Image Compression for Bill Money by Neural Networks

Sigeru Omatu Kenji Kibi Masaru Teranisi Toshihisa Kosaka
Computer and Systems Sciences Graduate School of Engineering
Osaka Prefecture University
Sakai, Osaka, 599-8531 Japan
omatu@cs.osakafu-u.ac.jp

Abstract

We propose an image compression method using Self-Organizing feature Map (SOM) for various kinds of bill money images which have been obtained by receiving the light reflected from the bill through a specific frequency band filter for the specific frequency incident light. The reason why such an image is required is to detect the false bill. Incident light for every 15 angstrom has been emitted toward the bill and the reflected light has been measured by using the filter with 15 angstrom wave length. The image size is 1,024x1,024pixls. Therefore, huge numbers of images are obtained. In this paper we will extract images with specific important features among those images by using the SOM clustering.
Keywords: SOM, Feature extraction, Bill Money data, Clustering Algorithm

1 Introduction

Recently, the rapid progress of electronic copying technology, there have many color printing machines which can print out almost the same quality of the original pictures. Although the technology has offered many advantages for users in printing field, there have appeared some disadvantages such as printing the false bills.

In order to recognize the bills correctly, we need more additional information about the bills. One of them is to check the spectral property of the bill. In this case, there are many images corresponding to the various frequency bands of the filter of the sensing devices as well as those of the emitted light frequencies.

In this paper, we consider the data compression methods of those various images of the bills which have been obtained by sensing the reflected images by using specific frequency band-pass filters to the specific emitted light for the various frequencies. The technique used here is Self-Organizing Feature Map technique which has been developed by Kohonen [1] and the bill is 10,000 Bolivar in Venezuela. We use 145 images with 1,024x1,024 pixels and 256 resolution levels. Five patterns of the emitted lights and twenty nine patterns for the sensing filter bands have been used in this experiment. The aim is to find the specific images among 5x29 images which keep the representative features to detect the false bills.

2 Image Data for Data Compression

The date used here are images with 1,024x1,024 pixels of 10,000 Bolivar bill in Venezuela which are obteined as the reflected light image through specific spectral band-pass filters for preassigned lights with several frequency bands. The data used here are shown in Table 1.

From now on we denote the image data as X-number such as A-01 to show the image with emitted light A and receiving filter frequency band number 01. The original image data of 10,000 Bolivar bill which has whole spectral data without no spectral band-pass filter is shown in Fig.1. Here, the fram in the picture is the study area and in this part there are many secret symbols which will appear if we emit a special light with specific spectral bannd and observe the refrected light through a filter with specific spectral band. Therefore, we can obtain various types of images which have been observed throughband-pass filters for various emitted lights. Some of them are shown in Fig.2. In oder to keep the secret, we cannot show the real values and we use the symbols, A,b,...E

Table 1: The image data used here.

Image size	1,024x1,024 pixels
Intensity	256
Emitted light frequency	5 patterns(A-E)
Received filter band	29 patterns(01-29)

for different emitted lights and use numbers 01 to 29. In this paper, we will propose a data compression method among those image data using the SOM of competitive neural networks which can cluster the image data such that the similar images can be clustered autonomously.

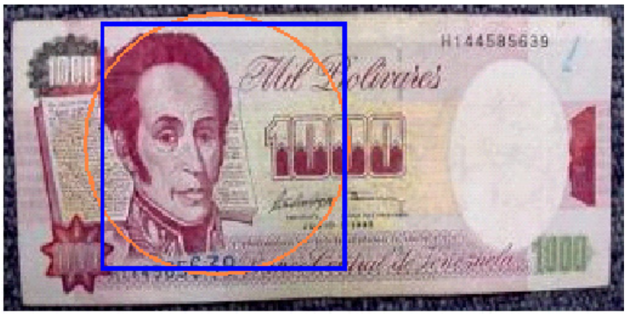

Figure 1: An example of images for data compression.

