COMPARISON OF CBF, ANN AND SVM CLASSIFIERS FOR OF OBJECT BASED CLASSIFICATION OF HIGH RESOLUTION SATELLITE IMAGES

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ABSTRACT

Remotely sensed satellite image analysis is a challenging task considering the volume of data and combination of channels in which the image is acquired. Image classification is the process of converting the volume of digital image data into an information product based on the native features recorded by the sensors and derived features by image segmentation methods. The traditional classification techniques for analyzing high resolution remotely sensed satellite images on a pixel by pixel basis suffer from radiometric differences between adjacent pixels, as well as noise due to short observation times and large radiometric resolution. High resolution images are information rich, containing spectral information as well as textural, shape, contextual and topological information. Object based classification methods are increasingly used for classification of land cover/use units from high resolution images, and often the final result is close to the way a human analyst would interpret the image. To deal with the problem of complexity of high resolution images, the image is first segmented into homogeneous regions, and a set of features are computed for each region segment. These segments are classified using one or more of the machine learning algorithms.

In this paper, the steps involved in classifying the high resolution image are illustrated in figure 1. After comparing different image filtering algorithms, we had chosen to use the adaptive Gaussian filtering approach to smooth the image to reduce intrinsic variability within objects so that extraction of homogeneous objects becomes simpler. The image is segmented using one of the many watershed transformation based algorithms, in which the seeds or markers are extracted in a different way from previously known approaches [1, 2, 3]. A fast connected component labeling algorithm proposed by [4] was used to form the regions, from which features such as region convexity, elongatedness, compactness, solidity are generated. Texture features [5] are generated from co-occurrence matrix, which is still one of the most popular methods.

Training data are selected in terms of several regions for each class using a point in polygon approach – click on a point in the image and select the region containing that point. We classified the image using a relatively new method known as cloud basis function classifier [6], and compared it with well-known classifiers based on

artificial neural network (ANN), and support vector machine (SVM) [7]. The drawback of classifiers with standard kernels such as the radial basis function is that the boundaries of the classes are taken to be spherical while the same is not true for majority of the real data. The boundaries of the classes vary in shape, thus leading to poor accuracy some times RBF based classifiers as in neural networks and support vector machines. The new basis functions, called cloud basis functions (CBFs) use a different feature weighting, derived to emphasize features relevant to class discrimination. Further, these basis functions are designed to have multiple boundary segments, rather than a single boundary as for RBFs. These new enhancements to the basis functions along with a suitable training algorithm allow the neural network to better learn the specific properties of the problem domain. Here a set of boundaries is considered for each class, which promises higher accuracy theoretically.

The entire package is implemented using C/C++ on Pentium 2.8 GHz processor machine. The methodology is tested on Quickbird windows of urban fringe area comprising a few buildings, a quarry site, ponds, road, vegetation and foot paths. The segmentation and classification results indicated that the proposed methodology was quite effective in producing high quality image classification. It was found that the neural network classifier trained using the standard backpropagation algorithm produced marginally better results compared to the other methods. The cloud basis function classifier produced marginally more errors of classification and, being a relatively new technique in the remote sensing arena, is still being investigated.

To compare the performance of the region segmentation with per-pixel classifier, we implemented the original Rosenfeld-Hummel-Zucker relaxation labeling algorithm [8] with the edge information integrated into the label updating process. The input image was smoothed as in case of region classification following which it was classified using the neural network. The response of the output layer of the network after due scaling was used as the initial likelihood of the pixel to belong to different classes. Canny operator was employed to derive boundaries from the image that were used as a constraint while updating the label likelihoods. When a pixel lies on an edge between two regions, it was either left without updating, or the label likelihoods are updated with reduced neighbor influence so that one class does not overgrow into another class. It was found that compared to simple per-pixel classification, the smoothing followed by relaxation labeling approach to classification was significantly better, yet the region segmentation-classification approach described above performed better than the relaxation labeling approach.

2. REFERENCES

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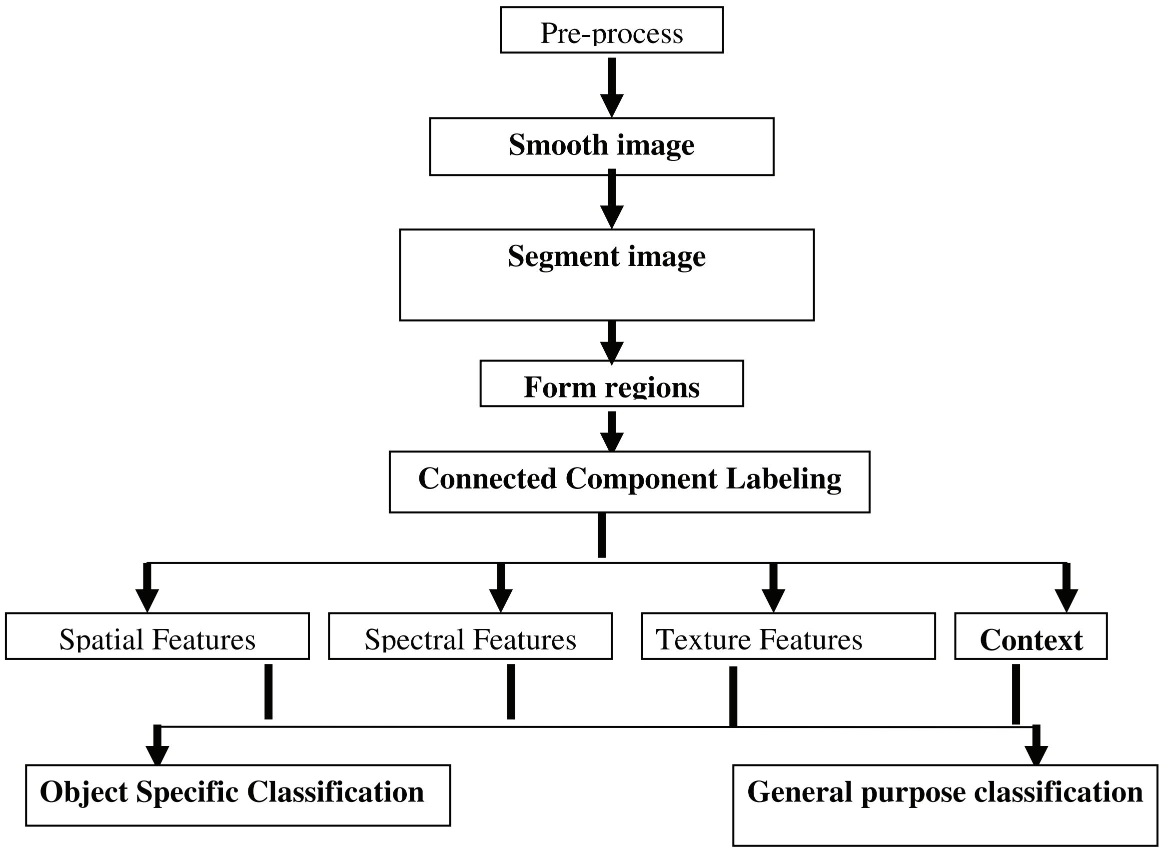

Fig 1: Proposed diagram for classification of high resolution remotely sensed images.