Neural networks for error detection and data aggregation in wireless sensor network

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Abstract

Correct information and data aggregation are very important in wireless sensor networks because sending incorrect information by fault sensors make to wrong decision about environment and increasing defective sensor during the time incorrect data decries reliability of wireless sensor networks. Previous methods have Problems such as there are fault sensors in wireless sensor network therefore wrong data are sent to CH by these sensors.

In this paper apply the neural network within the sensors, fault sensors and wrong data are discovered and eliminated. That is increased efficiency and reliability and longevity sensor networks.

Keywords: *CH, sink, Base Station, neural networks, error detection, data aggregation, reliability*

1. Introduction

Neural networks are a new tool to analyze complex and difficult issues, new strategies must be introduced. Neural networks are computer algorithms based on stimulus and response structure of the human brain have been the model. These networks often learn to map input - output a set of templates and are used samples. Functional relationships between variables "learned" are defined without the need is the relationship between individual variables. Neural networks to solve the problems that the relationship between variables is not clear, it isn't very useful. [1,2,3]. Recent technological advances such as sensors, electronics, computing devices, causing researchers tendency towards wireless sensor networks. Wireless sensor network typically consists of a large number of inexpensive sensor nodes, multi-functional, and limited energy and computing capabilities and communication [7,8]. We distributed sensors in the environment and clustered with clustering techniques them and we have chosen a cluster head for each cluster. Sensors send their information to CH. It using the techniques of data aggregation, it sends result to the sink, which this schema saves energy. Many sensors may be produce repetitive data with data aggregation schemas can reduce extra data. Different schemas are explained in [4,5]. Considering processing consumption energy less than transmits, data aggregation is very important because that, many protocols has been used this technique. We can use signal processing techniques, one of them is Data Fusion obtained more accurate information. Faulty sensor sends wrong data to CH and it sends to base station, and caused false information to be processed this is disadvantage of previous methods.

In this paper we presented embedded neural network into sensors and it is trained when the placement within them, which increases the reliability of neural network. We already have been determined the environment and therefore we know initial information about the environment. Education Network have done with them so that when we detect error with new data and neural network's result, which we can improve data collection in sensor networks. Section 2 a summary of neural networks and Section 3 the idea of using neural network within the sensor and check the results in Section 4.

2. Related work

Some of the data aggregation schemas [9,10] network is clustered at first. Then CH applies data aggregation. Lotfinezhad and Liang in [11] have tried to consider the effect of data to some extent dependent on the efficiency of clustering methods in data aggregation. Kstryn and his friends [12] have tried to estimates data of a node in a certain time with a third degree equation and instead send their data, send the polynomial coefficients. Dasgupta and his colleagues [13] have assumed every node able to do data aggregation into network. They presented a method based on the assumption for increasing the lifetime of the network. Beaver and Sheref in [14] have proposed an algorithm that tries to route a group of similar sensors discover (which sensors that produce the same data). In [10] sensors send model of data that shows how all the sensor's data based on predetermined intervals are subject to change. [11] Using the above negotiation transmission of extra data can be removed. In [15] published directly have been proposed as data gathering protocol for sensor networks which aims to monitor events that usually using a small number of nodes [16] a query system network. Roddy and Jack in [14] have been used a machine learning techniques which sensor nodes only send special data to the sink. Learning algorithm used in this way, the sink performed and then the results will be published on the network. Liang and colleagues [17] have used Q-learner for each node because they send their data along the path whit maximum rate of aggregation. In [18] are presented a method for data aggregation using learning automata.

Where are neural nets begin used?

The study of neural network is an extremely interdisciplinary field, both in its development and in its application. A brief sampling of some of the areas in which neural networks are currently being applied suggests the breath of their applicability. The examples range from commercial successes to areas of active research the show promise for the future. For example applied neural networks is signal processing, control [Nguyen & Widrow, 1989; Miller, Sutton, & Werbos, 1990], pattern recognition [Le Cun al., 1990], medicine [Anderson, 1989; Andeson Golden, and Murphy, 1989], [HechtNilson 1990], speech production, speech recognition and in the our idea used in wireless sensor network (WSN).

Who is developing neural networks?

