Wireless Sensor Networks: A Research Perspective Survey

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ABSTRACT: This paper highlights the research issues in wireless sensor networks and the current trends in overcoming such issues.

Keywords : Issues, Energy consumption, Routing, Coverage, Attacks

1 INTRODUCTION

THE Wireless sensor network has got much importance these days. With the tracking and monitoring activities become essential, the deployment of sensor networks through wireless medium have also increased. Although sensors are unavoidable in many fields, they got many issues pertaining to energy, routing, security, coverage, delay, architecture etc.; There are many ongoing researches in the field of wireless sensor networks. This paper highlights the issues related to key areas and the current methods to overcome those issues.

2 AN OVERVIEW:

2.1 Definition

Wireless sensor network refers to a network of sensors communicate through a wireless transmission medium. A sensor is a low cost, low power consuming device that is capable of sensing, data processing, communicating through components.

2.2 Deployment

The sensor deployment may vary according to applications. For instance, a single sensor with complex techniques to distinguish targets or several sensors that are used only for sensing and the sensed signals are sent to the central node where data get fused and communication is performed. The later sensor distribution approach allows for random deployment where position need not be engineered. In this case network protocols and algorithms which possess self organizing capabilities are used.

2.3 Components

A sensor device has following components
1. A sensing subsystem
2. A processing subsystem
3. Wireless communication system
4. Power source

2.4 Purpose of Deployment

The sensors are distributed along the wide geographic area for environmental or habitat monitoring, Acoustic detection, Inventory Monitoring, Military surveillance, Medical monitoring, Forest fire and flood detection etc.

3 ISSUES

There are many ongoing researches in the areas pertaining to
1. Energy
2. Routing
3. Security
4. Coverage
5. Delay

3.1 Energy

3.1.1 Importance

The enhancement of lifetime of sensors has become an important area of research. The fact that a sensor being a micro electronic device , equipped with limited power source. The power source supplies energy needed by the device for processing. If the nodes are deployed far apart, recharging and replacing are tedious process. Apart from hardware issues, the utilization of energy also plays a vital role. The energy go waste in many cases that includes
1. Idle listening
2. Retransmitting
3. Overhearing
4. Over-emitting

3.1.2 Energy Conservation Schemes

The effective use of power source can be achieved with some energy conservation schemes.
1. Duty Cycling Approach
2. Data – driven Approach
3. Mobility –based Approach

3.1.3 Duty Cycling Approach

Duty cycling approach is an effective way to conserve energy. When there is no transmission the radio transceiver is made to switch off to conserve energy. Duty cycling can be achieved with two approaches either via topology control or power management. In topology control, minimum subset of nodes is chosen to be active to ensure connectivity. Location driven protocols (Ex: **GAF-Geographical Adaptive Fidelity**) and Connectivity driven protocols (**Span, ASCENT (Adaptive Self-Configuring Sensor Networks Topologies)** are used. In Power management, **Sleep/wakeup Protocols (On - demand,   Scheduled ,Asynchronous) and MAC Protocols with Low Duty Cycle (TDMA, Contention-based)** are used.

3.1.4 Data-Driven Approach

The Data driven approach can be classified as data reduction schemes and energy efficient data acquisition schemes. The

Data reduction approach comprises of In-network processing, Data compression, Data prediction. Data acquisition schemes helps in conserving energy in sensing subsystem through samplings (adaptive, hierarchical, model driven active).

3.1.5 Mobility based approach
This includes **Mobile-Sink-based** and **Mobile-Relay-based** approaches. In Mobile-sink-based approach, sink moves to the sensor location and communicate whereas in Mobile-relay based approach, a message ferry is introduced in to the network which moves to every node and collect data. The message ferry stores and forward data to the destination.

