# Neural Network based Power Efficient Decision Making about Natural Hazards Using Wireless Sensor Network

P.K. Mishra
Senior Scientist,
Instrumentation division
CIMFR,Dhanbad

Harshit Bhardwaj
Senior Lecturer
KNGDMEC, Modinagar

Pradeep Rana
Senior Lecturer
KNGDMEC, Modinagar

## ABSTRACT
'Decision is not the instantaneous process, it is the logical analysis done on Past data.'WSN is the best system for real time monitoring of natural parameters. For prediction of natural hazards different sensors are employed. Natural hazards can be predicted by supplying the threshold values of the natural parameters. Natural hazard is not due to any one parameter, it is the result of collective result made by all sensors. For making the system self learning for the particular area the BP (Back Propagation) Neural Network algorithm is implemented. This paper will give an energy efficient algorithm for WSN by reducing the redundancy of data transmission.

**Keywords**: Wireless sensor network, Back Propagation Algorithm(BP), Neural Network, power efficient transmission

## 1. INTRODUCTION
This system is self learning about the natural parameter measured by the sensor. In wireless sensor network (WSN) Fully Functional Device (FFD) sends data to end device through other FFD or Reduced functional Device (RFD). If the same data is sensed by another wireless node it also sends data to the end device. This redundant transmission of same data is the measure cause of the power loss in the WSN, this power loss is approximately reduced to several hundred times by this method .In this paper we are giving the intelligent system based on neural network for saving energy consumption by reducing the redundancy of data.

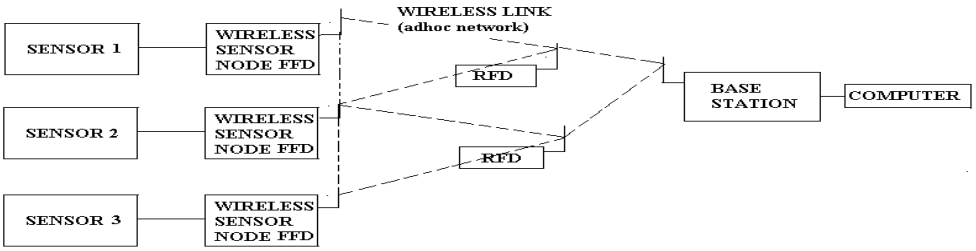


**Fig1. Block diagram of WSN with FFD and RFD**

## 2. NEURAL NETWORKS BY WIRELESS NODES
In WSN the each node which is FFD is considered as the neuron. All inputs from the sensors are the input of neuron. This data is then processed in the node by applying the BP algorithm. In BP algorithm there are 3 blocks first one is input block uses the output data of wireless node in training process this data can be fetched by the log files of the wireless view software. This collected data is given to second hidden layer which consists of the threshold values of the processed data. This threshold values are assigned after the survey at the site where the sensors are to be employed. These data is based on the sustainability of the natural property & offset value of sensor at the time of installation. This data is then compared with the present sensor data. This compared data is the input for the 3rd block which is named as the error block of the self learning system. If the error is less then there is less probability of hazard but if the error is high then the probability of hazard is very high.

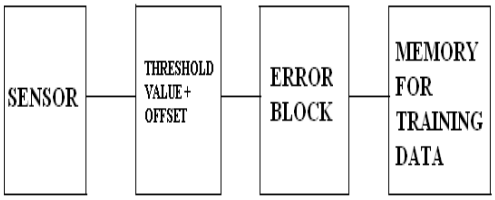


**Fig 2. Block Diagram of Neural Network for Training**

## 3. EXAMPLE OF NEURAL NETWORK
Suppose there are three sensors and three nodes that make the whole neural network. For implementing the network in lab three sensors were connected to different nodes which were placed at different places.
Thus obtained matrix can be visualized as:

$$\text{SENSOR\_DATA} = \begin{array}{c} \\ \text{node1} \\ \text{node2} \\ \text{node3} \end{array} \begin{array}{c} \begin{array}{ccc} \text{sensor1} & \text{sensor2} & \text{sensor3} \end{array} \\ \begin{bmatrix} S11 & S12 & S13 \\ S21 & S22 & S23 \\ S31 & S32 & S33 \end{bmatrix} \end{array}$$

$$\text{THRESHOLD\_DATA} = \begin{array}{c} \\ \text{node1} \\ \text{node2} \\ \text{node3} \end{array} \begin{array}{c} \begin{array}{ccc} \text{sensor1} & \text{sensor2} & \text{sensor3} \end{array} \\ \begin{bmatrix} th11 & th12 & th13 \\ th21 & th22 & th23 \\ th31 & th32 & th33 \end{bmatrix} \end{array}$$

**ERROR = (THRESHOLD_DATA – SENSOR_DATA)**

$$\text{ERROR} = \begin{array}{c} \\ \text{node1} \\ \text{node2} \\ \text{node3} \end{array} \begin{array}{c} \begin{array}{ccc} \text{sensor1} & \text{sensor2} & \text{sensor3} \end{array} \\ \begin{bmatrix} S11 - th11 & S12 - th12 & S13 - th13 \\ S21 - th21 & S22 - th22 & S23 - th23 \\ S31 - th31 & S32 - th32 & S33 - th33 \end{bmatrix} \end{array}$$

If the values of the error matrix are greater then there is less probability of natural hazard and if it is less then there is more probability of occurrence of natural hazard. Natural hazard is not the result of the single sensor data variation then the combined effect can be calculated by assigning the weights for the elements of error matrix.

