Global Journal of Computational Intelligence Research.
Volume 1, Number 1 (2011), pp. 1-7

http://www.ripublication.com/gjcir.htm

Offline Automatic Cost Efficient Multiprocess Signal Monitoring and Detection using Artificial Neural Networks

Syeda Asra

Department of Computer Science & Engineering,
APPA Institute of Engineering & Technology, Gulbarga, India
E-mail: asrasyedaali@yahoo.co.in

Abstract

Although neural networks based on multilayer architecture have been demonstrating high potential in recognizing the patterns efficiently. An approach for a model which is automatic and cost effective is the requirement. A control chart showing the direction of deviation of the patterns of a plant process is simulated.

In order to reduce the cost of hardware a system is proposed were in control charts of three different plant process is taken. Control chart consists of six different patterns. Same types of patterns from three different processes are trained. Practical applications are severely limited by the cost of hardware and the training time that they require. This paper addresses the question of how to perform off-line training of multilayer neural network by combining the patterns of same type from three different plant processes in an efficient way in order to reduce the cost and the training time for a multiprocess system. Artificial neural network have some desirable characteristics and capabilities, such as parallel processing, learning, nonlinear mapping, and generalization .Occurrences of deviation from normal signal are quite common in a plant processes. Precisely detecting the signals should be of paramount importance for any precision-based processes in real time applications. Area of applications are ample, a couple of them may be medical application or space application. Objectives are highly dependent upon controlling mechanism. To visualize this scenario any production plant is the best example. Conventional means of controlling are facing difficulties in providing the response as expected. A new methodology with respect to artificial neural network is looked as an option for optimising cost and training time. Instead of having a dedicated set up for each process one universal set up is proposed. Buffers are used to buffer the patterns. Control chart provides the information of flow about parameters of interest .The proposed system works on core methodology of neural network and is not an application specific but rather a generalized model based on simulating the data. This is a platform on which any application can be designed time and cost, efficiently.

Keywords*:* Multi processes, neural network, recognition, gradient descent, simulation, ANN.

Introduction

Artificial neural network are massively parallel-interconnected networks of simple adaptive elements and their hierarchical organizations, which are intended to interact with the objects of the real world in the same way as the biological counterparts. Neural networks find wide applications in parallel distributed processing and in real-time environments.

Neural Networks have considerable advantages over expert systems [1] in terms of knowledge acquisition, addition of new knowledge, performance and speed. Recently, interest in the application of associative memories and neural networks to problems encountered in diagnostic expert systems development has increased. Neural Networks appear to offer features, which coincide well with the requirements of pattern-based diagnosis. An important feature of neural networks is that they can interpolate the training data to give an appropriate response for cases described by neighbouring or noisy input data [2]. The proposed system is a universal set up where any type of pattern from any number of plant processes or health monitoring system can be tested and trained.

Artificial neural network based recognition system makes use of control charts. The number of processes considered is three. This control charts consists six patterns from each process. Thus we have eighteen patterns as shown in Figure.1 A lot of research to find the maximum possible signals that exists in any medical diagnostic system or for that matter any industrial unit or research lab ,is been done. The conclusion is that that there could be maximally six possible signals. Normal, cyclic, incremental, decremental, incremental, upward shift and downward shift. Five amongst them are considered to be abnormal, since these are deviations from normal signal remaining one is considered as an abnormal signal. The data is simulated for these signals by means of formulae that have been derived by the nature of the signal for three processes. The cost of the hardware is too high, hence a single neurosystem is used to recognize the patterns’ from all the three processes. Several researchers have proposed many systems for detection but hardly any research is done for development of generalized model, based on which any type of automated detection application could be developed. The paper proposed is not application specific rather an attempt to show ,the core methodology of how artificial neural networks could be used both as a classifier and a feature extractor which helps as a decision support for critical applications which is time and cost efficient.

Related Work

In proposed system multiprocess system is considered. Related work is found in [3].In this paper a single process is considered and artificial neural network is used to recognise the patterns faithfully. As such there was no other related work found.

