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A Survey of Shortest Path Routing Algorithm in Wireless Sensor Networks

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ABSTRACT: Wireless Sensor Network (WSN) has many applications in day to day life. One of the applications of WSN is target tracking that uses sensors to track and localize the targets. Sensor networks still have problems in conveying data from one sensor node to other node. Routing algorithms are developed for wireless sensor networks. These protocols still have some problems in sensor networks. Ad hoc networks and WSNs are similar to each other as both depend on hop-to-hop routing. So, protocols developed for ad-hoc networks are also used in many sensor applications. This paper shows various routing protocol for wireless sensors network applications.

KEYWORDS: Wireless Sensor Networks, Mobile ad-hoc networks, routing algorithm.

I. INTRODUCTION

Wireless sensor networks (WSNs) have many wirelessly connected sensor nodes spread over any region or area to take control or maintain many environmental or physical conditions. WSNs are used in various applications, e.g. to monitor area, health care, air pollution etc., to detect forest fire, landslide etc. WSNs are popularizing nowadays because they are flexible, cost-effective, reliable, easy to deploy and accurate. WSNs are mainly designed for sensing, collecting and disseminating information about environmental conditions. All sensor nodes sense the difference then collect important information and then send it to base station or gateway by multi hop communication.

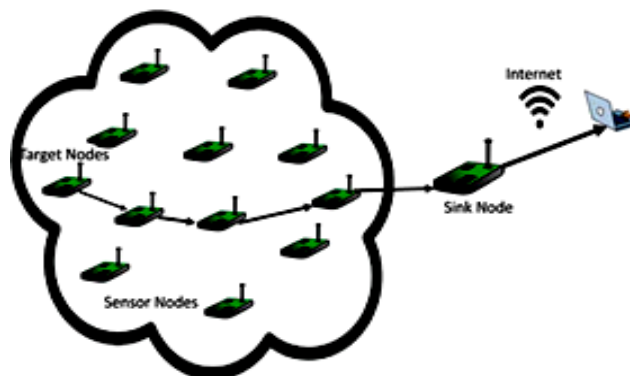


Figure 1: Wireless Sensor Network

WSNs firstly convert data into radio waves and then amplify it and then radio waves are received at receiving node. In many applications of WSNs routing is based on the routing algorithms developed for mobile ad-hoc networks. WSNs are usually very similar to mobile ad-hoc networks (MANETs). As both are distributed network connected wirelessly, use hop-to-hop routing for communication and are battery powered. MANETs are mostly used for communication purposes and to transfer data from one device to another device through internet. But both are different in many points. Nodes used in WSNs have very limited memory power and are of very high magnitude i.e. in order of many hundreds, as compared to MANETs. For WSNs communication is not very big issue, but collecting data is more important, while in MANETs communication is the only purpose. Because of so many differences routing mechanism for WSNs should be different.

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind, and so on.[1]

These are similar to wireless ad hoc networks in the sense that they rely on wireless connectivity and spontaneous formation of networks so that sensor data can be transported wirelessly. WSNs are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, both collecting data from distributed sensors[2] and enabling control of sensor activity.[3] The development of wireless sensor networks was motivated by military applications such as battlefield surveillance;[4] today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

Wireless sensor networks are composed of low-energy, small-size, and low-range unattended sensor nodes. Recently, it has been observed that by periodically turning on and off the sensing and communication capabilities of sensor nodes, we can significantly reduce the active time and thus prolong network lifetime. However, this duty cycling may result in high network latency, routing overhead, and neighbor discovery delays due to asynchronous sleep and wake-up scheduling. These limitations call for a countermeasure for duty-cycled wireless sensor networks which should minimize routing information, routing traffic load, and energy consumption.

II. RELATED WORK

N. Wang et al.,[1] presents, the areas that cover a set of dense CNs are called compromised regions (CRs) and apparently, they are a greater threat to the networks than single CNs. To defend against the attack of CRs, we design a secure shortest path routing algorithm (SPRA) to deliver packages properly around, rather than through, the CRs. Specifically, a source node first computes the shortest geometric path to the sink node without crossing any CRs and then decides agent nodes along with the path by a set of virtual locations in an indirect way.

M. A. Tamtalini et al.,[2] proposes a novel grid based joint localization and packet routing algorithm in WSN based on beacon nodes to improve the precision in location estimation. Firstly, system model of Grid based WSN node localization is constructed. Then localization algorithm of WSN is proposed by using Hybrid Algorithm called Particle Swarm Optimization and Type-2 Fuzzy Logic Filter. Next, form dynamic clusters using node energy. In third step, perform packet routing using Enriched Ant Colony Optimization Algorithm (E-ACO). A shortest and reliable path identified based on node residual energy, degree and distance between nodes.

