AN APPROACH TO THE TRAINING OF A SUPPORT VECTOR MACHINE (SVM) CLASSIFIER USING SMALL MIXED PIXELS

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ABSTRACT It is important that the training stage of a supervised classification is designed to provide the spectral information. On the design of the training stage of a classification typically calls for the use of a large sample of randomly selected pure pixels in order to characterize the classes. Such guidance is generally made without regard to the specific nature of the application in-hand, including the classifier to be used. An approach to the training of a support vector machine (SVM) classifier that is the opposite of that generally promoted for training set design is suggested. This approach uses a small sample of mixed spectral responses drawn from purposefully selected locations (geographical boundaries) in training. A sample of such data should, however, be easier and cheaper to acquire than that suggested by traditional approaches. In this research, we evaluated them against traditional approaches with high-resolution satellite data. The results proved that it can be used small mixed pixels to derive a classification with similar accuracy using a large number of pure pixels. The approach can also reduce substantial costs in training data acquisition because the sampling locations used are commonly easy to observe.

KEY WORDS: Support Vector Machine; Mixed Pixels; Training set

1. INTROUCTION

A supervised classification is one of the widely treated analyzes in remote sensing fields. The results of a supervised classification provide effective thematic maps that have a snapshot representation of spatial distribution in specific topics. The accuracy of supervised classification is generally dependent on the suitability of the training set. Thus, the training stage in the classification is crucial to accuracy, but most studies didn't have considered significantly about its suitability. Instead of, a large number of pure pixels are preferred because they may describe the nature of all classes. However, the training approach may have diversity according to the classifier selected for analysis. For example, SVM classification uses only constrained training samples that lie on an optimal separating hyperplane (OHP) closely. It means that if optimal small training sets can be achieved in advance of its classification, it can be effective to separate all classes although its size is relatively small. It also means that the conventional approach to select pure pixels can be inappropriate at some classifiers such as SVM. We evaluated the training sets based on an appropriateness of a SVM classification. It is a mixed pixel that is located at the boundary between classes, and viewed as a poor pixel in a conventional approach. The training stage was focused on providing information to separate all classes, not describing the nature of all classes.

2. METHODOLOGY

2.1 SVM classification

SVM based approaches have considerable potential for the supervised classification of remotely sensed data. Comparative studies have shown that a SVM classification can be more accurate than contemporary techniques such as neural networks and decision trees as well as conventional probabilistic classifiers such as the maximum likelihood (Huang et al., 2002).

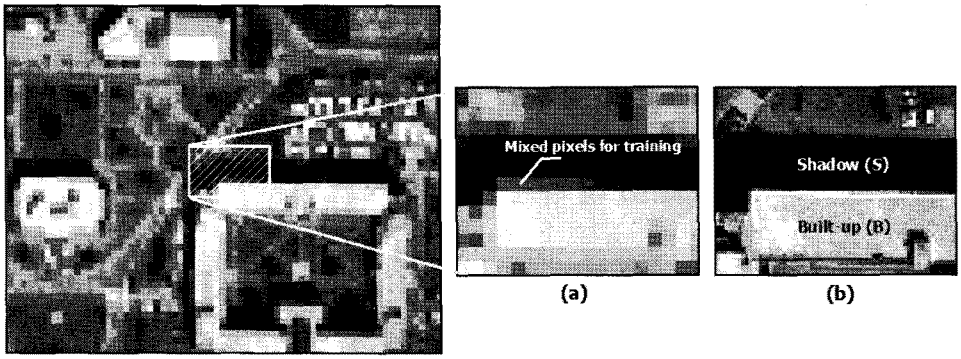

Fig. 1. The example of mixed pixels for classification SVM. (a) RGB composites, (b) panchromatic band.

A SVM classification is based on the fitting of an optimal separating hyperplane between classes by focusing on the training samples that lie at the edge of the class distributions and between the class centroids, the support vectors. The other training samples are disregarded as source of the hyperplane location estimation. In other words, only the training samples that lie close to the location of the optimal separating hyperplane are used to the establishment. Therefore, With SVM classification, although a small training set is used, if it's appropriate to fit an optimal hyperplane, then high accuracy may be obtained without any significant degradation of accuracy.

