Aerial images Segmentation by based on the segmentation methods fusion

Lec. Kalda A. Ahmed
Computer Sciences Dept./ College of Education/ Mustansriah University
Kalada_A_A@yahoo.con

Abstract:

In this paper, used two methods for image segmentation: fuzzy c-means and and to classify regions of aerial images based on the features they contain, namely the difference in shape and size.

The current algorithm was applied to aerial photographs, and at first the important areas were extracted from the images, then a preliminary optimization process was performed, and the next stage was to find the characteristics of these images. These features were introduced into fuzzy c-means algorithm and the artificial neural network, as well as the possibility of classifying regions after image segmentation, and the results gave high accuracy in segmentation and classification.

Keywords: artificial neural network, image segmentation, fuzzy c-means, classification.

تجزئة صور جوية معتمد الى دمج عدد من طرائق التجزئة

م. خالدة علي احمد
قسم علوم الحاسبات/ كلية التربية/ الجامعة المستنصرية

الخلاصـة

في هذا البحث، تم استخدام طريقتين لتجزئة الصورة: الوسيلة fuzzy c–means وتصنيف مناطق الصور الجوية بناءً على الميزات التي تحتويها، وهي الاختلاف في الشكل والحجم. تم تطبيق الخوارزمية الحالية على الصور الجوية، وفي البداية تم استخراج المناطق المهمة من الصور، ثم تم إجراء عملية التحسين الأولية، وكانت المرحلة التالية هي العثور على خصائص هذه الصور. تم إدخال هذه الميزات في خوارزمية c الضبابية والشبكة العصبية الاصطناعية، وإمكانية تصنيف المناطق بعد تجزئة الصورة، وأعطت النتائج دقة عالية في التجزئة والتصنيف.

الكلمات المفتاحية: الشبكة العصبية الاصطناعية، تجزئة الصورة، الوسيلة الغامضة، التصنيف.

1- Introduction:

The topic of neural network and digital image processing techniques plays an important role in many fields, as much software have been developed to obtain accurate image analysis to give information about images in the service of science and technology…etc.

1-1 Why Image segmentation?

Image processing, or more precisely, digital image processing, is the act of utilizing a set of algorithms for processing digital images. It ranges from simple tasks such as noise reduction to more common tasks such as identifying individuals, text objects, and so on, to more complex tasks such as emotion detection, image classification, anomaly detection, segmentation, and so on. Digital Image Processing utilizing Neural Networks (NNs) has been increasingly significant recently as AI algorithms and its ecosystem have grown in popularity. Banks, security, agricultural, military, manufacturing, law enforcement, and medical are just a few of the domains where it can be used. [1]

Digital images are made up of different components which must be "analyzed," for lack of a better term, and the "analysis" done on these components might disclose a lot of hidden information. Also, this data can assist in solving a variety of business problems, which is one of the numerous end goals associated with image processing. Image segmentation can be defined as a method of partitioning digital images into separate sub-groups (of pixels) known as image objects, with the goal of reducing the image's complexity and making analysis easier. Many image segmentation approaches are used for grouping and separating a specified set of pixels from an image. We are in fact assigning labels to pixels this way, and pixels with identical names are grouped together since they have something in common. With the help of labels, we may set limits, draw lines, and distinguish the most important objects in an image from the rest less relevant ones. In the example below, we are attempting to get the primary components, like chair, table, etc., from a main image on the left, and as a result, all of the chairs are colored uniformly. We discovered instances in the next tab, dealing with different objects; therefore, all chairs were of different colors. This is the way that many systems of image segmentation work in varying the complexity degrees and provide a variety of outcomes [2].

