

MISSING SENSOR IDENTIFICATION USING NEURAL NETWORK IN CONCRETE STRUCTURE

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ABSTRACT:

It is crucial to quantify location of sensor in the dam, for this purport numbers of the sensor are placed at various locations in the dam. Central water and Power Research Station (CWPRS) provided data of Dam sensor which utilized in this project to train the Neural Network. Identification of sensor location is the arduous task if the quandary is arrived in the control room, because of Mismatching in the wire, Noise. Learning Vector Quantization method used in this project to train the network. Estimating the values of dam sensor using the previous data of same dam sensor.

KEYWORDS: Artificial Neural Network, Learning Vector Quantization, Sensor Location.

INTRODUCTION:

Real time identification of sensor location in dam is essential. A neural network based on linear vector quantization algorithm is developed and a prototype scheme of real time identification can be achieved by using sensor model with neural network there has been much work done on the use of neural network in different field the important of sensor location for proper crop management needs to be stressed. In this paper 150 sensors data is used to train the neural network using learning vector quantization algorithm. With increasing safety, performance and automation requirements, control system are increasingly sophisticated and are heavily reliant on their sensors. This paper presents a neural network based learning vector quantization algorithm with dam sensor data. Neural network have been used in various application including sensor location identification and

estimating sensor values of dam sensors using previous dataset of the sensor.

This paper is organized as: it provides a review of the neural network detailed in the literature. an overview of the learning vector quantization algorithm and also present the settings used for this paper. the sensor used to collect data for this paper is briefly described with methodology. The experimental result are presented then concludes this paper.

NEURAL NETWORK:

Neural Network are typically organized in layers; layers are made up of interconnected nodes which contains an activation function parameters are presented to the network via the input layer which communicate to one or more hidden layer where the actual processing is done via a system of weighted connections. ANN are not intelligent, but they are good for identification and estimation for complex problems they also have excellent training capabilities which is why they often used in artificial intelligence research ANN are good at generalizing from a set of training data.

Now a day's when the training on ANN with a set of input and output data, wish to adjust the weights in the ANN. to make the ANN give the same output as seen in the training data. On the other hand, do not want to make the ANN to specific, making it give precise result for the training data, but incorrect result for all other data. When this happen, say that the ANN has been over-fitted.

LEARNING VECTOR QUANTIZATION:

Neural Network is based on competitive learning the output neurons of the network compete among themselves to be activated or fired. An output neuron

that wins the competition is called a winner takes all neuron or simply a winning neuron. Adaptation rules formulated at the microscopic level of a single.

Let an input pattern (vector) selected at random from the input space be denoted by

$$x = [x_1, x_2 \dots x_m]^T$$

The synaptic weight vector of each neuron in the network has the same dimension as the input space. Let the vector of neuron 'j' be denoted by

$$w_j = [w_{j1}, w_{j2} \dots w_{jm}]^T \quad j=1,2,\dots,l$$

Where l is the total number neurons in the network

$$i(x) = \operatorname{argmin} \|r_j - r_i\| \quad j=1,2,\dots,l$$

Co-operatives process the winning neuron determines the spatial location of a topological neighborhood of excited neurons, thereby providing the basis for cooperation among such neighboring neurons.

$$d_{j,1}^2 = \|r_j - r_i\|^2$$

Where the discrete vector r_j defines the position of excited neuron j and r_i defines the discrete position of winning neuron i.

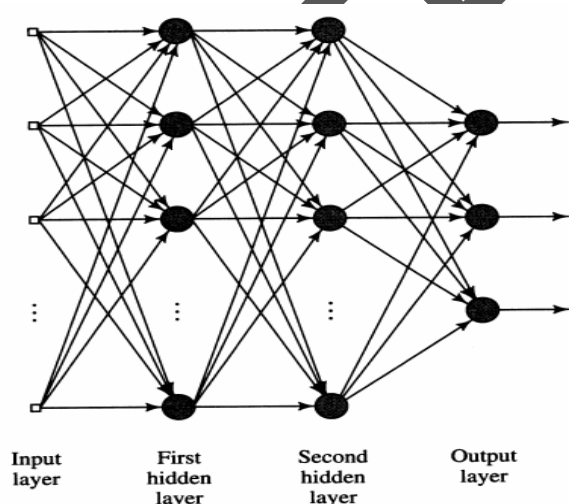


Fig 1: Hidden layers of LVQ algorithm

Synaptic adaptation in which the adjustment made are such that the response of the winning neuron to the subsequent application of a similar input pattern enhanced.

$$\Delta w_j = \eta y_j x - g(y_j) w_j$$

Where η is the learning-rate parameter of the algorithm.

