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Prediction of Neck and Shoulder Pain During Use of Vdt with the Use of Artificial Neural Network

KEYWORDS

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ABSTRACT *Present work focuses on prediction of neck and shoulder pain during use of VDT. Use of VDT has been a regular feature of Indian industry, however surprisingly Indians are unaware of pain generated during use of VDTs. This work basically looked after this problem. The work is divided in two phases. In first phase a questionnaire was prepared from various persons using VDTs. Using these data Artificial Neural Network was trained in second phase. Further this training enabled to develop a predictive model with the help of Artificial Neural Network. It was predicted that working for 7 to 9 hours for shoulder pain and for neck pain working from 6 to 9 hours are critical (i.e. generated pain in higher region). The developed model has also been found to be suitable for persons who regularly use the VDT. It is equally useful for both software industries employee and persons use VDT for their business/personal work.*

INTRODUCTION

Most of the office workers (Both male and female) now days have disorder in their neck and shoulder region. These stresses are the part of the musculoskeletal disorders. Musculoskeletal Disorders is the state in which musculoskeletal part is damaged with time [2]. Increasing working hours increases the amount of disorders in the persons. Musculoskeletal discomfort associated with VDU work is attributable to isometric load, repetitive work, and the required force output [11]. This type of muscular work may cause pain in neck and shoulders, and when a mouse is used there can also be pain in the arms and hands [10]. Data processing work in offices is a form of repetitive work so VDT workers are mostly affected of musculoskeletal disorders in neck shoulder arm region of the body.

Among women, an increased amount of VDT work, work in a seated position, work above shoulder level, and reduced opportunities to acquire new knowledge, and among men, an increased amount of sitting at work were associated with neck or shoulder pain[1]. Toomingas et al. suggested that 86% female and 68% male call centre staff reported musculoskeletal pain with the neck and shoulder regions most frequently affected [4].A.H. Subratty suggested that neck and shoulder pain is most prevalent (76% and 75.5% respectively) among the persons who are working on their computers either in their colleges or in offices [8]. Visual fatigue, burning/tearing of eyes, neck pain, shoulder pain, wrist pain and lower back pain was significantly higher in VDT operators compared to the other workers who were doing not doing work on VDT [9].

As many authors suggests above that in VDT workers pain in shoulder and neck is prevalent so there is need of ANN model which will suggest the amount pain in shoulder and neck among VDT workers. An ANN model is used in many ergonomics problems as discussed below.

Many Artificial neural networks are used in industrial design cases; there is a need to take into consideration various postures of the human body when the product is designed. The research carried will speed the posture transformation of the digital human modeling computationally for design purpose [5].

The neural networks are used as a tool for optimizing the placement of icons in an interface. Such networks will be used to determine the exact placement of icons on the screen. This method will be applied in the final phase of system interface evaluation, to give a group of users the opportunity to move icons on the screen as they see fit. Each new position is recorded by a neural network. Afterwards, the networks can be interrogated to deduce the optimal placement of each icon, thus avoiding the necessity of re-programming the interface several times [6].

DEFINITION

In India use of VDT has been a regular in both software and manufacturing industry. In Software industry especially people used to work on VDT for long hours continuously. They are unaware of pain generated during working with VDT. This problem is authors' main area of study for this paper. Twenty five persons who were working on VDT were asked about pain through questionnaire on the basis of systematic sampling. In present study the input-output data prepared on the basis of above mentioned questionnaire. Mostly office workers who use to work on VDT continuously usually have musculoskeletal problems. Number of working hours and sex of a person were considered as input, however pain in neck and shoulder were considered as output variable. Questionnaire was made in which 25 VDT workers working in office from 4 to 10 hours daily were asked to rate the pain on 0 to 5 scales in neck, shoulder, elbow and hand region. As according to Toomingas [4] et al large number of male and female workers feels pain in neck and shoulder region. So out of 4 pains we take only pain in shoulder and pain in neck region only. The data are present in Table1. Based on this data ANN model has been developed which would predict the amount of pain a male/female feel based on their daily working hours in their office.