M. Thilagavathi et al.,[3] propose PSO, To implement and optimized the traffic regulation unit at various algorithms of multiprocessor. We can enhance the performance and network utilization. To enhance the efficiency of routing algorithm PSO is optimized. A Multi-NOC design with particle swarm optimization algorithms for various subnets, and Integrated, to avoid overcrowding power gating and packet scheduling policy. Using PSO we focused low power, scalable architecture. By using this method, the performance improvement at varying network utilization is achieved.

W. Xia et al.,[4] study the stochastic shortest path problem on a directional graph with stochastic edge lengths, using reinforcement learning algorithms. We regard each edge length as a random variable following unknown probability distribution and aim to find the stochastic shortest path on this stochastic graph. We evaluate the performance of path-finding algorithms using regret, which represents the cumulative reward difference between the practical path-finding algorithm and the optimal strategy that chooses the global stochastic shortest path every time.

G. Yestemirova et al.,[5] shows the communication links between the nodes, and the sink may go down or crash due to energy depletion, harsh environment, or for some other reasons. If the sink crashes, then the network becomes useless as the sink will not be able to collect data from nodes. One way of making the network more reliable is to deploy networks with more than one sink. Existing efficient data aggregation protocols developed for WSNs with a single sink may not show the similar efficiency in WSNs with multiple sinks.

S. El Khediri et al.,[6] a new centralized hierarchical cluster-based routing algorithm is proposed which aims to mitigate energy consumption and prolong the lifetime of WSN's. The obtained results seemed that the proposed protocol outperforms other existing clustering protocols, on the basis of energy consumption, throughput, and network lifetime and packet delivery as performance metrics.



A. Agnihotri et al.,[7] Mostly routing approach use shortest path and minimal energy depletion model. Network operate on these routing scheme early partitioned due to unbalanced energy consumption of sensor nodes i.e. a single shortest route may used most of the time leads to faster consumption of energy of sensor nodes coming in route path. In current paper attempts has made to develop energy efficient routing scheme based on optimization techniques “particle swarm optimization (PSO) and genetic algorithm (GA)”.

R. M. Al-Kiyumi et al.,[8] spatial and temporal variations in sensor activities create energy imbalance across the network. Therefore, routing algorithms should make an appropriate tradeoff between energy efficiency and energy consumption balancing to extend the network lifetime. In this paper, we propose a distributed energy-aware fuzzy logic based routing algorithm (DEFL) that simultaneously addresses energy efficiency and energy balancing. Our design captures network status through appropriate energy metrics and maps them into corresponding cost values for the shortest path calculation.

M. Devika et al.,[9] WSN monitor physical or environmental conditions, such as whether, sounds, pulsation, pressure, motion's main problem is Energy hole. it's a critical issue for data congregation. Sensors near the fixed sink act as relays for far sensors and thus will reduce their energy very rapidly, finally energy holes in the sensor ground. We proposed new technique Efficient Route Block Avoiding algorithm in cluster based method.

M. A. Jawad et al.,[10] One of the main challenges in the wireless sensor networks (WSN) is to enhance the network lifetime. The uneven energy depletion phenomenon of the sensor nodes (known as Hotspot issue) gets more prominent with the increase in number of sensor nodes. These sensor nodes disperse their energy quickly and finally die down. Their battery replacement is not practically possible in the operating environments.

M. Saikia et al.,[11] propose a new routing algorithm called Secure Energy Aware Multipath Routing with Key Management (SEAM-KM) in Wireless Sensor Network. This protocol focuses on using a base station as the central control block for all kinds of computation like shortest path selection, routing table generation, Updating the routing table and distribution of pair wise keys among the sensor nodes and the base station. Leaving the energy consuming computations to be performed by the base station, the lifetime of the sensor nodes can be prolonged.

A. Sharma et al.,[12] Communication among the wireless links between mobile nodes is become popular research area because of its simplicity of deployment and mobility. Collection of all mobile nodes through which all wireless links are connected called as Mobile Ad hoc Network (MANET). MANET network gets too much attraction of researchers due to its mobility, reliability, self-repairing, dynamic infrastructure and independent with the help of center administration.

III. ROUTING PROTOCOL AND CHALLENGES

Sensor nodes used in wireless sensor networks can be fixed or mobile.

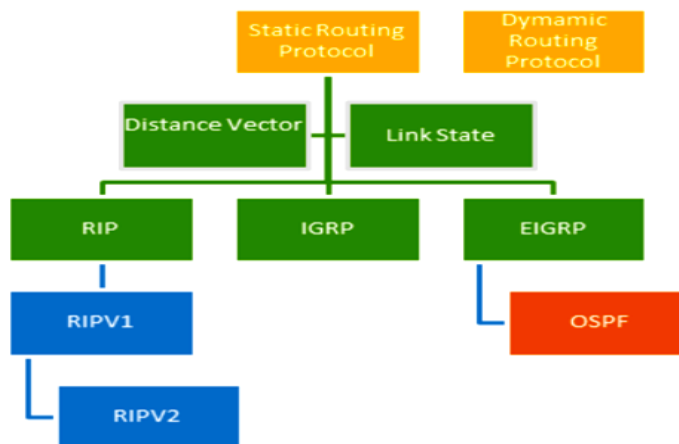


Figure 2: Classification of routing protocol



So, according to this WSNs can be classified in two types:

- Static Wireless Sensor Networks
- Mobile Wireless Sensor Networks

Static Routing Protocols

Static routing protocols are used when an administrator manually assigns the path from source to the destination network. It offers more security to the network.

