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A SURVEY ON ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORKS

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Abstract— *Wireless Sensor Networks (WSN) are framed with connected wireless nodes such that each node has the ability of sensing, store, information processing and communicate with other nodes. It comprises spatially scattered self-governing devices with sensors to monitor physical or environmental conditions. Among merits of those, adaptability is strong, fault tolerance is high, and wide-range sensing coverage. Its feature applications are included with a diverse range, like environmental monitoring, home, health care, battlefield surveillance, and so on. In recent times, WSNs have become a crucial space for research. In wireless sensor networks, energy consumption is the main constraint, because in wireless sensor networks during the communication process between the sensors nodes more amount of energy is consumed and reduces the lifetime of the sensor node, which leads to the inaccurate, loss of information.*
Key Words: Sensor, Wireless sensor network (WSN), Energy efficiency, Base Station (BS).

Introduction

A WSN illustrated as an organization of contemporary (probable low extent, low complex) devices indicated as nodes which could experience surroundings and speak the collected statistics from the monitored field information is sent perhaps through many jumps by handing-off to a sink which can utilize it locally, or is snared to a chance local area through a gateway.

- The nodes may be desk-bound or shifting.
- They are concerned about their location or not.
- They may be homogeneous or not

WSNs composed of embedded structures that might be able to:

- Interact to the environment via various sensors
- Processing information locally
- Communicating this data wirelessly with their associates

Sensor nodes are comprised of three parts which are most likely a singular board or implanted into a solitary gadget. Wireless modules are the most significant parts in the present day's sensor, as they have the correspondence capacities and programmable memory where the application code lives. A node normally incorporates a microcontroller, handset, energy source, memory unit and may incorporate a few sensors

A sensor board is snared at the node and is installed with more than one super present-day sensor, the sensor sheets incorporate the MTS300/400 and MDA100/300 that are utilized inside the Mica state of the art contemporary bits. As another option, the sensors might be coordinated into the remote module which incorporates inside the Telos or the SunSPOT stage. A programming board, moreover known as the passage board, gives more than one interface including Ethernet, Wi-Fi, USB, or sequential ports for associating elite bits to an association or business organization or locally to a PC/laptop.

Many software program systems have also been advanced especially for WSNs. Among those, the most recognized platform is TinyOS. The code contained in one TinyOS part incorporates commands adapting to exercises, which they execute

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in response to orders given from other associated parts. which include events dealing with exercises, which they execute in response to activities signaled by connected additives, which themselves timetable for later execution

In wireless sensor networks, nodes communicate with each other through radio alerts, which might be broadcast in nature. Broadcast is a unique case of modern-day multicast, where all the nodes inside the network ought to get broadcast messages.

LITERATURE SURVEY

In general, routing in WSNs can be sorted by network shape into flat-based routing, hierarchical-based routing, and area-based routing. A routing protocol is observed as adaptive if one can adapt to a modern network based on available energy levels in sensors.

Likewise, these protocols can be categorized into multipath-based, question-based, negotiation-based, QoS- based, or coherent-based routing strategies based on their behavior.

Further, based on path rely on, the classification of routing protocols onto proactive, reactive, and hybrid protocols. In proactive protocols, computation of all routes is done earlier, and in reactive protocols, the same will be done when required. By aggregating both ideas hybrid protocols will work[1]. If sensors are immovable, it is better to use table-driven routing protocols instead of reactive protocols.

Utilization of energy is high while discovering routes in reactive protocols. The other sort of routing protocol is known as a cooperative routing protocol, which directs records to a principal node in which data may be accumulated. A wide range of protocols relies on timing and position data.

In the residual section, we extant a comprehensive outline of the main routing paradigms in WSNs.

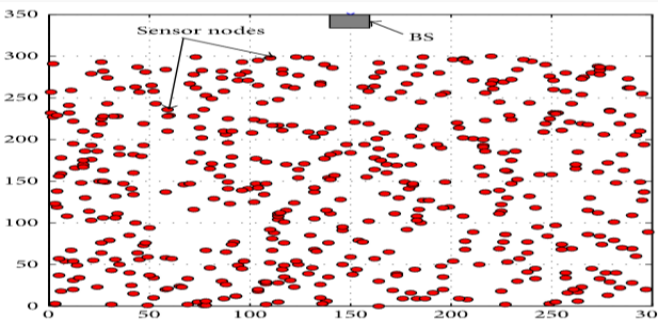

Fig. 1. Sensor nodes Distributed in space with a base station

Network Structure-Based Protocols

The WSNs' basic shape of the network plays a substantial chunk in operating routing protocol. In this, we survey the protocols that fall under this category.

Flat Routing

In flat networks, sensing by identical position, and then carrying the load will be the work of every node. Due to the wide variability of similar nodes, the assignment of global identification made it tough for each node. SPIN and directed diffusion were proven to save strength through data compromise and scrapping of contemporary data.

