CHALLENGES AND ISSUES IN WIRELESS SENSOR NETWORK – A REVIEW

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Abstract - *The recent technological advances make wireless sensor networks (WSNs) technically and economically feasible to be widely used in both military and civilian applications, such as monitoring of ambient conditions related to the environment, precious species and critical infrastructures. One of the primary objectives of wireless sensor networks is to provide full coverage of a sensing field as long as possible. Many task such as object tracking and battlefield intrusion detection require full coverage at any time. With the limited energy of sensor nodes, organizing these nodes into a maximal number of subgroups (or called set cover) capable of monitoring all discrete points of interest and then alternately activating them is a prevalent way to provide better quality of surveillance. So this paper showcases the various issues and challenges incurred in WSN. And a review of various routing algorithms and clustering techniques with load balancing techniques has been discussed.*

Key Words*: *Data Communication, Energy Efficient, Load Balanced, Routing, nodes.

1. INTRODUCTION

WIRELESS Sensor Networks (WSNs) are formed by connected wireless sensor nodes that each is compact and has the ability of sensing, processing, and storing environmental information as well as communicating with other nodes. High fault tolerance, strong adaptability, and comprehensive sensing coverage are the main merits of WSN. These features allow wireless sensor networks to be applied to a huge variety of range of applications, e.g. home health care, battlefield surveillance, machine monitoring, environmental monitoring, and many more. Recently, WSNs have also become an important area of research in today's world. Usually, wireless sensor nodes powered by batteries are deployed near the discrete points of interest (DPOIs) in remote areas. The events occurring at the locations that are inside the sensing coverage provided by each sensor node will be detected. A key feature of such networks is that each network consists of a large number of unattended sensor nodes. These nodes often have very limited and non-replenishable energy resources, which makes energy an important design issue for these networks. Routing is another very challenging design issue for WSNs [3]. A properly designed routing protocol should ensure a high message delivery ratio and low energy consumption for message delivery as well as balance the entire sensor network energy consumption, and there by extend the sensor network lifetime. In addition to the aforementioned issues, WSNs rely on wireless communications, which is by nature a broadcast medium. It is more vulnerable to security attacks than its wired counterpart due to lack of a physical boundary. In particular, in the wireless sensor domain, anybody with an appropriate wireless receiver can monitor and intercept the sensor network communications. The adversaries may use expensive radio transceivers, powerful workstations and interact with the network from a distance since they are not restricted to using sensor network hardware. It is possible for the adversaries to perform jamming and routing traceback attacks. It can provide connectivity between any two nodes or between a node and the BS. With a connected WSN, the information about events sensed by each sensor node will be transferred to the destination BS in an energy-efficient multi-hop manner [6]. Coverage issues are related to how well each DPOI in a sensing field is covered. The coverage preservation issue is one of the major problems in WSNs that can be studied from different aspects..

1.1 COMPONENTS OF WIRELESS SENSOR NETWORKS

The major components of a Wireless Sensor Networks are: Nodes – They sense data, they also forward and relay messages to other nodes in the network.

Sinks – They are the destinations of information. They can collect data either directly or indirectly using intermediate nodes. Sinks can use data coming from sensors autonomously or make them available on the Internet to interested users.

Mobile Data Collectors – They are neither sources nor destinations, they merely act as intermediate nodes to collect data. A network is said to be mobile when at least one of the above components is mobile.

2. CHALLENGES IN WSN

There are many challenges in the field of WSN .The major challenges are discussed below

2.1 TARGET COVERAGE AND CONNECTIVITY:

Target coverage is one of the fundamental problems for wireless sensor networks (WSNs). Target coverage is needed to select sensors in a given area that can monitor a set of interesting points. With the limited energy of sensor nodes, organizing these nodes into a maximal number of subgroups (or called set cover) capable of monitoring all discrete points of interest and then alternately activating them is a prevalent way to provide better quality of surveillance. In addition to maximizing the number of subgroups, how to guarantee the connectivity of sensor nodes (i.e., there exist links between the base station (BS) and sensor nodes) is also critically important while achieving full coverage.

2.2 DATA COLLECTION:

Data collection is also a primary objective in WSN. Data collection is needed to transmit the sensed data from sensors to a sink. Since, in many applications, sensors are battery powered, it is expected that a WSN can work Wireless Sensor Networks (WSNs) play a vital role in today's real world applications. The effectiveness of WSNs purely depends untended for a long period.[11] Numerous data collection schemes such as multipath, chain, tree, cluster and hybrid topologies are available in literature for collecting data in WSNs. However, the existing data collection schemes fail to provide a guaranteed reliable network in terms of mobility, traffic, and end-to-end connection.