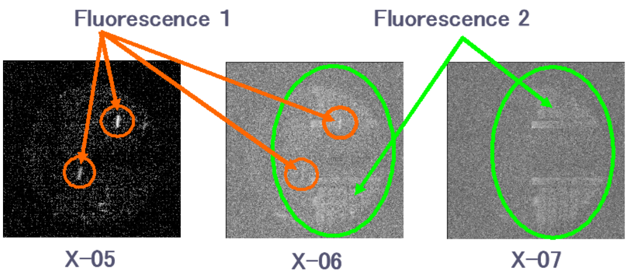

Figure 2: Examples of an fluorescence images.

3 The Data Processing Method

In this section, we will explain the proposed method by using the SOM. The observed images are low power reflected lights and sensitive to the temperature and humidity in the sensing environment. Thus, they includevaruious noises, especially, pepper and solt noises. Therefore, we apply median filter to original data to delete the noise. An example of noisy image and the noise removed data is shown in Fig.4. Comparing these images, we can see how much noise is included in the present image and the effect of the median filtering operation.

To make the comparison data, we will subtract the pixel values of the one image from the corresponding pixel values of the neighbouring next image. From these values we can see how much difference occurred by changing the filter band. If the difference values attain the maximum and the decrease, the image corresponding the maximum value difference is the typical image to be stored. But the maximum values are not reflect the precise measure for the image change. Thus, we store some neighbouring images and from those images we find the suitable representative image by using the SOM. The Som structure is shown in Fig.5.

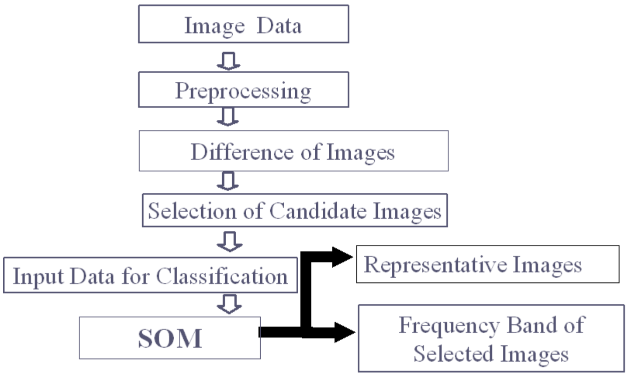

Figure 3: Flow of the proposed method.

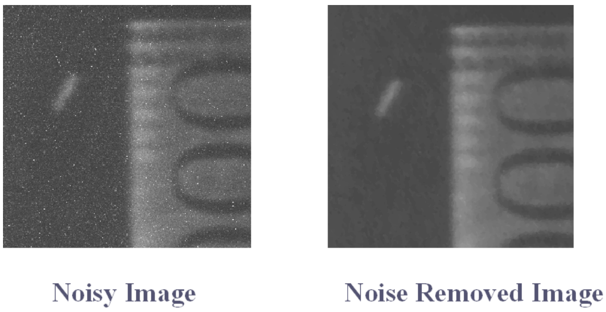

Figure 4: Noisy image and noise removed image.

The compressed input data for the SOM are given by projection to vertical and holizontal axes as hown in Fig.6. Using this technique we can rduce the image data size from 1,024x1,024 to 2,048 as shown in Table 1. Thus, for emitted light A we have obtained 29 images recived 29 filter bands. Some of the images is illustrated in Figs.7 and 8. Therefore, the object is to find the typical image data among those many data and store the specific features for the representative image.

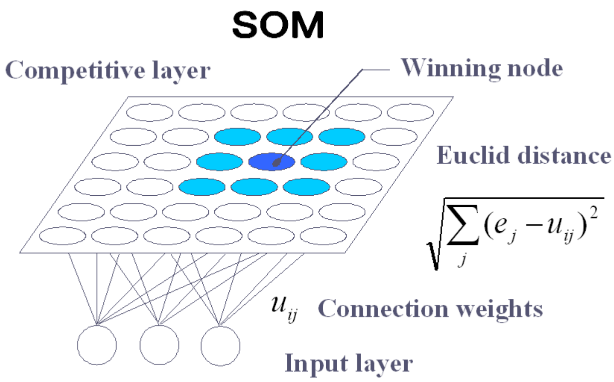

Figure 5: SOM structure for classification.

