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Wireless Sensor Networks - Energy Efficiency Routing Techniques and Applications

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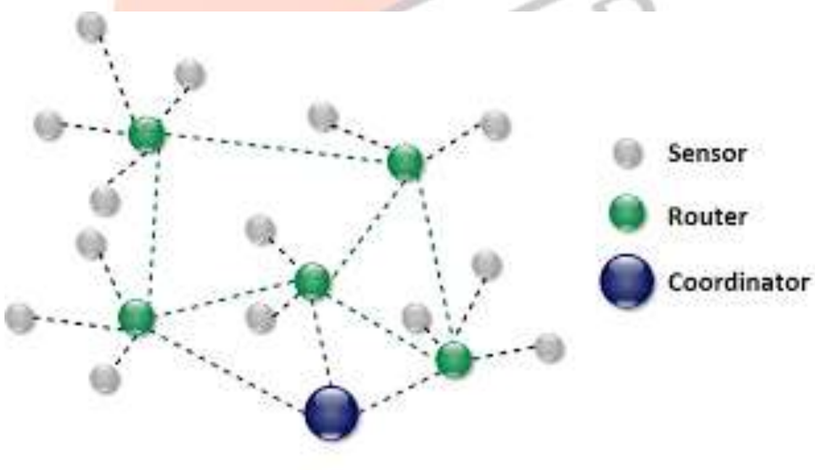
Abstract **- Distributed data storage schemes provides successful data distribution in large networks. WSNs contain large number of sensors distributed geographically over wide area. Energy saving can be achieved by reducing the number of transmissions and number of receptions. In this paper we present a new approach that exploits spatial and temporal (spatiotemporal) correlations among sensor readings simultaneously. The improved algorithm helps to save energy at nodes up to some extend**

Index Terms **- Distributed data storage, wireless sensor networks. Data availability, Security, Network lifetime, Energy efficiency, Fast Link Adaptation Algorithm**

1. Introduction

In WSN a large number of wireless sensors are connected to each other by wireless method. WSN's are widely used for various purposes, such as environmental monitoring, disaster relief, and industrial automation. These sensors monitor environmental or physical conditions, such as sound, humidity, temperature, pressure etc. The two main considerations in WSN designs are reliability and energy. To enhance the operational reliability and the robustness of sensor readings, distributed data storage was proposed. DDS provides redundancy in the network so that the sensor readings can be reconstructed even if a large number of sensor nodes fail to function. Without a centralized sink node, the whole sensor readings in a WSN can be reliably recovered by a mobile sink node visiting only a small subset of sensor nodes.

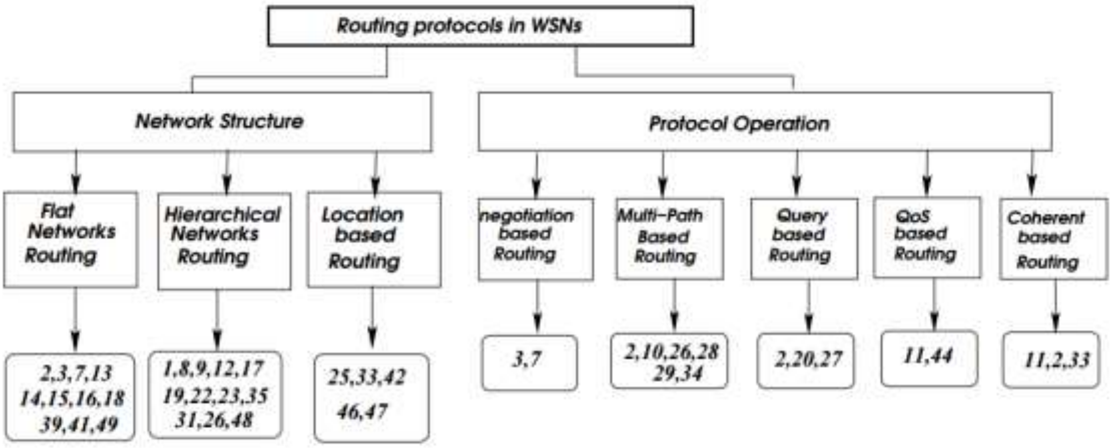
A wireless sensor network consists of three main components: sensor, router and coordinators. A spatially distributed measurement node is interfaced with sensors to monitor their environment. The received data is wirelessly transmitted to the router, which can operate independently or connect to a host system where you can collect, analyze, process, and present your measurement data using software. Routers are measurement nodes made specially so that they can be used to extend WSN distance and reliability.



WSN and components

1.1. Routing protocols: A general description

In this section, we discuss several energy saving routing protocols for WSNs. Mainly the routing in wireless sensor networks can be divided into two . Frist one is flat-based routing, hierarchical-based routing, and location-based routing . In the case of flat-based routing, all nodes are typically assigned equal roles or functionality. In the case of hierarchical-based routing, however, nodes will play different roles in the network. In location-based routing, sensor nodes' positions are exploited to route data in the network. A routing protocol is considered adaptive if certain system parameters can be controlled in order to adapt to the current network conditions and available energy levels. Furthermore, these protocols can be classified into multipath-based, query-based, negotiation-based, QoS-based, or coherent-based routing techniques depending on the protocol operation. In addition to the above, routing protocols can be classified into three categories, namely, proactive, reactive, and hybrid protocols depending on how the source finds a route to the destination. In proactive protocols, all routes are computed before they are really needed, while in reactive protocols, routes are computed on demand. Hybrid protocols use a combination of these two ideas. When sensor nodes are static, it is preferable to have table driven routing protocols rather than using reactive protocols. A significant amount of energy is used in route discovery and setup of reactive protocols. Another class of routing protocols is called the cooperative routing protocols. In cooperative routing, nodes send data to a central node where data can be aggregated and may be subject to further processing, hence reducing route cost in terms of energy use. Many other protocols rely on timing and position information. We also shed some light on these types of protocols in this paper. In order to streamline this survey, we use a classification according to the network structure and protocol operation (routing criteria). The classification is shown in below



Energy saving can be achieved by reducing the number of transmissions and number of receptions.

