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Texture features extraction in the fuzzy Kohonen neural network for image clustering

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ABSTRACT

In this paper, a new approach of fuzzy Kohonen neural network (FKNN) for image clustering using texture features of biopsy images was studied. The statistical textures have been extracted from co-occurrence matrix. This method allows the computing of different types of features: Energy, Homogeneity, Entropy and Contrast. Statistical texture can be defined as the spatial distribution of intensity variation in an image according to some underlying probabilistic model. These features are fed as input into the fuzzy Kohonen neural network (FKNN) to specify the number of clusters in the image. This technique is an example for estimation the number of clusters from searching a set of texture features to finalized image segmentation by fuzzy Kohonen neural network. Our proposed method is used to overcome the problem of large data set of pixels values as an input to fuzzy Kohonen neural algorithm to the number of texture features. These texture features are represented by a pre-processing step in the estimation number of clusters by FKNN. Our experiments show the ability of the proposed algorithm in the image segmentation with a quality number of texture features. It gives a high data clustering efficiency. This algorithm works effectively after noise has been removed from the image.

Keywords: Texture features, clustering, fuzzy Kohonen neural clustering, fuzzy c-mean clustering, segmentation.

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INTRODUCTION

Features extraction is one of the dimensionality reduction techniques. It extracts a subset of new features from the original feature set by means of some functional mapping, keeping as much information in the data as possible. Texture feature is one of the most commonly used feature extraction techniques (Pechenizkiy et al., 2003). Texture feature is a type of extracted features from structural pattern of surfaces which is homogeneous in spite of brightness and color. Random and natural textures classification is still one of the biggest challenges in the field of image processing and pattern recognition (Nassiri et al., 2008). Clustering is a process whereby a set of objects are divided into several clusters in which each of the members is in some way similar and is different from the members of other clusters (Zhang and Han, 2005). Image segmentation use clustering methods in utilizing many different feature types, such as brightness (the pixel intensity of a gray scale image) and others features extractions. In traditional clustering approach, there is only one cluster. Hence, the clusters in a hard clustering are disjoint. Fuzzy clustering extends this notion to associate each pattern with every cluster using a membership function (Shihab, 2000). Fuzzy C-Mean clustering (FCM) is the most popular fuzzy-based clustering technique. It was developed by Bezdek (1981) and it is still widely used in features analysis, pattern recognition, image processing, classifier design and clustering. The FCM algorithm is mainly based on the iterative minimization of the following objective function and constraints (Zheru et al., 1996; Moertini 2002).

The neural network approaches which rely on neural network architecture for image segmentation, have been introduced; also the hybrid of neural network with fuzzy is used in image segmentation (Zhang and Han, 2005; Shihab 2000). The hybrid learning scheme was a first attempt to merge fuzzy clustering and feature maps by Huntsberger. They attempted to establish a connection between feature maps and fuzzy clustering by modifying the learning rule proposed by Kohonen for the SOFM. Hamdi used Fuzzy Kohonen neural network for image segmentation (Tsao et al., 1994). The theoretical foundations of this paper are based on theoretical foundations of Fuzzy Kohonen Neural Network in Tsao et al. (1994). This paper consists of two steps. In the first step, we introduced a different statistics to describe texture features which is done after construction of the co-occurrence matrix. Also, we presented how to compute these statistics and the meaning of these statistics. In second step, we applied textures features in the Fuzzy Kohonen Neural network for clustering biopsy image.

APPROACHES OF FKNN ALGORITHM

This approach consists of two parts:

First part

To construct co-occurrence matrix, we considered a central pixel with a neighbourhood defined by the window size in the parameter. For each pixel of the neighbourhood, we counted the number of times that a pixel pairs appear specified by the distance and orientation parameters. After computing the co-occurrence matrix, we need to describe the texture using statistics. These descriptors exist to describe an image: contrast, energy, homogeneity and entropy (Rickard, 2001).

Contrast

Contrast is a measure of intensity contrast between a pixel and its neighbor over the entire image.

