Minimum Power Intelligent Routing In Wireless Sensors Networks Using Self Organizing Neural Networks 11 h 10 22 12 Abstract The routing problem in wireless sensor networks is one of the most important issues that guarantee the optimum functionality of a sensor network. Due to the energy limitation of each node in a sensor network, routing should be done in	Định Tuyến Thông Minh Công Suất Cực Tiểu Trong Các Mạng Cảm Biến Không Dây Bằng Các Mạng Nơron Tự Tổ Chức Tóm tắt Vấn đề định tuyến trong các mạng cảm biến không dây là một trong những vấn đề quan trọng nhất đảm bảo khả năng hoạt động tối ưu của một mạng cảm biến. Do những giới hạn về năng lượng của mỗi nút trong

a way that the overall network life time will be maximized. In this paper we present an intelligent method based on self organizing neural networks which optimizes the routing according to the amount of energy of each node in the network and its computation power.

một mạng cảm biến, quá trình định tuyến nên được tiến hành sao cho tổng tuổi thọ mạng đạt cực đại. Trong bài báo này, chúng tôi trình bày một phương pháp thông minh dựa trên xác mạng nơ ron tự tổ chức để tối ưu hóa quá trình định tuyến theo lượng năng lượng của mỗi nút trong mạng và công suất tính toán của nó.

I. Introduction

Recent developments in production of micro chips have led to creation of new and powerful tools for identification of different kinds of critical and dangerous environments. Wireless sensors network is one of the most important tools to do this job. These networks contain a set of small processing units equipped with different capabilities in understanding of the environment and transmitting gathered data. Usually, these small sensors (units) are produced in large number and are distributed on desired area using an aircraft. After distribution on the desired area, the set of these sensors should start to setup connections with other groups and form a network to be able to transmit the captured data from surrounding area to the data center. Due to the small dimensions and light weight, each node in a wireless sensor network has three big limitations.

The first and the most important limit is low power consumption. It means that each node should use the least possible amount of energy in its activities.

Because by reaching the end of its battery life, it won’t be able to do its job in the

sensor network and will be eliminated from the network set.

The second limit is the few computational power and storage of each node. Each wireless sensor is usually made of a low-frequency microcontroller and a small memory to be optimized in either mass production costs or power consumption. This limitation gives special requirements and features to the computational algorithm of the sensor network.

The third limit of a sensor node is its low radio coverage that is caused because of the lack of big and powerful antenna. This problem causes the access to only a limited number of sensors around each node and magnifies the importance of the routing problem.

II. The MODABER wireless sensor node

MODABER is a wireless sensor node made in the Artificial Intelligence Research Center of University of Isfahan. This wireless sensor node has such an especial features on which this project is based. This sensor node has an ATMEGA32L RISC processor with 8 MHz working frequency that is able to communicate with other sensors on 3.5 MHz radio frequency. Wireless communication in MODABER uses a Digital Coding method that has reduced the problem of frequency interference.

MODABER has a 256MB Flash memory that provides the capability of gathering reports from surrounding area for a long time for it. It has also a set of sensors which are able to sense the movement of an object in a 10m boundary. These sensors consist of a Sound Sensor and a

Light Sensor that understand the environment sounds and light changes. Picture1 shows an instance of the MODABER wireless node.

The routing algorithm of this paper is based on the features of the MODABER wireless sensor nodes. The MODABER node has around 1Km radio coverage and 10-15m sensing coverage. The MODABER wireless sensor network is a researching and experimental platform used for scientific testing of proposed algorithms in this research.

