MULTIPLE CLASSIFIERS AND DIMENSIONALITY REDUCTION METHODS FOR HYPERSPECTRAL IMAGE CLASSIFICATION

A thesis submitted
in partial fulfillment for the degree of

Doctor of Philosophy

by

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JANUARY 2015

ABSTRACT

The aim of this thesis is to develop efficient classification methodologies based on a multiple classifier system which minimize the classifier and data dependence and offer acceptable classification accuracy across various hyperspectral images and application domains. Hyperspectral remote sensing has been emerging as a reliable data source for the mapping and monitoring of various land surface features and processes. Hyperspectral data are interesting and challenging. Traditional supervised image classification techniques that use all available spectral bands often fail on hyperspectral data due to the curse of dimensionality that comes along. Dimensionality reduction methods coupled with appropriate classifiers could mitigate the dimensionality problem. But, identification of an appropriate dimensionality reduction method and classifier is subjective, based on analysts' prior knowledge and the performance is method and data specific.

A multiple classifier system provides a conceptual framework to combine the relative advantages of several classifiers to enhance reliability and accuracy of classification. Having diversity in the performance of classifiers is a pre-condition for the success of multiple classifier system. In principle, multiple transformations of the same hyperspectral image by different dimensionality reduction methods lead to differential classification performances. The potential of dimensionality reduction methods to create diversity in the multiple classifier system is not well understood. As the multiple classifier system involves parallel application of a diverse group of classifiers, understanding the impact of dimensionality reduction methods on the overall classification performance is important for developing optimal classification methodologies for land cover mapping.

The aim of this thesis is twofold. In the first part, there are two objectives. The first objective is to study the impact of different dimensionality reduction methods on the classification performance of a multiple classifier system. A multiple classifier system designed with five dimensionality reduction methods and seven classifiers has been used for a series of classification experiments on five different hyperspectral images (acquired at different sites) for land cover mapping. The change in classification accuracy for various combinations of dimensionality reduction methods and classifiers has been tracked across various information classes and land cover settings. Results indicate substantial change in the performance of the multiple classifier system with different dimensionality reduction methods (*peer reviewed journal manuscript on this aspect: Impact of dimensionality reduction methods on the classification performance of the multiple classifier system for hyperspectral image classification, International Journal of Remote Sensing*). The second objective is to assess the relationship between information class, classifier and dimensionality reduction method within the multiple classifier system framework. The multiple classifier system's architecture has been manoeuvred to compute magnitudes and patterns in the per-class classification accuracy of each information class for all the possible combinations of classifiers and dimensionality reduction methods within and across the different hyperspectral images. The results indicate the existence of empirical relationships across different hyperspectral images, wherein different information classes prefer different combinations of classifiers and

dimensionality reduction methods (*peer-reviewed journal manuscript on this aspect: Assessment of the impact of dimensionality reduction methods on information classes and classifiers for hyperspectral image classification by multiple classifier system, Advances in Space Research*).

The first part of the aim of thesis highlights the necessity of introducing dynamism in the multiple classifier system for the selection of classifiers and dimensionality reduction methods for effective hyperspectral image classification. Consequently, in the second part, the objective is to develop a novel classification technique which selects classifiers and dimensionality reduction methods according to input data dynamics. In particular, we propose two novel modifications to the functional architecture of the multiple classifier system. The first contribution is an algorithmic extension of the multiple classifier system, we name it as dynamic classifier system. The proposed dynamic classifier system pairs up optimal combinations of classifiers and dimensionality reduction methods, specific to the hyperspectral image, and performs image classification based only on the identified combinations (*peer-reviewed journal manuscript on this aspect: Dynamic linear classifier system for hyperspectral image classification, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*). The second contribution is the development of a new dynamic classifier selection approach based on extreme learning machine regression which selects a subset of optimal classifiers relative to each input pixel by exploiting the local information content of the pixel. Further, the spatial contextual information is incorporated in the proposed dynamic classifier selection approach to develop a new spectral-spatial classification model to exploit high spatial resolution of modern airborne hyperspectral images (*peer-reviewed journal manuscript on this aspect: Dynamic ensemble selection approach for hyperspectral image classification with joint spectral and spatial information, IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing*).

The objectives of this thesis make a significant contribution to the current knowledge about the application of multiple classifier system for hyperspectral image classification and present a novel multiple classifier system based dynamic classification framework, which offers optimal classification performance across different hyperspectral images, land cover settings, and information classes.