This section presents a very brief summary of this history of neural networks, in terms of the development of architectures and algorithm that are widely used today. Results of a primarily biological nature are not included, due to space constraints. They have however, served as the inspiration for a number of networks that are applicable to problems beyond the original ones studied. The history neural networks show the interplay among biological experimentation modeling, and computer simulation / hardware implementation. Thus the field is strongly interdisciplinary. The 1940s beginning of neural networks: Warren McCulloch and Walter Pitts designed what are generally regarded as the first neural networks. Then Donald Hebb, a psychologist at McGill University, designed the first learning law for artificial neural network in 1947.The 1950s and 1960s is first golden age of neural networks: algorithm today neural networks are often viewed as an alternative to traditional computing; it is interesting to note that John Van Neumann, "the father of modern computing," was keenly interested in modeling the brain. Johnson and Brown (1988) and Anderson and Rosenfeld (1988) discuss the interaction between von Neumann and early neural network research such as Warren McCulloch, and present further indication of van Neumann's view of the direction in which computers would develop.

3. Propose Idea

In this article we let embedded neural network into each sensor. Each sensor sense data from the environment and also which has sense of sensor data as well as its adjacent receives. So that each sensor to communicate with others without the knowing their location therefore sensors are not dependent on location, for example, if the effect of environment factors such as wind, sensors are moved and they identify new neighbors they haven't problem and then work with new neighbors. Figure (1) How to communicate the sensor has been shown that the sensor broadcast data to radius R and there are sensors in the radius R. If they need the data; they can receive data. The presented idea due to neural networks within the sensor; therefore sensors need data by the neighboring sensors. These data are input for neural networks using training neural networks.

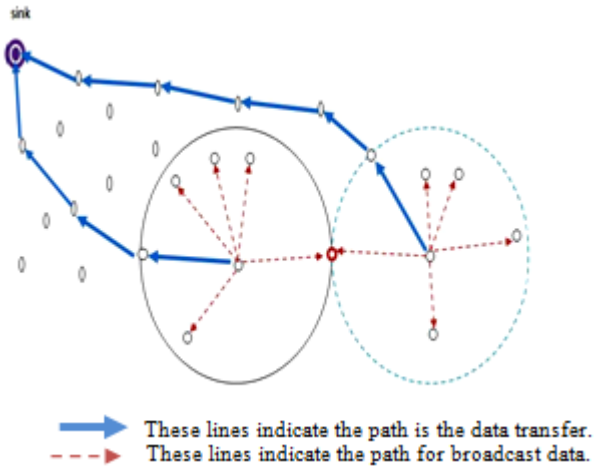

Fig. 1 A way to receive information from nearby sensors

Function neural network train with the data; they received from neighbor sensors and then they produce a data (That is generated neural network's data). This data compare with sense data by the same sensor and then calculate rates error between the two data (production data with neural network's data) and call this error α.

$$|\text{Data neural network} - \text{Data sensor}| = \alpha. \quad (1)$$

We consider β for accuracy of production data. If $\alpha > \beta$ then the sensor is defective (unsafe); therefore sensor and his data remove the wireless network (intercept to send unsafe data to CH, when happen this we save energy because we prevent consumption energy for sending unhealthy data to the CH). But if $\alpha < \beta$ then sensor is safe, therefore sensor can send data to CH (correct data is sent). Because the sensor adapt to changing environment and it's education is not only in the production stage, the neural network trains whit the own data and data received from neighboring sensors that are correct (according to above description) and we make update training of neural networks and we increase neural network's reliability. If we fail to discover and eliminate faulty sensors and the sensors can still send incorrect data to CH and this is continue whit increasing the number of faulty sensors to more false data will be sent to CH and because CH decide based on data received from sensors in cluster and CH dose data aggregation so CH can't decide and we can't trust the network's result after a certain time (This sensors of WSN haven't neural network), but we can trust the result of network which the sensors of WSN have neural network because increase reliability of WSN and lifetime of WSN.

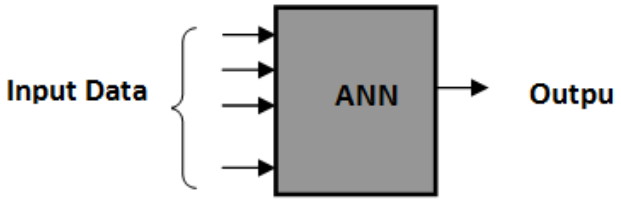

Fig. 2 neural network

How to schedule and arrange the input data to neural network. Figure (2) data of adjacent neighbors as input neural network time (t) and generated a output at the time (t_i) then compared this output whit the sense data by the sensor at the time(t_i+1), inputs at the time (t_i+2)are for training the neural network, this time training is applied with the supervisor then neural network is updating, at the time (t_i+3)all stages begin at first. Instructions sensor is as follows:

If sense data == true then

Continue;

Else

Turn off;

3.1 Sensor structure in our idea

Components of each sensor is shown in figure 3:

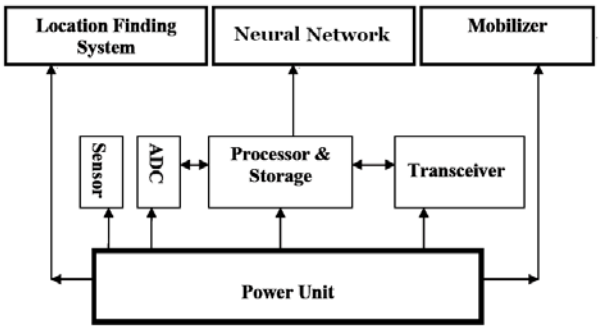

Fig. 3 Interior Sensor

Devising neural network within the sensors author to increase processing and because processing uses less energy than post processing so the amount of energy that we lose is more less than energy that we use to send data's and its reason of that we use neural network in the sensors

and the other reason is it increases longevity of the network and increases reliability about the network.
Figure (4) a. It considered the normal case of sensor network and in this shape when the failure occurs the sensor don't notice that and always send the incorrect data with the energy amount of NW joules that N is length and W is weight of the way during the course and this faulty sensor continuously sends this incorrect data that cause the increasing of the energy of the other sensors of the network. Figure (4) B. Because we have neural network in the sensor at the first of processing diagnosed that the data is incorrect. This incorrect data uses some energy for processing but after this, this data will never send to base station. Although neural network is considered redundancy for the sensor network but this redundancy is effective in using of energy because as the instructions provided the faulty sensor eliminate and because it doesn't send a fault data the energy can be saved. There is another way for the implementation neural network: We use nerve into the base station and this way not only decrease processing but also falsely stored the energy and also it includes some limits, for example it limited us that the sensor is be implant to know the location of the sensors and its neighbors and if a sensor shifts to other location it has trouble to identify its neighbors.

Fig. 4_a sensor without neural network

Fig. 4_b sensor with neural network

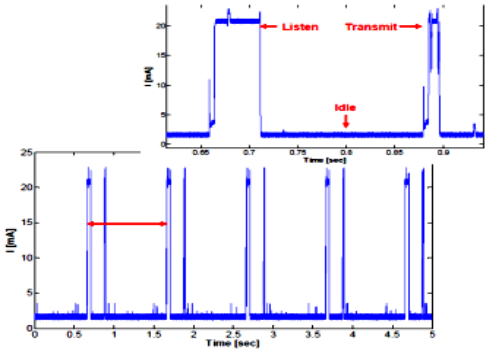

Fig. 5 consumption energy transferring data and processing data

As seen in the figure 5 transferring data uses more energy than processing data.

4. Simulation to verify the idea

4.1 Energy

If we assume that collecting data is time based, cluster collects the level of the data and the region is clustered but in the sensors there isn't any neural network and after a certain time all sensors start to send data to CH if the data was correct or incorrect! Sending to cluster is been done but in our idea sensors can decide that the generated data is correct or not and after that it be sure that the data is correct and then it goes to send it.
As sending data from any sensor in neural to cluster uses some power when the sensor is broken it use this energy again and send an incorrect data to CH (a useless send that just uses the energy in the sensors network and also reduce the accuracy of decision in the CH).in our idea this amount of energy that broken sensor uses to send the fault data to CH is stored in the network.(These broken nodes are the source of energy in the network that they can use in the routing of other clusters data to sink, after that they use they energy to send unbroken sensor's data to sink).
If in case that there isn't any neural network in the sensors we have assumedly 100 sensors in a cluster each time we send data to CH all of the sensors attempt to send data to CH and always the certain amount of energy have to used (if the sensors produced data is correct or not)we will use 100x W power (if any sensor use x W power).. The diagram 6 shows the use of energy with increasing breakdown in the cluster that its sensors have neural network to 50 breakdown of 100 of the network with increasing the measure of breakdown the amount of energy using is like this:

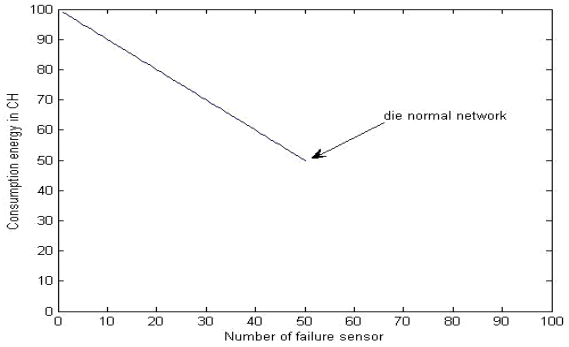

Fig. 6 energy consumptions

4.2 Data collection in networks without neural network

Currently available network sensitive sensors for collecting data work like this way that the sensed data with sensors send to the CH and CH collect the data's. If we consider some sensors in the environment with increasing of the sensor failure CH make a false decision about its area and if at least half of sensors work incorrectly the cluster dead will happen and limited cluster will send a false data to sink. The following chart shows the same. By this diagram (2) if we consider a cluster with 100 sensors (at first we consider that all of the sensors are work correctly) if our sensors are safe they build data 7, 8 or 9 and if they were rotten they build data 0,1,2,3,4,5,6, or 10. (That the data range in this environment is between 0 to 10) because sensors are distributed in clusters using a majority vote when the CH has healthy majority of sensors (with using of aggregating data's) the correct answer sends from CH to sink (the correct answer is 7, 8 or 9) but by this diagram when the most of sensors are defective the incorrect data is send to sink.

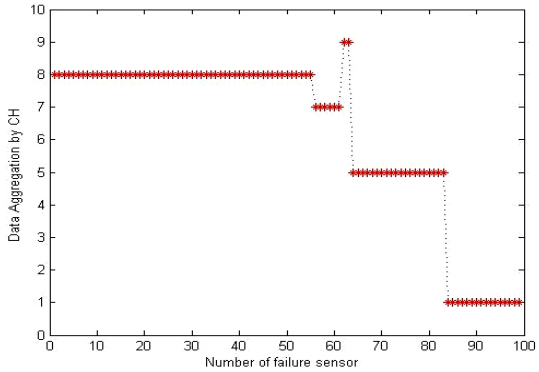

Fig. 7 Data aggregation networks with neural network

4.3 Data aggregation networks with neural network embedded within the sensor

In our idea to prove the accuracy of data produced in each sensor we embedded neural network in each of them. To simulate the above environment that we implement with normal sensors or sensors without neural network at this time we implement it with sensors that they have neural networks and by the below diagram with increasing of failure of sensors still data sent from CH to sink (data is just one of the data 7, 8 or 9 and the range of data is between 0 and10). When death has occurred in the regular network or more than half of the sensors are broken (means that the aggregate data is the result of incorrect data) by the below diagram this network still make correct data's and send it to sink.

Even with only 1 healthy sensor in the environment the network continue its life (it means death of the network don't be happen) the diagram tells it:

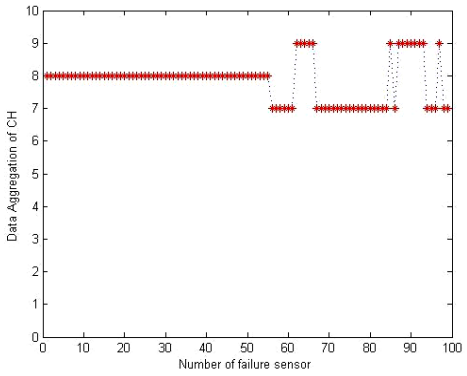

Fig. 8 Data aggregation

4.4 Increased longevity of Network

Bye the diagrams 2 and 3 because increasing the number of sensors failure still the network that its sensors have neural network give us the correct answer and it shows us that the network death don't happen with increasing of the corrupted sensors.

By the diagram 2 death of cluster (small sensor network) is happen if the 61 sensor of 100 sensors corrupted. But the sensor network that the sensors have neural network or data isn't send from sensor to CH or if data will be sent we can trust that data is correct.

5. Conclusion

Because each sensor depends on the performance of its neural network and neural network performance is the way that its performance increase at the time that you learn and in this passage studying neural network is continued and

this work cause the increasing of ensure of neural network with the time going up and it cause increasing reliability of the wireless sensitive networks.

And neural network also can increase the longevity of wireless sensor network. Another desired result is achieved by using this method is identify and delete incorrect data element that they are destructive, redundancy that created by using neural network in the sensors is prevent transmission of false information and it results in energy consumption is being optimized.

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