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WIRELESS SENSOR NETWORK: STUDY ROUTING PROTOCOL

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Abstract- Wireless sensor network is emerging field because of its wide applications. It is a wireless network which subsist a group of small sensor nodes which communicate through radio interface. The four basic elements of these sensor nodes are sensing, computation, communication, and control. With the notion that there will be cases for energy awareness, many routing, power management, and data dissemination protocols have been explicitly developed for wireless sensor networks. However, the key resource constraints are limited energy, communication capability, storage, and bandwidth.The flexibility, fault tolerance, high sensing fidelity, low cost, and rapid deployment characteristics of sensor networks create many new and exciting application areas for remote sensing. Our survey is based on various aspects of routing protocols in wireless sensor networks.

***Keywords*:WSN, Sensor nodes, Routing, Ad hoc networks**

I INTRODUCTION OF WSN

Wireless Sensor Networks (WSNs) have begun to draw the attention of researchers with the fast technical advancement of wireless technologies and embedded electronics. A standard WSN consists of small devices that are known as nodes. New technologies and standards are used for wireless sensor networks. They include lightweight, energy-efficient machines, co-design of hardware/software, and support for networking. Wireless sensor networks are now an integral part of everyday, technological and military systems of everyday life. As new technologies are evolving and new applications are being created, this is a fast-growing field.These nodes have a built-in CPU, some intelligent sensors and minimal processing power. Nodes are used with these sensors to track environmental conditions such as heat, humidity, vibration and noise surrounding them. In every WSN, a node usually includes a transceiver unit, a sensor controller, a computer unit, and a control unit. By having nodes capable of communicating with each other to relay data collected by their sensors, these units perform critical tasks. To have a centralised structure, coordination between the nodes is essential. The need for this device contributes to the growth of the notion of the internet of things (IoT).