2.3 NETWORK LIFETIME:

One of the key challenges facing wireless sensor networks (WSNs) is extending network lifetime due to sensor nodes having limited power supplies and non-replenishable energy resources. Extending WSN lifetime is complicated because nodes often experience differential power consumption. For example, nodes closer to the sink in a given routing topology transmit more data and thus consume power more rapidly than nodes farther from the sink[10]. Also energy consumption is severely disproportional to the uniform energy deployment for the given network topology, which greatly reduces the lifetime of the sensor networks. In order to improve the lifespan of the network, load balancing techniques using efficient routing mechanisms must be employed such that traffic is distributed between sensor nodes and gateway(s).

2.4 DATA COMPRESSION:

Wireless sensor networks are resource constraint: limited power supply, bandwidth for communication, processing speed, and memory space. One possible way of achieve maximum utilization of those resource is applying data compression on sensor data. Usually, processing data consumes much less power than transmitting data in wireless medium, so it is effective to apply data compression before transmitting data for reducing total power consumption by a sensor node.

3. VARIOUS TECHNOLOGIES AND ALGORITHMS TO OVERCOME THE WSN CHALLENGES AND ISSUE

A review of various technologies and algorithms implemented to overcome the WSN challenges and issue has been made in this section. Many researchers have implemented different routing algorithms, clustering techniques, load balancing mechanisms and compression techniques to enhance the network lifetime, data collection and connectivity of the nodes. Here we discuss some of the methods.

3.1 VARIOUS DATA COLLECTION ALGORITHMS

On the data collection scheme. Numerous data collection schemes such as multipath, chain, tree, cluster and hybrid topologies are available in literature for collecting data in WSNs[1].Some such algorithms are discussed in this section.

A recent technology Energy-efficient Delay- Aware Lifetime-balancing protocol have been proposed for data collection in wireless sensor networks, which is inspired by recent techniques developed for open vehicle routing problems with time deadlines (OVRP-TD) in operational research[5]. The goal of EDAL is to generate routes that connect all source nodes with minimal total path cost, under the constraints of packet delay requirements and load balancing needs. The lifetime of the deployed sensor network is also balanced by assigning weights to Furthermore, a distributed heuristic based on ant colony gossiping is also developed to further decrease computation overhead for large-scale network operations. The data collection efficiency is refined through an emerging technique called *compressive sensing* (CS). CS is a technique through which data are compressed during their transmission to a given destination by exploiting the fact that most sensors may not always have valid data to report when they sample the environment ,especially for nodes deployed in stable environments with rare and infrequent events to be detected

A clustering technique have been proposed Velocity Energy-efficient and Link-aware Cluster-Tree (VELCT) scheme for data collection in WSNs which would effectively mitigate the problems of coverage distance, mobility, delay, traffic, tree intensity, and end-to-end connection. This scheme consists of set-up phase and a steady state phase. In the set-up phase, cluster formation and data collection tree construction is initiated to identify the optimal path between cluster members and sink. In an intra cluster communication all the sensor node elects the cluster head with threshold value, and forms a cluster with better connection time, coverage time and robustness for connection. After the intra cluster communication, DCT communication is initiated to collect the data from its cluster head and then forwards the aggregated data packet to the sink. Once the set-up phase completed, steady-state phase is initiated. In steady-state phase, all the cluster members send the collected data to the cluster head in allocated time slots. Then, the cluster head starts to collect and aggregate the data from its cluster members. It provides better QoS in terms of energy consumption, throughput, end-to-end delay, and network lifetime for mobility-based WSNs. [1]

In this paper, author have presented the Maximum Lifetime Coverage Scheduling (MLCS) problem for WSNs, considering both target coverage and data collection To overcome the computational intractability of MLCS, a polynomial-time approximation algorithm having a constant-factor ratio to general MLCS have been developed. In addition, a polynomial-time approximation scheme for MLCS has also been developed, assuming the number of target points is bounded by a constant in a unit area. It is proved that it is *NP*-hard to find a maximum lifetime scheduling of target cover and data collection for a WSN, even if all the sensors have the same sensing radius and the same transmission radius [11]

3.2 RECENT TECHNOLOGIES FOR IMPROVING THE NETWORK LIFETIME OF A SENSOR NODE.

One of the key challenges facing wireless sensor networks (WSNs) is extending network lifetime due to sensor nodes having limited power supplies. Extending WSN lifetime is complicated because nodes often experience differential power consumption. For example, nodes closer to the sink in a given routing topology transmit more data and thus consume power more rapidly than nodes farther from the sink.[10] Several centralized algorithms have been presented for the network life time Problem. Then Swap-Rate, a more efficient algorithm is presented that maximizes the network lifetime while reducing the number of rounds. Then Swap-Level, an algorithm with the sole objective of maximizing the network lifetime is presented. This algorithm trades uninterrupted operation for a longer lifetime [10]

Yet another routing algorithm, called Game Theoretic Energy Balance Routing Protocol (GTEB), is implemented to extend the network lifetime by balancing energy consumption in a larger network area using geographical routing protocols (GRPs). The objective of the protocol is to make sensor nodes deplete their energy at approximately the same time, which is achieved by addressing the load balance problem at both the region and node levels. In the region level, evolutionary game theory (EGT) is used to balance the traffic load to available sub-regions. At the node level, classical game theory (CGT) is used to select the best node to balance the load. [9].