Methodology

Neural networks are computational models that share some of the properties of the brain. These networks consist of many simple “units” working in parallel with no central control, and learning takes place by modifying the weights between connections. The basic components of an ANN are “neurons”, weights, and learning rules. In general, neural networks are utilized to establish a relationship between a set of inputs and a set of outputs. Figure 2 shows the general architecture of a multilayer, feed forward neural network. Ann’s are made up of three different types of “neurons”. (1) input neurons (2) hidden neurons and (3) output neurons. Inputs are provided to the input neurons, such as machine parameters, and outputs are provided to the output neurons. These outputs may be a measurement of the performance of the process, such as part measurements. The network is trained by establishing the weighted connections between the input neurons and output neurons via the hidden neurons. Weights are continuously modified until the neural network is able to predict the outputs from the given set of inputs within an acceptable user-defined error level.

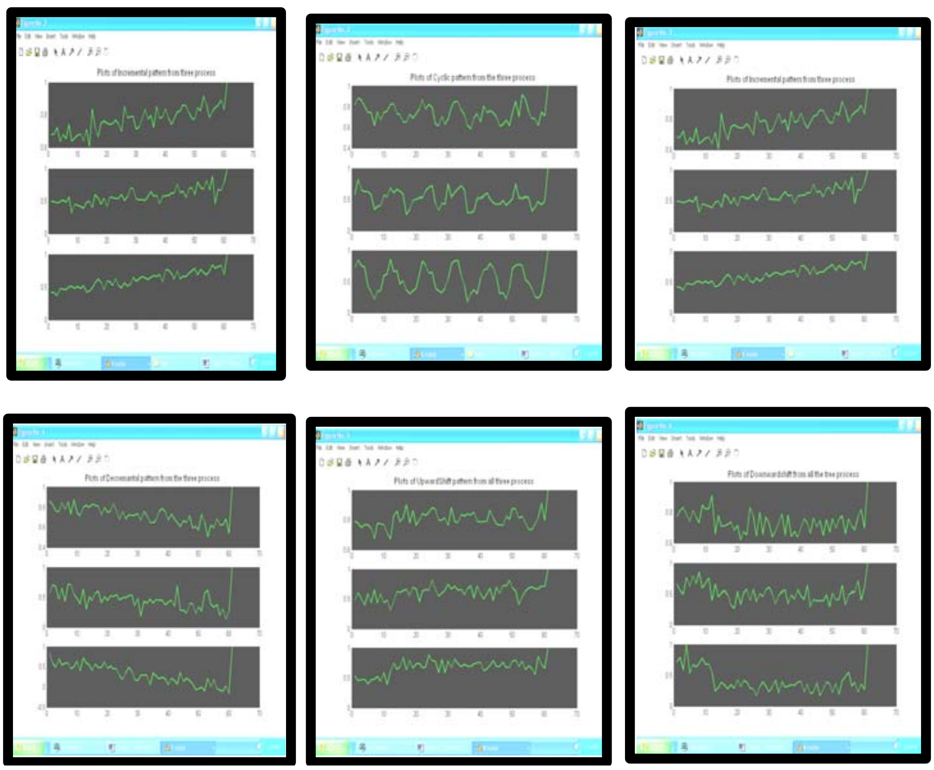

Figure 1: Control Chart of Six Patterns from three processes.

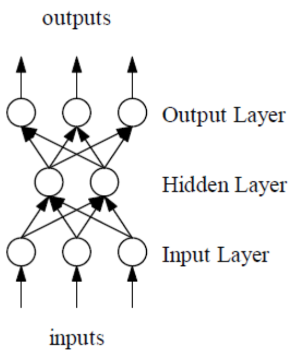

Figure 2: Multilayer Feed Forward Artificial Neural Network.

Materials and method

Fig.3 shows the block diagram of the proposed system. A particular signal say cyclic from all the three processes are trained and tested hence reducing the cost of hardware by having single monitoring system.Fig.4 shows the block diagram of the application phase of the proposed system as to how the proposed system can be deployed. In this system all the six signals from the three processes are trained using gradient descent rule. Since this is a supervised learning hence the targets are known. If the error is minimum then the training is stopped otherwise a new iteration is started.

