RESEARCH FOR CLASSIFICATION OF REMOTE SENSING IMAGES OF SALT FIELDS WATER BASED ON ARTIFICIAL NEURAL NETWORK *

Xian-kun ZHANG, Long YI

Tianjin University of Science and Technology, Tianjin 300222, China

E-mail: zhxkun@tust.edu.cn

Abstract: The development of the satellite remote sensing technology provides effective means of monitoring the resources of salt industry production. Firstly, the principles and common methods of remote sensing image classification are introduced in this article. Then the basic concepts of Artificial Neural Network and some common algorithms are expounded, and the Back Propagation network（BP network） are emphatically introduced. Finally, the article introduces a case when the researchers chose the area of Tianjin Tanggu Saltern as the research field and distinguished salt fields water by BP network.

Key words: Artificial neural network, Salt fields water, Remote sensing image classification, Back propagation network（BP network）

INTRODUCTION

Sea salt, Known as "the mother of the chemical industry", salt is one of the basic raw materials of chemical industry and a necessity for human life. In order to strengthen the monitoring of salt production, it is essential for the development of national economy to ensure applicable area of the salt production and the reasonable production structure [1].

Satellite remote sensing is an emerging exploring technology which developed quickly since 1960s. Compared with other monitoring technologies, it has many merits and features: (1) It can be applied macroscopically、quickly、economically ; (2) It can provide abundant information in variety; (3) there is no contact with research subject and hence no damage to it; (4) it has high objectivity and credibility. The development of the satellite remote sensing provides a significantly efficient method of monitoring the resources of salt production.

There are plenty of information in remote sensing images, and classification of remote sensing image will divide all the different information into due groups. Its theoretical support is: when the electromagnetic radiation of the area being monitored at some time was recorded in remote sensing image, the grayscale value of the elements in the image would reflect the feature of the

* The present work is supported by Nature Science Fund of Tianjin (043600411)

electromagnetic radiation spectrum from the ground of this area. The reflected wave spectrums of some typical ground were shown in Figure 1. From this figure, one can find different energies reflected from different grounds in different wavebands. The same grounds in one remote image have the same or similar wave spectrum features and spatial features in the same condition (texture、landform、illumination、vegetation, etc), so the pixel feature vectors corresponding to the different grounds can be gathered at an unified feature spatial area, but as for different grounds, due to different wave spectrum feature vectors and spatial feature, they will be gathered at different feature spatial areas. This principle is used in remote sensing image classification, where the pixels of a remote sensing image are classified to some different grounds according to the difference between wave spectrum energies and structural characteristics of the grounds, so the thematic information can be extracted for different users. Among all the different methods of remote sensing image classification, artificial neural network (ANN) has received a great deal of attention because of its analysis of the non-normal distribution of data.

ARTIFICIAL NEURAL NETWORK AND THE APPLICATION SITUTATION OF IT BE USED IN REMOTE DATA PROCESSING

The basic concepts of Artificial Neural Net-work

ANN is an artificial intelligence information processing theory which developed since 19th century based on the simulation of the human brain-working processes. By building a nonlinear dynamic system from a lot of simple processing units which was named the Neuron Model and simulating the human thinking and associative memory, ANN can realize the information processing capabilities of human learning、recognition and memorizing.

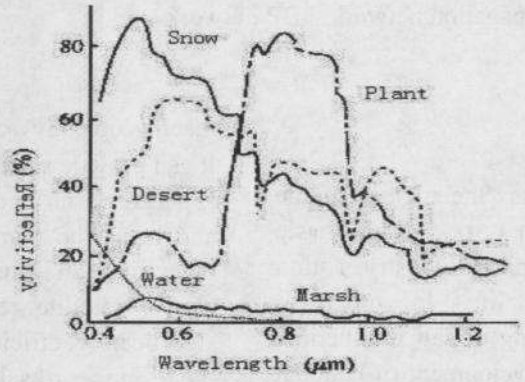

Fig.1 Some reflected wave spectrum curves of typical grounds

Figure 2 shows the Neuron Model. In Figure 2, y represents the value of output; values from x1 to xn being different inputs, values form ω1 to ωn being the weights for each input, and T being the threshold value.