1.2 Achieving energy efficiency by Compressive Sensing(CS)

The sensor readings in a WSN exhibits correlation in both spatial and temporal domains [12]. The projections of sensor readings within several consecutive time slots are first generated and then linearly combined along multiple random paths in a network coding based manner. The compressive sensing (CS) theory has established that a compressible signal can be accurately recovered from a relatively small number of measurements.

2. System Model

A WSN with N nodes randomly and uniformly distributed in a unit square area is considered. N nodes are assumed to have identical transmission radius 'r' and thus any two nodes are connected if there distance is smaller than 'r'. Each node is assumed to have large capacity so that multiple data packets can be stored. It is assumed that the sensor readings exhibit spatial and temporal correlation [12].

Working of the proposed scheme is as follows:

1. Initialization of each node.
2. Encoding of sensor reading
3. Disseminating the sensor reading in a 2D compressive sensing[CS] manner

Each node forms its initial transmission packet. Then every node starts broadcasting its own packet. Every node considers itself as the source node and when it receives packet from the neighboring node it checks whether the received packet has any common term with the other packets already reached the node. If there is no common terms that packet is also received by the node. In this way the broadcasting is completed. The number of transmission and reception are used to measure energy efficiency. It can be expressed as $T_{tot}= L \times N_L$ where L denotes the length of the transmitted data packet and N_L denotes the total number of packets transmitted in L time slots and $R_{tot} = R \times N_R$ where R denotes the length of the received data packet and N_R denotes the total number of packets received in R time slots. So by exploiting the spatio temporal correlation among sensor readings simultaneously, this scheme can jointly compress and recover the sensor readings in a more energy efficient manner.

3. Design Challenges in Wireless Sensor Networks

Now a days wireless sensors network design faces many design issues like efficiency, bandwidth, range etc. The one of the main characteristic of WSN is to carry out effective data communication and increase the network lifetime. The design of routing protocols for wireless sensor networks is still challenging because of various sensor network parameters and requirements. The limitation of network resources like energy, bandwidth and storage , the design issues of wireless sensor network include the following aspects

a) Position of the sensor.
b) Scalability.
c) Limited energy resources.
d) Position of the sensor.
e) Network characteristics.
f) Massive sensor deployment.
g) Data collection.
h) Hardware resources.
i) Fault tolerance.

4. Applications

Wireless sensor networks have wide area of applications. Few are listed below for discussion

Air pollution monitoring
Wireless sensor networks can be used for remote air pollution monitoring which is deployed in several cities to check the concentration of dangerous gases. WSN takes advantage of the ad hoc wireless links rather than wired installations, which make them more mobile for testing readings in different areas.

Area monitoring
Wireless sensor networks can use for remote area monitoring in which the wireless sensor networks are deployed over an area where some phenomenon is to be monitored. A typical military example is the use of sensors which can detect enemy intrusion; a civilian example is the geo-fencing of oil or gas pipelines.

Person Health monitoring
The medical applications can be of two types: implanted and wearable. The implantable medical devices are inserted inside human body. Wearable devices are connected on the body surface of a human or at close proximity of the user. There are many other applications. Example: body position measurement and location of the person, complete monitoring of ill patients in hospitals and at homes. Body-area networks can collect information about fitness, health, and energy expenditure.

Forest fire detection
A network of sensor nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation. The early detection is crucial for successful action of the firefighters.

Water quality monitoring
Wireless sensor networks can use for remote water quality monitoring which means analyzing water properties in rivers, oceans, dams & lakes, as well as underground water reserves. The use of many WSNs enable the creation of accurate map of the water status, and allows the permanent deployment of monitoring stations in remote locations of difficult access, without the need of any manual data retrieval.

Natural disaster prevention
The Wireless sensor networks can be used for efficiently to prevent the consequences of natural disasters like floods. For example the wireless nodes deployed in rivers where changes of the water levels have to be monitored in real time remotely.

Water/Waste water monitoring
The Wireless sensor networks can use for monitoring the quality and level of water which includes many activities such as checking the quality of surface or underground. It ensures a country's water infrastructure for the benefit of all. It will help to reduce wastage of water.

Industrial monitoring
Example of Industrial monitoring is monitoring of the Machine health. It helps for 24 x7 monitoring. It helps significantly cost saving of the system. Wireless sensors can be placed in locations where it is difficult or impossible to reach with a wired system, such as untethered vehicles and rotating machinery.

Landslide detection

Wireless sensor networks can be used for landslide detection in remote area . It helps to detect the slight movements of soil and changes in various parameters that may occur before or during a landslide. Through the data gathered it may be possible to know the occurrence of landslides long before it actually happens.

5. Conclusion

In this paper we gave an introduction to the wireless sensor networks and how to make the transmissions energy efficient by exploiting spatial and temporal correlation among the nodes. Also we discussed various applications of the wireless sensor networks .How erasure and network coding techniques can be used for storage in wireless sensor networks.

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