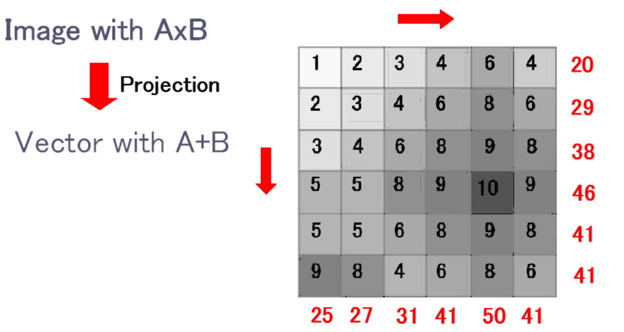

Figure 6: Data compression by projection to vertical and horizontalaxes.

3.1 Classification Results by SOM

3.2 Classification Results by SOM

Using the proposed method we can get the representative images which has been extracted by deleting the similar images from the observed images. By taking the difference of grey levels by pixel to pixel between the successive two images, we could reduce the number of images from 145 to 22 among which there are four different patterns as shown in Fig.9. Those four patterns include A-01,14(for Pattern 1), B-01,02,26, C-01,05,28(for Pattern 2), D-01,04,19,28(for Pattern 3), and E-01,05,08,26(for Pattern 4). Pattern 1 shows the background image, Patterns 2 and 3 show the central part without and with slanting lines, and Pattern 4 shows the dashed symbols near 10,000. These images correspond to the images selected by our inspection.

Table 2: Parameters of SOM.

Parameters	Values
Number of nodes	5x5
Total learning time	1,000
Learning rate	0.8
Initial distance of neighorhood	3

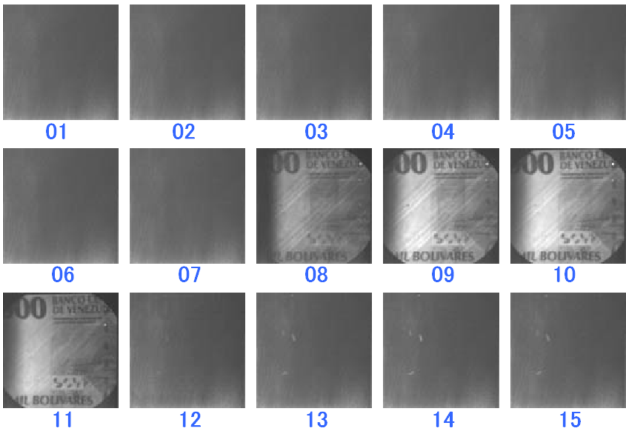

Figure 7: An example of rceived images from 01-15 for emitted light A.

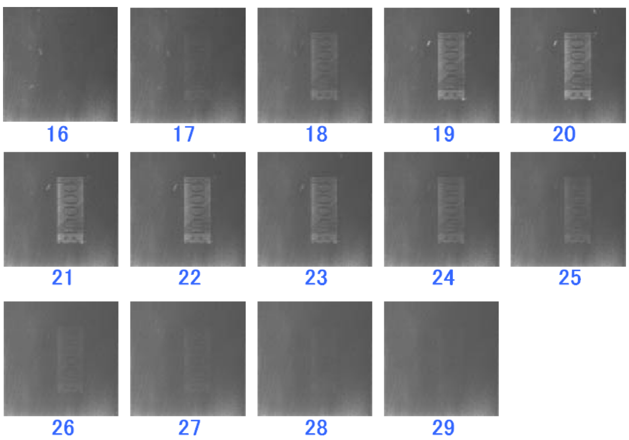

Figure 8: An example of rceived images from 16-29 for emitted light A.