2.2 Small mixed pixels for a training set

The training approach using small mixed pixels was introduced by G.M. Foody, A. Mathur (2004), and it was experimented from the agricultural test sites only having three classes (G.M. Foody, 2006). In the experiment, the mixed pixels were manually created from the neighbourhood statistics of the decision boundary region, effectively. But, it has also limitation of application in more complex land cover classification. Therefore, we focused on the potential of using just mixed pixels in the image.

With a SVM, the most useful training cases are those that lie close to the optimal hyperplane. For classification by techniques such as SVM a small training set based around mixed pixels can be used to derive an accurate classification. The usefulness of these training sets was evaluated by a remotely sensed dataset.

2.3 Study area and data set

The portion image of IKONOS high-resolution satellite image, in which was acquired from May 9, 2002, in Daejeon, was used to evaluate the presented training set (Fig. 2). No pre-processing of the image was undertaken, for example, atmospheric correction viewed as unnecessary for the classification. The study area showed relatively systematic land cover properties that may be classified into built-up (B), land (L), asphalt (A), forest (F), and shadow (S). The built-up and land classes can be separated more detail because the color of the elements is various, but the commonly

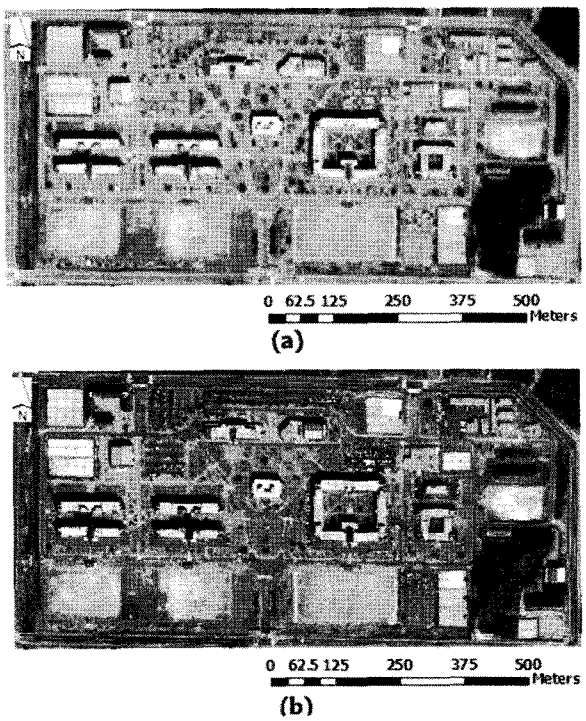

Fig. 2. The portion of IKONOS imagery for the study area. (a) RGB composites, (b) panchromatic band.

