Review paper on design of distributed Energy Efficient and Reliable Routing Protocol for Wireless Sensor Networks

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ABSTRACT

Wireless sensor networks have discovered a wide range of applications in the recent era. Wireless sensor networks (WSN) have gained wide popularity and have increased tremendously in recent time due to growth in Micro-Electro-Mechanical Systems (MEMS) technology. Routing in wireless sensor networks has attracted a lot of attention to the researchers in the recent years. One of the main challenges in the design of routing protocols for WSNs is energy efficiency due to the scarce energy resources of sensors. Energy awareness is always a key issue to design a routing protocol for WSNs due to the capability limitation of the nodes. Reliability has come to an important issue in WSNs, since the nodes are prone to failure and the networks are unstable. The work in this paper aims at designing a multipath energy efficient, reliable and fault tolerant routing protocol. A review on routing protocol in WSNs is carried out which are classified as data-centric, hierarchical and location based depending on the network structure. Multipath routing protocols improve the load balancing and quality of service in WSN and also provide reliable communication. Energy Efficient and Reliable Routing Protocol (EERRP) uses clustering hierarchical structure to efficiently decrease the amount of data transmissions between nodes and the base station (BS). EERRP is able to improve the reliability of the traffic transmission, in the same time reduce the energy consumption of the whole network. Saving the nodes energy leads to an increase in the node life in the network, in comparison with the other protocols. Furthermore, the protocol reduces propagation delay and loss of packets.

Keywords: distributed, multi-path, reliability, energy efficiency, routing protocol, clustering, network structure, network lifetime, WSN.

1. INTRODUCTION

A wireless sensor network (WSN) is typically composed of a large number of low-cost sensor nodes, which work collectively to carry out some real-time sensing and monitoring tasks within a specific area. Wireless sensor networks have discovered a wide range of applications in the recent era. The low cost and ease of deployment make WSNs a promising solution to many challenging tasks. Sensors are characterized by some intrinsic properties representing important design factors, such as energy constraints, limited computation and storage capacities, etc. we developed a distributed energy efficient and reliable protocol, which combines the advantages of clustering hierarchy and multi-path routing protocols. Energy efficiency and reliability is one

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of the most important factors in WSNs. In this hierarchical (clustering) techniques can aid in reducing useful energy consumption. routing protocols are discussed based on three categories: Flat based routing, Hierarchical-based routing and Location-based routing on the basis of network structure. They have the common objective of trying to extend the lifetime of the sensor network.

We use various routing protocol such as EERRP (distributed Energy Efficient and Reliable Routing Protocol), LEACH (Low Power Adaptive Clustering Hierarchy), H-SPREAD, SEIF (Secure and Efficient Intrusion-Fault Tolerant Routing Protocol), CMDS (Cluster-based Multipath Delivery Scheme),multipath routing protocol etc which help us to recover drawback from the previous protocol. And using this protocol we can overcome the problems like energy efficient, reliability for single path, multipath, joint and disjoint path.

2. LITERATURE REVIEW

G. Kalpana [1] This paper, WSN have gained wide popularity and have increased tremendously in recent time due to growth in Micro-Electro-Mechanical Systems (MEMS) technology. WSN has to connect the physical world with the virtual world by forming a network of sensor nodes. In cluster-based routing, special nodes called cluster heads form a wireless backbone to the sink which collect data from sensor and forward it to sink. Energy saving in these approaches can be obtained by cluster formation, cluster-head election, data aggregation at the cluster-head nodes to reduce data redundancy and thus save energy. One of the main challenges in the design of routing protocols for WSNs is energy efficiency due to the scarce energy resources of sensors. Therefore, routing protocols designed for WSNs should be as energy efficient as possible to prolong the lifetime of individual sensors, and hence the network lifetime. We have surveyed a routing protocols and we got Spatial queries and databases using distributed sensor nodes and interacting with the location-based routing protocol are open issues for further research. Future research issues should focus on security, QoS and node mobility. Routing techniques for WSNs should address application-dependent security issues such as reliability, authentication, confidentiality etc. and examined.

Mohammad Masdari [2] In this paper, Multipath routing protocols improve the load balancing and quality of service in WSN and also provide reliable communication. This investigates various multi-path routing protocols of the WSN in the literature and illustrates its benefits. The main elements of these schemes and their classifications based on their attributes have been also discussed. Multipath routing is one of the effective methods to improve the capacity of network and productivity of sources under heavy traffic conditions. It presented a comprehensive analysis of multipath routing protocols in wireless sensor networks. The researchers also specified the challenges related to designing multipath routing protocols in WSN and compared various properties of these routing protocols. The mentioned comparison is of great importance to understand the existing solutions and also design new multipath routing protocols.

K. Vinoth Kumar [3] This paper work aims at designing a multihop energy efficient, reliable and fault tolerant routing protocol. It proposes to maintain an asymmetric network of sensors so that the nodes get a chance to configure their transmission ranges best, and thus delivers data to the base station. Our protocol design concentrates on the load sharing feature by maintaining multiple routes and selecting the best one for relaying the data packets. The problem of bottleneck around the base station is addressed by varying the transmission ranges of the nodes periodically, which changes the topology, to balance the responsibility among the nodes across the network. The effort was directed towards uniform distribution of data transmission and dissemination load among the nodes across the network. We studied the specification of MICAz motes and came to conclusion that by per-node transmission power adjustment, it is possible to control topology and thus eliminate the bottleneck around the base station. It resulted in increase in the lifetime of the network.

