The Generation of SPOT True Color Image Using Neural Network Algorithm

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Abstract: In an attempt to enhance the visual effect of SPOT image, this study develops a neural network algorithm to transform SPOT false color into simulated true color. The method has been tested using Landsat TM and SPOT images. The qualitative and quantitative comparisons indicate that the striking similarity can be found between the true and simulated true images in terms of the visual looks and the statistical analysis.
Key words: True color image, False color image, Neural Network

1. Introduction

Satellite images are advantageous to large-area coverage and repetitive observation, and therefore, are largely adopted in the tasks of resource monitoring [1]. Although numerous computer-based analysis techniques have been developed to automatically analyze and investigate remote sensing images [2], the manual interpretation and image visualization of remote sensing data are still of basic importance for many areas of applications [3]. From a practical point of view, a satellite image with true color composite could be the most comfortable combination for conventional interpretation and visualization for human eyes. For the present, the most widely used SPOT satellite covers only two of visible bands (green and red) and one near-infrared band, and therefore can only produce a false color image. In an attempt to increase the visual effect of SPOT images, this study proposes a procedure to transform false color into true color. Basically, the study uses the backpropagation neural network algorithm [4] to perform the color transformation with the aid of Landsat TM data. The method employs Landsat false and true color data as the training data in the learning phase, and stores the network's weights at the end of the training stage. The weights are then used to transform SPOT false color into true color. The backpropagation network used in this study is detailed in section 2. The testing data can be found in section 3. The results will be discussed in section 4. Finally, the conclusion remarks are given in section 5.

2. The Neural Network

The neural network is the method that attempts to simulate the learning and recognition processes of the human brain. One of the most popular and most widely used neural network models is known as backpropagation neural network (BPN). The topology of BPN typically consists of an input layer, an output layer, and one or more hidden layers in between. Each layer contains a number of nodes, which correspond to the human's biological neurons. The input layer accepts input signals, and the output layer stores the results of the network. The hidden layer performs activation of the input signals and transfers the activation to the output layer through a nonlinear procedure. A complete processing of the neural network normally begins with pattern learning and ends with pattern recognition. The purpose of learning is to use training data to train the network to recognize a set of desired output patterns. As a result of learning, the connection between layers will contain a set of weights, which can be used to perform pattern recognition. After the network has been trained, the unknown input can be processed and recognized as the proper pattern by the derived weights stored in the network. In this study, Landsat false color bands (green, red, and near-infrared) and true color bands (blue, green, and red) are used as the input and output data respectively in BPN's learning stage. Accordingly, the resultant weights are used to transform SPOT false color into simulated true color in BPN's recognition stage.

3. Test Data

The data used in this study includes one Landsat TM image and two SPOT images. Three tests are carried out in this study. In test 1, the training data selected from Landsat false and true color bands are used to train the network and the network's weights are stored for further use. Basically, these weights are used to transform Landsat and SPOT false color images into simulated true color images in test 1, 2, and 3. The images used in three tests and their acquisition dates are listed in Table 1. It is noted that 1^{st} SPOT image was acquired at the same day (October 31, 1995) as Landsat with only one-hour acquisition difference and 2^{nd} SPOT image was acquired six years later (October 23, 2001) than Landsat.

4. Results

The results are examined visually and quantitatively for each test. The visual results of all three tests can be examined in Fig.1, 2 and 3. Noted that Fig.1 (a), Fig.2 (a), and Fig.3 (a) show the false color images input in BPN for Test 1, 2, and 3. The resulting simulated true color images output from BPN are illustrated in Fig.1 (b), Fig.2 (b), and Fig.3 (b). In order to perform the comparison, Landsat true color images are displayed in Fig.1 (c), Fig.2 (c), and Fig.3 (c). On comparison, it is found that both simulated true (Fig.1 (b), Fig.2 (b), and Fig.3 (b)) and true (Fig.1 (c), Fig.2 (c), and Fig.3 (c)) color images are spectrally indistinctive in terms of the color and tone. Moreover, for Test 3, the visual inspection also indicates that it is very difficult to make a color distinction between the simulated true (Fig. 3(b)) and true (Fig. 3(c)) color images even the acquisition date of two images had a six-year difference. The calculation of the correlation coefficients between simulated and true color bands are used to carry out the quantitative comparison. Table 2 shows the quantitative results of all three tests. The results show that the correlation coefficients can reach over 0.90. Such strong correlations indicate that BPN used in this study indeed develops a successful transformation between false and true color images.

