J. Basic. Appl. Sci. Res., 3(4)859-865, 2013
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ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Artificial Neural Network-Based Microfossil Recognition System, a Case Study on Miocene Sample in Harsin Area West of Iran[1]

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ABSTRACT

In this investigation, a noble and intelligent strategy has been delivered to recognize microfossils using Image processing technique and Neural Networks. It was done in such a way that after receiving photomicrograph sample of microfossil from Microscopic thin section (profile), the system processes and corresponds it with the sample pattern which has been instructed before. Thus, considering the information instructed to it, its output is worth studying using a complete identification of Taxon. On the other hand, The distribution of microfossil is displayed in numerical form on computer desktop. This study test a new technique for recognize microfossils on Miocene sample in Harsin area, west of Iran.
This innovation is a noble and intelligent strategy with learning potential in quick recognition and classification of microfossils that are of great importance in oil industry and universities considering its economic importance in searching for sedimentary minerals and especially in oil and gas reservoirs.
KEYWORDS: Microfossils, Photomicrograph, Image Processing, Neural Networks, and Microscope.

1. INTRODUCTION

As the Microscopic study of sedimentary deposits and microfossils increase on a daily basis, present plan considering the economic importance of microfossil identification in research and exploration of hydrocarbon reservoir, is one of the most useful and applied ideas toward increasing quality, accuracy, and the speed of exploration operation in the gas and oil industry that could be provided in higher education centers for the students and investigators in the geology domain at a large scale (Sempa ,1976). Nowadays, the Micropaleontology science does not have a definite boundary and is very widespread and oil exploration companies and universities have priori zed investigation in the field of Micropaleontology which forms quantitatively the greatest section of the paleontology background.

It is necessary to mention that this innovation is an intelligent system that in the field of microfossil recognition is of no limitation and has learning potential. The exploration operation rate in study and administrative phase of investigative projects could be considerably increased using it, on the other hand, it allows the designers to focus on the quality, scrutinize, and complete the results of the study along with high rate, accuracy, quality on the basis of the latest scientific methods of the day in the form of a software or through delivering service as a data base. Thin section Images of Miocene sample in Harsin area, west of Iran can be successfully model data base to test a new technique for microfossil recognition.

In addition to above characteristics, geology students and other graduates can also use it for instruction and increase their own knowledge.

2. Description of microfossils, the method of image processing and artificial Neural networks :

Description of microfossils, the method of image processing and artificial neural networks:

Microfossil refers to the mineralized remains of animals or mono-cellular or multi-cellular plants that have lain in sedimentary rock layers microfossils are of great importance to oil exploration. Investigations can recognize the probability of oil existence in a layer through studying microfossils available in small specimens of rock brought up using drilling equipment.

Micropaleontology science focuses on the study of microfossils. Because of the small size of microfossils, we have used Microscopes to observe them. The wall of most microfossils is made of aragonite, calcite, and silica or organic materials (Cushman, J. A, 1959). The section of rock containing microfossils is very important in the study and recognition of microfossils. Distribution rate of a type of fossil and the number of different types of organisms in a single type of rock, contributes a lot in

1. This paper is extracted from a research project at the University of Payam Noor.[1]

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recognition of the environment and the method of subsistence of living organisms (Jonkins , D.G & Murray , J.W , 2008).

Image processing is nowadays referred mostly to digital Image processing which is a branch of computer science. Image processing deals with digital processing that represents Photographs taken by digital camera or photographs developed by developer.

Image processing has two important aspects 1- Image improvement and 2- the machine video.

Image improvement consists of methods such as using obliterating filters and increasing contrast to improve visual quality of images and to be assured of their correct display in the target environment like computer printer or monitor, while machine audio reacts to methods through which we can perceive the meaning and content of images and use them in jobs like robotic ones or Image axis.

Image processing in its specific meaning refers to any kind of signal processing which is the input of the Image. Image processing output could be an instruction or a series of specific signs or variables related to image. Image Processing techniques consist of dealing with image as a two-dimensional signal and applying standard techniques for processing signals.

