IJBPAS, February, 2015, 4(2): 386-400

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

DIAGNOSING JOINT INJURY IN ATHLETES USING NEURAL NETWORKS

BEHROOZABDOLI[1], ABDULLAH SHAMISA[2], MONA TEIMOORY[1]

1: Shahab Danesh Institute of Higher Education

2: Khatam Institute of Higher Education

***Corresponding Author: E Mail: Sport_karate2009@yahoo.com**

ABSTRACT

Currently, the doctors face a huge mass of ever-increasing information and findings in various medical branches which sometimes confuse them and make the interpretation of clinical findings problematic. The aim to this research is diagnosis of joint injury in athletes by neural network. So, a scheme has been presented to diagnose orthopedic diseases using artificial neural network technique. This research was used and studied on diagnosis process and ANN structure which have been proposed for work. In the present research, the library method and a questionnaire have been used to collect data. The purpose of this research is to propose an efficient technique for improving the noise reduction process in radiography images which are used for osteoarthritis diagnosis. Thus, the filters are selected based on Perceptron neural network. An appropriate filer has been used in order to facilitate random signals with small spectrum. The best results were achieved at the time of feature extraction from 8*8 blocks with two stages of wavelet transformation (the first method in feature extraction section). Moreover, the speed of algorithm implementation was higher than other stages.

Keywords: Artificial Intelligence, Human Intelligence, Neural Network, Robotic, Osteoarthritis

INTRODUCTION

One of the most important and reliable techniques for disease diagnosis is clinical approach. But the medicine science will achieve more success if it can combine the clinical and experience-based methods with robust tools of information and

communication technology (ICT). In modern medicine world, the data for different patients' symptoms and the results of auxiliary techniques to diagnose these diseases are such comprehensive that analyzing and considering all effective factors seem difficult **(Bae, S-C, Lee E-o, Song R, 2003)**.

So, prognosis of people's disease status is of high importance and timely prognosis prevents the small complications from changing to severe injury and long-lasting problems. Meanwhile, one of the problems doctors are currently facing is weakness in joint injury diagnosis in its primary stages. Joint problems may remain hidden long before emerging as a complete damage and becoming a disabling pain for life. Joint injury finally leads to osteoarthritis development **(Ramana, K.V., Basha, K., 2004)**.

Therefore, the research purpose is to present the artificial neural network and its function in medicine, because it is a more robust technique in comparison with current methods and holds the minimum error rate and maximum reliability in athlete's joint injury diagnosis.

All joint injuries finally lead to arthritis. Unfortunately, arthritis has no definite treatment now. The cure methods are known to be able to prevent it from deterioration, and in the primary stages, can improve it to a limited extent. In the course of arthritis, the ligaments and knee meniscus may suffer damages, but the most serious injury is osteoarthritis. Arthritis is the escalating destruction of joint cartilage which results in cartilage destroying. In this situation, the bones start to move over one another. The joint structure is so complicated and includes cartilage bone and all parts of joint such as synovial membrane, joint capsule, etc. the joint injury will affect the entire structure, resulting in osteoarthritis extension. The excessive pressure on injured joint causes cartilage destruction, bone abrasion in the joint and its deformation. In joint injuries, symptoms which reduce the athlete's strength during the game and may or may not be painful should be examined by orthopedic doctor. So, an orthopedic surgeon will examine the ones with joint injury, while timely diagnosis and treating this disease is the key point to control it **(Hinman *et al*, 2002)**.

Thus, an auxiliary system for discovering the existing pattern and predicting the future events seems mandatory. "Artificial neural networks" is one of the most novel and effective possibilities. Benefitting medicine science from intelligent tools in diagnosis and

treatment of diseases can contribute to timely diagnosis and error rate reduction which in turn prevents physical and financial loss. So, taking feasible and practical approaches in neural network field and other mathematical models helps the doctors to access computer programming information, and increases their interest in mathematical principles and performance, especially in neural networks **(Fatahian, 2009)**.