5. Conclusion

A color transformation method is developed to transform SPOT false color into simulated true color. The method uses backpropagation neural network to carry out the color transformation. The simulated true color images have been compared visually and quantitatively with true color images. The results indicate that SPOT false color images can be spectrally transformed to nearly identical true color images in terms of the visual effects. Moreover, the high correlation coefficients between the simulated true and true images also demonstrate the potential of the proposed method to the visual application of SPOT images.

Table 1 The image data used in the tests and their acquisition dates

Test	Image	Acquisition Date
Test 1	Landsat TM (IR, R, G, B)	10/31/1995
Test 2	1st SPOT (IR, R, G)	10/31/1995
Test 3	2nd SPOT (IR, R, G)	10/23/2001

Table 2 Correlation coefficients of true color and simulated true color images

Band	Red	Green	Blue
Test 1 Landsat(10/31/1995) Landsat(10/31/1995)	0.96	0.96	0.96
Test 2 Landsat(10/31/1995) 1stSPOT(10/31/1995)	0.95	0.95	0.95
Test 3 Landsat(10/31/1995) 2ndSPOT(10/23/2001)	0.89	0.92	0.93

References

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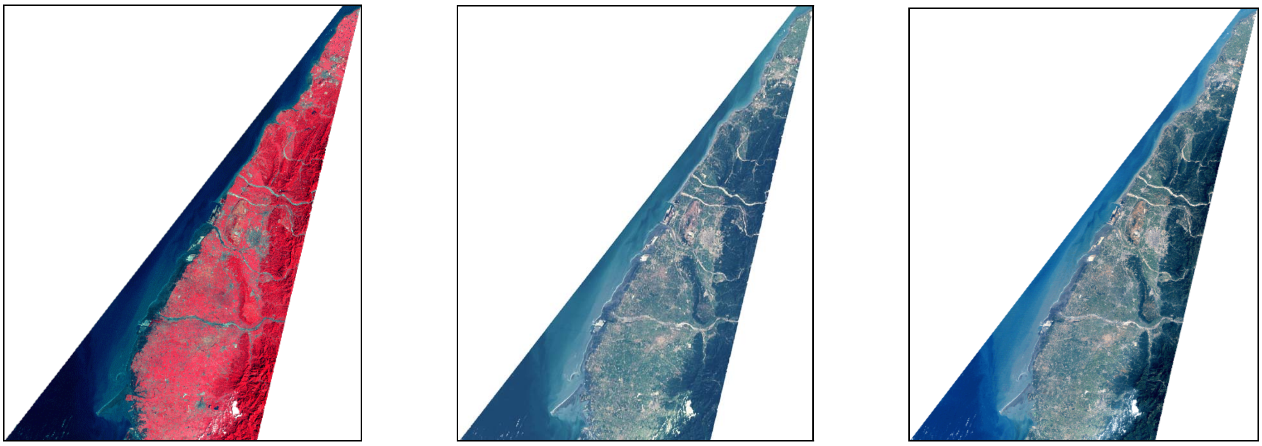
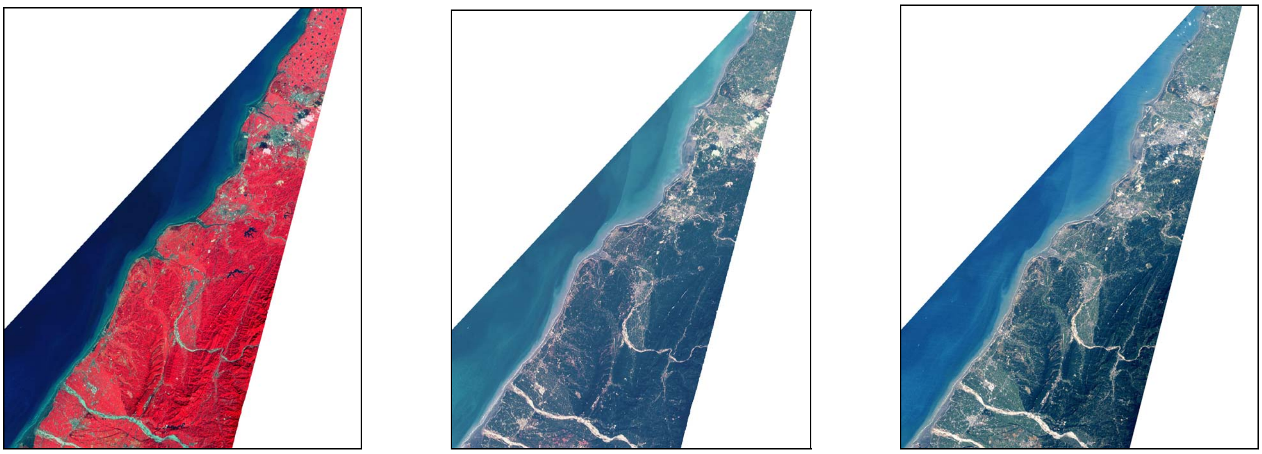