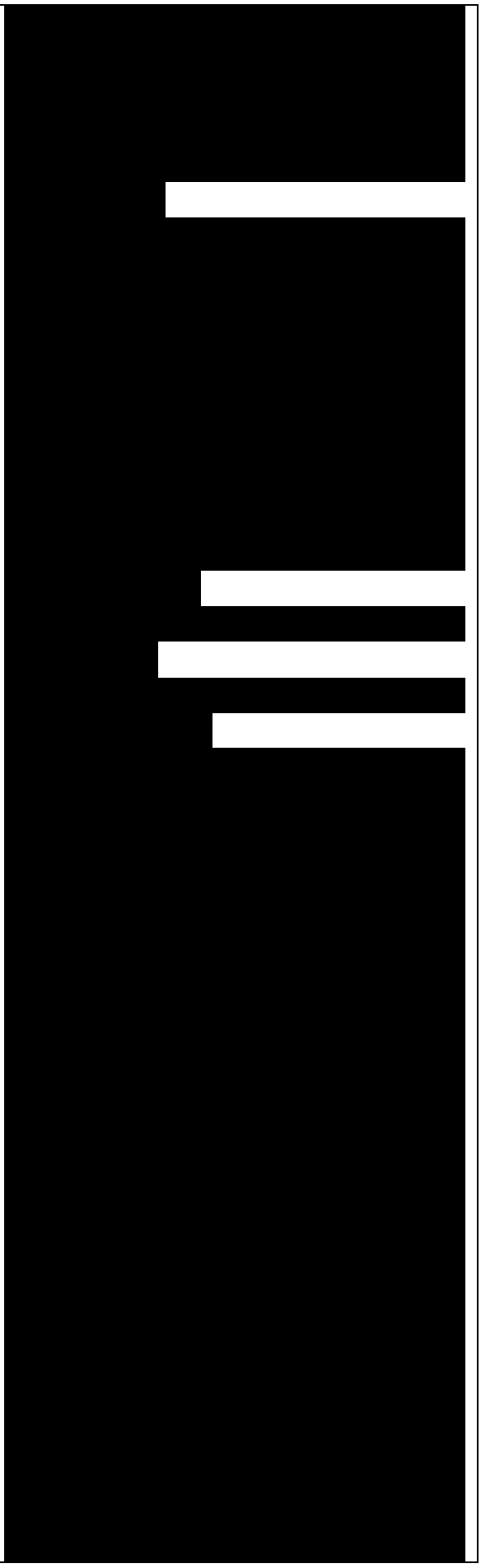

Fig. 1 MODABER wireless sensor node

III. Routing in Wireless Sensor Networks

Networking unattended sensor nodes are expected to have significant impact on the efficiency of many military and civil applications such as combat field surveillance, security and disaster management. These systems process data gathered from multiple sensors to monitor events in an area of interest. For example, in a disaster management setup, a large number of sensors can be dropped by a helicopter. Networking these sensors can assist rescue operations by locating survivors, identifying risky areas and making the rescue crew more aware of the overall situation. Such application of sensor networks not only can increase the efficiency of rescue operations but also ensure the safety of the rescue crew. On the military side, applications of sensor networks are numerous. For example, the use of networked set of sensors can limit the need for personnel involvement in the usually dangerous reconnaissance

missions. In addition, sensor networks can enable a more civic use of landmines by making them remotely controllable and target specific in order to prevent harming civilians and animals. Security applications of sensor networks Include intrusion detection and criminal hunting.

Routing in sensor networks is very challenging due to several characteristics that distinguish them from contemporary communication and wireless ad hoc networks. First of all, it is not possible to build a global addressing scheme for the deployment of sheer number of sensor nodes. Therefore, classical IP-based protocols cannot be applied to sensor networks. Second, in contrary to typical communication networks almost all applications of sensor networks require the flow of sensed data from multiple regions (sources) to a particular sink. Third, generated data traffic has significant redundancy in it since multiple sensors may generate same data within the vicinity of a phenomenon.

Such redundancy needs to be exploited by the routing protocols to improve energy and Bandwidth utilization. Fourth, sensor nodes are tightly constrained in terms of transmission power, on-board energy, processing capacity and storage and thus require careful resource management.

IV. Minimum Power Routing

In a wireless sensor network the nodes are distributed in different positions in a desired geographical area. Each node according to its position has a specific importance and value in the routing procedure of packets. Due to the limitation of battery life of each node, the nodes that participate in routing more than the others will have less battery life. So it's needed for the nodes playing more important rule in routing because of their position to have more battery life in order to let the routing process stay stable after destroying of them. We define the network life time parameter of each wireless sensor network as below:
i^LT=(KIMIr /«£„>

In this equation NLT is the total lifetime of sensor network, is die importance of node i in routing in the network at time t, ££; is the amount of energy consumption of node i for routing at time t and a is a constant.

The goal in the Minimum Power Routing is to maximize the sensor network life time (NLT) and we present a solution with low computational complexity for this problem.