LEVENBERG-MARQUARDT ALGORITHM:

This method minimized as the sum of squared errors between the target outputs and the networks simulated outputs, namely

$$F(w) = e^T e$$

Where $W = [w_1, w_2, \dots, w_n]$ consist of all weights of the network. 'e' is the error vector comprising the error for all the training examples. When training with LM method, the increment of weights Δw can be obtained as follows

$$\Delta w = [J^T J + \mu I]^{-1} J^T e$$

Where J is the jacobian matrix μ is the learning rate which as to be updated using the β depending on the outcomes.

TRAINING AND DATASET:

All learning methods used for adaptive neural network can be classified into two major categories supervised learning and unsupervised learning. Learning vector quantization is the type of supervised neural network.

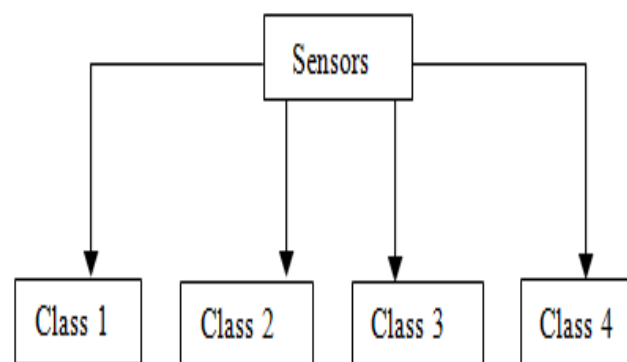


Fig 2: Classification of sensors

Central water and power research station (CWPRS) provided different sensors like temperature, pressure, water level sensors, strain meter and joint meter etc. For the training purpose total 150 sensors divided into four classes. Classification of sensors is used to train the dataset using learning vector quantization method it used less amount of time to train the network. Training of neural network is performs by varying number of sensors reading.

MORPHOLOGY:

This project contains following blocks to perform the operation, the aim of the project is collect sensor data of known location, pre-processing operation performed sensor data. Implementation of neural network, training, testing and validation of unknown signal. Estimating the values of sensor

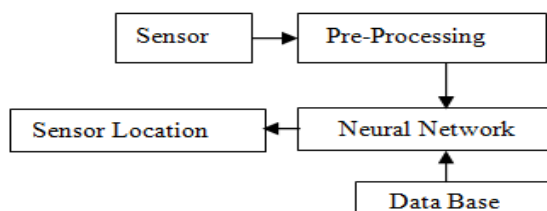


Fig. No.3. Block diagram of sensor identification using NN.

1. Data Base Collection: Central Water and Power Research Station provided the data of the sensor, in this paper data of sensors are divided into classes which consider for training the neural network. Sensors are placed at the different location in the dam. This data is used to identify the location of the sensor.

2. Pre-processing: Pre-processing involves series of operations performed to enhance the quantity of data to make it suitable for training. It involves noise removal generated during updating of weights. To remove noise wavelet transform is used in this transform "Harr Transform" is used because of its peak signal to noise ratio (PSNR) is good compared to another type of wavelet transform. [6].

3. Fig. 1 shows the two layers Neural Network Structure, here Learning Vector Quantization is used hence two layers of Neural Network is required. Sensor Location: The weight of the matrix is updated unless least means square value near to zero. Any sensor given value compared with trained Neural Network and shows the location of the sensor.