3.2 Routing
Routing in sensor networks has got many challenges when compared to traditional data routing. Keeping energy consumption and network traffic in mind, the routing protocols are classified as follows. Data- centric, Hierarchical, Location Based, QoS aware, Network flow, Data aggregation. The routing posses many issues as follows. The selection of routing path must ensure energy conservation and optimization. In case of failure of any nodes, routing must be designed carefully to choose other nodes with less load and high energy. The multiple path selection ensures the reuse of routing path. Thus it improves sensors life time. In case of node failures, either node can be replaced or reused. Whenever this situation is encountered, a routing protocol must take decision with consideration of energy conservation and related issues. Sometimes multiple sensors generate same data which leads to redundancy. The routing protocol must avoid routing such redundant data to conserve energy and help bandwidth utilization. The routing protocols must support heterogeneous environment because of the fact that not all sensors perform similar computation and may vary in power levels. The QoS routing algorithm has got many challenges in recent days. The QoS remain unachievable due to network topology which keeps changing, bandwidth consumption, unbalanced traffic, energy consumption etc., Though the multiple path routing conserve energy, the overhead related to data transmission is unavoidable. The implementation of buffers in multi path routing again increases the overhead. It ultimately paves a way for poor QoS. The researches going on for the development of energy efficient routing protocol for the communication between sensor and wired network as the sink connected to internet ,which helps monitoring and tracking. Another important issue related to routing is node mobility. The ability to keep track of node and sink location and developing an energy efficient routing protocol for mobile nodes is of great challenge in routing.

3.3 Security
Security in wireless sensor network has got many challenges due to the sensitive applications where sensors have been deployed. Achieving security despite having less resource has got much attention. The security in wireless sensor networks requires
1. Data Confidentiality
2. Data Integrity
3. Data Freshness
4. Availability
5. Self-Organization
6. Time Synchronization
7. Secure Localization
8. Authentication
9. Privacy
10. Non repudiation
11. Key management
12. Robust against Denial of Service
13. Secure routing

The attacks related to sensor networks are as follows
1. Types of Denial of Service attacks
2. The Sybil attack
3. Traffic Analysis Attacks
4. Node Replication Attacks and Node capture attacks
5. Attacks Against Privacy
6. Physical Attacks
7. Eavesdropping/Spoofing
8. Selective forwarding
9. Sinkhole, wormhole, black hole
10. Hello flood
11. Acknowledgement spoofing
12. Time correlation attacks
13. False routing information

- Attacks on physical layer: Jamming, Tampering
- Attacks on link layer: Collision ,Exhaustion, Unfairness
- Attacks on Network layer: Neglect and greed, Traffic analysis ,Misdirection ,Black holes
- Attacks on Transport layer: Flooding, Desynchronization

3.4 Coverage
In wireless sensor networks, the nodes are distributed in various locations and they are infrastructure less. The main challenge is to provide connectivity and coverage to the area to be sensed. The coverage can be said as how well an area can be sensed with number of sensors needed. This is suitable for static sensors. How well the coverage can be achieved with mobile sensor, moving in an arbitrary path is determined by location discovery algorithms. The research issues include identifying the nodes to be involved in duty cycle which share common sensing region. The sensors are scheduled in a way, even after included in duty cycle must show same coverage along with energy conservation. Some of the coverage problem identifying techniques includes Computational geometry and graph theoretic techniques (Voronoi Diagrams and graph search algorithms), Centralized approach, Optimal polynomial time algorithm for coverage in sensor network.

3.5 Delay
Delay determines the time taken to report an event. This is one of the major research areas in wireless sensor networks. Many applications are delay sensitive. For ex, health care, plant automation control etc., So it is necessary to measure the delay inside the network. The abnormal delays must be detected and corrected. The factors used to determine the delay is as follows
1. node density
2. transmission range
3. the sleeping schedule of individual nodes
4. the routing scheme etc.,

These factors are analyzed and the delay is rectified. Delay factors in the signal transfer path between two nodes

1. Sender Processing Delay
2. Media Access Delay
3. Transmit Time
4. Radio Propagation Time
5. Receiver Processing Time

3.6 Other Issues

The other issues involved in wireless sensor networks are as follows.

1) Hardware and Operating System for WSN
2) Wireless Radio Communication Characteristics
3) Medium Access Schemes
4) Deployment
5) Localization
6) Synchronization
7) Calibration
8) Network Layer
9) Transport Layer
10) Data Aggregation and Data Dissemination
11) Database Centric and Querying
12) Architecture
13) Programming Models for Sensor Networks
14) Middleware

4   CONCLUSION

The wireless sensor network has got many advantages and many features like fault tolerance, low cost, high flexibility, rapid deployment etc., There are many ongoing researches to overcome the existing issues and to enhance the sensor's performance. The wireless sensor network is deployed in almost many fields and it will continue growing every now and then.

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