V. Self Organizing Neural Networks in wireless sensor network routing

Self Organizing Map Neural Networks are a kind of neural networks that use the unsupervised learning. The capability of distinguishing the clusters has led to description of the concept Self Organizing. Biological theories, expansions and expressions of this kind

of networks are very important. Neural biologic systems, almost present a significant arrangement or local structure of neurons based on learning or teaching. It's very important that unsupervised learning algorithms can be implemented with first order equations. These equations show how the weights of network change by time or by repetition in discrete form to be compatible. Self organizing criteria try to

In a wireless sensor network each node has low computational power and limited storage. In addition it's required to perform the environment sensing, data processing, receive and send of data packets in parallel. So it's impossible to use the intelligent methods with much processing efforts in optimizing the routing method. The learning algorithms of SOMs generally obey from linear computations, so they can be used efficiently in a wireless sensor node. In addition low storage capacity and capability of using during learning are other advantages that encourage us in using neural networks in solving of minimum power routing problem.

a) Problem Modeling

A Wireless Sensor Network consists of some nodes that cover a geographical area. Each wireless node communicates with a number of its neighbor nodes according to its wireless hardware coverage. Each node after sensing an object from surrounding environment performs some processing on it and tries to identify it and then reports its findings as a data packet to the center, if it's

needed. This report is put in the data field of the packet. Data packet of this protocol is shown below:

Each node according to the kind of its report from the occurred event in the surrounding area puts the Data field in the packet and sends it to the lower layer. This protocol has 3 layers which are shown at below:

1- Sensor Layer
2- Routing Layer
3- Physical Layer

The Sensor Layer is responsible of sensing and identifying the environment and making the Data field according to the sensor data.

The Routing Layer adds the feature vector of the routing, generated address of the source and the destination, request number, sequence number and CRC to the packet.

At the Physical Layer each sensor transmits a sequence of bits of the information packet in the form of radio waves to make the neighbor nodes able to receive these signals. Each sensor after receiving a packet delivers it to the Routing Layer and by extracting the Feature Vector field from it, generates the new value of Feature Vector according to its neural network decision making system and puts it into the packet. By moving of a packet from a node to its neighbor node, the value of the field of Feature Vector replaces according to the neural network decision making system of that node. The replacement of feature vector of the packet should result in the minimum total cost of transmitting a packet from source to the destination. It means that the variations of the NLT

parameter should be minimized. By each pass of a packet through a sensor node, the value of the feature vector updates the weights of its self organizing neural network so that finally the NLT become maximum.

b) Training of the neural network during the routing

The goal of minimum power routing is to distribute the routing function in the network so that any node won't go down because of heavy load and also none of the nodes exit routing process because having nothing to do! So, the self organizing neural network should manage the decision making of the nodes in a way that more useful nodes last longer. Each node consumes its energy by running the routing process and transmitting information and shapes the routing. Each feature vector has N elements. N is equal to the number of the nodes in a wireless sensor network and is initialized to 1. By arrival of a packet and extraction of its feature vector, this vector will be delivered to the self organizing neural network of that node and after winning of a node in the competition between neurons the node will be allowed to send the packet. It should reduce the value of Kth element of the feature vector by B and replace the new feature vector in the packet and transmit it. (K is the index of the receiver node between N sensor nodes.) The received packet will be dropped by lose of neuron K in the competition inside neural network.

The equations show the changes of weights of neurons in this network:

In this formula mi is the ith neuron of the

Som , P is a learning factor and i(t) is the Feature vector in time t which has been entered the som. N c is the winner neuron in the competition of neurons

The figure 3 shows the functionality of this algorithm.

Fig. 3 Flowchart of our routing algorithm

VI. Simulation

We have designed a simulation environment to test our algorithms for MODABER wireless sensor system. this simulation environment simulates functionality of our Nodes with respect to our limitation in a MODABER node .This can help us finding the problems and errors of our algorithms before running them in the real nodes.

In this environment we can change the values of training the system to find out the best values of these parameters .figure 4 shows this simulation environment.

Fig. 4 :MODABER simulation environment

VII. Conclusions

We introduced a new method for routing in a wireless sensor network which uses self organizing neural network in each wireless node to decide containing the packet and taking part in routing or dropping it out. This system has been established to uses in MOBABER wireless nodes which we try to make it available to perform in the real situations. The time complexity of the algorithm is linear so it can be useful for our wireless nodes. Currently we are working on the other algorithms of our physical platform to test the system in a real battlefield.

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