Cloudy Area Detection Algorithm By GHA and SOFM

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Abstract: This paper proposes new algorithms for cloudy area detection by GHA (Generalized Hebbian Algorithm) and SOFM (Self-Organized Feature Map). SOFM and GHA are unsupervised neural networks and are used for pattern classification and shape detection of satellite image. Proposed algorithm is based on block based image processing that size is 16×16. Results of proposed algorithm shows good performance of cloudy area detection except blur cloudy area.
Keywords: Cloudy area detection, Neural networks, SOFM, GHA, Satellite Image

1. Introduction

Cloudy areas in satellite image are able to detect easily by human's (visual and recognition) system. But computer systems have many difficulty problems because ability of feature extraction and recognition is the characteristics for only human. For an imitation of human's system, this paper used two neural network algorithms. First Algorithm, SOFM, can classify data several group for efficient training of neural network, and last one, GHA, can extract shape information from images. By two neural network algorithms we can copy human's system and can detect cloudy area in satellite image. To proof the algorithms, we used a Dea-Jeon EOC (Elector Optic Camera) image by the KOMPSAT-1.

2. Based Theories

There are two neural algorithms for detection of cloudy areas. Image processing of this paper based on 16 ×16 block. Because of all of the neural algorithms are kinds of supervised learning ones, so they need a lot of time for learning.

1) Input Image

Figure 1. is a EOC Image by KOMPSAT-1. We used the image resizing from 2592×3300 to 1024×1296 and dividing 16×16 blocks. Number of blocked images is 5184 (64×81) and each blocked image has 256(16×16) data of 2^8 grayscale. Proposed cloudy area detected by AND operation between bright areas and simple shape areas.

2) Self-Organized Feature Map

Tuevo Kohomen of the University of Helsinki demonstrated that systems could be built that would organize input without being supervised or taught in any way. The system that Kohonen described was able to perform the mapping of an external signal space into the system's internal representational space, without human intervention. He called the process a self-organizing feature map and showed how it could be performed by a neural network[1]. In Kohonen's network, the reward for winning is that the jth fan-in vector is modified slightly, rotating toward the input vector. This can be done by moving the jth fan-in vector incrementally along the vector difference between itself and the input vector, as shown by Figure 2.

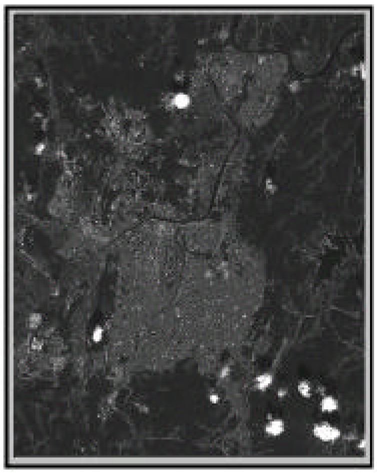

Fig. 1. Input Image

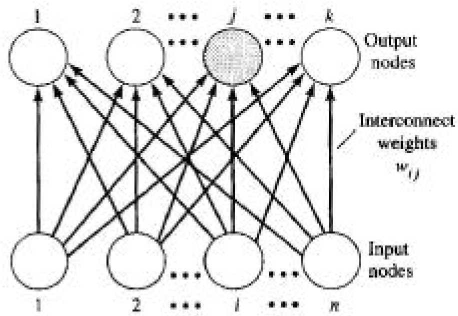

Figure 2. Self-Organized Feature Map

If $x(t)$ is the input vector during cycle t, then the modified fan-in vector looks like this at the start of cycle $t+1$:

$$w(t+1) = w(t) + \alpha(t)[x(t) - w(t)]$$

The factor $a(t)$ is a function such as

$$a(t) = 0.1(1 - t/10^4)$$

3) Generalized Hebbian Algorithm

Generalized Hebbian Algorithm is a simple unsupervised technique especially in feed-forward networks. Oja has shown that simple Hebbian learning applied to single linear neuron extracts features describing best, in the mean-square error sense, the input data[2] [3]. In Hebbian rule, the learning terms is proportional to the product of the input and the output of a neuron. The computations involved in the GHA are simple; they may be summarized as follows:

$$y_j = \sum_{i=0}^{p-1} w_{ji}(n) x_i(n)$$

$$\Delta wj(n) = \eta [y_j(n) x_i(n) - y_j(n) \sum_{k=0}^{j} w_{ki}(n) y_k(n)]$$

Where $j = 0, 1, .., m-1$, $i = 0, 1, .., p-1$, and $x_i(n)$ is the i th component of p-by-1 input vector $x(n)$ and m is the desired number of principal components.

3. Proposed Algorithms

1) Bright Area Selection by Block Average

We can know that cloudy area in the Fig. 2 is brighter than others and that means values of cloudy area has high grayscale values. For the first candidate area that has clouds, mean values of each block are used for the detection of cloudy areas.

2) Simple shape Area Selection by GHA and SOFM

Cloudy areas have large grayscale values (white pixels) and also there shapes are very simple. In Fig. 2, for example, some of building areas are white but they have complicated shape than cloudy areas. The Second candidate areas are decided by GHA coefficients that have degrees of complicatedness.

In a general image processing all of feature data join a training, but it is not appropriate for satellite image because that there are a lot of duplicated blocks[4]. Duplicated data can system lead to slow and wrong performance. So, proposed algorithm applied SOFM for make decision of candidate data for GHA training. Candidate data selection is very simple. First, all of data just classifying several groups by SOFM, and last select same number of data per each group.

Fig. 3. explain meaning of coefficients in GHA. Magnitudes of coefficients are related shape (or complicatedness) of each block. A large coefficient indicates that the basis effects larger to applicable block than smaller ones.

Fig. 3. Coefficients of GHA

3. Experimental Results

1) Bright Area Selection by Block Average

Each 16×16 block has 2^8 grayscale. For detecting of bright area, we select area that mean of grayscale is over that 140. Fig. 4 shows results of bright area by block average. In the bright area image, we can see that bright blocks of buildings area are included.

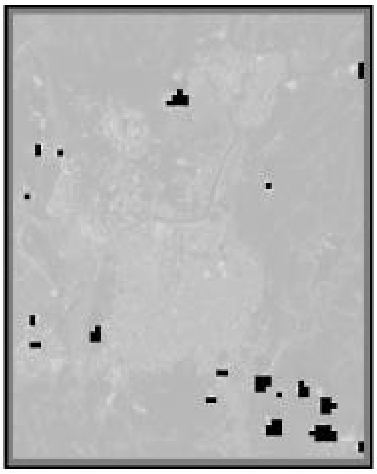

Fig. 4. Bright Area by Block Average

2) Simple shape Area Selection

1. Candidate data selection by SOFM

1024×1296 size image has number of 5184 blocks. For efficient training of GHA, we separate all of blocked data into 16 groups and select 10 blocks data each group. Numbers of data for each group are form 32 to 1303. Fig. 5 shows distributions of each block of data and Fig. 6. shows 160 data joining GHA training by SOFM.