ARTIFICIAL NEURAL NETWORK

Artificial Neural Network is a tool in which signals are processed in non linear direction. Ann is made of interconnected element called as neurons. Artificial Neural Network is an imitating tool which predicts results like human brains [12]. This method is used to find out the outcome of process parameters and relationship when analytically there is no existence of relationship between them. ANN itself assigns individual weight to each neuron of all layers. Further it minimizes the error through adjustment of weight iteratively.

1. NEURAL NETWORK STRUCTURE

Processing neuron is the basic unit of ANN. Processing Neuron is basically inspired from natural neurons of human brain. Signals are received through the synapses located on the dendrites. When the intensity of signal received is very high

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and it crosses the threshold value then the neuron gets activated and the signal is passed through the axon to give an output [7]. In this way signal is retrieved by neuron in input layer and passed to the another neuron in next layer.

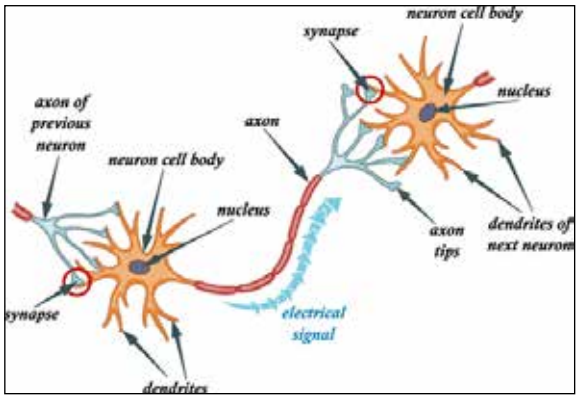

FIGURE 1-NEURON DIAGRAM
SOURCE-www.benchprep.com/blog/wp-content/uploads/2012/12/dendrite-axon.gif

2. DEVELOPMENT OF ANN MODEL

Using data of Table1 Artificial Neural Network is trained through Feed Forward Back Propagation Method. Back Propagation Technique minimizes the mean squared error (MSE) through iteratively readjusting the weight on each neuron. After that ANN develop an input-output relationship of its own on the basis of Mean Squared Error. The back propagation method iteratively tries to minimize the MSE to be 0.00001. MSE is given by

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2$$

Source-www.aoml.noaa.gov/hrd/Landsea/artificial

3.PARAMETERS OF ANN NETWORK

1. Learning rate - 0.35.
2. Number of hidden layers - 2
3. Value momentum - 0.75.
4. Number of neurons assigned on each hidden layer-10
5. Number of epochs – 40000

Tan sigmoid transfer function was used in hidden layer and linear transfer function (purelin) was assigned at output layer. The architecture of developed ANN model is shown in Figure 2.

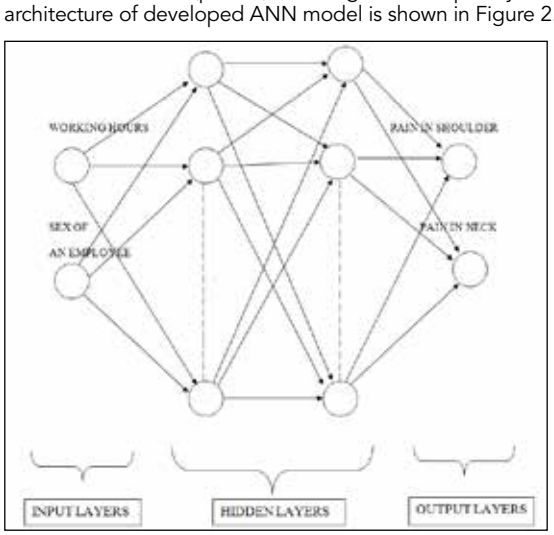

Figure 2-ANN MODEL FOR VDT ERGONOMIC PROBLEM

Table 1 shows the values of pain in shoulder and neck of both male and female based on questionnaire

TABLE-1 VALUES OF PAIN IN SHOULDER AND NECK BASED ON QUESTIONNAIRE

SEX	WORKING HOURS	PAIN IN SHOULDER	PAIN IN NECK
FEMALE	6	3	3
MALE	8	4	2
MALE	4	2	1
MALE	9	4	2
MALE	5	1	2
FEMALE	8	3	2
MALE	7	2	1
FEMALE	8	1	3
MALE	7	3	1
FEMALE	8	3	2
FEMALE	8	3	3
MALE	4	1	1
MALE	7	4	2
MALE	8	3	1
MALE	4	2	0
MALE	6	1	3
FEMALE	5	3	1
MALE	8	4	3
MALE	8	4	2
FEMALE	4	3	1
MALE	4	2	1
MALE	9	3	3
MALE	8	3	2
MALE	8	4	1
FEMALE	8	3	2