Database compares the values of sensor with the trained network in neural network using learning vector quantization (LVQ) algorithm and finds the sensor value belongs to which location of the dam.

$$x_n = (b - a) * \frac{x_0 - x_{min}}{x_{max} - x_{min}} + a$$

Where x_n is the normalized value and x_0 is the value to be normalized. a and b are the minimum and maximum values of the range to be normalized to, x_{max} and x_{min} are the maximum and minimum values of the range from which x_0 is normalized. Synaptic weights of neurons are updated by the following equation.

$$W_{n+1} = W_n - (Q + \mu I)^{-1}$$

Where W_{n+1} is the new weight vector, W_n is the previous weights vector, Q is the quasi-Hessian matrix, g is the gradient vector, and μ is the combination coefficient [1].

RESULTS:

1. Identification of Sensor Location

Unknown values of sensor location compare with the neural network trained by learning vector quantization (LVQ) because this algorithm is better compare to other algorithm in classification. Neural network is trained until mean square error (MSE) reduce to less than 10^{-2} . Neural network trained used for different values of sensor

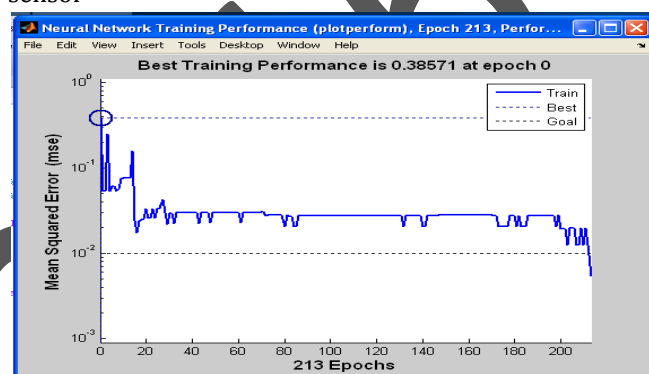


Fig No 4 performance of trained NN (N=20).

Learning vector quantization used two hidden layers to perform training of neural network. Learning rate and number of hidden neuron this two varying parameter while performing training number of operations are done by varying these two parameter. In Fig 3 learning rate used is 0.01, numbers of hidden neurons are 60, and mean square error is reduce to 0.00567 for 20 values of dam sensor.

In Fig 4 learning rate is 0.01, number of hidden neurons are 60 and mean square error is reduce to 0.00343 for 25 values of dam sensor.

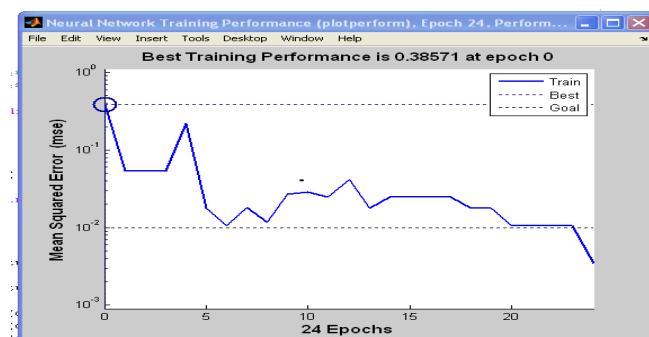


Fig No 5 performance of trained NN (N=25)

Number of networks are trained using different values of dam sensor is shown in following table with all the features.

Table 2 different operations performed in NN

Samples per sensor	Time for training	error	Learning rate	Epochs
10	51 sec	0.0513	0.01	14
30	9:46 min	0.0100	0.01	52
50	46:47min	0.00357	0.01	138
75	31min	0.00600	0.01	66
100	10hr	0.054	0.01	350
100	3min	0.0046	0.2	3
120	3:30min	0.00542	0.2	4
170	7min	0.00643	0.2	6
200	9:47min	0.00671	0.2	8
220	6min	0.00714	0.2	4
230	5min	0.00755	0.2	4
250	3min	0.00734	0.2	4

Algorithm tested with simulated critical academy.

CONCLUSION:

It is further proposed to valuable the estimation is also in dam data being collected from one or more Indian dams. Training of Neural Network depends on Learning Parameter and Numbers of Neuron Present in the hidden layer. TO TRAIN THE NEURAL NETWORK Learning Vector Quantization (LVQ) ALGORITHM is good for classification to train the network. It takes less number of iteration (Epoch) to train the network and to achieve the goal, Mean Square error is 0.01. Accuracy and time for training is better in learning vector quantization algorithm.

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