Sensor Protocols for Information via Negotiation (SPIN):

Sensor Protocols for Information through Negotiation (SPIN) that spread every one of the information at each midpoint point to every data center in association with all midpoints in the association are conceivable BS.

SPIN works with 3-sorts of messages for communicating in sensor networks, which are ADV, REQ, and DATA. The main merit of the contemporary SPIN is topological variations which are limited for every node that wants to know just its immediate colleagues.

Directed Diffusion

It is a data-centric (DC) and operation aware paradigm created for

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sensor nodes for data transfer. The crux of this DC lies in consolidated in-degree information by removing the redundancy to enhance the network lifetime by saving energy. Not like a conventional launch to finish routing, DC routing involve solitary ideal communication with solidification of repetitious information.

In directed diffusion, all sensor nodes are operation-aware, which empowers to negotiate energy by choosing empirical great ways, storing and handling information in the association. Additional use of directed diffusion is to suddenly gain a significant occasion to certain areas of the detector association. A similar kind of data recovery is applicable just for tenacious questions where mentioning nodes aren't awaiting information that fulfill an inquiry for a while.

Hierarchical Routing

Hierarchical or cluster-based routing was proposed for wired networks, with excellent benefits and effective communication. In hierarchical armature, the nodes with high energy are used to transfer data to the BS by acting as head of the cluster, while the nodes with less energy are used to sense the data.

Hierarchical routing is an effective way to reduce the energy consumption in the cluster by doing data aggregating to decrease the number of transmissions to BS, which can increase the lifetime of the node and also reduce the duplicated information.

LEACH protocol:

LEACH is a cluster-based convention, that incorporates discrete cluster arrangement. LEACH randomly chooses cluster heads (CHs) and pivots and assigns the jobs equally based on the energy level in the sensor node. In this, the cluster head (CH) nodes pack information showing up from nodes that have a separate place with cluster and send accumulated data to the BS to decrease how much data should be communicated to the BS.

LEACH has 2 phases, the setup phase, and the steady-state phase. During the setup phase, a random node, p, chooses itself as CH. A sensor node picks an irregular number, r, somewhere in the range of 0 and 1, if the chosen random number is less than the threshold value, T(n), the node turns into a cluster-head and changes from time to time in each round[4]. The threshold value is calculated and which satisfies will a cluster-head for the round, and the nodes that are not selected as a cluster-head in the last (1/P) rounds, denoted by

$$\mathbf{T(n) = p/1 - p(r \bmod (1/p)) \text{ if } n \in G}$$

Where G is the set of nodes that are involved in the CH election. Each chosen CH broadcast a notice message to the remaining nodes in the network that they are the new cluster-heads. All the non-cluster head nodes will be forwarded a notice to choose the cluster for further communicative nodes.

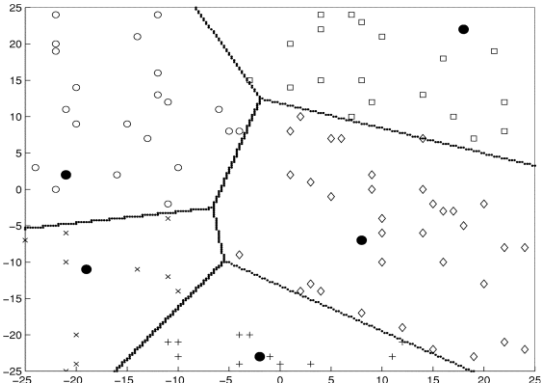

Fig. 2.1. Sensor nodes with cluster heads

Table1 analyzes SPIN, LEACH, and the Directed Diffusion steering methods as indicated by various boundaries. The table says that Directed Diffusion has a promising methodology for energy-effective steering in WSNs because of the utilization of network handling.

	SPIN	**LEACH**	**Directed Diffusion**
Optimal Route	×	×	✓

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Network lifetime	✓	✓	✓
Resource Awareness	✓	✓	✓
Use of Meta-Data	✓	×	✓

Table 2.1: Contrast between SPIN, LEACH, and Directed Diffusion.

Minimum Energy Communication Network (MECN):

The protocol suggested an energy-effective subnetwork, for a specific detector network by using low-power GPS. It distinguishes a hand-off locale for each node. The hand-off quarter comprises nodes in an encompassing region communicating through those nodes is further energy productive than direct transmission[8]. The quadrangle node is also made by taking the association of all transfer sections that the node can reach. The study of MECN is to observe a sub-network for smaller and low-power transmission.

The extension of MECN is a Small Minimal Energy Communication Network (SMECN). The data transmission between all the nodes of a network cannot be done all the time in MECN, but in SMECN possible pairs of nodes are considered for communication. Still, a fully connected network is presumed in the case of MECN.

The flat and hierarchical protocols are diverse in many aspects and comparisons are shown below.