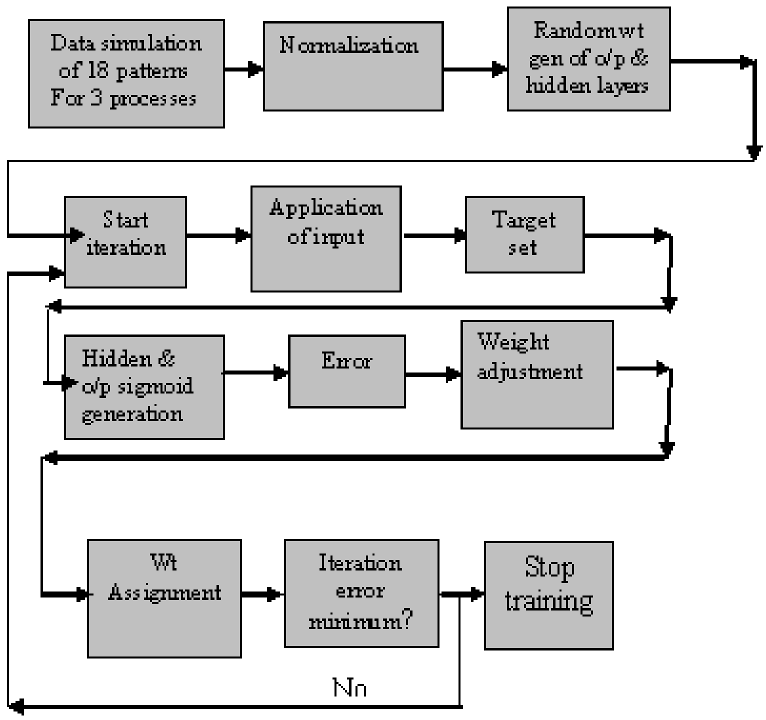

Figure 3: Block diagram of the proposed system.

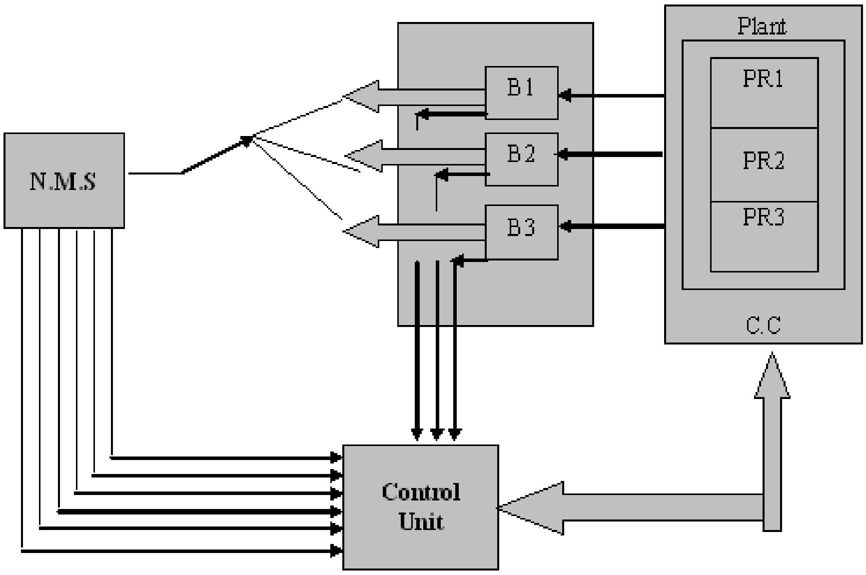

Figure 4: Application phase of the proposed system.

Types of signals

Six sets of data corresponding to i) normal ii) cyclic iii) incremental iv) decremental v)upward shift vi) downward shift are used as experimental data set for the proposed network based recognition system. Each pattern will be taken as time series of 60 data points. The cyclic, incremental, decremental, upward & downward shift is considered as abnormal signals. Fig.1 shows specimens from normal to downward shift respectively.

