{i=1}^{n} l_i * (\acute{C}_L^{nDSM} - \acute{C}_{Li}^{nDSM})$$

Where l : the boundary length of the image object C_L ;

n: the number of objects that are adjacent to C_L ;

l_i :the boundary length shared by number i adjacent object and C_L ;

$\acute{C}_L^{nDSM}$: mean nDSM of object C_L ;

$\acute{C}_{Li}^{nDSM}$: mean nDSM of number I adjacent object.

Mean absolute value of difference among neighborhood objects base nDSM(diff_nDSM(abs))

Similar to diff_DSM , but calculate with the absolute value of difference.

$$|¿| = \frac{1}{l} * \sum_{i=1}^{n} l_{si} * \left| \acute{C}_L^{nDSM} - \acute{C}_{Li}^{nDSM} \right|$$
$$diff_n DSM ¿$$

Changes of DSM value in an object

$$MN_{DSM} = DSM_{Max} - DSM_{Min}$$

Where DSM_{Max} and DSM_{Min} respresent Maximum and Minimum DSM value inside the object.

5) Redundant features and irrelevant features are existing in the initial feature space. The invalid features are filtered by combining filter and wrapper method. Random forest classifier are trained respectively for shadow and non-shadow objects. A reasonable feature number for each node is determined by experiments.
6) Corresponding classification map regularization rules are applied to optimizing classification results.