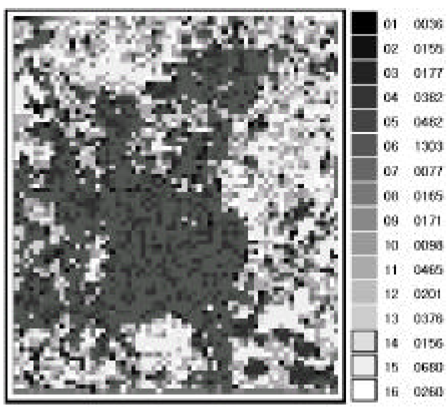

Fig. 5. 16 groups for candidate data selection

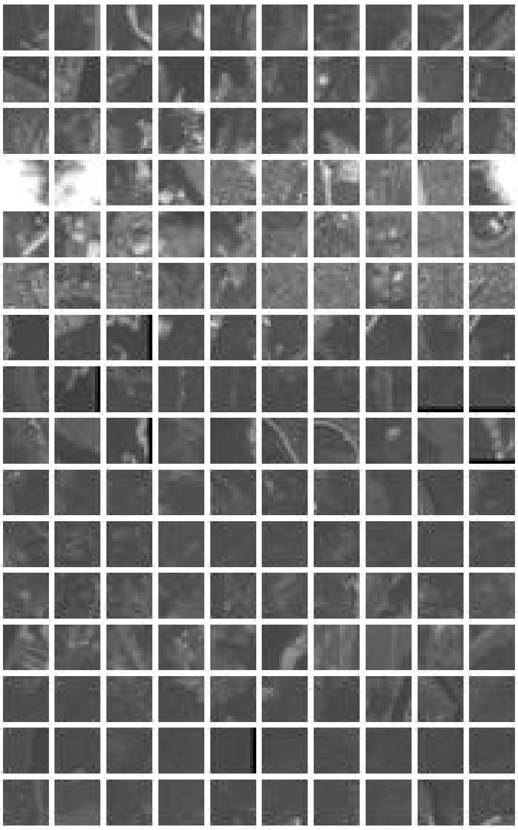

Fig. 6. 160 data for GHA trainning

2.Shape Detection by GHA

For shape detection, we used a GHA system that has 30 Basis. By much trial and error process, we know that learning rate of GHA is larger than others image processing and the value is around 0.2. Fig. 7. shows trained basis at 0.2 learning rate and 100 iterations.

First basis has not shape. Because of it contain overall grayscale gain for each block. Over than 10^{th} basis, there is no information for shape of blocked images.

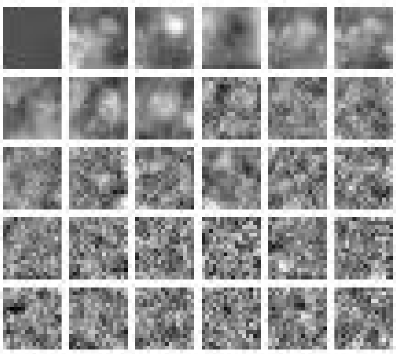

Fig. 7. Trained basis by GHA

So we used upper 10 basis of GHA to determine simple areas. Because of lower basis has not enough information of complicatedness. Blocks of large coefficients indicate that there are many complicated information like the basis shapes.

Fig. 8 is last result of proposed algorithm. It made by AND operation between bright area and simple shape area.

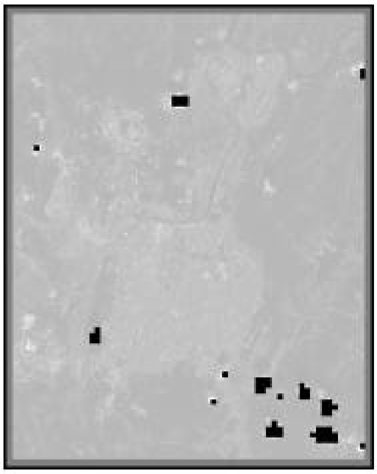

Fig. 8. Detected cloudy area by proposed algorithm

4. Conclusions

This paper proposes a new algorithm for cloudy area detection by SOFM and GHA. SOFM is used efficient training (of GHA) and GHA for simple shape detection. It is difficult finding the proper training rate for learning of both neural networks, and determining proper number of basis for training of GHA.

By means of experiments with neural networks, cloudy areas could determine by combinations of its grayscale and complicatedness. As you know, we can find out complicatedness of blocked images by DCT (Discrete Cosine Transform). But DCT required more calculate time than GHA. Even though GHA needs long time for training of neural networks, in the practical state we can compute complicatedness of blocked image with few multiplies and additions.

In this paper just shows an outline of neural approach for cloudy area detection, so we can' t detect right areas have clouds. In the near future, we will find the right basis of GHA for the analysis of cloud shapes.

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