다중센서 영상자료를 이용한 무감독 영상분류

경원대학교 산업공학과
이 상 훈, 홍 현 기

Unsupervised Classification Using Multisensor Imagery

1. Introduction

In remote sensing, images are acquired over the same area by sensors of different spectral ranges (from the visible to the microwave) and/or with different number, position, and width of spectral bands. These images are generally partially redundant, as they represent the same scene, and partially complementary. For many applications of image classification, the information provided by a single sensor is often incomplete or imprecise resulting in misclassification. Fusion with redundant data can draw more consistent inferences for the interpretation of the scene, and can then improve classification accuracy.

The common approach to the classification of multisensor data as a data fusion scheme at pixel level is to concatenate the data into one vector as if they were measurements from a single sensor. The multiband data acquired by a single multispectral sensor or by two or more different sensors are not completely independent, and a certain degree of informative overlap may exist between the observation spaces of the different bands. But, when bands are dependent, the combined analysis of these bands may give worse information. The multiband data are split into two or more subsets according the dependence between the bands Each subsets are classified separately, and a data fusion scheme at decision level is applied to integrate the individual classification results.

In this study, the two-level algorithm using hierarchical clustering procedure[1] is used for unsupervised image classification. Hierarchical clustering algorithm is based on similarity measures between all pairs of candidates being considered for merging. In the first level, the image is partitioned as any number of regions which are sets of spatially contiguous pixels so that no union of adjacent regions is statistically uniform. The regions resulted from the low level are clustered into a parsimonious number of groups according to their statistical characteristics. The algorithm has been applied to airborne multispectral and SAR data.

---

[1] 이 상 훈, 2001. **공간지역확장과 계층집단연결 기법을 이용한 무감독 영상분류, 대한원격탐사학회지 17 권 1 호.**

2. **Fusion for Image Classification**

1) For each sensor, estimate initial class configurations individually using the two-stage hierarchical clustering segmentation.
2) Partition the image such that every segment has different combination of the classes associated with individual sensors.
3) For each sensor, calculate class state vectors for all segments using fuzzy classification method based on the initial class configurations of hierarchical clustering segmentation.
4) For each sensor, calculate class state vectors for all segments using fuzzy classification method based on the initial class configurations of hierarchical clustering segmentation.
5) Calculate uncertainty coefficients of the segments using the class state vectors and re-classify the segments with a value of the coefficient larger than a given threshold value by assigning one of the classes of the remaining segments/
6) Find the best classification for the segments.

(Fuzzy Classification)

EM Iterative Approach with Additive Gaussian Assumption

- **E-step** - Calculateing Indicator Vectors

$$s_{km}^{(h)} = \frac{w_k^{(h)} f_k(\mathbf{X}_m \mid \boldsymbol{\theta}_k^{(h)})}{\sum_k w_k^{(h)} f_k(\mathbf{X}_m \mid \boldsymbol{\theta}_k^{(h)})}$$

$$f_k\left(\mathbf{X}_m \mid \boldsymbol{\theta}_k^{(h)}\right) \propto \left|\Sigma_k^{(h)}\right|^{-\frac{N_m}{2}} \exp\left\{-\frac{1}{2}\sum_{j \in J_m} (\mathbf{x}_j - \boldsymbol{\mu}_k^{(h)})' \Sigma_k^{(h)^{-1}} (\mathbf{x}_j - \boldsymbol{\mu}_k^{(h)})\right\}$$