If error (i,j) ≥ 0--- then sensor input data is greater than threshold so possibility of natural hazard

If error (i,j) < 0--- then sensor input data is less than threshold value so no possibility of natural hazard

Now the sum of each row of error matrix is calculated, if the sum is greater than 2, then this can be predicted that there is possibility of natural hazard at corresponding node.

## 4. SELF LEARNING PROCESS OF THE SYSTEM

In this system we are taking the two stage process. Firstly the training is given to the neural network in the lab then the data is fed in the FFD to take the decision whether to send data or not.

In first process the data is processed at the base station. The input is taken from the output of the sensor nodes which is send to the end device through WSN. On the basis of this data the first input block of the BP algorithm is made by using the output given by sensor to the wireless node view software. This data is then processed by using any mathematical tool at the base station.

In our work this data block is compared with the threshold value data by using the neural network toolbox in matlab. This threshold block is like the hidden layer in BP algorithm. The third error block is made by comparing these data. This block data is our processed and trained data for our system. This block data is the training data for the nodes.

This trained data is used for the decision making by the nodes. Real-time error block data will be compared by the training data which is saved in the memory of nodes. If that compared data block consists the high error than the data will be transmitted to the end device otherwise that data will be saved for experience purpose of the node. By using this trained data node will make the whole WSN intelligent for power management.

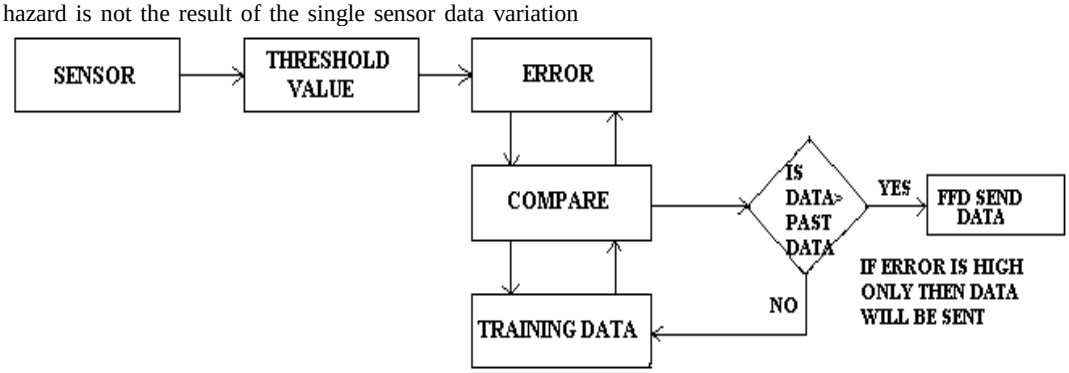


**Fig 3. Neural Network for Trained Node**

## 5. POWER EFFICIENCY INCREMENT BY REDUCING DATA REDUNDANCY

Energy consumed by sending byte data is hundred times than energy consumed by executing an instruction, and times of RF transceivers will remarkably be reduced by data fusion, after training the wireless nodes by the lab data. When the error block value increases high than the preferred value, only then the FFD will send the data to the end device otherwise it will process the next data. So the same data will not be sent to the end device more than one time. This process will decrease the power consumption of the WSN up to very less level.

## 6. EXAMPLE OF TAKING A DECISION

Data are taken arbitrarily. These are not real field data.

$$\text{SENSOR\_DATA} = \begin{array}{c} \\ \text{node1} \\ \text{node2} \\ \text{node3} \end{array} \begin{array}{c} \begin{array}{ccc} \text{sensor1} & \text{sensor2} & \text{sensor3} \end{array} \\ \begin{bmatrix} 100 & 2 & 1 \\ 200 & 3 & 2 \\ 300 & 4 & 3 \end{bmatrix} \end{array}$$

$$\text{THRESHOLD\_DATA} = \begin{array}{c} \\ \text{node1} \\ \text{node2} \\ \text{node3} \end{array} \begin{array}{c} \begin{array}{ccc} \text{sensor1} & \text{sensor2} & \text{sensor3} \end{array} \\ \begin{bmatrix} 275 & 2.6 & 2.4 \\ 235 & 2.2 & 2.1 \\ 250 & 2.4 & 2.6 \end{bmatrix} \end{array}$$

$$\text{ERROR} = \begin{array}{c} \\ \text{node1} \\ \text{node2} \\ \text{node3} \end{array} \begin{array}{c} \begin{array}{ccc} \text{sensor1} & \text{sensor2} & \text{sensor3} \end{array} \\ \begin{bmatrix} -175 & -0.6 & -1.4 \\ -35 & 0.8 & -0.1 \\ 50 & 2.4 & 0.4 \end{bmatrix} \end{array}$$

$$\text{WEIGHTED ERROR} = \begin{array}{c} \text{node1} \\ \text{node2} \\ \text{node3} \end{array} \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 3 \end{bmatrix}$$

By seeing the weighted error sum matrix we can easily predict the following results:

node 1------ no possibility of hazard

node 2------ no possibility of hazard but it should be observed

node 3------ surety of natural hazard, proximity warning can be given

On the basis of this calculation natural hazard can be predicted

## 7. CONCLUSION

This process will give WSN self learning and decision making capabilities whether to send data or not. By implementing this we can also make the decision of time span when the hazard will take place on the basis of the past collected data. In this system the data is send when the data crosses the threshold value. If the data is within the prescribed value, then data is not send by the FFD to the network. By implementing this method we can reduce the power consumption to a very low level and the data redundancy is also been decreased. Reduced data redundancy will also reduce the size of our database.

## 8. REFERENCES

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