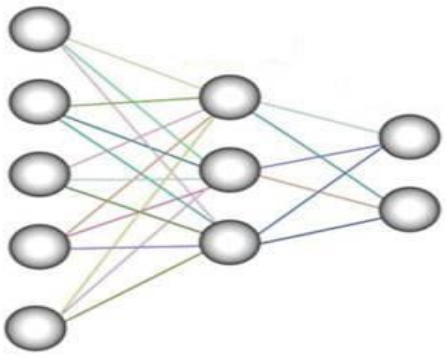
Neural networks also process information as human brain does. Human brain has been made up of neural cells called Neuron,that send to each other.

Every neuron consists of some axons and dendrites. Axons play the role of output and dendrites play the role of input. Neurons require a certain amount of signal power for activation when neurons are activated. They send electrical signals to other ones .The more the number of active neurons, the stronger the relations between axons and dendrites.(Fu, L. (1992):214)

Artificial neural networks are a combination of artificial neurons that operate the same as human brain neurons. They receive many inputs with different volumes and produce one output which is dependent on the inputs.

Neural networks are of extended use in the recognition of patterns because they also have the capacity to respond to unexpected inputs. If a pattern is received during administration, neurons learn how to recognize specific different patterns .If a pattern is accepted while during administration. The input is not related to output, based on information learned previously, the neurons select the output pattern that is similar to the pattern and is of the least difference with the input.(Kalantari , A . (2008):87)

As you observe below the figure, neurons are located in several layers, the first layer, that is, input layer, receives the incoming information and sends the incoming signal to the next layer depending on the relation power with each neuron in the next layer. The relation power of each neuron with other neurons is referred to as the weight of the neuron. The number of neurons in each layer depends on the weight and on the number of neurons in previous layer. In the end, the neural network consists of output layer. Neural networks operate the same function, that is, they receive as many inputs as incoming neurons and sends them as many out puts as out going neurons.



Incoming layer middle layer exit layer

Fig.1: Process cycle

The neural network function that you see on previous page is as following: F(XL, X2, X3, X4, X5) =y1.y2

- In order to know how the neural network in this example operates, we send this function 100 examples with answers. We conduct Back propagating operation each time.

Back propagating operation is an operation during which we change the weight of neurons in such away that the network answers become close to answers that we expected.

In fact, we make a function with out knowing its equation and we have only some answers to the equation.

Receiving information and conducting neural network propagating operation is called instruction or training stage. In summary, every neuron that we have designed from neural network, at the beginning and prior to training, has a random weight. After neural network instruction and training along with desired responses, it is ready to respond to the questions.(Cushman , J . A.(1959):154)

Different stages of recognition and introducing through intelligent software are as follows:

1- Receiving Image from the camera installed on Microscope
2- Extraction of the area consisting microfossils from Image received.
3- Recognition of microfossils using neural network
4- Calculation of fossil distribution in Microscope profile
5- Representation of microfossil information and distribution.

3. The Intelligent system method of operation

At first it is necessary to mention that the above mentioned system designing base has been conducted by mat Lab software.

Through installing a digital camera on Microscope which is nowadays completely common and is conducted with different methods and qualities . The capacity for digital imaging and transferring the digital image to computer is provided.

Then the Photomicrograph software received from Microscope camera with dimensions (M+N) pixels after making it more efficient, converts it to "Gray" type.

A typical efficient image converted to "Gray" from the original image.

A typical efficient image converted to "Gray" from the original image.

Fig.2 : A typical received image. of the camera microscope.

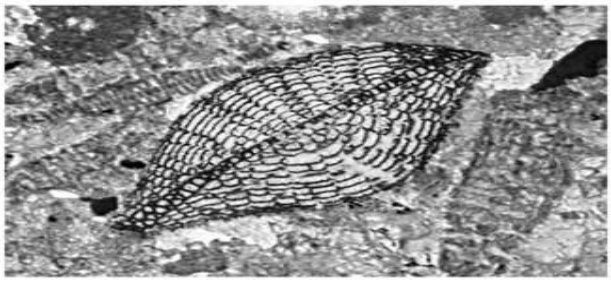


Fig.3 : A typical efficient image converted to "Gray" from the original image.

In order to access to microfossil environment (perimeter of microfossils), we differentiate the output of efficient making stage of the image. The selected differential is of "sobel" type, because in spite of "canny" differential, it is of less complexity and is conducted faster.