Simulation

Normal pattern: $P(t) = \eta + r(t) * \sigma$

Cyclic pattern: $(t) = \eta + r(t) * \sigma + a * \sin(2 \pi t / T)$

Increasing trend: $P(t) = \eta + r(t) * \sigma + g * t$

Decreasing trend: $(t) = \eta + r(t) * \sigma - g * t$

Upward shift $(t) = \eta + r(t) * \sigma + b * s$

Downward shift: $P(t) = \eta + r(t) * \sigma - b * s$

Where

$\eta \rightarrow$ Nominal value if process variable

$\sigma \rightarrow$ Standard deviation of process variable

$a \rightarrow$ amplitude of cyclic variation in cyclic pattern

$g \rightarrow$ gradient of increasing /decreasing trend pattern

$b \rightarrow$ shift position in up/downward shift pattern

$s \rightarrow$ magnitude of shift

$r(\,) \rightarrow$ random number

T → period of cycle in cyclic pattern
P (t) → value of sample data point at time t

Normalization of data
Using the above formula the data is generated. Since there is lot of variation in the data, hence the data is normalized. In this system normalization of data accelerated the neural network to learn quickly.

Neural network classifier
Artificial neural networks are considered to be good classifier [4] due to their inherent features such as adaptive learning, robustness, self organization and generalization capabilities. ANN namely multilayer feed forward is employed for recognition. The values corresponding to the normal and other signals are used as the inputs for the neural network. The activation function used is sigmoid. The number of neurons used in the hidden layer and the output layer are 10 and 6 respectively. Gradient descent algorithm is used for training .The target value for each of these signals is 1.The range of the output values for all the signals are 0.7-1.Table 1 shows the different parameters used in our proposed system.

Table I: Parameters.

Description	Value
Learning Constant	0.9
Number of input nodes	60
Bias Node	61^{st}
Number of hidden nodes	10
Number Of output nodes	06
Data simulation	500 data sets
Training data	02

Table II: Performance evaluation.

Efficiency in %		Execution time in secs	
With bias	Without bias	With bias	Without bias
87.8111%	87.3889%	2.3120 mins	2.5664 mins

Result
Values are computed for all normal, cyclic, incremental, decremental, downwardshift, upward shift and are fed as inputs to the neural networks from three processes. 500 sets of data is generated for each of the above mentioned signals, out of which only 2 blocks of data are used for training and the remaining used for testing. This choice is made arbitrarily keeping in mind that enough datasets are provided for the neural

network to understand the inherent structure of the data so that it can classify the unknown datasets properly.Fig5 shows the outstanding results of the signals. It can be observed from the table II that the training from three different processes was achieved with significantly less time. Hence the system can be used to train n number of same type of patterns by a universal set up. Thus reducing the cost of hardware and time.

Discussion

It can be observed from Table II that high overall accuracy values of 87.81 is achieved with bias node and execution time is less compared to without bias node. Thus one can say that the use of bias node accelerates the learning process. The proposed system can be used for online recognition of the signals cost effectively.

Conclusion

In this paper, artificial neural network using gradient descent rule have been employed for the automatic recognition of signals. This proposed recognition system can be used as a platform for designing specific applications like epileptic seizure detection system. Thus this system can be used as expert system for medical diagnosis. Experimental results show that accuracies as high as 100% can be achieved by this system. A single neuro monitoring system can be used to recognize the same types of patterns from different processes thus reducing the cost of hardware and also time. The work is further enhanced by trying to combine the six patterns in various ways.

Acknowledgement

The author would like to thank Dr. M.K. Singh IISc Bangalore for the useful discussion on offline recognition based on neural network and its application.

References

[1] Regina Barzilayy, Daryl McCullough(1999) “A New Approach to Expert System Explanation”

[2] Lambert Spaanenburg “Early Detection of Abnormal Emergent Behaviour”

[3] Syeda Asra , "Recognition of divergent behaviour of plant process based on directionof deviation of the patterns using artificial neural network " , In IJCIIS July 2010,vol No 4,pp62-70.

[4] Jacek M.Zurada “An Introduction to Artificial Neural System”