

Abstract

In this work, a new method for automatic feature extraction by aerial images and lidar data fusion is developed and tested based on four study areas with different sensors and scene characteristics. The proposed method can be considered to have two phases, the classification and vectorization.

During the classification phase, the lidar point clouds were first filtered to generate a Digital Terrain Model (DTM) using a novel filtering technique based on a linear first-order equation which describes a tilted plane surface, and then the Digital Surface Model (DSM) and the Normalised Digital Surface Model (nDSM) were generated. After that a total of 25 uncorrelated feature attributes have been generated from the aerial images, the lidar intensity image, DSM and nDSM. The attributes include those derived from the Grey Level Co-occurrence Matrix (GLCM), Normalized Difference Vegetation Indices (NDVI) and slope. Then, three different statistical and neural network classifiers were used to detect buildings from aerial images, lidar data and the generated attributes. The classifiers used include: Self-Organizing Map (SOM); Classification Trees (CTs); and Support Vector Machines (SVMs), with average overall accuracies of 96.75%, 95.9% and 93.7% for SVMs, SOM and CTs respectively. An innovative Multiple Classifier System (MCS) based on Dempster-Shafer theory of evidence was then developed to combine measures of evidence from the three classifiers, incorporating three methods for the prior probabilities. The maximum reduction in commission and omission errors was 64% and 72% respectively, of the total error, compared to the best classifier, while the overall classification accuracy was 98.8%, which is gratifying considering the limited room for improvement beyond 96.9% accuracy achieved with the SVM classifier. During the vectorization phase, the classified images were processed through a series of image processing techniques to produce the digital vector map. An accurate estimation of buildings and roads was carried out from the reference data and compared against the corresponding results. According to the National Map Accuracy Standard (NMAS), accuracies suitable for a 1:2,500 mapping scale have been achieved based on the 10cm and 15cm resolution images. For the images with 50cm resolution an accuracy suitable for a mapping scale of 1:5,000 were achieved.