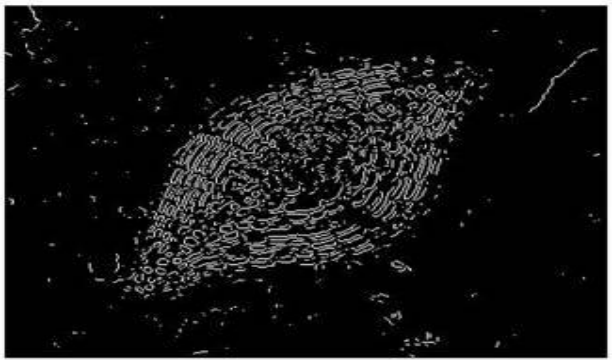


Fig.4 : A typical binary image with "sobel" differential.

In continuation toward more connection, those lines(the edge of microfossils). The out put of differentiation stage of "sobel" is expanded in the form of star.

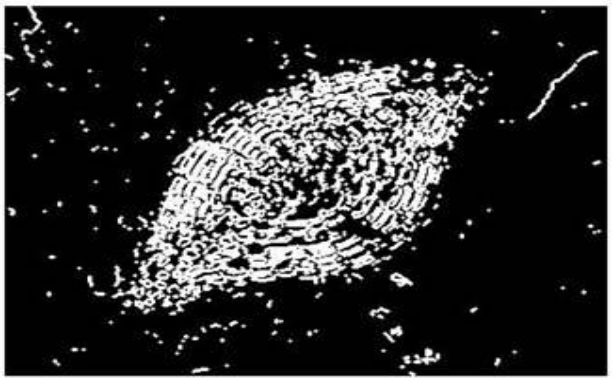


Fig.5 : A typical expanded binary image.

After expanding the image, the lines approach come closer to each other more. In this case they can fill the closed environments available in microfossils.

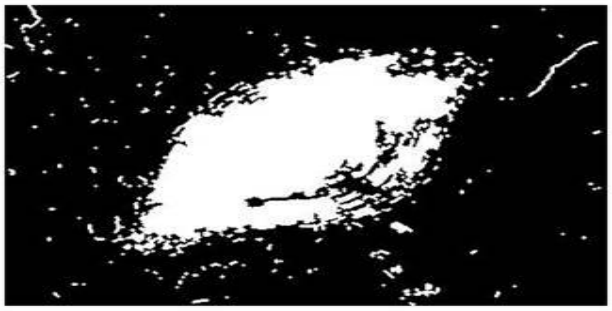


Fig.6 : A typical binary image of fossils along with filled holes

Then we assign numbers to the environments that have been filled and connected to each other, among the numbered objects with following conditions are the microfossils available in the picture.

1- To have an area of at least more than 10,000 (in pixels unit)

2- To have the ratio of white blanks to black ones at least more than 82 percent

Now through having the coordinates as dimensions of given microfossils, the system separates them from the rest of the image.

Fig.7 : A typical binary image from the coordinates of microfossil

In regard with separating microfossils in case that in thin Microscope profile, the number of samples is greater than one, to recognize and calculate the distribution rate of each group , the samples should be separated.

To separate microfossils from previous stage binary images, first the binary image and its drawing is obtained through adding matrix columns. (Fu, L. (1992):375)

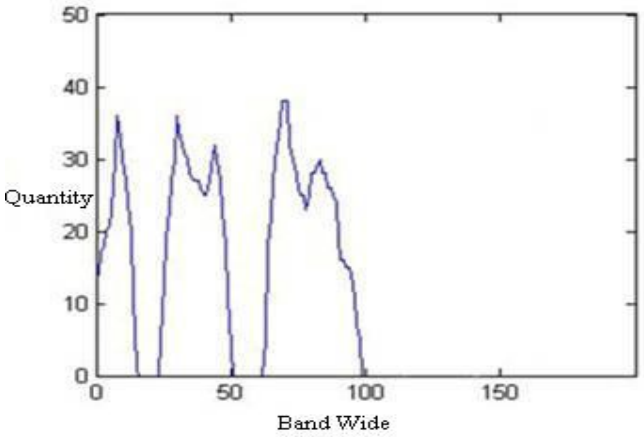


Fig.9 : Quantity and band wide graph

In order to recognize each microfossil, the processor starts on the left and moves right.

In this case, if the drawn amount is greater than assigned amount, It increases the primary amount to start the operation and repeats it, whereas, if the drawn amount is smaller or equal to predetermined amount, these two points represent the beginning and ending microfossils, first from left, for other microfossils also the system continues the operation in this way.

