Building Coverage Estimation using Satellite Images

Ashutosh Choudhary
ashutoshchou@cs.umass.edu

1 Problem Statement

Evaluating building coverage in large urban areas of this world is essential for the survival of these large cities and the world as a whole. While United States Forest Service (USFS) and many regional departments of parks have gathered statistics of land use in cities in particular, the information is far from complete and does not have any centralised way of evaluating and keeping a tab on the tree canopy vs land use statistics. The idea of this project is to use easily available open source satellite imagery to identify buildings and use it to keep this information updated in order to help make policies to keep our cities habitable.

2 Data Set

I will be using High Resolution Orthoimagery (tif files) from United States Geological Survey (USGS) http://earthexplorer.usgs.gov with a zoom resolution of 1 meter per pixel. The feature set extracted from these images would consist of mainly three types of features: subsampled pixel values, color histograms and histogram of gradient (HOG) features. Also, to combine multiple features a tree-based structure would be used as elaborated in [2] (Link) To get the gold standard labels in the satellite image dataset, OpenStreetMap dataset with ⟨building⟩ tag would be used over the training satellite images.

3 Problem description

The problem is a classification task which has features as described in the dataset section. The entire map would be divided into 20x20 tiles with each tile signifying a label of a building or not. Each tile may be labeled on the basis of the tag mentioned in latitude - longitude based key in OpenStreetMap data as described by M, Volodymyr [1]. If OpenStreetMap isn't feasible due to zoom precision, then manually classified tiles would be used as a gold standard, over which error and accuracy would be calculated [2].

4 Methods

In this project, I plan to investigate KNN, sweeping window SVM, Random Forest Ensembles and CNNs. I will be using feature extraction techniques such as color histograms and HOG features for KNN, SVM and Random Forests. However, for CNN the task of feature extraction would be left to the network itself using raw image pixels.

5 Experiments

The experiments would include use of: 1) Feature extraction methods common in vision tasks. 2) Evaluation of models for the learning task 3) Use of basis expansion. 4) Investigation of possible use of clustering in order to directly cluster all building pixels to get building coverages rather than extracting each building and then calculating total. [3] 5) Investigation of other ariel image detection techniques described in [3]

6 Related work and novelty

Object Detection on satellite images is a field extensively explored by V Mnih[1][6]. However, in each of his approaches use of neural network is explored without much experimentation with sliding window SVM trained on labelled features. Other objects which have been detected in research are roads, highways and even swimming pools. The identification of building would help in knowing the extent of urbanisation and also its comparison with green cover in the same area. This may have both ecological and social implications of finding urbanization and climate change impact.

7 References

[1] Mnih, Volodymyr. Machine learning for aerial image labeling. Diss. University of Toronto, 2013.
[2] Bietti, Alberto. Active learning for object detection on satellite images. Technical report, Caltech, 2012.
[3] Image Classification Techniques in Remote Sensing. (2016). Retrieved November 10, 2016, from http://gisgeography.com/image-classification-techniques-remote-sensing/
[4] Shahbaz, Muhammad, et al. "Classification by object recognition in satellite images by using data mining." Proceedings of the World Congress on Engineering. Vol. 1. 2012.
[5] TrailBehind, Inc., DeepOSM, (2016), GitHub repository, https://github.com/trailbehind/DeepOSM.git
[6] Mnih, Volodymyr, and Geoffrey E. Hinton. "Learning to detect roads in high-resolution aerial images." European Conference on Computer Vision. Springer Berlin Heidelberg, 2010.