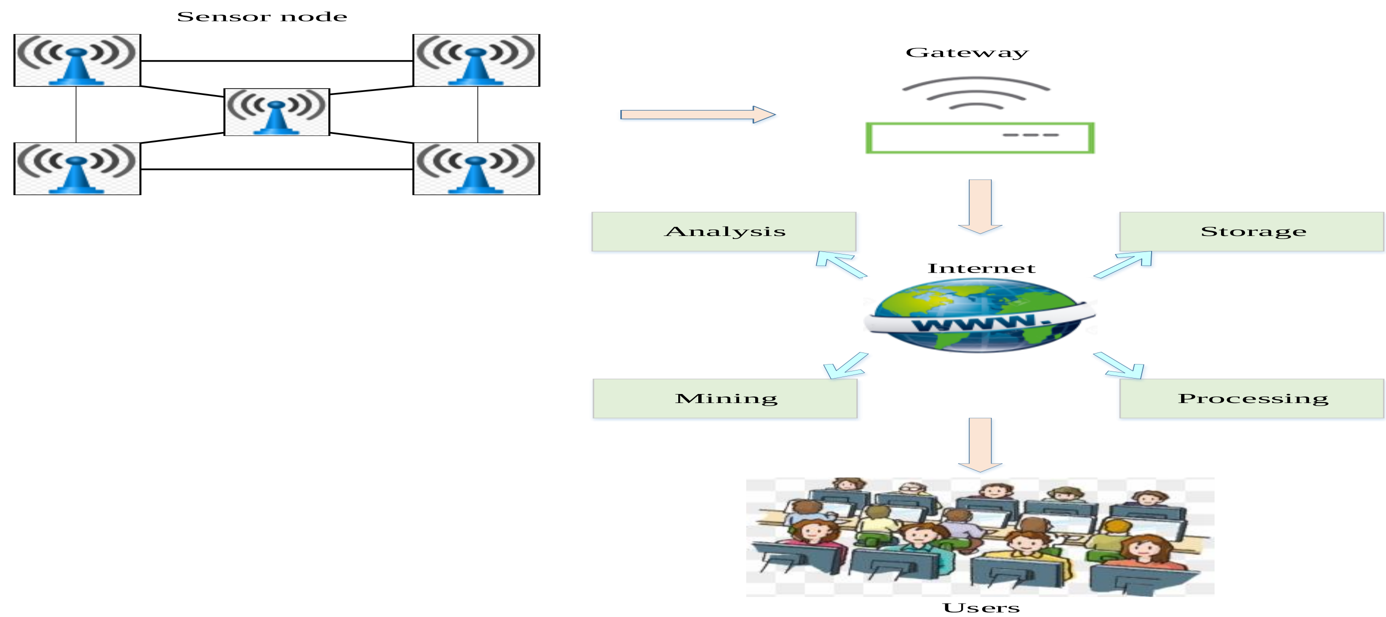

Figure 1: Architecture of WSN.

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A WSN may usually be described as a network of nodes that act in a cohesive way to sense and regulate the world around them. Through wireless networks, these nodes are linked. This relation is used by nodes to communicate with each other.There are 3 elements in the structure of a standard WSN such as sensor nodes, internet and user nodes. The sensor area constitutes sensor nodes and gateways. Gateways and observers are linked by special networks or, most often, through the internet

II. COMPONENTS OF WSN

A WSN consists of multiple sensor numbers and a gateway to offer an Internet connection. The components of WSNs are sketched in figure 2.

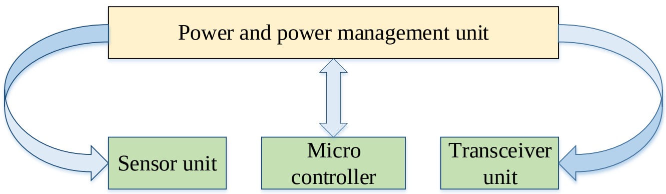

Figure 2: Components of WSN

Sensor Unit

A sensor node is a compact computer with a low power supply. While it has small energy capacity, it has a simultaneous processing role and has a low price as well. Individual units of a sensor node accomplish data collection and data transfer steps. The power source is located at the base of the sensor node. It provides power for different sensor node devices, such as sensor units, radio and CPU.

Microcontroller

Usually, a microprocessor and a flash memory are made of the CPU of a sensor. It provides connectors for most sensor nodes that can easily add external processing units and sensors to the main device.For the critical functions of the CPU, decision-making and coping with collected data can be identified as examples.

Transceiver

It's responsible for a sensor node's wireless communications. The transceiver primarily has four working conditions such as receive, transmit, idle and sleep.Radio Frequency (RF) and Infrared Laser can be selected as wireless networks in the transceiver. For WSNs, RF is commonly favoured among these wireless communication technologies.The standard RF range of operation is 10s of indoor meters and 100s of outdoor meters.

III. ROUTING PROTOCOLS IN WSNS

Depending on the network layout, routing in WSNs can in general be divided into flat-based routing, hierarchical-based routing, and location-based routing. All nodes are usually allocated equivalent roles or features in flat-based routing. Nonetheless, in hierarchical-based routing, nodes can perform various network functions.In location-based routing, the locations of the sensor nodes are exploited to route network data.