Figure 10 shows the classification results among the classified patterns stated above by using the SOM. The number of input data for the SOM is 2,048 and the number of the competitive layer is 5x5. The initial value of the neighborhood distance is 3, the learning rate is 0.8, and the total learning time is 1,000 as shown in Table 2.

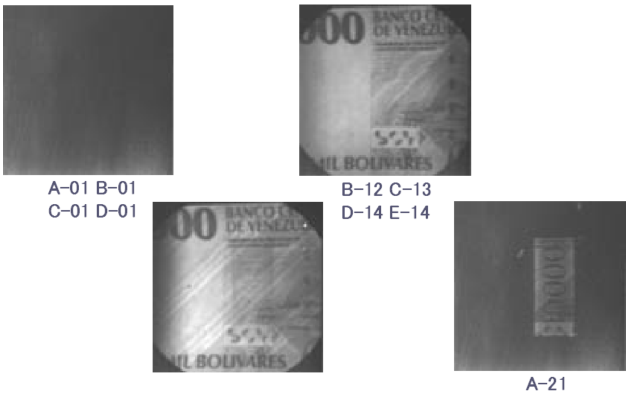

Figure 9: Representative images.

4 Conclusion

In this paper, we have proposed a new method to select representative images among huge image data by using the SOM. To reduce the number of images we have used the difference method in the first and then applied the SOM to four pattern classes to find the specific features. The results obtained here show the effectiveness for image data compression.

References

[1] T. Kohonen, "Self-Organizing Maps", Springer-Verlag, 1997.

[2] R. Palaniappan, P. Raveendran, and S. Omatu,Improved Moment Invariants for Invariant Image Representation, World Scientific, 2000.

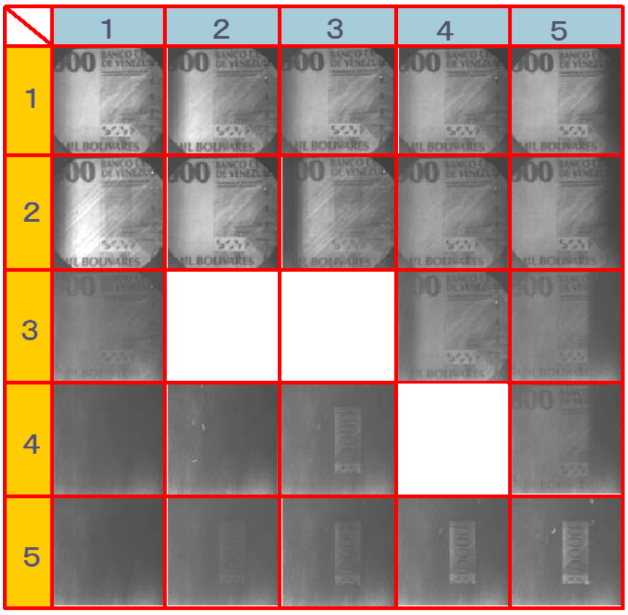

Figure 10: Classification results by the proposed method.

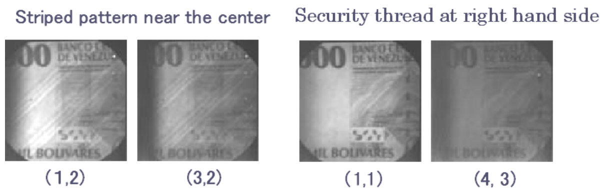

Figure 11: An example of specific feature of the representative image.

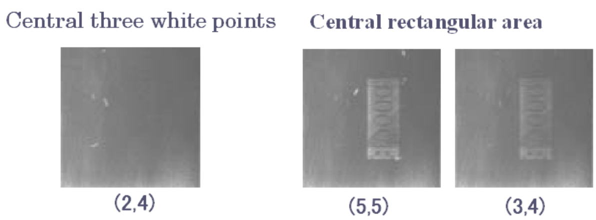

Figure 12: Feature extracted from the representative image.