In the end, to prepare incoming images of typical microfossil to Neural Networks , it separates the separated image in Taxon separating stage from Photomicrograph received and then converts the obtained images at first to "Gray" and then to binary.

Fig.10 : A typical image of the area extracted from the original image

Fig11 : A typical "Gray" image from extracted area

Fig.12 : A typical binary image from the extracted area

Through determining axis angle of given samples with horizontal axis, we rotate the extracted binary image the same amount, but in opposite direction.

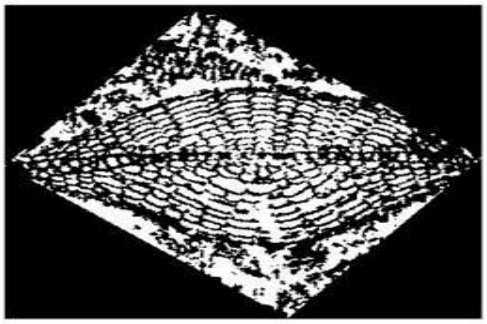


Fig.13 : A typical micro fossil image with horizontal angle

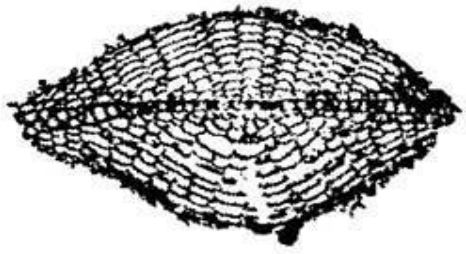


Fig.14 : A typical binary image ready to enter Neural Networks

4- Recognition of microfossils using Neural Networks

The entrance of this section consists of the image of all separated microfossils that have been prepared in previous stage. These images are delivered to Neural Networks through an algorithm and then the neural system compares the picture with other pictures that have been saved in its data base during instruction , and after conducting internal searching algorithm, approximation and decision making, it announces the highest probability as to which image it is the closest, as the out put.

In case of lacking the capability to recognize the microfossil by the system, the program is transferred to instruction section and it receives the information related to given microfossil and adds it to its data base.

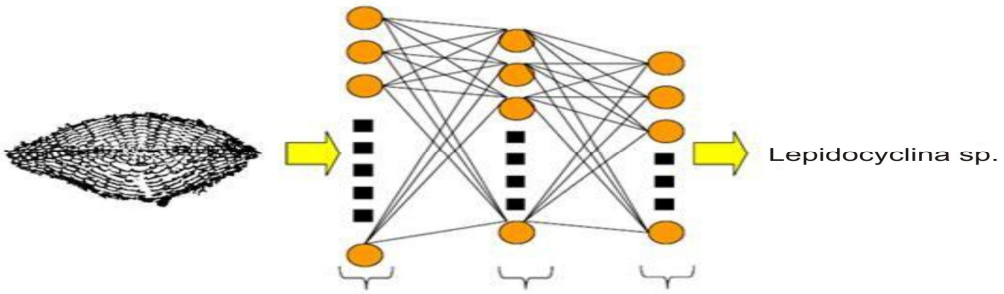


Fig.15 : Final process cycle

After recognition of microfossil and computing distribution rate of each Taxon, the information related to specimens available on Microscopic profile, is displayed on computer desktop in numerical form, then the number and distribution of each Taxon is determined in such a way that similar fossils are classified and their number is studied and the result is delivered to determine the distribution of each Taxon.

It is necessary to mention that all the stages of microfossil recognition is conducted in only a few seconds.

4. RESULTS

Among the results and achievements of this investigation, is the production of an intelligent tool that is used as very exact software for recognizing and classifying the groups material or type of microfossils with high speed, care and quality. In addition, this software has other capabilities such as: computing the distribution rate of a type of fossil in Microscopic profile, having instructional potential on microfossils , the possibility of scrutinizing and completing the software data by the experts in Micropaleontology science, storing information and the images of microfossils in data base in a regular and classified form, changing the angle of given axis with horizontal axis for the purpose of inserting images in scientific texts. Helping in research and exploration of sediment minerals, particular, in oil industry and instruction and investigation centers. Miocene sample in Harsin area, west of Iran show that Artificial Neural Network-based Microfossil Recognition System is successfully model for microfossil recognition.

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