Development of Network Few newer inputs are predicted and presented in Table 2. It can easily be seen the convenience this model that pain generated during use of VDT can be predicted

TABLE-2 ANN PREDICTED VALUES

SEX	WORKING HOURS	PAIN IN SHOULDER	PAIN IN NECK
MALE	5.7	1.7	3.0
FEMALE	6.9	3.7	4.2
FEMALE	7.6	2.5	2.3
MALE	8.6	3.5	2.4
MALE	6.6	2.0	2.0
FEMALE	4.9	3.1	1.0
MALE	7.5	3.4	1.5
FEMALE	6.2	3.1	3.1
MALE	9.2	3.2	2.6
FEMALE	8.2	2.5	2.3
FEMALE	4.7	2.9	1.0
MALE	4.9	1.2	1.8
MALE	9.8	2.4	4.1

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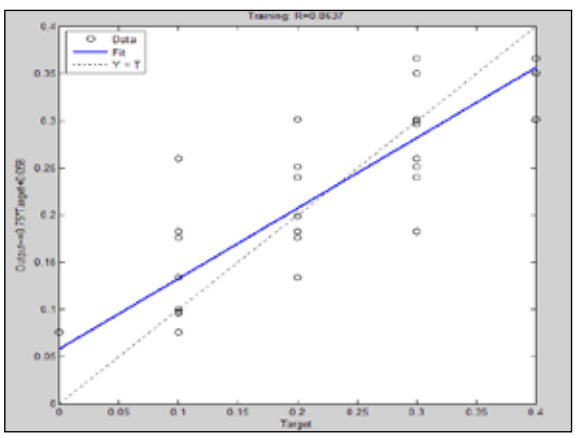
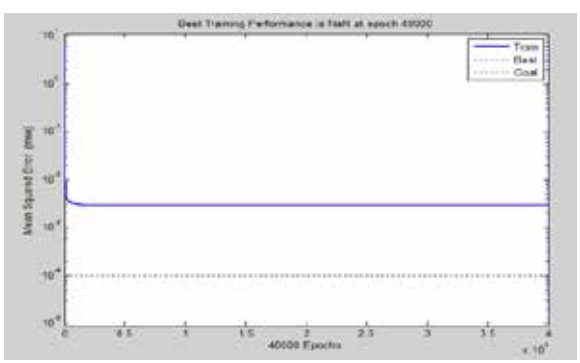
FEMALE	7.1	2.9	3.6
MALE	6.2	1.8	2.9
FEMALE	6.6	3.9	4.6
MALE	4.9	1.0	1.8
MALE	7.7	3.6	1.2
FEMALE	6.0	3	3.0
MALE	8.2	3.6	2.0

GRAPHS

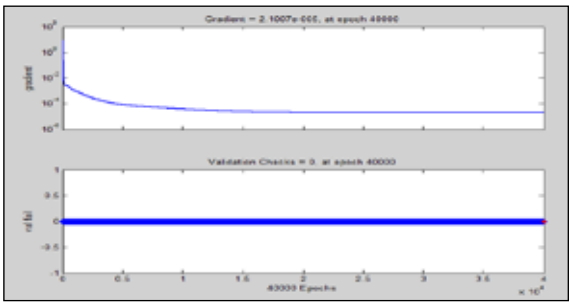
GRAPH-1 REGESSION GRAPH



GRAPH-2 PERFORMANCE GRAPH



GRAPH-3 TRAINING STATE GRAPH



CONCLUSION

Artificial Neural Network has been used for predictive modeling in this study. Matlab version 7.10.0.499(R2010a) was used for ANN programming in this study. The developed model can easily be seen quite useful for various employees and self employee person who has been regular user of VDTs. The following brief conclusion may be drawn from this study.

1. This model can predict two output values (i.e. neck and shoulder pain) simultaneously.
2. The neck pain is not substantial while working in the region between 4 to 5 hours.
3. The neck shoulder is not substantial while working in the region between 4 to 6 hours

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