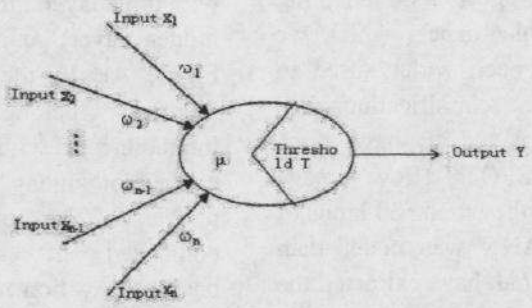

Fig.2 Neuron model

The algorithm of the neuron model is:

Weighted Computing: calculating the weight sum of all the inputs and their weights.

$$\omega_1 x_1 + \omega_2 x_2 + ...\omega_n x_n \quad (1)$$

Threshold Computing:

$$\mu = \omega_1 x_1 + \omega_2 x_2 + ...\omega_n x_n - T \quad (2)$$

Generally, if the weighted value is bigger or equals the threshold($\mu \geq 0$), the neuron will be excited; If not, it will be restrained. Obvious, if a group of ωi is given , the output can be computed easily for any group of inputs (x1,x2,...,xn) T， and the aim of algorithm of ANN is to make the output computed by ANN as true to the fact from the input given by user as possible. So the major work of algorithm of ANN is to set up a model and study the value of ωi .

The computing process of ANN is divided into two phases (shown in Figure 3).The first phase is learning process (shown in Figure a), and the task of this process is comparing the output computed from the learning data by using this model and then adjusting the weight according to the compared result, until the difference between the output and the fact value is close to an acceptable degree, the learning process could be ended, and a group of weight could be found. The second phase is computing process (shown in Figure b).Using the weight found in the previous process one can get output data which are wanted, if the actual data are input.

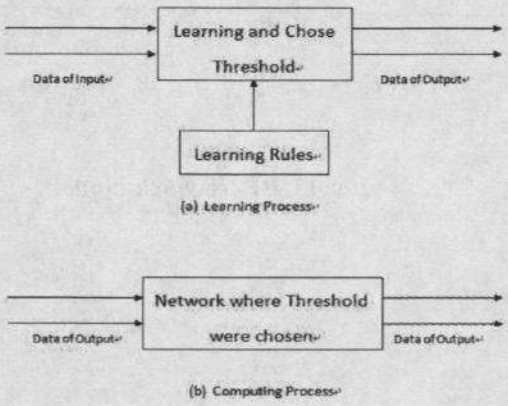

Fig.3 learning phase

The Application of ANN in remote data processing

Because ANN is a nonparametric method, there is no need to suppose or estimate the probability distribution function of the model, and it has a good adapting ability. According to the papers which we could find, ANN has been widely used in remote sensing images classification. For example, Kanellopoulos, et al, have done some research in SPOT HRV image classifying (1992), and they made 20 kinds of division, and found ANN was better than other methods; Deng ,et al, have extracted the status of coal field fire from TM data in thermal infrared band by using ANN. Considering simple landform of salt fields, the small number of categories, and the large monitoring area, application of ANN and correlation algorithms for identifying salt fields water have a excellent prospect.

At present, there are many researches into ANN and the correlation algorithms, with the core content being the learning process. According to the different learning processes, artificial neural networks can be divided into BP network (back-propagation)、Kohonen network (self-organizing feature map)、CP network(Counter Propagation network) and Hopfield network, among which, BP network is the one more frequently applied.

BACK PROPAGATION NETWORK(BP NETWORK)

The concept of BP network

BP network is a hierarchical network, with three layers: Input layer, middle layer (or hidden layer) and output layer (shown in Figure 4). In the network, all the nodes (neuron) belong to adjacent layer interconnected with each other, but there is no connection among the nodes which belong to one layer. The network learning process is composed of forward-propagation and back-propagation: the input information will be spread to the nodes of hidden layers, and then be output to the nodes of output layers through hidden layer. If there is difference between output value and the expected value, then the process will use back-propagation, with the errors returned backwards. The weight of all nodes will be modified among each layer, from output layer through each hidden layer, and back to input layer. The process will start again with forward-propagation when the modification of the weight of input layer is finished. Both of the two propagations will be repeated again and again and the process would not stop until the difference between output value and the expected value is acceptable.

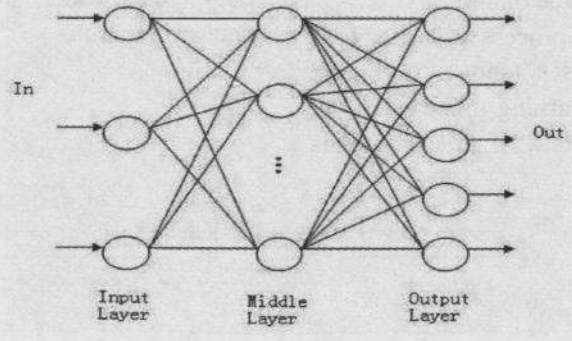

Fig.4 BP Network model

The Basic BP algorithm

The process of classifying remote sensing images based on BP ANN can be divided into 4 steps (shown in Figure 5), the first step being remote sensing image pretreatment including geometric correction、cloud processing、geographic location and so on. In the second step, the remote sensing digital images to be classified will be read into the computer and classified. The third step is the design of neural network model, and it is a network learning process including the design of network layer、determining all weights and the threshold value. In the last step, the images will be classified by the BP network and the result will be exported.

