

Hybrid method of self-organization of wireless sensor and actuator networks

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Abstract – Wireless sensor and actuator networks (WSANs) are used for longterm observation and monitoring. Such long-lasting deployments require different maintenance tasks, such as the replacement of nodes - motes, and the most critical initial installation of the sensor nodes. We propose the algorithm is the self-organization of wireless sensor and actuator networks, which determines the productivity of the network during operation. During maintenance, the actual motes placement is modified resulting in temporary topology fluctuations, which are very expensive in terms of energy. We analyzed an algorithm for constructing a route taking into account aspects of the effective energy usage of network objects.

Keywords – sensor, actuator, self-organization, initialization

I. INTRODUCTION

The operation of wireless sensor and actuator networks (WSAN) are the subject of numerous studies and articles. This is because for effective operation of the WSAN require optimal energy efficiency, fault tolerance, timeliness of information delivery, detection and correction of errors, etc. But the system will not be effective without a proper network configuration in the initial stage of work between the placement of the motes (nodes WSAN) and the compliance of their immediate network functions. This stage is called – self-organization. It is often the most energy intensive, time-consuming, but very important phase of work. Let us consider this phase of the WSAN work.

Self-organization is the process of self-configuration, reception of information on the position of the nodes, possible routes, about the state (operability) of nodes and a large number of other proprietary information that determines the capacity and effectiveness of the network.

Routing and self-organization in the WSAN is difficult separable from each other processes. The protocols of the network layer include the basics task of self-organization – fully working network with the structure and a finite set of routes.

Currently the self-organization in WSAN will also explore the process of self-education, configure, and maintain a wireless network that is able to regu-

late its parameters and change the logic operation in response to the treason of external factors such as load, change of the structure due to failure of nodes due to the reduction of energy power sources, because of the presence of errors in transmission/reception with the communication over the air, etc. And the purpose self-organization in WSAN is the creation of fully autonomous network after deployment can function without operator intervention.

The algorithm of self-organization takes into account several aspects:

- support of different number of devices in the network (scalability);
- organizing network with minimum energy costs (energy saving);
- the limited capacity of reel (limited computational abilities, small amounts of memory, etc.).

II. THE BASIC METHODS OF SELF-ORGANIZATION OF WSAN

To date, there are over 100 different algorithms of self-organization in the WSAN, which can be divided into groups. [1,2]

The creation of clusters. This approach was different in that a group of several network nodes organized in a cluster. Of the nodes of this group is selected as the cluster head. All cluster nodes gather information and transmit it to the head of cluster, then the head of the cluster processes the received information and transmits it to the data collection node.

Creating chains of links. Many sensor devices build chains to a single node, which subsequently transmits the collected data to the special node.

The creation of a tree structure. This approach resembles the previous one. The difference is that the root of the tree links is the node of data collection.

Geographical approaches. In geographical approaches use knowledge about the location of nodes, obtained, for example, with installed on the device modules of location-GPS/GLONASS. Using these data, the nodes can be organized into the appropriate structure.

Approach using the *heterogeneity of network nodes*. It is assumed the presence of a network of heterogeneous nodes (heterogeneous network). Nodes of the same type are only collecting data, and the nodes of the other type are engaged exclusively in

the distribution of the collected data over the network.

Hybrid. Combine the advantages of several of these methods.

III. A HYBRID METHOD OF SELF-ORGANIZATION WITH CHAINS OF SITUATIONAL CLUSTERS

A hybrid method of self-organization with CSC (Chains of Situational Clusters) is developed based on the algorithms with the creation of clusters and chains. The algorithm involves the following steps.

Corresponding base station (BS) sends a signal to the activation of the nodes, which is in the center of the sensor field. To begin collecting information on the initialization phase all nodes of sensor field need to start the transfer, which requires to media access. At the MAC layer (media access control) IEEE 802.15.4 specification [3] recommended the use of the CSMA/CA protocol.

If channel is free the node transmits in broadcast mode the address and location (strength of signal from BS, Fig. 1).

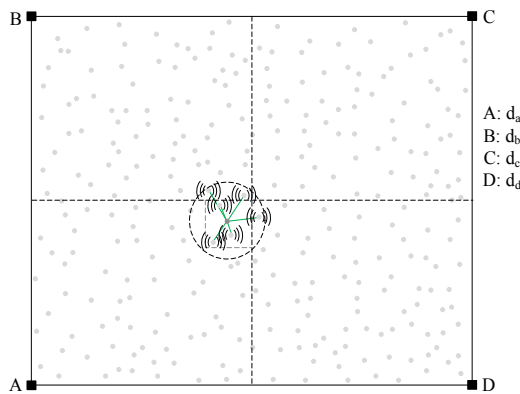


Fig. 1. Creating situational cluster

Nodes, which received this information, send confirmation and settings (address, strength of signal from BS and the value of the controlled parameters) situational cluster head (Fig. 2).

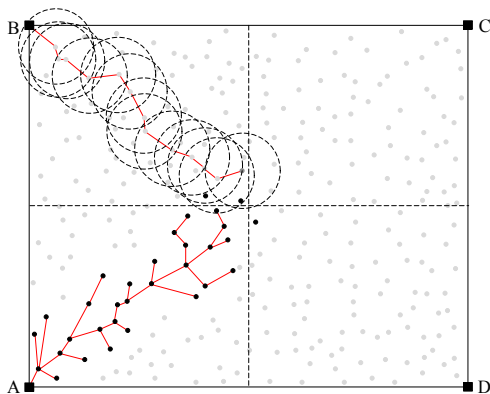


Fig. 2. Chains of Situational Clusters building

Cluster head is getting information from all neighbors and measures the strength of signal to each neighbor, process, consolidates and forwards all information received. Selected node-repeater becomes the next head of the cluster and collects information about its neighboring nodes.

After cycle of gathering information become available a certain percentage of the nodes. Those nodes that are not "shown" in the initialization process of the network, further can be used as a backup and to join the network already in the process of its further functioning. If the number of nodes, information against which reached BS, not enough or the sensor field is too large it can be divided quadrants on additional sectors.

IV. CONCLUSION

Self-organizing networks are the most attractive in our time variant networks, not only for the WSN, but also for telecommunications networks other type. It is not difficult to imagine the network that are absent mechanisms self-organization. This is usually a small network with few nodes (less a few tens), where the data about routes, addresses, gateways, etc. are entered manually. But, to imagine such a network, where the number of nodes exceeds tens of thousands, already hard. It is impossible to manually enter all the necessary information for operation of the network without error. That is why the initialization phase in self-organizing networks often determines the effectiveness of further exploitation. This is an important step. It requires deep analysis and design of the optimal scenario.

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