

Fuzzy Kohonen Clustering Network for Color Image Segmentation

Nahla Jabbar¹, S.I.Ahson², Monica Mehrotra³

^{1,3} Jamia Millia Islamia, Dept. Computer Science

² Patna University, Pro-vice Chancellor

Abstract. In this study, a Fuzzy Kohonen Clustering Network (FKCN) algorithm is proposed for color image segmentation. We study the ability of FKCN in color image segmentation; we compare the segmentation between a different color images. Experiments show that the proposed method can segment an image and robust performance to noise.

Keywords: Color image processing, Segmentation, Clustering, FCM, Kohonen Neural Network

1. Introduction

Segmentation an image consist of subdividing it into a number of non _overlapping ,homogeneous regions ,each of which is spatially connected and differs from neighboring regions in some meaningful properties .Segmentation is a process of partitioning the image into some non-intersecting regions that each region is homogeneous and the union of no two adjacent regions is homogeneous .It can be formally defined as follows : if F is the set of all pixels and $p(\)$ is a uniformity(homogeneity)predicate defined on groups of connected pixels, then segmentation is a partitioning the set F into a set of connected subsets or regions (s_1, s_2, \dots, s_n) such that

$$\bigcup_{i=1}^n S_i = F \text{ with } S_i \cap S_j = \emptyset, i \neq j \quad (1)$$

The uniformity predicate $p(s_i) = \text{true}$ for all regions (s_i) and $p(s_i \cup s_j) = \text{false}$, when S_i is adjacent to S_j [1]. There are many approaches developed for image segmentation, it divided into four classes: classical, statistical, fuzzy and neural .Classical approaches include such methods as edge and Region-based techniques or intensity thresholding .statistical approaches are based a maximum likelihood estimators represent learned classification rules as mathematical formulas. One popular fuzzy technique involves using fuzzy c-means(FCM) for image segmentation [2] .The neural network approaches have been introduced in which relay on a neural network architecture for image segmentation, also the hybrid of neural network with fuzzy used in image segmentation[3][4]. In this paper produced fuzzy clustering by using neural network for image segmentation using mean features .Clustering is an unsupervised image segmentation method .A clustering method is used to group the point in the characteristic features space into clusters, these clusters are then mapped back to the original spatial domain to produce a segmentation of an image .The characteristic features that are commonly used in image segmentation by clustering not only include gray values(pixels),it may include any features helpful to this segmentation problem. We do not have training samples, and some cases we do not know the exact number of classes .also there are two main approaches to clustering which is crisp clustering and fuzzy clustering techniques. In this work we applied fuzzy kohonen clustering network for color image segmentation.

2. Fuzzy Kohonen Clustering Networks (FKCN)

Bezdek ,Pal and Taso [5] considered this approach. , they extended the ideas of FCM and Kohonen neural network to a new family of algorithms called Fuzzy Kohonen Clustering Network (FKCN). The

Kohonen Clustering Network (KCN) clustering is closely related to the Fuzzy c-Means (FCM) algorithms. Since Fuzzy c-Means algorithms are optimization procedure because the objective function is approximately minimized. The integration of FCM and KCN is one way to address several problems of KCN. They combine the ideas of fuzzy membership values for learning rates, the parallelism of Fuzzy c-Means, and update rules of KCN. FKCN is self-organizing algorithm, since the “size” of the updated neighborhood is automatically adjusted during learning, and FKN usually terminates in such a way of minimized objective function of FCM.

3. Fuzzy Kohonen Clustering Network Algorithm

The algorithm of FKCN is summarized as following [6],[7]:

Step1: Given sample space $X = \{x_1, x_2, x_3, \dots, x_n\}$ distance $\| \cdot \|$ cluster c and error threshold $\varepsilon > 0$.

Step2: 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 $\{\alpha_{ij}\}$.

$$u_{ij} = \frac{1}{\sum_{k=1}^c \left(\frac{\|X_i - v_i\|}{\|X_j - v_k\|} \right)^{\frac{1}{m_i-1}}} \quad (2)$$

$$\alpha_{ij}(t) = (u_{ij}(t))^{mt} \quad (3)$$

where $m_t = m_0 - t\delta m$, $\delta m = \frac{m_0 - 1}{t_{\max}}$

Step4: Update all the weight vectors

$$v_i(t) = v_i(t-1) + \frac{\sum_j^n \alpha_{ij}(x_j - v_i)}{\sum_{s=1}^n \alpha_{js}(t)} \quad (4)$$

Step5: Compute the function

$$E(t) = \|v(t) - v(t-1)\| \quad (5)$$

Step6: If $t+1 > t_{\max}$ or if $E(t) < \varepsilon$, and terminate the iteration ;otherwise ,return step3.

FKCN is the heuristic learning neural network .It can find the clusters center and partition the feature by distance, to overcome the problem of KCN for updating the non winner prototypes in the determination of learning rate.

4. Color Image Processing

Color images can be considered as a special case of multi-spectral images and any segmentation method for multi-spectral images can be applied to color image [8][9].

In this field of color image segmentation, Fuzzy Kohonen Clustering Network is often seen as an unsupervised classification of pixels. Generally, a prior knowledge of the image is not used during the clustering process. Pixel clustering in three dimensional color spaces on the basis of color similarity colors are dominating in the image, create dense clusters in the color space in a natural way.