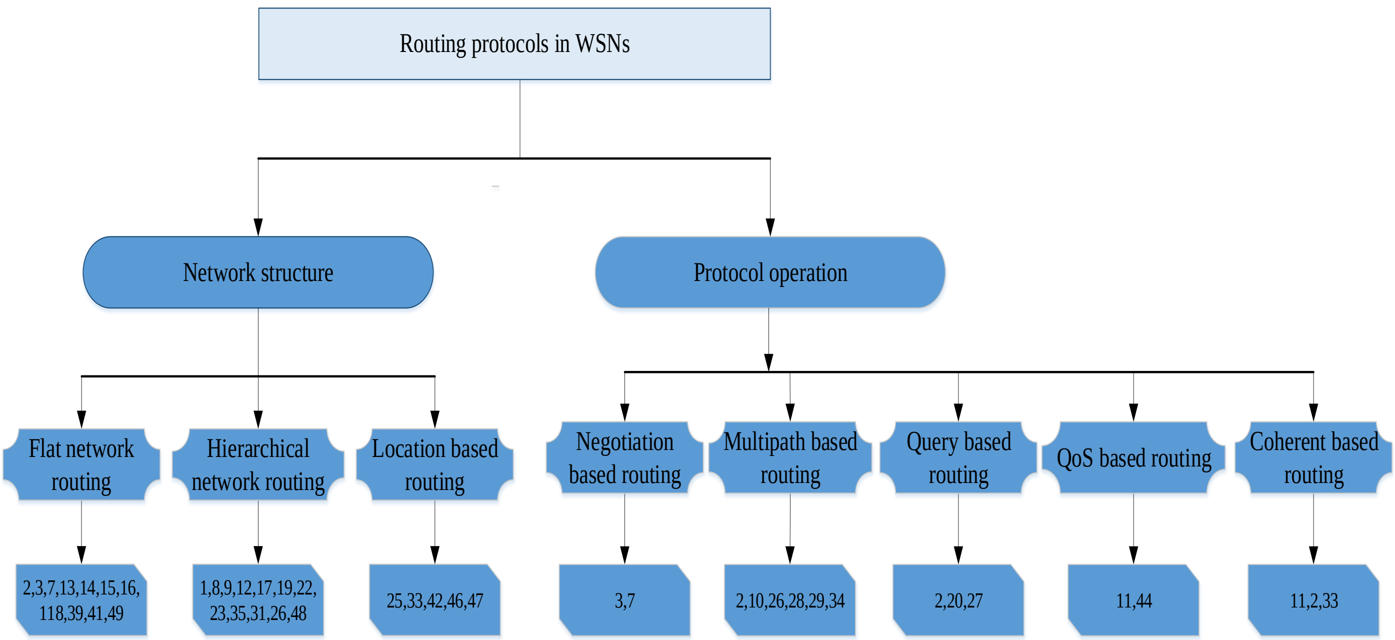

Figure 3: Routing protocols in WSNs

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In order to adjust to current network conditions and available energy levels, a routing protocol is called adaptive if certain device parameters can be managed.In fact, these protocols can, depending on the protocol operation, be divided into query-based, negotiation-based, multipath-based, QoS-based, or coherent-based routing techniques. In addition to above, based on how well the source flows a path to the destination, routing protocols can be divided into three sets, namely proactive, reactive, and hybrid protocols.In proactive protocols, all routes are calculated before they can be really required, whereas routes are computed on demand in reactive protocols. A mixture of these two thoughts is used by hybrid protocols. If sensor nodes are fixed, instead of using reactive protocols, it is preferable to have table guided routing protocols.In the route discovery and configuration of reactive protocols, a significant amount of energy is used. Cooperative routing protocols are called another class of routing protocols. Nodes send data to a central node in cooperative routing, whereby data could be aggregated and further processed, thus reducing path costs in terms of energy usage. Many other protocols are based on timing and information.

(i) Network Structure Based Routing Protocols

In the application of the routing protocol within WSNs, the underlying network structure may play a significant role. In this chapter, we discuss most of the protocols that come under this category in detail.

A. FLAT NETWORK ROUTING

Multi-hop flat routing protocols are the first type of routing protocols. Each node usually plays the same function in flat networks and sensor nodes cooperate to conduct the sensing task collectively. This is not feasible to allocate each node a global identifier due to the large number of such nodes. . Such factor has resulted in data centred routing, where the BS sends queries to some regions and waits for sensor data located in the regions selected.

Sensor Protocols for Information via Negotiation (SPIN):

About Heinzelman et.al. A family of adaptive protocols called Sensor Protocols for Information through Negotiation (SPIN) was proposed to disseminate all the information at each node in a network, suggesting that all nodes in the network are possible access points. This allows any node to be queried by a user and get the necessary details instantly [45].Such protocols make the use of premise that identical data is available to nodes in close proximity, so it is only necessary to transmit the information which other networks do not have.