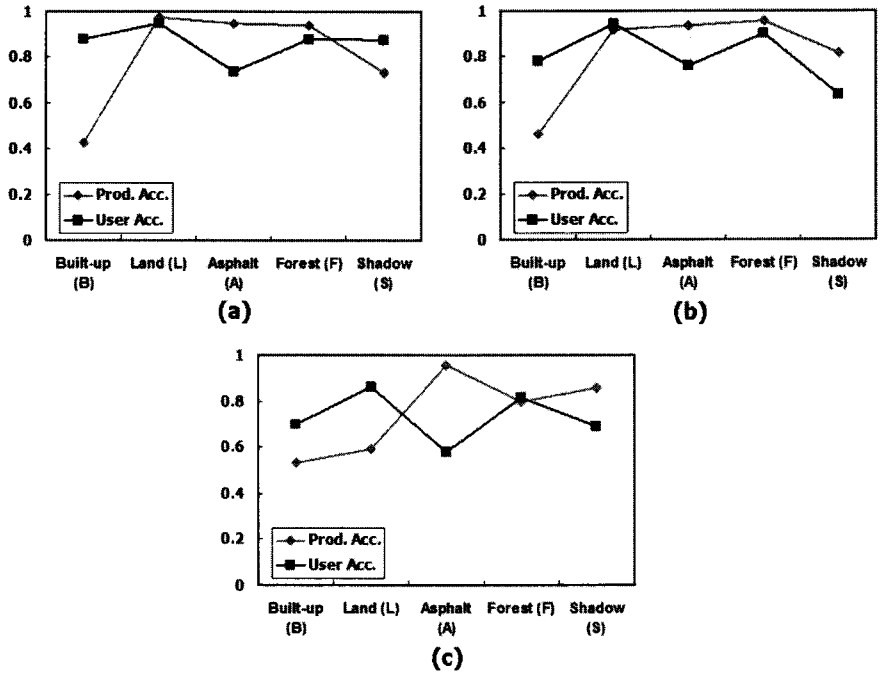

Fig. 3. The producer's and user's accuracies distribution of all classes. (a) Conventional (b) small mixed (c) conventional, same size.

undertaken land cover classification don't separate them. Thus, we used only 5 classes for the classification.

2.4 Training stage using different approaches

The smallness of the training set represented a major problem and resulted in low accuracy of classification. Alternatively, simple heuristics are often used to determine training sample size (Mather, 2004; Van Niel et al., 2005).

The three training dataset was used to compare between them. The first training set was acquired using conventional approach. The samples of each class were collected from the centre location of the classes that is expected to pure pixels. The sampling count was adjusted according to the heuristic 30p method, in here; p means the counts of the used multi-spectral datasets. We used the multi-spectral dataset consisting 4 bands, so the required number of each class is 120. Therfore, a total 600 training set was used to evaluate the classification.

The second training set was acquired from the small mixed pixels that are biased to one class in the decision boundary; it is theoretically laid closely on an optimal separating hyperplane. Fig. 1 showed the example of a training set acquisition. In the panchromatic band, the two classes that is shadow (S) and Built-up (B) is identified apparently. But, the multi-spectral bands showed the mixed distribution of the two classes because of the spatial resolution. The edge between the classes indicates the biased values to the shadow (S), it may be used training sets for the shadow class (S). In most cases, the sampling of the mixed pixels is not difficult and it has an advantage of getting the small accounts readily. In this experiment, it was acquired from the image only 138 training pixels; the total count is about 1/5 comparing the conventional training sets.

The final training set was acquired using the conventional method, but the pixel count of each class was constrained into that of the small mixed training set. The purpose of this training is to compare the classification ability between conventional and proposed training method. The spatial location of the training pixels was considered nearly to the used small training set. It is because the different location of the training set can affect the accuracy of the training comparison.

3. RESULTS AND DISCUSSION

To avoid optimistic bias (Hammond & Verbyla, 1996), accuracy assessment is typically based on a sample of pixels not used in training the classifier. In this experiment, a complete classification map was created manually using visual interpretation of the panchromatic band. It was used as a ground truth, and it evaluated the accuracy of the three land cover map results. The land cover map was also derived from the SVM classification derived with the use of each training set approaches.

The classification using conventional training set, 30p heuristic, showed the most accurate classification results. The overall accuracy of the classification was 86.25% and the Kappa coefficient was 0.7993.

The result trained with the small mixed pixels also showed an accurate classification. The overall accuracy of the classification was 84.52% and the Kappa coefficient was 0.7777. The small mixed training set used only 138 ground truths on total fields, whereas the conventional training set used 120 ground truths on each field (5 fields).

The classification using same size on conventional approach was evaluated that showed lower accuracy than others relatively. The overall accuracy of the classification was 70.64% and the Kappa coefficient was 0.5929. The pattern of accuracies also showed significant difference compared to the others.

4. CONCLUSION

In SVM classification, the presented approach was evaluated and showed its appropriateness. The use of small mixed training set makes the sample acquisitions readily and also accurate classification results. It is especially suggested the situation having a problem to acquire pure pixels or using similar classifiers.

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