An Approach Based on Self-Organizing Map and Fuzzy Membership for Decomposition of Mixed Pixels[1]

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1. INTRODUCTION

The decomposition of mixed pixels in the remote sensing images has great value for high-accuracy ground object recognition and quantitative remote sensing [1, 2]. A new method which combines Self-Organizing Map (SOM) neural network and fuzzy membership (FM) in the fuzzy theory is proposed to fulfill this job (shown as figure 1), after considering the applicable limitations of the existing methods, such as the severe demand for endmember prior-knowledge in Linear Spectral Mixture Model (LSMM) [3], the loss of abundances non-negative constraint (ANC) and abundances summed-to-one constraint (ASC) in Backward Propagation (BP) and Radius Based Function (RBF) neural network method [4], and the local-optimum problem in Fuzzy C-Means (FCM) method [5] and some methods based on parameters' training of probability model [6].

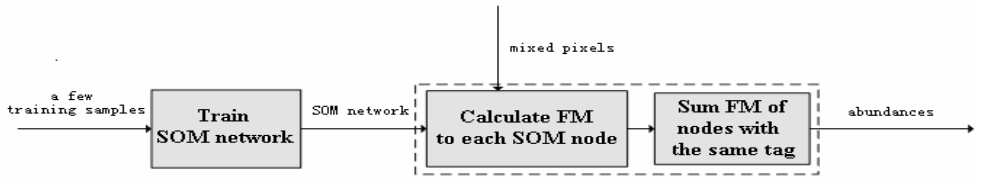

Fig. 1 framework of the proposed method

2. METHOD

In the proposed method, instead of severe demand for endmember prior-knowledge, we only need some training samples to train the SOM network, which can get rid of the local-optimum problem due to its competitive learning without any objective function. Instead of using the original unsupervised SOM [7] directly, we apply some tagging technique on the training samples to realize the supervised version of SOM. So, after training of SOM, we get every neural node with its class-tag in the competitive layer. Then, we calculate the FM of each mixed pixel corresponding to each neural node of SOM. The optimal weighted index m in the FM formulation is predicted according to the current dataset in advance [8, 9]. Finally, we calculate the summation of the FMs of each mixed pixel corresponding to the neural nodes with the same class-tag. This summation is the abundance of the mixed pixel corresponding to this endmember class. The ANC and ASC conditions would be satisfied automatically for the used fuzzy unmixing model.

3. EXPERIMENTS

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Both the simulated data experiments and the real-world data experiment are used to demonstrate the effectivity of the proposed method. In the simulated data experiments, we generate the simulated data sources by both ways of random mixing and down-sampling, then we show that the predicting way of optimal weighted index in the FM formulation is effective, and the unmixed result is accurate than some other methods and robust to Gaussian noise, and also we analyze the influence of the SOM network size to the unmixing result. In the real-world data experiment, we apply the proposed method to the real Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) hypersepctral remote sensing image of Indian Pine Test Site, and the unmixing result agrees with the ground truth investigated by the research group of Purdue University [10] very much.

4. CONCLUSION

A new method is designed for decomposing the mixed pixels in the remote sensing images here. It firstly trains the SOM in a supervised way, and then gets the unmixing abundances by calculating FM. Compared with the existing methods, it relaxes the demand of prior knowledge, gets rid of the local optimum, and satisfies the ANC and ASC conditions. In the experimental part, we evaluate the algorithm accuracy and robusticity by both simulated data experiments and real-world data experiment, and compare it with some existing methods to demonstrate its effectivity. As the experimental result shows, the proposed method is very useful for decomposition of mixed pixels in multispectral/hyperspectral remote sensing image, and can get good unmixing result with good anti-noise ability.

5. REFERENCES

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