The application of decision making support system as a solution for medical diagnosis and providing treatment services in recent years is a significant field of research. In all the researches conducted on this subject, promotion of medical support system in which neural network is used is known as an effective method for diagnosing the disease. In fact, one of the most important functions of medical informatics is implementing and using the decision making system for predicting and medical diagnosis, based on some symptoms. Moreover, decision making support system assists medical specialist to make effective laboratory test and curing the diseases **(Saghiri, 2012)**.

So, promoting the science bases using artificial neural network technology has a positive effect on prognosis and diagnosis of the disease. Therefore, due to its dynamic nature and learning capability, neural network can be reviewed and updated by obtaining information from patients. The efforts have been made to make this research useful for researchers of both fields of artificial intelligence and medicine. First, a description of neural network is given. Neural network applications in medicine are then discussed. Finally, the neural network function is studied athlete's joint injury diagnosis. We hope the present research generates relevant ideal for further works.

The main question of the research is: how one can diagnose the joint injury using neural network?

The disease diagnosis process done by the physician

Some stages should be passed in order to receive the physician's diagnosis. The disease precedent of the patient should be examined first. Then, the physician should analyze the history of disease using his/her background knowledge and state his/her diagnosis in the final step.

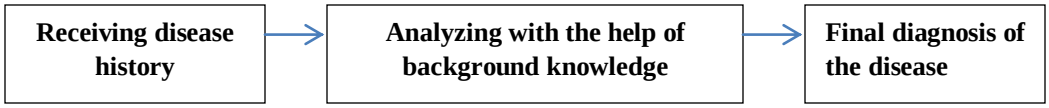


Figure 1: process of disease diagnosis by the physician

Test results and patient's disease background can be useful in diagnosis process which is not a simple task for a general physician. In some cases, if the disease symptoms exist in patient's body, physician is assured of the presence of the disease. But there are cases that disease symptoms cannot contribute to diagnosing. If the orthopedics specialist is not experienced or the symptoms are not visible, the probability of diagnosis error will be high.

In diagnosis process, orthopedics doctor gives a local examination and asks questions about the type of injury and the symptoms that patient has experienced. Also, X-rays can examine the swelling in injured joint. Today, various radiography devices can take digital images from different radiography devices and the images are widely used for treating and diagnosis of the diseases. The important function of X-rays is detecting changes or the progress of the disease to obtain complementary information about the image location **(Ghassabi, 2009)**.

In detection program, the higher the image quality, the more precise will be the joint injury detection. In order to enhance X-ray quality, several methods are used and applied on the image before any kind of processing. These methods are categorized in pre-processing stage. Simulated polarizing filter is a robust pre-processing technique which improves X-ray quality to a significant extent by increasing the contrast, reducing audio distortions and eliminating the shadows. In this method, by simulation of a sample polarizing filter, the elimination of light re-radiation from the impact point which can be due to oily substances, reducing the audio distortion, eliminating the adverse effect of hair presence in the image and also reducing the shadows in the final image are considered. The important point is that classifying the rate of injury has a significant part in early diagnosis. In other words, determining the rate of injury progress and extracting the exact border between injury and the context is one of the primary and effective parameters in correct extraction of image features **(Shanbeh zadeh, 2010).**

Using proper features for image detection facilitate the process of joint injury diagnosis for orthopedics specialists. These features include color, diameter of injury place, congestion, geometric dimensions, injury location (knee or elbow joint) and the rate of destruction which are all detectable through using modern techniques. Considering what has been said, the selected features of proposed program should be minimized in order to make a precise classification of injury and enhancing the diagnosis process. In any of the feature reduction methods in the

selected program, a different algorithm is used which results in different responses in diverse applications. The images are classified for their features to be optimized and the classifications are compared at last. Classification of joint injuries includes the learning and experiment stages which is comprised of all used classifiers (same source).

In this research plan, neural network is used to classify information. The neural networks are consisted of indiscrete nodes. These networks follow some features of biological neural networks and are accordant with biological systems and that is why their learning process is close to biological acquisition.