Parameter	**Hierarchical Routing**	**Flat Routing**
Scheduling	Based on the Reservation	Contention-based
Collision	avoided	overhead present
Duty cycle	Reduced due to periodic sleeping	Variable by controlling sleep time of nodes
Data Aggregation	By the cluster head	Node on multihop path
		aggregates incoming data from neighbors
Routing complexity	Simple but non-optimal routing	Routing can be made optimal but with an added complexity.
Synchronization	Requires global and local synchronization	Links formed on the °y without synchronization
Cluster Overhead	Formation throughout the network	Necessary if data is present
Latency on hop	Lower latency as multiple hops network formed by Cluster heads always available	Latency in waking up intermediate nodes and setting up the multipath
Energy dissipation	Uniform and cannot be controlled	depends on traffic patterns and is adaptable to latter

Table 2.2: Hierarchical vs. Flat topologies routing

Location-based routing protocols

Here the routing protocol is decided based on the location of sensor nodes present. Based on the signal strength received at the node, the distance between nodes can be calculated. If the nodes are with a low-power GPS receiver, the area of nodes can be known by communicating with satellite, via GPS. To save energy, nodes may rest if there's no action[7]. Furthermore, energy can be saved in the network by having more sleeping nodes. The different protocols that come under this are

- Geographic Adaptive Fidelity (GAF)

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- Geographic and Energy Aware Routing (GEAR)
- MFR, DIR, and GEDIR
- The Greedy Other Adaptive Face Routing (GOAFR)
- SPAN

Routing Protocols based on Protocol Operation

Here, they have given a study over routing protocols with different routing functionality. In this, some of the protocols may be grouped under one or more of the above routing categories.

Multipath routing protocols

These routing protocols use different paths to transfer the data instead of same path to increase the network lifetime. Fault tolerance is measured based on the alternate path that exists between the source and destination if the main path fails. The alternative paths will be kept alive by sending the parodic messages, which increases the reliability of the network.

In WSN to enhance the lifetime and reliability of the network multipath routing was utilized, which is useful for delivering the data in defective situations[5]. The data is forwarded from source to destination by dividing into segments and transmitting through multiple paths to increase the reliability of the network. If any packet is lost during the transmission, it can be easily recreated[9].

Query-based routing

In this, the destination node sends a request for data through the network and the node which has the requested data that transmits to it. Every node has the tables that store the requested query and send the required data.

The rumor routing protocol is utilized when location awareness is not known. Hera an agent will drive the route path and it is passing through the node. And it is updated in the routing table corresponding.

QoS-based routing

In this, the network needed to stabilize energy consumption and data quality, fulfill specific QoS measures, like delay, energy, data transfer capacity, etc. while conveying information to the Base Station (BS).

Sequential Assignment Routing (SAR) is the prime routing protocol in WSNs with QoS in the routing choices. Routing in SAR is reliant upon 3 variables energy means, QoS in every way, and the packet priority. Multipath approach and localized path restoration schemes are used to avoid single path failure[10].

Another QoS parameter for WSNs is soft real-time end-to-end data transmission, in which every node should maintain the information about neighbor nodes to find the path and speed strives are used to avoid the collision by maintaining speed in the network for every packet.

ISSUES IN WIRELESS SENSOR NETWORKS

a. Node deployment:

Node positioning in WSNs depends on application and routing protocol performance.

b. Energy consumption without losing accuracy:

Sensor nodes shall perform calculations with their energy and communicate data in a remote environment. Energy consumption types of correspondence and calculation are fundamental.

c. Data Reporting Model:

Information detecting and detailing in WSNs are subject to application and time-criticality of the information revealing.

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d. Node/Link Heterogeneity:

Utmost all homogeneous sensor nodes have equivalent limits thorough in the calculation, correspondence, and power.

e. Fault Tolerance:

Some sensor nodes might fizzle or be obstructed because of the absence of force, actual harm, or natural impedance. The disappointment of sensor nodes ought not perspective the general errand of the sensor organization.

f. Scalability:

Any routing plan should have the option to work with an enormous number of nodes and the number may reach zillion if procured.

g. Connectivity:

Node thickness in WSN blocks them from being disconnected from one another. Sensor nodes are relied upon exceptionally associated even after post disconnection blockage in the network.

h. Coverage:

In WSNs, given sensor's perspective on the restricted environment in range and inexactness covering with restricted actual space of the environment.

i. Data Aggregation:

Since sensor nodes might produce critical repetitive information, comparable packets from various nodes will be summed onto the decreased quantity of transmissions.

j. Quality of Service:

Applications in a few, the communication shall be limited and accurate and shall not be wasted. Thus, time obligation shall be avoided. Instead in various applications, energy preservation shall be worked out when identified with network lifetime.

Conclusion

In this paper, an inclusive survey on routing techniques in WSN is given, subjective to increase network lifetime without compromising the quality. Multipath can enhance the throughput and reduce latency by providing more reliability. Cluster-based data collection enhances the lifetime of the network by reducing energy consumption and traffic. Although many of these routing techniques look promising, there are still many challenges that are still open. in the sensor networks.

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