5. Implementation of FKCN in Color Image Segmentation

The objective of experiments is to test the performance of the Kohonen Clustering Network in the color image segmentation

5.1. Experiment

In fig.1 (a) shows a color image of fruit. In fig.1.(b) shows results segmentation of FKCN with $c=6$ where c is the number of clusters, $\epsilon = 0.0001$, number of iteration =100 and the parameter $m=0.85$.

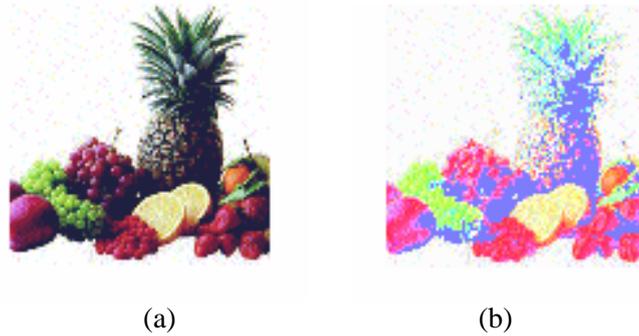


Figure .1. (a) original image (b) segmentation image

5.2. Experiment

Fig.2 (a) shows a color image of fish. Fig.2.(b) results segmentation of FKCN with $c=3$ where c is the number of clusters, $\epsilon = 0.0001$, number of iteration =100 and the parameter $m=0.85$.

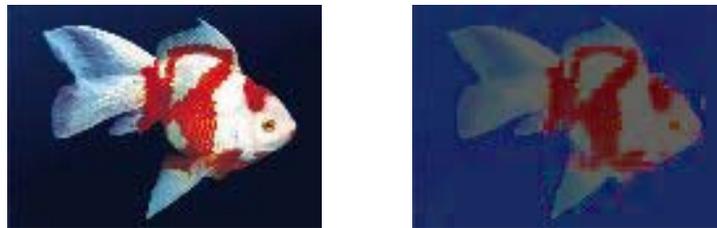


Figure 3.15 (a) original image (b) segmentation image

6. Simulation and conclusions

We summarize the conclusions of this chapter in two parts, the first part explains comments about general behavior of Fuzzy Kohonen Clustering Network and second part is related to the behavior of Fuzzy Kohonen Clustering Network in color images.

6.1. Comments on Fuzzy Kohonen Neural Network

1. There is no need to choose an update neighborhood.
2. Reduction of the learning coefficient with distance from the winner node is not required. Instead, reduction is done automatically and adaptively by the learning rule.
3. The learning process attempts to minimize a well-defined objective function(stepwise)

6.2. Comments on Color Image Segmentation

Another problem is how to choose the color representation each color representation has its advantages and disadvantage. There is no single color representation that can surpass others for segmenting all kinds of color images. From the experiments above, it is proved that FKCN have ability to segment the color image and the HSV is suitable for color representation.

7. References

- [1] Nikhil R. Pal, and Sankar K. Pal, "A Review on Image Segmentation Techniques," *Pattern Recognition*, Vol.26, No.9, pp.1277-1294, 1993.
- [2] Amine M .Bensaid, Lawrence O.Hal l,James C.Bezdek ,Laurence P.Clarke, Martin L.Silbiger,Jone A .Arrington and Reed F .Murtagh,Validity-Guided (Re) Clustering with Applications to Image Segmentation, "*IEEE*

Trans .Fuzzy Systems, Vol.4, No.2, May 1996.

- [3] L.O.Hall,A.M.Bensaid,L.P.Clarke,R.P.Velthuisen,M.S.Silbiger and J.C.Bezdek, “A Comparison of Neural Network and Fuzzy Clustering Techniques in Segmenting Magnetic Resonance Image of the Brain,”*IEEE Trans. neural networks*,Vol.3,Iss.5,pp.672-682,1992.
- [4] Bugao. Xu, and Sheng. Lin, “Automatic Color Identification in Printed Fabric Images by A Fuzzy Neural Network,”*AATCC.Review*,Vol .2,No .9,pp.42-45,2002.
- [5] Eric Chen-Kuo Tsao ,Jamec C.Bezdek and Nikhil R.Pal , “Fuzzy Kohonen Clustering Networks, Pattern Recognition,”Vol.27, No.5p.757-764 , 1994.
- [6] Hamdi ATMACA,Mehmet BULUT and Derya DEMIR, “ Histogram Based Fuzzy Kohonen Clustering Network for Image Segmentation,”*IEEE* 1996.
- [7] Dong Liu,Yinggan Tang and Xiping Guan, “ Texture Segmentation using Intensified Fuzzy Clustering Kohonen Network,” *Springer Berlin / Heid.* 2004.
- [8] Gan.G,Ma.C and Wu.J, “ Data Clustering Theory ,Algorithms ,and Applications”, pp5, *Libray of Congress Cataloging-in-Publication Data*,2007.
- [9] Petrou.M,Sevilla.P.G, “Image Processing Dealing With Texture”,*Jon Wiely &Sons Ltd*,2006.