Research Background

Tadashi *et al*. (2013) studied the linked multi-layer neural network of GMDH model using a principle regressive analysis and its application in diagnosis of kidney cancer X-rays. In this study, the linked neural network using regression analysis was presented and applied on computer-aided design (CAD). In neural network of GMDH model, an intuitive self-organized technique is used to organize the neural network architecture. In this revised GMDH, the optimized architecture of neural network is organized among three models of neural networks by self-organizing method. The three models are curve function neural network, radial basis function (RBF) and multi-phrase neural network. Moreover, structural parameters such as number of layers, number of nerves in hidden layers and functional variables input was computed automatically by intuitive self-organizing method.

Kamruzzaman *et al* (2004) in their article, "medical diagnosis by using neural network", examine modified feedforward neural network constructive algorithm (MFFNCA) and propose a new algorithm for medical diagnosis which offers a pattern for classifying very small neural networks. Algorithm begins with minimum number of hidden units in a hidden layer. Then other layers are added to hidden layers one by one which results in enhancing the network preciseness and achieving an optimum size of a neural network. This research aims at studying relevant alternatives with separating "complicated medical diagnosis where human science should be understood generally. The successful applications show that human capability in diagnosis is far weaker than neural network diagnosis.

Rudiger *et al* (2013) in "therapeutic analysis using neural networks" studied the application of neural networks on therapeutic problems briefly and categorized its advantages and

disadvantages based on type of therapy. Successful applications demonstrated the weakness of human diagnosis in comparison with neural network. Then, an example of a neural network was introduced and the main troubles, therapeutic data and essential approaches for training and testing a network by therapeutic data were explained. Moreover, the network communication problem and its outcomes were obtained and presented as the "game-neurotic approach". Finally, case study of neural rules on the basis of cystic shock, were studied by both neural network and principle-based system.

In their research with the title of "application of artificial neural networks in processing color images", Rahmanian et al. (2012) state that using computer programs in radiology images processing has had a significant progress in the recent decade and ultrasound image processing and M.R.I have been accepted as a valuable tool to extract maximum data. Anatomic and pathologic cuts which are obtained using these techniques will contribute significantly to diagnosis and therapeutic process. In this research, using artificial neural networks in digital images processing techniques and medical images in particular is discussed. First, artificial neural networks and their application in digital image processing are studied and explained and its special applications in various medical fields have been examined further.

Mohammadpour Tahamtan et al. (2011) discussed the application of artificial neural network to examine coronary artery disease. A multi-layered artificial neural network of perceptron with the algorithm of error propagation was utilized to evaluate the state of coronary artery disease among 150 people of heart diseases center of Mazandaran. Then, the artificial neural network with NN (1-12-14) structure, Sigmond function and 1500 training cycles based on 80% of available data was designed and instructed. In order to design the artificial neural network, the Pythia-Neural Network was used. The mean of observed error squares in testing stage reduced to 0.0238 and the sensitivity and feature was 0.96 and 1 respectively. Finally, the obtained model categorized the healthy people without need for treatment or angiography thoroughly.

Ashrafi and Monajemi (2009) discuss the detection of vehicles plate number with the assist of image processing techniques of Hough transform. They state that analyzing the scenes with focus on object detection is one of the wide applications in image processing. One of the recent methods for object detecting which has been widely used is Hough transform. The feature of Hough

transform is clarifying the lines, circles and other shapes with analytic relations. In this research, an internal scene has been analyzed by Hough transform considering the mentioned feature. For instance, the numbers in a car plate are considered as the internal objects within the scene and will be detected using Hough transform and neural network. Using performed tests and the relevant results, 85% accuracy was obtained in detecting the numbers. Probably better results can be achieved using extended Hough transform and other neural networks.

METHODOLOGY

The method is the way by which one goes toward a given purpose. Therefore, explaining a scientific method is describing the essential principles which are implemented in any research work. In this research, required data is collected using library method and questionnaire. The purpose of this research is presenting an efficient and effective technique to improve noise reduction in radiography images for Osteoarthritis diagnosis. Thus, the filters are selected on the basis of multi-layer neural network of perceptron. A proper filter is utilized for facilitating the random signals with small spectrums. Low-passing filter induce changes on high-frequency pixels by passing through low-frequency pixels.