Advantages

- No overhead on router CPU.
- No unused bandwidth between links.
- Only the administrator is able to add routes

Disadvantages

- The administrator must know how each router is connected.
- Not an ideal option for large networks as it is time intensive.
- Whenever link fails all the network goes down which is not feasible in small networks.

Dynamic Routing Protocols

Dynamic routing protocols are another important type of routing protocol. It helps routers to add information to their routing tables from connected routers automatically. These types of protocols also send out topology updates whenever the network changes' topological structure.

Advantage:

- Easier to configure even on larger networks.
- It will be dynamically able to choose a different route in case if a link goes down.
- It helps you to do load balancing between multiple links.

Disadvantage:

- Updates are shared between routers, so it consumes bandwidth.
- Routing protocols put an additional load on router CPU or RAM.

Distance Vector Routing Protocol (DVR)

Distance Vector Protocols advertise their routing table to every directly connected neighbor at specific time intervals using lots of bandwidths and slow converge.

In the Distance Vector routing protocol, when a route becomes unavailable, all routing tables need to be updated with new information.

Advantages:

- Updates of the network are exchanged periodically, and it is always broadcast.
- This protocol always trusts route on routing information received from neighbor routers.

Disadvantages:

- As the routing information are exchanged periodically, unnecessary traffic is generated, which consumes available bandwidth.



Internet Routing Protocols:

The following are types of protocols which help data packets find their way across the Internet:

Routing Information Protocol (RIP)

RIP is used in both LAN and WAN Networks. It also runs on the Application layer of the OSI model. The full form of RIP is the Routing Information Protocol. Two versions of RIP are

1. RIPv1
2. RIPv2

The original version or RIPv1 helps you determine network paths based on the IP destination and the hop count journey. RIPv1 also interacts with the network by broadcasting its IP table to all routers connected with the network.

RIPv2 is a little more sophisticated as it sends its routing table on to a multicast address.

Interior Gateway Protocol (IGP)

IGRP is a subtype of the distance-vector interior gateway protocol developed by CISCO. It is introduced to overcome RIP limitations. The metrics used are load, bandwidth, delay, MTU, and reliability. It is widely used by routers to exchange routing data within an autonomous system.

This type of routing protocol is the best for larger network size as it broadcasts after every 90 seconds, and it has a maximum hop count of 255. It helps you to sustain larger networks compared to RIP. IGRP is also widely used as it is resistant to routing loop because it updates itself automatically when route changes occur within the specific network. It is also given an option to load balance traffic across equal or unequal metric cost paths.

Link State Routing Protocol

Link State Protocols take a unique approach to search the best routing path. In this protocol, the route is calculated based on the speed of the path to the destination and the cost of resources.

Routing protocol tables:

Link state routing protocol maintains below given three tables:

- **Neighbor table:** This table contains information about the neighbors of the router only. For example, adjacency has been formed.
- **Topology table:** This table stores information about the whole topology. For example, it contains both the best and backup routes to a particular advertised network.
- **Routing table:** This type of table contains all the best routes to the advertised network.

Advantages:

- This protocol maintains separate tables for both the best route and the backup routes, so it has more knowledge of the inter-network than any other distance vector routing protocol.
- Concept of triggered updates are used, so it does not consume any unnecessary bandwidth.
- Partial updates will be triggered when there is a topology change, so it does not need to update where the whole routing table is exchanged.



Challenges:

Communication also has to change with respect to movement of nodes. Node which has to transfer the data, called source node, and node to which the data has to be sent is called sink node. But MWSNs are more advantageous over static WSNs in terms of MWSNs can be further divided in two parts: (i) Sensor networks with mobile source node and (ii) sensor network with static source node.

Challenges in such WSN include high bandwidth demand, high energy consumption, quality of service (QoS) provisioning, data processing and compressing techniques, and cross-layer design.

The routing protocols can be categorized based on the nodes' participation, clustering protocols, mode of functioning and network structure. The various challenges in routing include energy consumption, node deployment, scalability, connectivity, coverage, security.

IV. CONCLUSION & FUTURE SCOPE

Wireless sensor network has many of the application. The routing protocols algorithm plays important role during the path selection and communication. This paper reviewed various routing protocol for path selection, advantages and disadvantages. The key challenges of these protocols are also mentioned. The future work will be included the implementation of some of the routing protocol in the MATLAB software and finding best out of them as per the simulation environment and optimized the significant improved results.

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