The split of an image to categories or regions that correspond to various objects or parts of the objects is known as image segmentation. Each one of the image pixels is classified into one of such categories. A decent segmentation consists of the following elements:

• The greyscale of multivariate values of pixels in the same category are comparable, forming a connected region,

• The values of neighboring pixels in many categories are varied. Each cross-sectional fibre, for instance, may be considered as a different object in the muscle fibres image, and effective segmentation might result in a separate set of pixels corresponding to each fibre. Comparably, each one of the fields in the SAR image may be considered a separate category. [3]

The point at which we move from considering each one of the pixels as a unit of observation to working with objects (or sections of objects) in the image, made of several pixels, is known as segmentation. In the case when segmentation is done correctly, the rest of the image analysis process becomes much easier. However, as we will show, when using automatic segmentation techniques, success is typically only partial. Manual intervention, on the other hand, can generally solve such problems, and by this point, the computer must have completed the majority of the task. The following is how this chapter fits within the book's overall structure. Furthermore, segmentation algorithms can be used to images as they were originally recorded, or after modifications and filters have been applied.

2- Artificial Neural Networks:

They are computational methods that use vast processing distributed in parallel and made up of small processing units for simulating how the human brain does a certain activity. Those units are nothing more than computational elements known as (Nodes Neurons), which have a neurological characteristic in that they store the empirical information and practical knowledge and make it available to users through a user (Adjust the weights). As a result, NNs are comparable to the human brain in that they acquire knowledge through training and retain it with the use of synaptic weights, which are connections between neurons. There is

also a neural biological similarity, which allows biologists to use NNs to better comprehend the evolution of biological processes. [4]

Here we can see that the normal neuron consists of main parts:

1. Dendrites: They are the branches of the nerve cell that carry the nerve impulses and they are sensors that pick up nerve signals from other nerve cells.
2. Cell body: It is based on collecting the received signals through the appendages that are used in comparison.
3. Axon: The part that decides to send a signal to the cells following the current cell.

Here, computer and engineering scientists have proposed building a system that simulates the process in a natural nerve cell, as shown in Figure (1), which also describes the human nerve cell. [5]

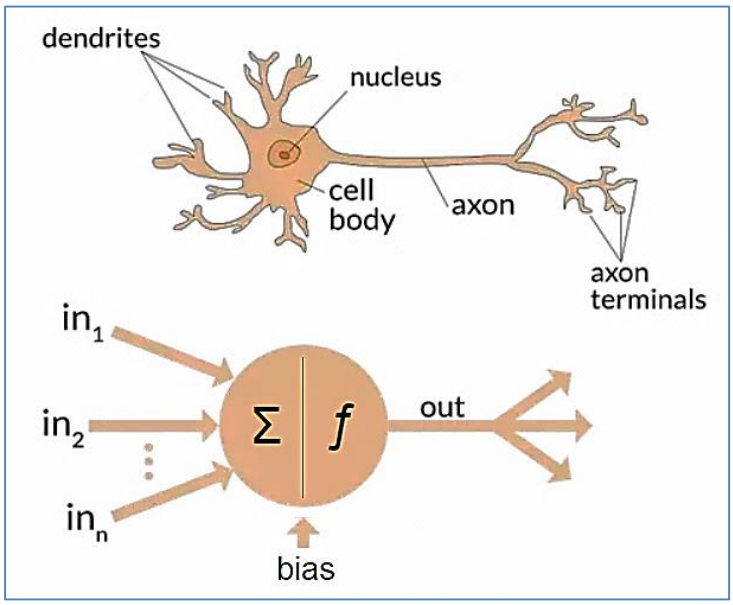


Figure (1) Simulating a natural neuron [6]

From Figure (1), we find that it consists of: [12]

- Input vector represented by X((X1,X2,X3,...,Xn). We can imagine that it represents the dendrites of the cell, i.e. the set of input signals to the cell. It is either (1), meaning there is no signal, or (0) meaning there is no signal.

-Weights is represented by W ((W1, W2, W3... Wn) and represents the weight degree of the input signal. For example, we can give the weight of the high temperature to be 48, the weight of the low temperature 5, and the normal temperature 25.

- Neuron, which is the basic unit in building artificial neural networks. or Processing Element and this element is divided into:

a- Adder to collect signals in weighted income.

b- Activation Function

c- Output.