If the image is constant, contrast equals 0 while the biggest value can be obtained when the image is a random intensity image and pixel intensity and neighbor intensity are very different. The equation of the contrast is as follows:

$$\text{Con} = \sum_{i=1}^{k}\sum_{j=1}^{k}(i-j)^2 p_{ij} \quad \dots\dots\dots (1)$$

Energy

Energy is a measure of uniformity, which is maximum when the image is constant. The equation of the energy is as follows:

$$\text{Ene} = \sum_{i=1}^{k}\sum_{j=1}^{k} p_{ij}^2 \quad \dots\dots\dots (2)$$

Homogeneity

Homogeneity measures the spatial closeness of the distribution of the co-occurrence matrix. Homogeneity equals 0 when the distribution of the co-occurrence matrix is uniform and 1 when the distribution is only on the diagonal of the matrix. The equation of the contrast is as follows:

$$\text{Hom} = \sum_{i=1}^{k}\sum_{j=1}^{k}\frac{p_{ij}}{1+|i-j|} \quad \dots\dots\dots (3)$$

Entropy

Entropy measures the randomness of the elements of the co-occurrence matrix. Entropy is maximum when elements in the matrix are equal while it is 0 if all elements are different. The equation of the contrast is as follows:

$$Ent = -\sum_{i=1}^{k}\sum_{j=1}^{k} p_{ij}\log p_{ij} \quad \dots\dots\dots (4)$$

We normalized descriptors features contrast, homogeneity and energy between 0.0 and 1.0.

Second part

After this step, we feed the textures features in the Fuzzy Kohonen Neural Network. The algorithm of FKCN is summarized as follows (Atmaca et al., 1996; Tsao et al., 1994; Tarkov et al., 2002):

Step 1: Given number of cluster from part 1, given textures features $X = \{x_1, x_2, x_3, \dots\dots, x_n\}$ distance $\|.\|$

Cluster c and error threshold $\varepsilon > 0$.

Step 2: Initialized the weight vector v(0), set fuzzy

Parameters m_0 iteration limit t_{max} , initial iteration Counter, t =0.

Step 3: Update all memberships $\{u_{ij}\}$ and calculate learning Rate $\{\alpha_{ij}\}$

$$u_{ij} = \frac{1}{\sum_{k=1}^{c}\left(\frac{\|x_i - v_i\|}{\|x_j - v_k\|}\right)^{\frac{1}{(m_t-1)}}} \qquad (5)$$

$$\alpha_{ij}(t) = (u_{ij}(t))^{mt} \qquad (6)$$

$$\text{where } m_t = m_0 - t.\Delta m, \Delta m = \frac{m_0 - 1}{t_{max}} \quad (7)$$

Step 4: Update all the weight vectors.

$$v_i(t) = v_i(t-1) + \frac{\sum_{j}^{n} \alpha_{ij}(x_j - v_i)}{\sum_{s=1}^{n} \alpha_{js}(t)} \quad (8)$$

Step 5: Compute the function

$$E(t) = \|v(t) - v(t-1)\| \quad (9)$$

Step 6: If $t+1 > t_{max}$ or if $E(t) < \varepsilon$, and terminate the iteration; otherwise, return step 3.

EXPERIMENTAL RESULTS

Figure 1a shows an original image. Figure 1b shows results of segmentation of FKNN ε = 0.0001, number of iteration = 100 with window 5×5. Figure 1c shows results of segmentation of FKNN ε = 0.0001, number of iteration = 100 with window 9×9. When we compare Figures 1b and c, the first one gives more details from an image in Figure 1c. Figure 2a shows an original image, Figure 2b shows the results of segmentation of FKNN ε = 0.0001, number of iteration = 100 with window 5×5. Figure 2c shows results of segmentation of FKNN ε = 0.0001, number of iteration = 100 with window 9×9. When you compare Figures 2b and c, the segmentation of Figure 2c is better than Figure 2b because noise is removable.

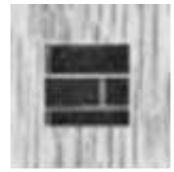

Figure 1a. Original image.