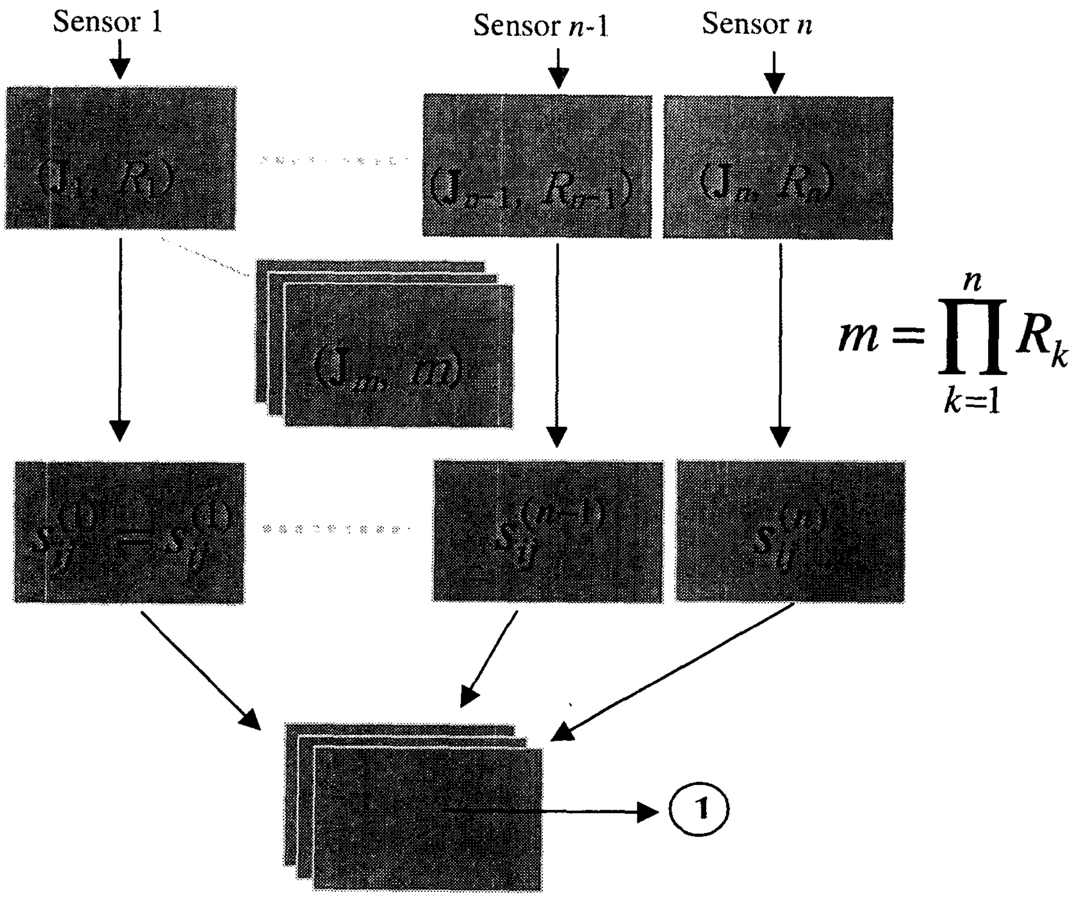
$\sum_k s_{km}^{(h)} = 1$ Conditional Probabilities of Data Set $\mathbf{X}_m$ belonging to Class k at hth Iteration

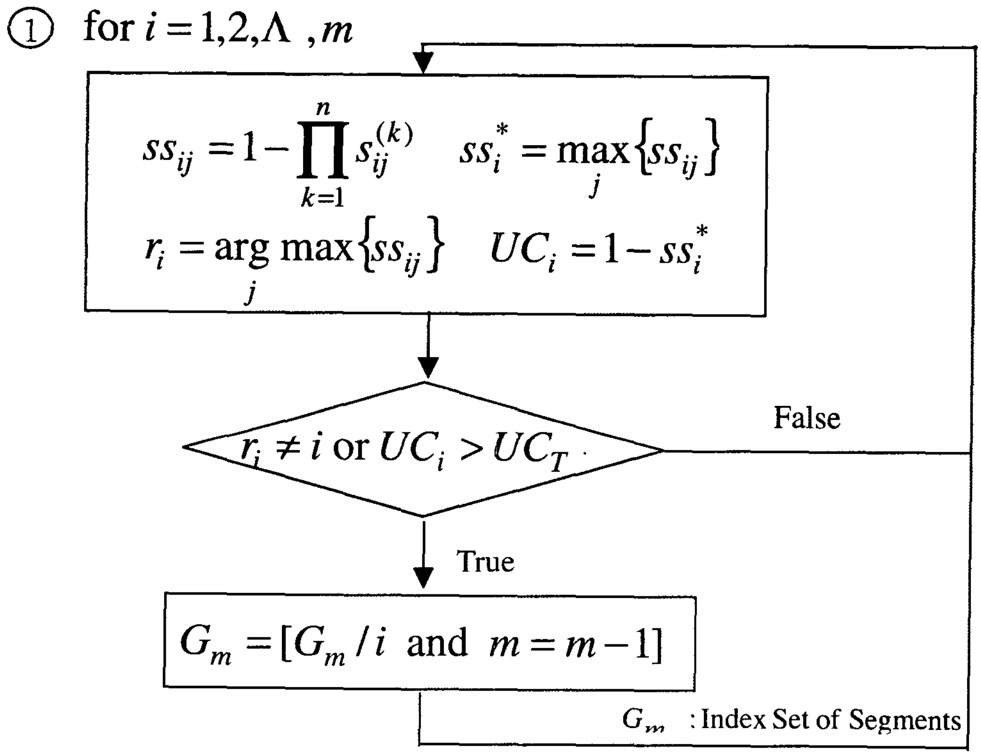
- **M-step** - Computing Maximum Likelihood Estimates of **W**, $\boldsymbol{\Theta}$

$$w_k^{(h+1)} = \frac{1}{N}\sum N_m s_{km}^{(h)} \qquad N = \sum_m N_m$$

$$\boldsymbol{\mu}_k^{(h+1)} = \frac{1}{N w_k^{(h+1)}} \sum_m s_{km}^{(h)} \sum_{j \in J_M} \mathbf{x}_j$$

$$\Sigma_k^{(h+1)} = \frac{1}{N w_k^{(h+1)}} \sum_m s_{km}^{(h)} \sum_{j \in J_M} (\mathbf{x}_j - \boldsymbol{\mu}_k^{(h+1)})'(\mathbf{x}_j - \boldsymbol{\mu}_k^{(h+1)})$$





UC_i : Uncertainty Coefficients of ith Segments

UC_T : Threshold Value for Uncertainty Segments