Each neural network is trained using a backpropagation algorithm called a backpropagation neural network. Backpropagation neural network is a very familiar model in neural networks. It is the most widely used architecture in neural networks, and the main reason for this is that

it is easy to implement, as the networks used for the backpropagation algorithm learn complex multi-dimensional schemas more easily than they use other algorithms. Many applications can be formulated using a backpropagation network as it has a model for most multi-layer neural networks. Hence, we can say that the most commonly used training method in multi-layer neural networks is the back propagation algorithm, and it has been successfully tested for different types of tasks. Although the network does not include feedback links, errors are propagated backwards throughout the training process. The errors in the output layer define error measures in the hidden layer, which are used as a bias to adjust the link weights between input and hidden layers. Each iteration processing involves modifying at least two sets of the weights between a pair of the layers and rotating the output, and this processing continues until errors fall below a level of tolerance [6].

3- Fuzzy C-means clustering

Fuzzy clustering (also known as soft k-means) is a type of clustering where each one of the data points can be allocated to many clusters. Clustering, also referred to as cluster analysis, is the act of grouping data points into clusters with the goal of keeping things in the same cluster as similar as possible while keeping things in other clusters as different as possible. Clusters are characterized using similarity metrics. Similarity measures include distance, intensity and connectivity. Many measures of similarity might be used depending on the data or the application. [7]

Any point x has a group of the coefficients that give the degree of being in k-th cluster wk(x). With fuzzy c-means, the cluster centroid represents the average value of all the points, which are weighted by their degree of belonging to that cluster, or, mathematically according to the following equation:

$$c_k = \frac{\sum_x w_k(x)^m x}{\sum_x w_k(x)^m} \quad \dots (١)$$

In which m refer to the hyper-parameter which is used to control the way that the fuzzy cluster is going to be. The higher it is, the fuzzier the cluster will ultimately be.

The FCM algorithm attempts at partitioning a finite group of n{\displaystyle n} elements $X = \{\mathbf{x}_1, \ldots, \mathbf{x}_n\}$ to a set of c fuzzy clusters based on a given criterion.

Given a finite set of data, the algorithm returns a list of c{\displaystyle c} cluster centers $C = \{\mathbf{c}_1, \ldots, \mathbf{c}_c\}$ and a partition matrix $W = w_{i,j} \in [0,1],\ i = 1, \ldots, n,\ j = 1, \ldots, c$, where every one of the elements, {\displaystyle w_{ij}}wi,j , tells the degree to which an element, {\displaystyle \mathbf{x} _{i}}xi, belongs to a cluster cj {\displaystyle \mathbf{c} _{j}}.

The goal of the FCM is minimizing an objective function: [8]

$$\arg\min_C \sum_{i=1}^{n} \sum_{j=1}^{c} w_{ij}^m \|\mathbf{x}_i - \mathbf{c}_j\|^2 \quad \dots (٢)$$

Where:

$$w_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|} \right)^{\frac{2}{m-1}}} \quad \dots (3)$$

4- Statistical Operations:

There are a number of statistical measures that were used in the current study: [9]

- Signal –to-Noise Ratio (SNR): It is a measure of the relative power of the signal part or the desired and unwanted signal noise. It is usually expressed (SNR) in Signal Processing in decibels (dB) as the ratio (Signal Power) to (Noise Power) and it is expressed by the following equation:

$$\text{SNR} = ١٠ * \log_{١٠} \frac{\sum_{i=١}^{M} \sum_{j=١}^{N} [x(i,j)]^{٢}}{\sum_{i=١}^{M} \sum_{j=١}^{N} [x(i,j) - y(i,j)]^{٢}} \dots (٤)$$

- Peak Signal –to- Noise Ratio (PSNR): It is a statistical measure that represents ratio between maximal possible power of the signal and power of distorted noise entered by pressure, meaning that it measures the accuracy of the image. (PSNR) is measured in a unit called (decibel) and it is symbolized by (dB), as the ideal values for it range between (30-50 dB), and the largest value of (PSNR) indicates that the image has Better Quality and it is calculated from the following equation.

$$PSNR = 10 * \log\left(\frac{(L-1)^2}{MSE} \right) \dots (5)$$

where L is the number of gray levels and it ranges between (0-255).