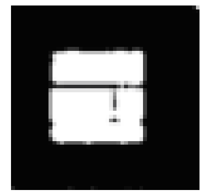

Figure 1b. Image segmentation with window 5×5.

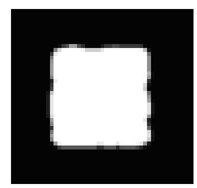

Figure 1c. Image segmentation with window 9×9.

Figure 2a. Original image.

Figure 2b. Image segmentation with window 5×5.

CONCLUSION

We implemented Fuzzy Kohonen Neural Network by using texture features extraction which is extracted from biopsy images. This technique consists of two parts: in the first part, statistics features constructed from using co-occurrence matrix. This method allows to find easier way to segment image. In the second part, we applied the Fuzzy Kohonen Neural Network algorithm and implemented image segmentation with input textures features. After completion of the two parts, we saw that results are affected by the following set of parameters:

i) The window size of the neighborhood.
ii) The number of gray levels.
iii) The orientation and the distance parameters to construct the co-occurrence matrix.

Finally, the role of each parameter in the performance

Figure 2c. Image segmentation with window 9×9.

algorithm is observed. We computed the set of images with different window sizes to see the influence of this parameter. For all examples, the results are the same. The descriptor images are more and more blurring when the size of the window is bigger and bigger. Adjusting this parameter, we can deal with scale variation and periodic textures. We computed result images with a distance of 2 pixels and 4 pixels. The main idea of this algorithm is determining the interesting patterns from large data sets which give the term of data mining fast and accurate. The time of computing FKNN using features textures for clustering is less than from the using input pixel values. The new algorithm is sensitive about noise; therefore noise removal must be used before algorithm. The main advantage of the proposed algorithm is that it combines part 1 and part 2 to produced stable clustering middle pixel in the window corresponding to the global coordinates in the picture.

To speed up and make things easier in the extraction of the minutiae, an assumption is made. The portions of data that are viewed by the neural network are only those that have a black pixel in the middle. Since the minutiae are made only from thinned lines, there is no need to examine data where lines are off the center in the data portion. This assumption gives three very good improvements.

REFERENCES

Atmaca H, Bulut M, Demir D, 1996. Histogram Based Fuzzy Kohonen Clustering Network for Image Segmentation. Proceedings of the International Conference on Image Processing, pp: 951 - 954.

Bezdek JC, 1981. Pattern recognition with fuzzy objective function algorithms. Plenum: New York, 256. p.

Moertini VS, 2002. Introduction to Five Data Clustering Algorithms. Integral, 7(2):87-96.

Nassiri MJ, Vafaei A, Monadjemi A, 2008. Texture feature extraction using Slant-Hadamard transform. World Acad Sci Eng Technol, 17:790-794.

Pechenizkiy M, Puuronen S, Tsymbal A, 2003. Feature extraction for classification in the data mining process. Int J Inform Theor Appl, 10:271.

Rickard HE, 2001. Feature Selection for Self-Organizing Feature Map Neural Networks with Applications in Medical Image Segmentation. Thesis, Department of Electrical Engineering, December.

Shihab AI, 2000. Fuzzy Clustering Algorithms and their Application to Medical Image Analysis. Ph.D Thesis, University of London.

Tarkov MS, Mun Y, Choi J, Choi H, 2002. Mapping Adaptive Fuzzy Kohoen Clustering Network onto Distributed Image Processing System. Parallel Comput, 28:1239-1256.

Tsao E, Bezdek JC, Pal NlR, 1994. Fuzzy Kohonen Clustering Networks. Patt Recogn, 27(5):757-764.

Zhang J, Han L, 2005. D-GridMST: Clustering large distributed spatial databases. Classif Cluster Knowl Discov Stud Comput Intel, 4:61-72.

Zheru C, Hong Y, Tuan P, 1996. Fuzzy Algorithms: with Applications to Image Processing and Pattern Recognition. World Scientific Publishing Co. Pte. Ltd.