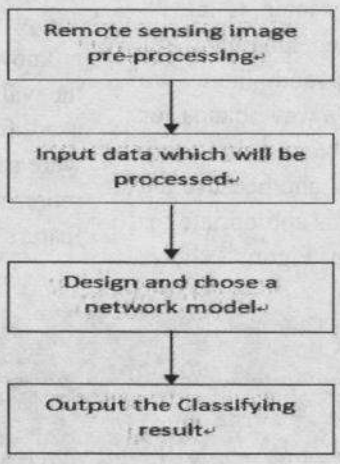

Fig.5 The flow diagram of remote sensing image classification

The most important work here is to determine the BP network structure in the classification, with its core being the algorithm of BP network learning process, shown in Figure 6.

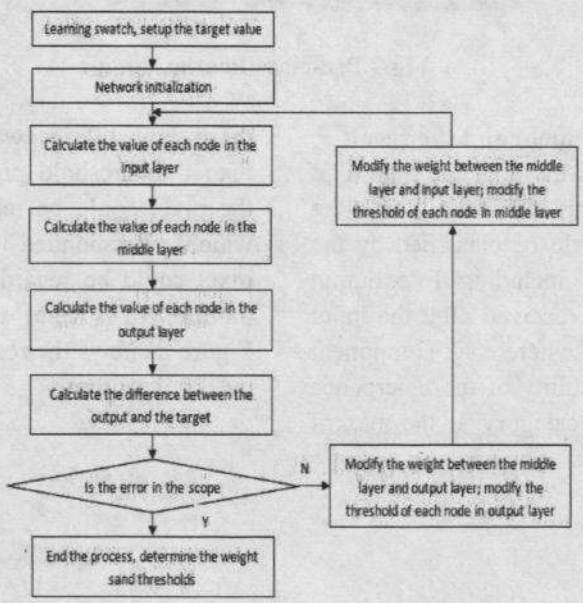

Fig.6 The flow diagram of BP algorithm

THE EXPERIMENT OF SALT FIELDS WATER IDENTIFICATION

The experiment data

The experiment area chosen for this research is the Tianjin Tanggu Saltern, and the remote sensing image is the TM image of LANDSAT 5 received by China Remote Sensing Satellite Ground Station on April 13, 2005. The coordinate of center is at 38 degrees 53 minutes north and longitude 117 degrees 47 minutes east, and there are 6756*5733 data. There are 7 wave bands for the TM image, with each band's dpi being 30m except for the 7th band, and because the area of salt pond is big, so it is appropriate for salt field water identification. Figure 7 shows the initial image.

After the field-study in the experiment area, this area was divided into five grounds: 1- Shallow density brine zone(including sea area、tidal area、breeding pond, etc)、2- High density brine zone(e.g. crystal pond)、3-Shallow offshore or mud area、4-land surface(road ,etc) and 5-others.

At first, the pixels from the training area were used to train the network (The training area was the piece of image where the ground is known), and after the K-L transformation, the values of all pixels of each band were used for input samples. Five output nodes were set in the network, and each output node represented the probability of one ground feature emergence.

Fig.7 Pre-classification image

The process of experiment and the result

After the sample training, the matrix of weight was determined, and then the unknown samples could be classified by the network. The vector including five output components could be received after the input of unknown samples, where each component represented the probability of the emergence of the pixel of given category. If the max of these probabilities was equal to or greater than the threshold predetermined (e.g. 0.8), the pixel could be regarded as the category which corresponded to the node; if not, the pixel could be regarded as a mixed one-- a mixture of several types of grounds The Figure 8 shows the result of the classification by BP algorithm.

Fig. 8 Classified image after using BP

CONCLUSION

There are many researches into ANN application in remote sensing image classification, but not in its application in monitoring the resource of salt production. This paper tried to do some experiment of monitoring the salt production using the advanced remote sensing technology, but the precision needs improvement, and there are many other algorithms which can be used in mixture pixel processing. The study of understanding remote sensing images is still in development, and it is a trend to monitor the resource using remote sensing technology. With the introduction of new methods and new tools, the precision of classifying methods in the future will reach a higher level.

References

Liu, W.L., Zhang, X.K.,2005.The Application of Remote Sensing Technology using in Salt Industry. First Asian Salt Forum (in China).

Xiu, L.N., Liu, X.N.,2003. Current Status and Future Direction of the Study on Artificial Neural Network Classification Processing in Remote Sensing. *Remote Sensing Technology and Application*, 10:339-343.

Qiao, P.L, et al.,2004.The Research of regional eco-environment Classification based on ANN, 3:97-99.

Wu, Z.J., Liu, J.P., 2002.The Classification Method for Land Cover/Land User Based on the Integration of Genetic Algorithm and Back-Propagation Algorithm. *Resources Environment & Engineering*, 6:33-36.