In the present research, the problem is studying the process of athletes' joint injury diagnosis using neural network. So the research hypotheses are:

- Athletes' joint injury seems to be explicable by neural network.
- With its unique capabilities, neural network can remove the defects in cases where various fields of science have not been able to solve the problems yet.
- Cost reduction, the maximum reliability, doctors' preciseness in their decisions and producing more efficient medical devices are a number of services provided for doctors through neural networks.
- Artificial neural networks have been widely used in diagnosing the diseases.
- Neural networks are applied in early diagnosis of joint injuries in athletes.

RESULTS AND DISCUSSION

In this research, simulation of proposed method which is a combination of presented methods is discussed and its results are compared with other methods.

Pre-processing

In X-rays, fracture images produce noises due to magnetic fields, patient movement, metal components, etc. In order to obtain more

accurate results in further steps, these side effects should be eliminated in pre-processing stage. In implementing all methods, pre-processing is the first stage.

Data bank

We need a data bank in order to implement the proposed algorithm. In this stage, the fracture images are collected after being passed through pre-processing stage. Then, sampling was carried out in fractured and healthy parts. Finally, the samples were gathered to form the required data bank. **Figures 1 and 2** depict the gathered data bank.

Segmentation

We attempted to use methods to have the image context analyzed. Each block has some contextual features which are useful in training process. Therefore, the fractured and healthy samples were blocked first. Then, the wavelet transformation was done on each of them. So, during the feature extraction process, similar features will be eliminated too, resulting in classification improvement and enhancing the algorithm performance. Blocking techniques will be clarified in feature extraction chapter.

Feature extraction

Wavelets have been used to extract features, but the methods of applying them to images are different. Three methods are explained:

Method 1: dividing to 8*8 blocks: this stage includes a two-step wavelet transformation. First a 4*4 matrix is achieved and a 2*2 matrix is created in the next step. The feature vector is generated afterwards.

Method 2: dividing to an 8*8 block: in this stage, a 4*4 matrix is generated with a wavelet transformation. Then, the feature vector is drawn for network training.

Method 3: dividing to a 4*4 block: a 2*2 matrix is created with a wavelet transformation, and then the feature vector is drawn for network training.

Classification

In the classification stage, the extracted features were used to carry out the classification. It consists of two stages: training and testing done by SVM and neural networks. Both of them will be explained further. At the end, the results are being compared against each other to derive the best method.

Training

To instruct and train the supporting vector we should have a set of data to

train by. Therefore, a sample of contexts of fractured and healthy bones is required. **(Figures 1 and 2)**. As it is seen, fracture sample has brighter colors due to the effect of radiography. It should be noted that the training for all the mentioned stages is carried out by supporting vector machine. Then, the neural network is used for instructing the data of that stage to achieve the optimum status of SVM classifier and the results were compared with each other at the end.

Test

In testing stage, radiography image or fractured or healthy samples were given to the supporting vector machine and the algorithm stages such as pre-processing or wavelet transferring were followed. Then, the obtained features of input picture were attributed to fracture and non-fracture. A white dot represented fractured spots and a black one represented healthy bones.

Finally, feature extraction was performed through three methods according to the suggested method in feature extraction chapter. In this part, the extracted data are given to training network and the results of test stage are as follows. When the features were extracted by the first method and given to the training supporting machine, the result were achieved as it is seen in **Figure 3**.

The output of suggested algorithm test was exceptionally acceptable. When the second method was used, the results were as it is in the **Figure 4, 5** below.

Figures 4 and 5 are two radiography images beside which the tested sample is presented through the proposed method.

The accuracy was estimated 94%.

When the third method was used to extract the features in order to give it to the supporting vector machine, the result were as it is depicted in the figures below. **Figures 6 and 7** are radiography images beside which the tested sample by the proposed method is presented.