Directed Diffusion:

Directed diffusion is a common data aggregation model for WSNs that has been proposed. Directed diffusion is a data-centric (DC) and application-aware paradigm in the sense that all data provided by sensor nodes is called by attribute-value pairs. The key concept behind the DC model is to integrate data from different sources en route by removing redundancy and reducing the number of transmissions, saving network resources and extending its lifespan. Unlike conventional end-to-end routing, DC routing searches for routes from different sources to a single destination, enabling redundant data to be consolidated within the network. In Directed diffusion, sensors quantify events and establish information gradients in their immediate surroundings.

Rumour Routing:

Rumour routing is a form of guided diffusion that is used in situations where geographic routing is not possible. When there is no regional requirement to diffuse activities, guided diffusion uses flooding to inject the query through the entire network. However, in some situations, the amount of data required from the nodes is insignificant, and flooding is therefore unnecessary. If the number of events is small but the number of queries is high, flooding the events is an alternative.

Minimum Cost Forwarding Algorithm (MCFA):

The MCFA algorithm takes advantage of the fact that the routing path, that is, towards the fixed external base-station, is always known. As a result, a sensor node does not need a unique ID or the maintenance of a routing table. Instead, each node keeps track of the cheapest route from itself to the base station. Each message that the sensor node needs to forward is broadcast to its neighbours.

Gradient-Based Routing:

Gradient-Based Routing is a variant of guided diffusion suggested by Schurgers (GBR). When the interest is dispersed throughout the entire network, the main concept in GBR is to memorise the number of hops. As a result, each node can measure a parameter known as the node's height, which is the minimum number of hops required to reach the BS. The gradient on a connection is defined as the difference in height between a node and its neighbour. The highest gradient connection is used to forward a packet.

Information-driven sensor querying (IDSQ) and Constrained anisotropic diffusion routing (CADR):

Information-driven sensor querying (IDSQ) and constrained anisotropic diffusion routing (CADR) are two routing techniques proposed in. CADR aspires to be a broad definition of guided diffusion. The main concept is to query sensors and route data through the network in such a way that information gain is maximised while latency and bandwidth are reduced. CADR diffuses queries by selecting which sensors should receive data based on a set of information parameters. This is accomplished by only triggering sensors that are in close proximity to a specific event and dynamically changing data routes.

COUGAR:

COUGAR, a data-centric protocol, sees the network as a massive distributed database system. The main concept is to use declarative queries to separate query processing from network layer functions such as sensor selection and so on. To save even more resources, COUGAR uses in-network data aggregation. An additional query layer sits between the network and application layers to facilitate the abstraction. COUGAR includes a sensor database system architecture in which sensor nodes choose a leader node to conduct data aggregation and transmission to the BS.

ACQUIRE:

Sadagopan proposed the Active Query Forwarding In Sensor Networks (ACQUIRE) technique for querying sensor networks. ACQUIRE, like COUGAR, sees the network as a distributed database where complex queries can be broken down into several sub questions. The following is a summary of how ACQUIRE works. The BS node sends out a query, which is forwarded to each node that receives it. During this time, each sensor node tries to partially respond to the query by using pre-cached information before passing it on to another sensor node. If the pre-cached information is out of date, the nodes look up information from their neighbours within d hops. Once the question has been fully resolved, it is sent back to the BS via the reverse or shortest direction.

Energy Aware Routing:

The aim of the energy-aware routing protocol, which is a destination initiated reactive protocol, is to extend the lifetime of the network. While similar to guided diffusion, this protocol differs in that it maintains a number of paths rather than maintaining or implementing one optimal path at higher rates. These paths are held and chosen based on a collection of probabilities. The value of this probability is determined by how low each path's energy consumption can be reduced. The energy of any single path would not deplete quickly because the paths were chosen at different times. As energy is dissipated more evenly over all nodes, this can result in a longer network lifetime. The protocol's key metric is network survivability.