-Root Mean Square Error (RMSE): It is the square root of the mean square error (MSE) between the original images x(i,j) and the improved y(i,j), as the minimal value of (RMSE) indicates that the image has Better Quality) and it is calculated from the following equation.

$$RMSE = \sqrt{\frac{1}{MN} \sum_{i=1}^{N} \sum_{j=1}^{M} [x(i,j) - y(i,j)]^2} \quad \dots (6)$$

5- Digital image acquisition:

-Satellite Images and Aerial Photographs

Space and aerial images provide a thorough record regarding the ground features. An image interpreter analyses the images and, in some cases, other supporting information like reports of filed observations and maps, in a systematic manner. On the basis of this research, an interpretation related to the object's physical nature and phenomena shown in the images is created. Interpretation takes place at many complexity levels, ranging from basic object's recognition on the surface of the earth to extraction of precise information about complex interactions between sub-surface characteristics and earth surface. Throughout the classification of features on improved satellite imagery, a systematic work of space and aerial images typically includes many major properties of the features that are displayed on an image, such as tone/color, pattern, texture, shape, and size, which aid in interpretation or

recognition of different features on improved satellite imagery. During interpretation of satellite images, a preliminary image classification key for fused pictorial data has been created and utilized for analyzing land use/land cover patterns to the extent possible. In addition, preliminary interpretation related to satellite imagery is done with the use of the image interpretation key through moving features from the base map to transparency. The satellite imagery is after that overlaid with such transparency with baseline data characteristics. Thematic aspects are after that retrieved from the satellite pictorial data and delivered. Visual image interpretation is the term for such type of interpretation. Digital image analysis or digital image processing approaches are used to apply the same analysis to a digital image of remotely sensed data using image processing software. The process of interpretation will be automated; with today's modern digital computers, each of such two ways has its own set of benefits and drawbacks. This is beyond the scope of work book to explain. [10, 11]

Google™ Earth

The aerial image acquisition of GoogleTM Earth. By software of GoogleTM Earth is given and download many images from the weather. Where aerial images many cities, buildings, terrain and pleases are available, many color images is used in study, show in Figure (2) from GoogleTM Earth.