The accuracy was estimated 94%.

When the third method was used to extract the features in order to give it to the supporting vector machine, the result were as it is depicted in the figures below. **Figures 6 and 7** are radiography images beside which the tested sample by the proposed method is presented.

The accuracy was estimated 96.5% in this stage.

The results of neural network for training the obtained data from first method in the feature stage (dividing to 8*8 blocks and two stages of wavelet transformation) are shown in the

image below. It should be noted that neural network is used for the optimum state of three aforementioned methods.

The accuracy of this stage was estimated about 96.4%.

Considering the obtained results, we observed that the optimum results were achieved when the feature extraction was carried out from 8*8 blocks with two stages of wavelet transformation (the first method in the feature chapter). Also, the performance of algorithm was faster than it was in the other stages. **Table 1** shows the results of the comparisons.

Figure 1: fracture sample

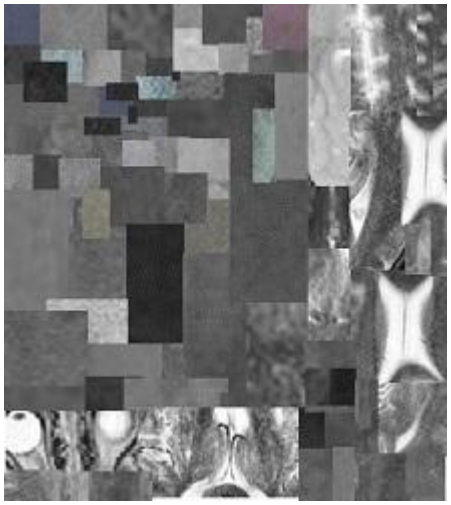


Figure 2: non-fracture sample

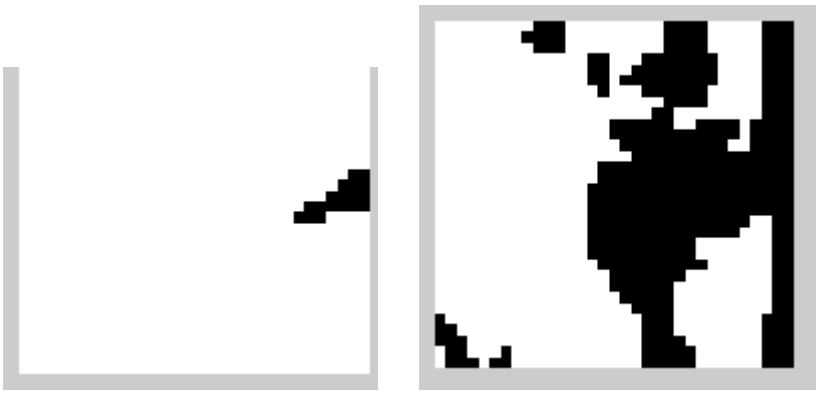


Figure 3

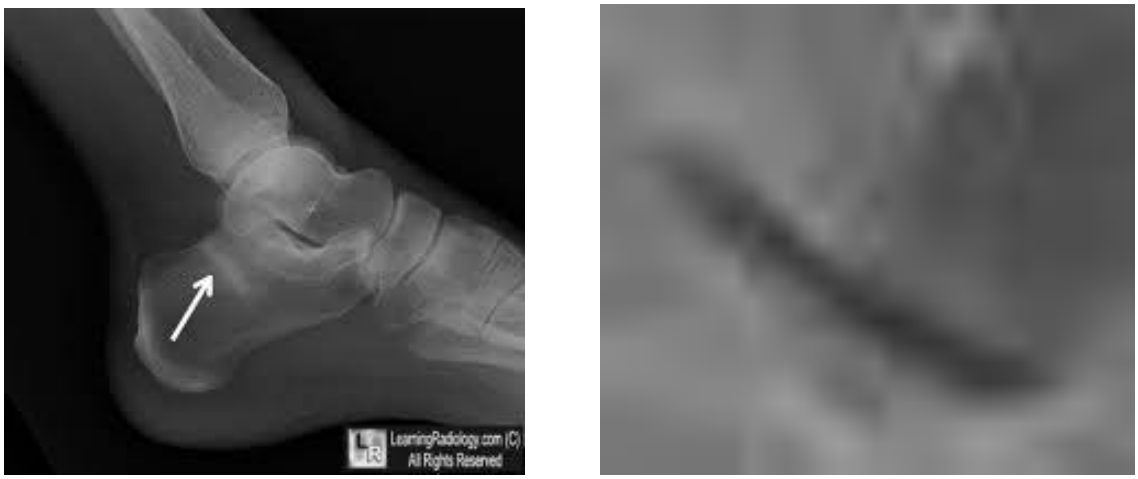
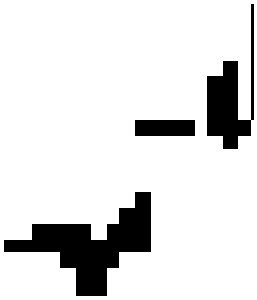