Routing Protocols with Random Walks:

The aim of the random walks-based routing technique is to achieve load balancing in WSNs using multi-path routing in a statistical sense. Only large-scale networks with very restricted mobility are included in this technique. Sensor nodes are assumed to be switched on and off at random times in this protocol. Furthermore, each node has its own unique identifier, but no information about its location is needed. The topology may be irregular, but nodes were arranged so that each node falls exactly on one crossing point of a normal grid on a plane.

B. HIERARCHICAL ROUTING

Hierarchical or cluster-based routing, originally proposed in wire line networks, are well-known techniques with special advantages related to scalability and efficient communication. As such, the concept of hierarchical routing is also utilized to perform energy efficient routing in WSNs. In a hierarchical architecture, higher energy nodes can be used to process and send the information while low energy nodes can be used to perform the sensing in the proximity of the target.

LEACH protocol

Low Energy Adaptive Clustering Hierarchy was introduced by Heinzelman as a hierarchical clustering algorithm for sensor networks (LEACH). LEACH is a cluster-based protocol that involves the creation of distributed clusters. LEACH selects a few sensor nodes at random as cluster heads (CHs) and rotates them to spread the energy load equally across the network's sensors. To minimise the amount of data that must be transmitted to the base station, the cluster head (CH) nodes compress data arriving from nodes belonging to the respective cluster and send an aggregated packet to the base station. To minimise inter-cluster and intra-cluster collisions, LEACH employs a TDMA/CDMA MAC.

Power Efficient Gathering in Sensor Information Systems (PEGASIS):

It was suggested that the LEACH protocol be improved. PEGASIS (Power Efficient Gathering in Sensor Information Systems) is a chain-based protocol that is near optimal. The protocol's basic concept is that nodes only need to connect with their nearest neighbours in order to expand network lifetime, and they take turns communicating with the base station. A new round will begin when the round with all nodes interacting with the base-station ends, and so on. Since the power draining is distributed evenly over all nodes, the power needed to transfer data per round is reduced. As a result, PEGASIS has two primary goals. To begin, use collective techniques to extend the lifetime of each node, resulting in a longer network lifetime. Second, only allow local collaboration between nodes that are close together to minimise communication bandwidth use. Unlike LEACH, PEGASIS does not form clusters and instead sends data to the BS through a single node in a chain rather than multiple nodes.

Threshold-sensitive Energy Efficient Protocols (TEEN and APTEEN):

TEEN (Threshold-sensitive Energy E–cient sensor Network protocol) and APTEEN (Adaptive Periodic Threshold-sensitive Energy E–cient sensor Network protocol) are two hierarchical routing protocols proposed for time-critical applications [51]. Sensor nodes continuously sense the medium in TEEN, but data transmission is done less frequently. A cluster head sensor gives its members a hard threshold, which is the sensed attribute's threshold value, and a soft threshold, which is a minor shift in the sensed attribute's value that causes the node to turn on its transmitter and transmit. As a result, the hard threshold attempts to minimise transmissions by allowing nodes to transmit only when the sensed attribute is within the range of interest. If there is little to no shift in the sensed attribute, the soft threshold decreases the number of transmissions that would otherwise occur.

Small Minimum Energy Communication Network (MECN):

By using low power GPS, a protocol is proposed that computes an energy efficient sub network, namely the minimum energy communication network (MECN), for a specific sensor network. Every node in MECN is assigned to a relay area. The relay region is made up of nodes in the immediate vicinity where transmitting through those nodes saves energy over direct transmission. The union of all relay regions that node I can access is then used to establish the enclosure of node i. MECN's main goal is to find a sub-network with a smaller number of nodes and lower power requirements for transmission between any two nodes.

Self-Organizing Protocol (SOP):

Subramanian et al. define a self-organizing protocol and an application taxonomy that were used to create heterogeneous sensor architecture. These sensors may also be mobile or stationary. Some sensors collect data from the atmosphere and send it to a group of nodes that serve as routers. The backbone of communication is formed by router nodes, which are stationary. The collected data is forwarded to the more powerful BS nodes via routers.