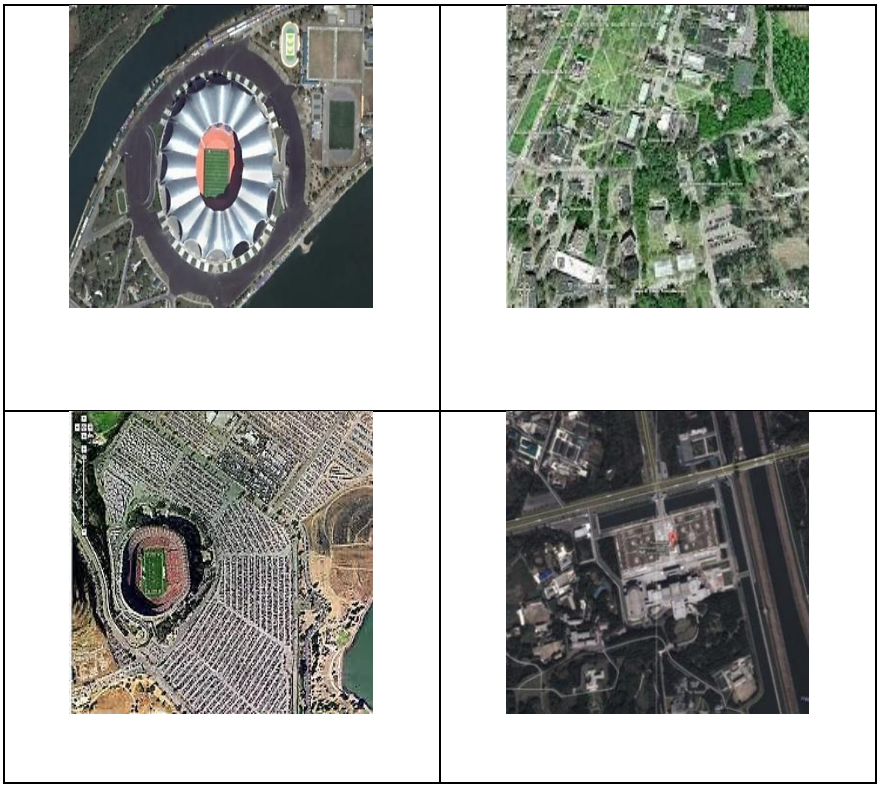


Figure (2) Simulating a natural neuron

6- Working algorithm:

Aerial images are divided by morphological processes such as Thresholding, Erosion and Dilation. It is utilized to maintain shape and size characteristics [14]. The features are then obtained from the segmented images with the use of study algorithms. Then the artificial neural network is used to classify the crystals more efficiently in order to distinguish the study images, as in Figure (2).

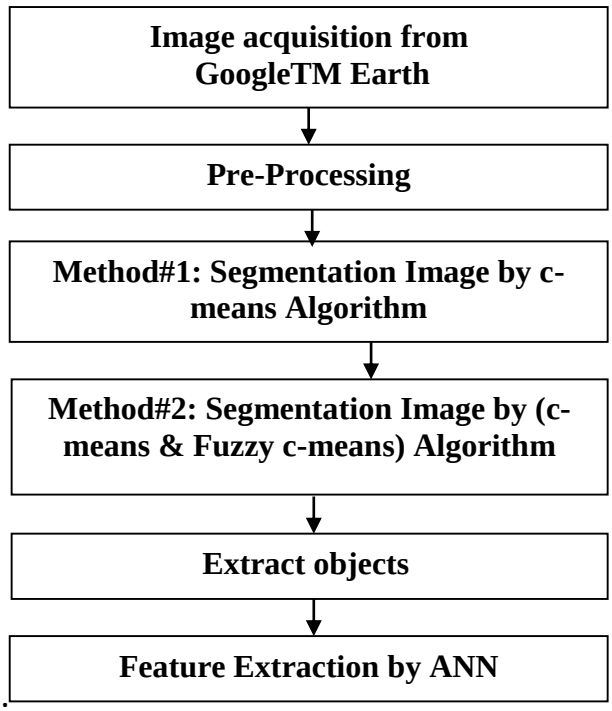
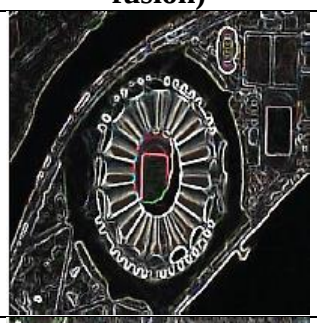
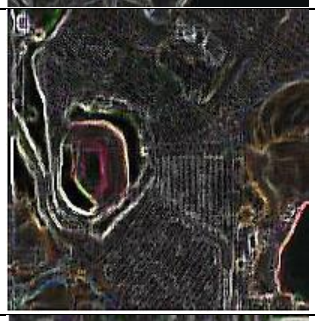
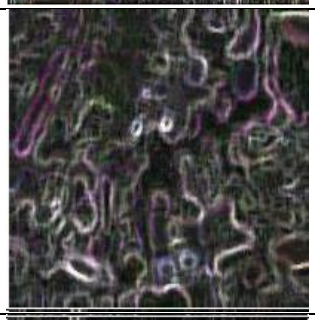
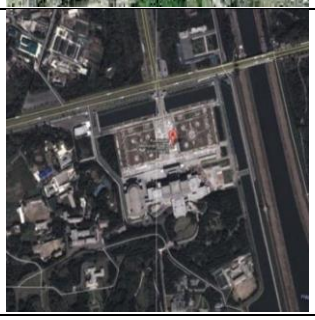
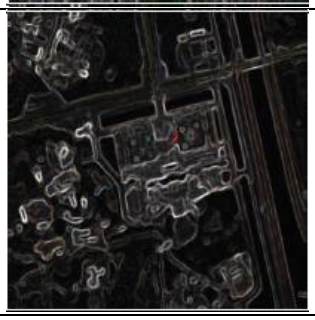
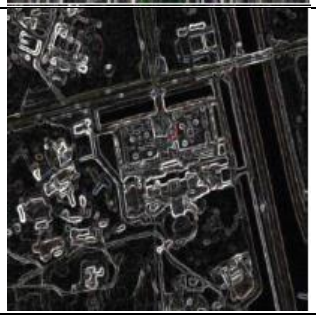