Figure 4: a) the input of proposed algorithm test

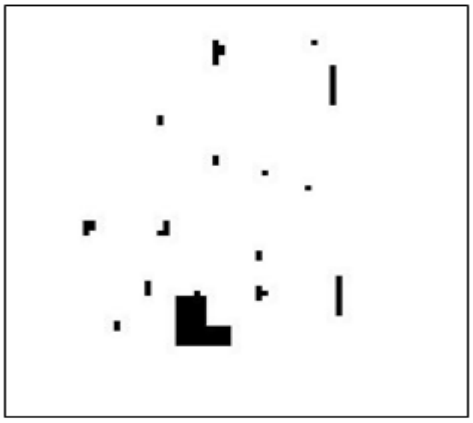
b) The output of proposed algorithm

Figure 5: a) the input of proposed algorithm test



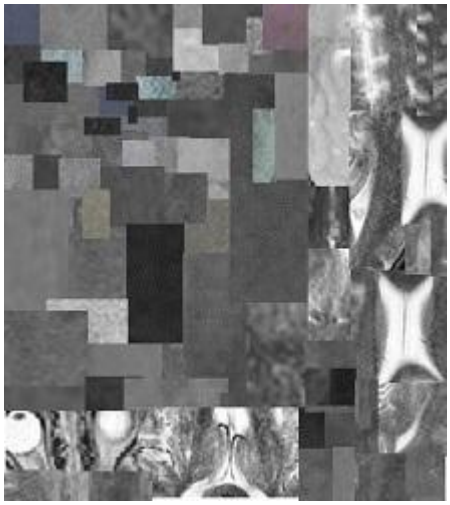
b) the output of proposed algorithm test

Figure 6 (a) fracture information bank



the output of proposed algorithm test

Figure 6 the sample of fracture the test of fracture sample are shown.



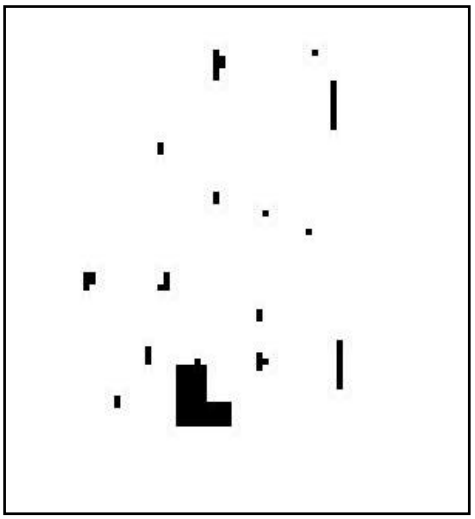


Figure 7: non-fracture sample

Table 1:

Implementation speed measured by chronometer	Accuracy for fracture information bank	Proposed algorithm considering the feature extraction method
4.19sec	**98.5**	**8*8 blocks with two stages of wavelet transformation**
4.99sec	**94**	**8*8 blocks with one stage of wavelet transformation +SVM**
9.42sec	**96.5**	**4*4 blocks with one stage of wavelet transformation + SVM**
23sec	**96.4**	**8*8 blocks with two stages of wavelet transformation+ neural network**
-	**98**	**Wavelet transformation + neural network [11]**
-	**98**	**Wavelet transformation + SVM [11]**

CONCLUSION

The purpose of this research was diagnosis of athlete's joint injury using neural network. So we proposed a plan for diagnosing orthopedic complications with the use of artificial neural network technique. The result showed that the optimum results were achieved when the feature extraction was carried out from 8*8 blocks with two stages of wavelet transformation. Also, the performance of algorithm implementation showed higher speed in this method.

1. Using fuzzy and expert systems
2. Implementation this method with combined wavelets can be considered

as the second idea is more efficient than normal wavelets.

3. The last idea is using neural fuzzy system for edge determining. In this method, the image trained by proposed algorithms is used to train the network. Edge identification can be implemented through various methods such as genetic identification, identification with PSO and edge identification with neural fuzzy systems. The mentioned algorithms can be combined with these methods.

REFERENCES

[1] Fatahian, Masoud; Farbehi, Nona. 2009. "Neural network and its application in medicine". Virtual electronic community of Iran.

[2] Ghasabi, Zeynab; Shanbehzadeh, Jamshid. 2010. "Applications of intelligent methods in recording medical images" the articles collection of first congress of information technology and health.

[3] Rahmanian, Mohammad Sadegh; Almasinejad, Peyman; Farahi, Ahmad. 2012. Application of artificial neural network in processing medical images. First national congress of information technology and computer networks in Payam-e-noor University.

[4] Mohammad Pour Tahamtan, Reza Ali; Esmaeili, Mohammad Hadi; Ghaemian, Ali; Esmaeili, Javad (2011). Application of artificial neural network to examine coronary artery disease. The Journal of Medical Sciences of Mazandaran, Course 21. No. 86 (9-17)

[5] Ashrafi Khuzani, Neda; Monajemi, Amir Hassan (2011). Detecting the numbers of vehicle plate with the assist of image processing techniques of Hough transform. Second national conference of electronic engineering of Iran.

[6] Saghiri, Mohammad Ali; Ahmadi, Mohammad Hadi; Elyasi, Maryam; Mohaghegh, Melika; Ja'fari, Ali (2012). The principles of image processing and its application in medical sciences, culture and civilization.

[7] Tadashi Kondo, Junji Ueno, Shoichiro Takao, Hybrid, 2013. Multi-layered GMDH-type Neural Network Using Principal Component Regression Analysis and its Application to Medical Image

Diagnosis of Liver Cancer, Procedia Computer Science Volume 22,

[8] Kamruzzaman , S. M., Hasant Ahmed Ryadh, Siddiquee Abu Bakar and Md. Ehsanul Hoque Mazumder, ICECE 2004. MEDICAL DIAGNOSIS USING NEURAL NETWORK , 3rd International Conference on Electrical & Computer Engineering , , 28-30 December 2004, Dhaka, Bangladesh

[9] Rüdiger W. Brause, J.W. Goethe-University, Computer Science Dept., Frankfurt a. M., Germany. 2010 ,Medical Analysis and Diagnosis by Neural Networks,, https://www.surrey.ac.uk/.../Jiang_2010_2.pdf,

[10] Hinman R S, Bennell K L, Metcalf B R, and Crossley K.M. 2002. Balance impairments in individuals with symptomatic knee osteoarthritis: A comparison with matched controls using clinical tests. J Rheum; 41:1388-1394.

[11] Song R, Lee E-o, Bae S-C. 2003. Effects of tai chi exercise on pain , balance, muscle strength , and perceived difficulties in physical functioning in older woman with osteoarthritis: A randomized clinical trial .J Rheum;30:9.

[12] Ramana, K.V., Basha, K., 2004. Neural Image Recognition System with Application to Tuberculosis Detection, IEEE proceeding of International Conference of Information Technology,