Sensor Aggregates Routing:

The authors proposed a series of algorithms for constructing and preserving sensor aggregates. The aim is to control target behaviour in a specific setting as a group (target tracking applications). A sensor aggregate is made up of nodes in a network that meet a predicate for grouping in a collaborative processing activity. The predicate's parameters are determined by the mission and its resource requirements. In terms of allocating resources to sensing and communication tasks, the creation of suitable sensor aggregates was addressed. Sensors in a sensor area are grouped into clusters based on the frequency of their sensed signal, with only one peak per cluster.

Virtual Grid Architecture routing (VGA):

An energy efficient routing paradigm is proposed that utilizes data aggregation and in-network processing to maximize the network lifetime. Due to the node stationarity and extremely low mobility in many applications in WSNs. A GPS-free approach is used to build clusters that are fixed, equal, adjacent, and non-overlapping with symmetric shapes. Square clusters were used to obtain a fixed rectilinear virtual topology. Inside each zone, a node is optimally selected to act as cluster head. Data aggregation is performed at two levels: local and then global.

Hierarchical Power-aware Routing (HPAR):

A power-aware hierarchical routing was suggested. The protocol divides the sensor network into classes. Each zone is made up of a group of sensors in close proximity, and each zone is regarded as a separate entity. To perform routing, each zone is given the freedom to choose how a message will be routed hierarchically through the other zones, maximising the battery life of the system's nodes. The max-min course, which has the maximum over all the minimum of the remaining capacity, is used to route messages. The reason for this is that using nodes with high residual power can be more costly than taking the path with the least amount of power consumption. The max-min zPmin algorithm is an approximation algorithm.

C. LOCATION BASED ROUTING PROTOCOLS

Sensor nodes are addressed by their positions in this form of routing. On the basis of incoming signal strengths, the distance between neighbouring nodes can be calculated. By sharing such information between neighbours, relative coordinates of neighbouring nodes can be obtained. If nodes are fitted with a small low-power GPS receiver, the location of nodes can also be obtained directly by communicating with a satellite via GPS (Global Positioning System).

Geographic Adaptive Fidelity (GAF):

GAF is an energy-aware location-based routing algorithm designed primarily for mobile ad hoc networks, but may be applicable to sensor networks as well. The network area is flrst divided into fixed zones and form a virtual grid. Inside each zone, nodes collaborate with each other to play different roles.

MFR, DIR, and GEDIR:

Simple distance, development, and direction-based approaches are covered in these protocols. The most important topics are forward and backward movement. Any intermediate node or source node will choose one of its neighbours based on a set of criteria. MFR (Most Forward inside Radius), GEDIR (The Geographic Distance Routing), a variation of greedy algorithms, 2-hop greedy method, alternative greedy method, and DIR are all routing methods that fall into this group (compass routing method).

IV. CONCLUSION

One of the newest areas of study is wireless sensor networks. Sensor networks' versatility, fault tolerance, high sensing fidelity, low cost, and fast deployment characteristics open up a slew of new and exciting remote sensing applications. Sensor networks will become an important part of our lives in the future as a result of this broad variety of application areas. The ability to track environmental and physical conditions is a unique advantage of wireless sensor networks. We addressed different types of routing protocols for wireless sensor networks in this paper. Sensor networks will become an integral part of our lives in the future due to their wide range of applications. One of the most promising areas for future research is the energy efficiency of wireless sensor networks. Due to the limited energy resources of sensors, one of the main challenges in designing routing protocols for WSNs is energy efficiency. The ultimate goal of the routing protocol is to keep the sensors running for as long as possible, extending the network's lifespan. Data transmission and reception account for the majority of the sensors' energy consumption. As a result, WSN routing protocols should be as energy efficient as possible in order to extend the lifetime of individual sensors, and thus the network's lifetime. We surveyed a sample of routing protocols in this paper, taking into account a variety of classification criteria such as location information, network layering and in-network processing, data centricity, path redundancy, network dynamics, QoS requirements, and network heterogeneity.

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