REDUCTION OF INTRA-CLASS SPECTRAL VARIABILITY IN SOFT CLASSIFICATION PREDICTION AND ITS APPLICATIONS FOR SUPER-RESOLUTION MAPPING

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ABSTRACT

Mixed pixels are often abundant in remotely sensed imagery and cannot be appropriately or accurately classified by conventional (hard) image classifiers. To reduce the mixed pixel problem, a range of methods may be used to derive a soft classification which allows for multiple and partial class membership. The output of a soft classification is typically a set of fraction images that show the predicted coverage of each thematic class in the area represented by each pixel. Soft classifications have been found to provide more informative and potentially more accurate representations of land cover than conventional hard classifications. However, classes typically display a degree of spectral variability and the accuracy of soft classification is negatively related to the degree of intra-class variation present. Soft classifications predict the proportion of each land cover class within each pixel but they do not indicate where the land cover classes are spatially located within the pixels. The sub-pixel class fractions may, however, be located geographically through super-resolution mapping.

This paper aims to explore the impacts of intra-class spectral variability on the use of soft classification for super-resolution mapping and to investigate a possible approach to reduce these impacts through the reduction of the intra-class spectral variation.

The impacts of class spectral variation on the use of soft classification outputs in super-resolution mapping were assessed. This work focused on mapping part of the shoreline of the Isle of Wight, UK, from Landsat ETM+ data. There was a large degree of intra-class spectral variation for the land cover classes to be mapped. A soft classification of the remotely sensed imagery was derived with two land cover classes, water and land, using a linear mixture model. This soft classification was then used to derive a super-resolution map of the shoreline through the use of contouring and Hopfield neural network approaches. It was evident that the accuracy of the soft classification as well as of the shoreline mapping declined as the degree of intra-class variation increased.

A possible approach to reduce the impacts of intra-class spectral variation was investigated. This was based on reducing the impacts of intra-class spectral variation and achieved by defining spectral sub-classes for use in the soft classification. To illustrate the method, the water class was divided into two sub-classes, based on relative turbidity. A three-class soft classification of the Landsat ETM+ image was derived with three land cover classes, water1 (turbid), water 2 (clear) and land, using a linear mixture model. The accuracy of the soft classification was assessed using correlation coefficient between the predicted and actual (ground data) coverage. Accuracy of the shoreline was evaluated using RMSE based on the predicted and actual locations of the shorelines. The three-class analysis provided higher accuracies of the soft classification and shoreline mapping than those from the original two-class analysis. Soft classification from three-class analysis was achieved with the correlation coefficient of 0.939, while that from two-class analysis was 0.867. These two correlation coefficients were statistically significant at 99% level of confidence. Similarly, shoreline mapping from three-class analysis was derived with the RMSE of 37.21m, while this figure in two-class analysis was reached to 44.68m.

The results highlighted that reducing intra-class spectral variation may be used to increase soft classification accuracy as well as shoreline mapping accuracy. The paper will conclude with a discussion of some concerns and highlighting future research directions.