HYPERSPECTRAL REMOTE SENSING IMAGE CLASSIFICATION BASED ON DECISION LEVEL FUSION

Peijun Du, Wei Zhang and Shubi Zhang
China University of Mining and Technology,
Xuzhou City, Jiangsu Province, 221116, China;
Email: dupjrs@cumt.edu.cn, dupjrs@gmail.com

Abstract: Hyperspectral Remote Sensing (HRS) is one of the most significant achievements of advanced Earth Observation technology. Traditionally, hyperspectral remote sensing image classification is implemented by a single classifier, for example, Spectral Angle Mapper (SAM) and support vector machine (SVM), using original hyperspectral data and other derived features as input signals. Those methods have proved their effectiveness for many applications, but there are still some problems. First, each classifier has its own merits and limitations, and it is difficult to achieve satisfied classification accuracy by a single classifier. Second, adjacent wavebands of hyperspectral remote sensing data are highly correlated, which results in that the simultaneous use of all bands can't assure high accuracy. Owing to those limitations in classifiers and data, it is necessary to find some new ways to improve the classification performance. Decision level fusion, using a specific criterion or algorithm to integrate the classified labels from different classifiers, has shown great benefits to improve classification accuracy of multi-source remote sensing image. Based on a survey to hyperspectral remote sensing classification techniques and decision level fusion algorithms, some issues on hyperspectral remote sensing image classification based on decision level fusion are explored in this paper. Decision level fusion should be exerted to the outputs of multiple classifiers, so two factors play important roles in this process. One factor is combination criterion or algorithm of multiple classified outputs, and the other is the generation of multiple classifier labels from different classifiers.

In order to obtain multiple classified results, it is necessary to provide input dataset for every member classifier. Four methods are proposed and experimented to generate classifier input. The first method is the most commonly used way in which the original hyperspectral dataset is used by different classifiers, that is, all classifiers use the original data to generate their own

outputs for further combination. The second method is an improved way in which all classifiers still use identical input dataset, but the dataset consists of both the original data and some derived features from original data, for example, one order or two order derivative spectra and texture features extracted from one specific waveband, which means that more sufficient features are used and some feature extraction approaches are required. In the third method, all wavebands are divided into different groups based on inter-band correlation analysis, and each group of data along with texture feature extracted from this group are used to a specific classifier, which means that the input for multiple classifiers are different but every group of data should be a representative subset of original data. In the fourth method, the special components derived by PCA or MNF transformation to original data and texture features are used as input of different classifiers.

As for combination of multiple classifier labels for each pixel, many algorithms have been proposed. In this paper, three combination approaches are proposed and experimented based on general combination algorithms. The first approach is a modified D-S combination model which can handle the inconsistency of evidence among multiple classifiers and integrate the merits of different classifiers. The second is an improved logarithmic consensus combination approach which can adjusts the inconsistent outputs of measure level and abstract level. The third approach is a multiple classifier combination strategy based on decision rules, in which some combination rules are generated to guide the combination process.

Finally, the OMIS hyperspectral remote sensing image is used as the example data, and some widely used member classifier including MLC, SVM, BPNN, SAM and decision tree are employed to form a classifier ensemble. Both the four dataset generation schemes and three classifier combination approaches are experimented for multiple classifier combination on decision level. The results show that the classification accuracy based on decision level fusion are higher than traditional methods because the advantages of different classifiers can be integrated, therefore it is possible to improve the classification performance of hyperspectral remote sensing image based on decision level fusion.

Keywords: decision level fusion, hyperspectral remote sensing, multiple classifier combination