Approaches and Techniques to form Wireless Sensor Networks

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ABSTRACT

A Wireless sensor network (WSN) has been extensively used in a specified Area for monitoring environment conditions such as temperature, air pressure, light, humidity, motion or vibration and can communicate with each Other using a wireless radio device. Normally, sensor nodes in wireless sensor networks (WSNs) have resource Constraints like limited energy, low storage capacity and weak computing ability. Despite the open problems in WSNs, there are already a high number of applications available. In all cases for the design of any application, one of the main objectives is to keep the WSN alive and functional as long as possible. A key factor in this is the way the network is formed. This survey presents most recent formation techniques and mechanisms for the WSNs. In this paper, the reviewed works are classified into distributed and centralized techniques. The analysis is focused on whether a single or multiple sinks are employed, nodes are static or mobile, the formation is event detection based or not, and network backbone is formed or not. We focus on recent works and present a discussion of their advantages and drawbacks.

***Keywords:* Base station, Cluster Head, Hierarchy, Network life time, routing protocol, Topology, Wireless sensor network (WSN)**

I. INTRODUCTION

Despite the open research areas in wireless sensor networks (WSNs), there are already a high number of current problems in which these networks can be applied. Some application fields include tracking, monitoring, surveillance, building automation, military applications, and agriculture, among others. In all cases for the design of any application, one of the main objectives is to keep the WSN alive and functional as long as possible. A key factor in this is the way the network is formed. In fact, the topology is mostly defined based on the application environment and context. The sensor information is usually collected through the available gateways in a given topology. This information is then forwarded to a cluster head (CH) node or to a base station known as sink.

The design complexity of a WSN depends on the specific application requirements such as the number of nodes, the power consumption, the life span of the sensors, information to be sensed and its timing, geography of where the sensors are placed, the environment, and the context.

This survey presents most recent formation techniques and mechanisms for the WSNs. In this paper, the reviewed research works are classified into distributed and centralized techniques. In the former, nodes are autonomous and the communication is only between neighboring nodes while, for the latter, the network formation is controlled by a single device. The analysis is focused on whether a single or multiple sinks are employed, nodes are static or mobile, the formation is event detection based or not, and network backbone is formed or not.

The survey is dedicated to recent works and presents a discussion of their advantages and drawbacks.

II. Wireless Sensor Networks

Wireless sensor networks (WSN) are composed of a finite set of sensor devices randomly deployed in a given indoor or outdoor environment. A WSN aims to gather environmental data and the node devices placement may be Known or unknown a priori. Network nodes can have actual or logical communication with all devices; such a communication defines a topology according to the application. For instance, there can be a WSN with both types of topologies being the same (mesh, star, etc.). However, this may not be the case for all applications. The logical topology is mainly defined based on the nodes logical role (tasks, etc.). It can be either ad hoc or strategy based (self-organization, clustering, and so on). The strategy is defined based on the network available resources.

Centralized formation techniques are suitable for networks in which the processing power capacity relies mostly on a unique device. In such cases, this device is responsible for the processing, coordination, and management of the sensed information activities. It also forwards this data to a sink node.
The main advantages of this approach are as follows:
(i)Centralized schemes allow more efficient energy management.
(ii)Roaming is allowed inside the network.
(iii)Network coverage analysis is simplified.
(iv)Context information availability allows a better application design (placement of nodes, application awareness, etc.).

III. Centralized strategy

In Distributed formation techniques, the information is managed by each node and decisions are locally taken and limited to its neighborhood (single-hop neighbors). The main characteristics of distributed networks include the following:

(i)There are autonomous devices.

(ii)Each node shares information to its neighborhood.

(iii)It is suitable for distributed applications (multi agent systems, self-organized systems, etc.)

(iv)The information is mainly forwarded to a single node.

(v)Interconnection devices (routers, bridges, etc.) are not required.

The complexity of the forwarding information process requires robust algorithms. The former have to assure the execution of specific tasks with comparable performance to the centralized solutions.

One of the most important distributed techniques in recent years has been self-organization. A sensor network using this strategy is able to achieve an emergent behavior in which nodes interact individually and coordinate autonomously. The target is to achieve tasks that exceed its individual capabilities as a single node. Examples of these techniques are found in nature (biological cells, the flock of birds, the foraging behavior of ants, etc.) [1, 2].

IV. Self-organization strategy

The protocols intended for distributed wireless sensor networks must be able to provide efficient energy consumption considering nodes mobility, environmental noise, limited batteries, and loss of messages, among others. This is a matter of discussion in the following section.

It can be seen that all WSN organization techniques can be classified into one of the discussed groups: centralized or distributed. The following sections present a further classification for each group and their associated main works.

V. Proposed classification

Centralized Wireless Sensor Networks

Centralized networks take directions from a unique device. This central node is responsible for providing network operation services such as node localization, event detection, and traffic routing. A suitable logical topology for this approach is a star. The centralized networks can be classified according to how the information is processed. These groups include the following:

(i) Single Sink- The objective of the formation strategy is to reduce the forwarding time and route the information towards a unique sink. The main drawback of single sink systems is the lack of redundancy.

(ii) Multi sink- Multiple sinks are employed for scenarios in which the previous tasks are distributed to several nodes. This is done for a number of reasons such as network density, coverage area, redundancy, distribution of traffic flows, network life span, and possible energy consumption.

A further classification can also be made according to the dynamics of the node roles. The classes are Hierarchical Networks, Static Networks, and Defined Operational Networks. A brief discussion of this type of networks is given below.

VI. Hierarchical Networks

A sensor defines priorities according to its role in the network. Traffic forwarding nodes have a lower precedence than fully functional nodes (sense, coordinate, process, and forward information). The network control is performed in a hierarchical way and is defined based on the roles. This kind of networks is usually implemented using the 802.15.4 [3] protocol.

For instance, [4] presents a multi sink environment architecture (I Catch you) [5] based on the protocol 802.15.4. It employs a multihop forwarding strategy and addresses the sensor the localization problem. They proposed a centralized technique to guarantee high mobility between sink nodes.

Self-configuration is used to find the appropriate sink for the registration process; there are some metrics used for choosing appropriate sink, how the information is gathering, and so on. Each sensor node receives all messages directly through the sink node. They consider two scenarios; the first one is a closed one with obstacles and interference and the second one without obstacles or interference. The second scenario presents best results because nodes achieved a better performance with a higher distance. Although multihop offers some advantages and it is also easier to guarantee an efficient fast handover between sink nodes. Their algorithms are inefficient because all nodes send broadcast messages and may cause a flooding of the network. Besides, energy consumption or scalability is not taken into account.

VII. CONCLUSION

We focus on recent works and present a discussion of their advantages

and drawbacks. Finally, the paper overviews a series of open issues which drive further research in the area.

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