Figure (2) Simulating a natural neuron

7. Results

Matlab 2016a using done Image Processing Toolbox and software. To imitate a real-world situation, we set all of the images' parameters to the same value. Our approach is fully non-parametric for users in this sense. We also evaluated processing speeds for two distinct ways for evaluating the suggested procedure. Table 1 summarizes the findings.

Table 1: The results of image segmentation

Images	Method#1	Method#2 (methods fusion)
		
		
		
		

Tables (2) The results of applying the statistical operations of image segmentation

No.	time		SNR		PSNR		RMSE	
	#1	#2	#1	#2	#1	#2	#1	#2
1	45 s	40 s	42.14	44.56	21.87	42.91	1.90	1.99
2	23 s	20 s	33.14	34.64	29.23	30.78	1.10	1.16
3	51 s	45 s	41.32	43.19	33.91	35.64	1.22	1.31
4	30 s	22 s	50.35	52.20	21.87	25.40	1.01	1.81

5. Conclusion

We describe a unique two-stage segmentation method for detecting artificial materials and objects in non-urban environment for use in search and rescue missions in this research.

This study; showed when use ANN method with Fuzzy c-means and application with aerial image was given a high results and features.

References

١. Farhana Sultana, Abu Sufian, Paramartha Dutta, Evolution of Image Segmentation using Deep Convolutional Neural Network: A Survey. University of Gour Banga, Dept., Visva-Bharati University. 29 May 2020

٢. Richard Nagyfi, The differences between Artificial and Biological Neural Networks, Sep 4, 2018. https://towardsdatascience.com.

٣. Ziad M. Abood, Benign and Malignant of Breast Tumors Classification by Backpropagation Neural networks, Iraqi Journal of Information Technology, vol. 6, no. 2, 2014.

٤. Salim J. Attia, Ziad M. Abood, Ibrahim R. Agool, Detection of malignant Cases by Segmentation of Cells in Medical Images and Applying Fuzzy Logic Technique, Journal of Thi-Qar Science, vol. 4, no. 4, 2013.

٥. M. A. Mediani, "Image Segmentation simulated Annealing", Univ. of Technology, 003-M697I, 2002.

٦. Kinnebrack, W., “Neural Networks Fundamentals Applications, Examples”, Galgotia Publications; 1995.

٧. D. Patterson, "Artificial Neural Networks”, Singapore: prentice Hall; 1996.

٨. James C. Bezdek, Robert Ehrlich, William Full FCM-the Fuzzy C-Means clustering algorithm, December 1984, Computers & Geosciences 10(2-3):191-203 10.1016/0098-3004(84)90020-7.

٩. Ghada S. Karam, Ziad M. Abood, Muntaha Abood Jassim, Thermal image segmentation based on density slicing of color histogram of images, American Academic & Scholarly Research Journal, vol. 7, no. 4, 2015.

١٠. M. Balakrishna Reddy, Baiantimon Blah, Topographic normalization of satellite imagery for image classification in northeast India, Progress in Physical Geography 33(6):815-836 November 2009. doi:10.1177/0309133309351048.

١١. Ziad M Abood, Rafal Naser Salah, Haeder Raad Hamed, Iris Eye Segmentation and by multiple FCM International Journal of Engineering Research and Development. vol. 5, no. 5, May 2014.