3.3 VARIOUS LOAD AND ENERGY BALANCING TECHNIQUES

The proposed maximum connected load-balancing cover tree MCLCT consists of two components: a coverage-optimizing recursive heuristic for coverage management and a probabilistic load-balancing strategy for routing path determination. Through MCLCT, the burden of nodes in sensing and transmitting can be shared, so energy consumption among nodes becomes more evenly. The goal of the MCT problem is to construct several connected cover trees. By doing so, a longer network lifetime and full coverage can be acquired. [6] A novel secure and efficient Cost-Aware SEcure Routing (CASER) Protocol has been proposed to address the two conflicting: energy balance control (EBC) and probabilistic based random walking. It, focus on two routing strategies for message forwarding: shortest path message forwarding, and secure message forwarding through random walking to create routing path unpredictability for source privacy and jamming prevention. In this scheme, the network is evenly divided into small grids. Each grid has a relative location based on the grid information. The node in each grid with the highest energy level is selected as the head node for message forwarding. The whole network is fully connected through multi-hop communications. The sensor network lifetime can be optimized through balanced energy consumption throughout the sensor network. [2]. Fixed priority scheduling is a common class of real-time scheduling policies in practice .Considering a network model inspired by Wireless HART. This network consists of a set of field devices and one gateway. These devices form a mesh network that can be modeled as a field device is a sensor node, an actuator or both, and is usually connected to process or plant equipment. The gateway connects the Wireless HART network to the plant automation system, and provides the host system with access to the network devices. The network manager collects the network topology information, and determines the routes. It then creates the schedule of transmissions, and distributes the schedules among the devices.[7] Coverage of interest points and network connectivity are two main challenging and practically important issues of Wireless Sensor Networks (WSNs). Two heuristic algorithms are proposed: the Basic algorithm based on clique partition, and the TV-Greedy algorithm based on Voronoi partition diagram of target points. The Basic algorithm reduces the total movement distance by minimizing the number of sensors to be moved. The TV-Greedy algorithm minimizes the total movement distance by grouping and dispatching sensors according to their proximity to targets in the Voronoi diagram. [12]. In a new algorithm, SurF (Survival of the Fittest), a bulk data dissemination protocol has been implemented which selectively utilizes negotiation to improve efficiency. Flooding is adopted as a substitute for negotiation opportunistically. It adaptively decides the best strategy and switches between flooding and negotiation to achieve improved dissemination efficiency while remaining reliable. [13]

3.4 DIFFERENT COMPRESSION TECHNIQUES

Since data transmission is one primary factor of the energy consumption of sensor nodes, many research efforts focus on reducing the amount of data transmissions through data compression techniques. The data compression techniques have been implemented, which can be classified into five categories: 1) The string-based compression techniques treat sensing data as a sequence of characters and then adopt the text data compression schemes to compress them. 2) The image-based compression techniques hierarchically organize WSNs and then borrow the idea from the image compression solutions to handle sensing data. 3) The distributed source coding techniques extend the Slepian-Wolf theorem to encode multiple correlated data streams independently at sensor nodes and then jointly decode them at the sink. 4) The compressed sensing techniques adopt a small number of Non adaptive and randomized linear projection samples to compress sensing data. 5) The data aggregation techniques select a subset of sensor nodes in the network to be responsible for fusing the sensing data from other sensor nodes to reduce the amount of data transmissions.[15] In the present contribution, practical lossy compression schemes that rely on different techniques, such as the exploitation of the temporal and spatial dynamics of the signal as well as recent algorithms based on Compressive Sensing (CS) are considered. For CS, the impact of the node selection scheme has been assessed and gauges its performance gap with respect to an idealized CS scheme where the signal covariance matrix is perfectly known at the reconstruction point. The compression techniques Temporal Correlation-based Compression and Spatial Correlation-based Compression [8]

4. CONCLUSIONS

WSN consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. As wireless sensor networks are still a young research field, much activity is still ongoing to solve many open issues Key metrics which determines best performance for optimized wireless sensor network is the coverage and connectivity of the nodes, data collection, data routing, data compression and load balancing. Looking into the literature review, issues & challenges, it is necessary to study the different routing algorithms, load balancing techniques, clustering techniques and compression techniques. So in this paper many routing algorithms and clustering techniques with load balancing techniques has been discussed. Wireless Sensor Networks. As some of the underlying hardware problems, especially with respect to the energy supply and miniaturization, are not yet completely solved, wireless sensor networks are having certain short comings, which are to be solved.

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