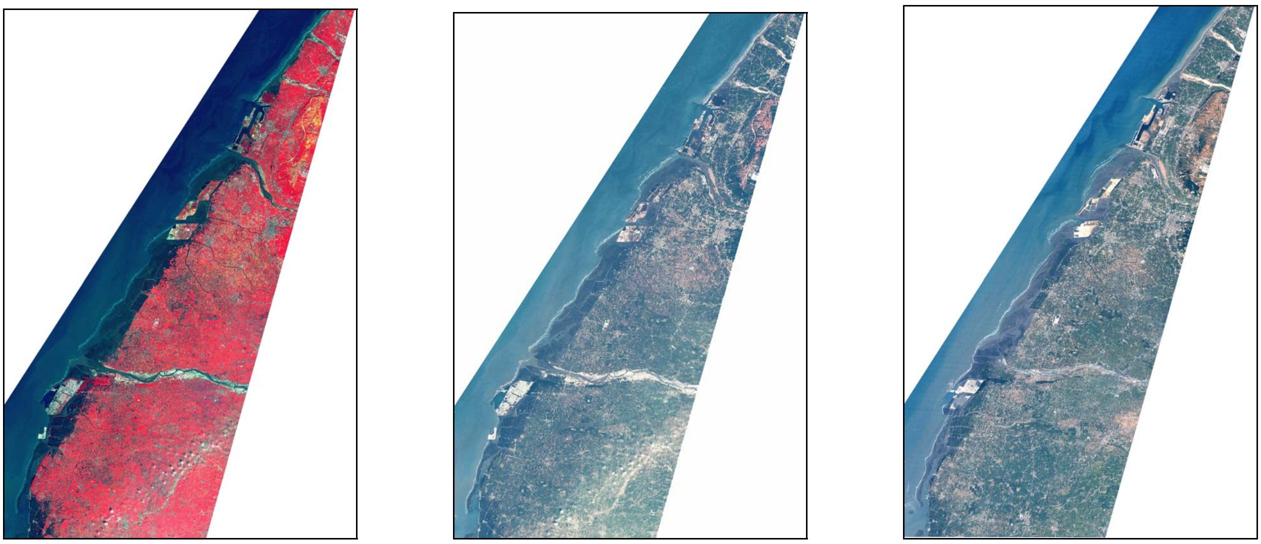
(a) (b) (c)

Fig. 1 Images for Test 1: (a) Landsat false color image acquired on 10/31/1995; (b) Simulated true color image generated from (a); (c) Landsat true color image acquired on 10/31/1995.



(a) (b) (c)

Fig. 2 Images for Test 2: (a) SPOT false color image acquired on 10/31/1995; (b) Simulated true color image generated from (a); (c) Landsat true color image acquired on 10/31/1995.



(a) (b) (c)

Fig. 3 Images for Test 3: (a) SPOT false color image acquired on 10/23/2001; (b) Simulated true color image generated from (a); (c) Landsat true color image acquired on 10/31/1995.