Ning Sun [4] In this paper, Energy awareness is used to design a routing protocol for wireless sensor networks (WSNs) due to the capability limitation of the nodes. Reliability has an important issue in WSNs, since the nodes are prone to failure and the networks are unstable. The proposed Energy Efficient and Reliable Routing Protocol (EERRP) uses clustering

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hierarchical structure to efficiently decrease the amount of data transmissions between nodes and the base station (BS). Furthermore, our protocol allows cluster heads (CHs) transmit data to the BS along multiple disjoint paths, so as to improve the transmission reliability even if some paths are in failure, in the same time reduce the energy consumption of the whole network. EERRP uses distribute probability algorithm to group network into clusters, which reduces the number of messages that need to be delivered in the network. Furthermore, algorithms of cluster head rotation and multipath discovery are employed to evenly distribute energy consumption among all the nodes. Both of the process of cluster formation and multiple path discovery are in distributed manner, it guarantees the scalability of the network. The methods in turn result in load balance and fault tolerance, finally prolong network lifetime.

Ali Norouzi1 [5] In this paper, WSNs are employed in several applications, energy usage is the determining factor in the performance of wire- less sensor networks. Consequently, methods of data routing and transferring to the base station are very important because the sensor nodes run on battery power and the energy available for sensors is limited. We intend to propose a new protocol called Fair Efficient Location-based Gossiping (FELGossip-ing) to address the problems of Gossiping and its extensions. Saving the nodes energy leads to an increase in the node life in the network, in comparison with the other protocols. Furthermore, the protocol reduces propagation delay and loss of packets. Hence we studied the operation of a Gossiping routing protocol with safe energy consumption, and discussed the factors of energy optimization. And we find the ways in which we choose the next hop, the network life- time can be extended. As a result, we have extended the network lifetime, a high packet delivery ratio, reduced the message overheads and the energy consumed by the nodes. In Green Wireless Networks" we propose a new routing protocol that optimizes energy consumption and bandwidth. Using less energy in routing protocols reduce nature pests.

Satvir Singh [6] In this paper, An energy efficient routing is a significant issue in the designing of Wireless Sensor Network (WSN) protocols. It presents a comprehensive survey on energy efficient routing protocols in WSNs. From the protocols, it is clearly seen so far that, the performance of protocols is worth promising in terms of energy efficiency. There is very little research done in improving QoS parameters in a very energy constrained sensor networks. The sink node and sensor node are mostly stationary thus research can be done by assuming sink and source node as mobile Various topologies, routing algorithms can be used based on the different application of WSN. Results can be improved using multiple sink nodes.

Monica R Mundada [7] In this paper, WSN consists of low cost, low power, small in size and multi-functional sensor nodes. Routing protocols in WSNs emphasize on data dissemination, limited battery power and bandwidth constraints in order to facilitate efficient working of the network, thereby increasing the lifetime of the network. WSN has a design trade-off between energy and communication overhead which forms the nerve center of the routing techniques. we present a survey of state-of-the-art routing techniques in WSNs under all the three categories. We epitomize these routing techniques and bring out the advantages and disadvantages followed by their application domain. We classify the routing protocols in WSNs into data-centric, hierarchical and location based depending on the network structure. Data-centric protocols use the metadata structure to transmit the sensed information to the BS. Naming the data helps to construct a query which requests for only certain attributes of the data, thus known as data-centric routing techniques. Hierarchical routing protocols adopt the clustering approach by grouping sensor nodes. This approach is highly scalable and thus used in a number of applications. Location based protocols use the information of position of sensor nodes intelligently to route data. We epitomize the logic behind these protocols followed by the advantages and constraints. We also mention the possible application domain of these protocols and scope for improvement in the future.

Ahmed Ali Saihood [8] Designing energy efficient and reliable routing protocols for mobility centric applications of wireless sensor network (WSN) such as wildlife monitoring, battlefield surveillance and health monitoring is a great challenge since topology of the network changes frequently.

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Existing cluster-based mobile routing protocols such as LFCP-MWSN, LEACH-Mobile, LEACH-Mobile Enhanced and CBR-Mobile consider only the energy efficiency of the sensor nodes. However, reliability of routing protocols by incorporating fault tolerance scheme is significantly important to identify the failure of data link and sensor nodes and recover the transmission path. The protocols allocate extra timeslots using time division multiple access (TDMA) scheme to accommodate nodes that enter a cluster because of mobility and thus, increases end-to-end delay. Enhanced the existing LFCP-MWSN to ELFCP-MWSN in which we reduce network energy consumptions and slightly less end-to-end data transmission delay than the existing LFCP-MWSN. ELFCP-MWSN also incorporates a simple range free approach to localize sensor nodes during cluster formation and every time a sensor moves into another cluster. ELFCP-MWSN protocol is more efficient in terms of energy consumptions, have less end-to-end network delay , Packet Delivery Ratio is higher than those of the existing LFCP-MWSN protocol.

Neha Rathi [9] In this paper, WSNs are harshly restricted by storage capacity, energy and computing power. So it is essential to design effective and energy aware protocol in order to enhance the network lifetime. A review on routing protocol in WSNs is carried out which are classified as data-centric, hierarchical and location based depending on the network structure. Then some of the multipath routing protocols which are widely used in WSNs to improve network performance are also discussed and compares and summarizes the performances of routing protocols. Routing protocols are discussed based on three categories: Flat based routing, Hierarchical-based routing and Location-based routing on the basis of network structure and trying to extend the lifetime of the sensor network. Most of the routing protocols require location information for sensor nodes in wireless sensor networks to calculate the distance between two particular nodes on the basis of signal strength so that energy consumption can be estimated. Single-path routing approach is unable to provide efficient high data rate transmission in wireless sensor networks due to the limited capacity of a multi-hop path and the high dynamics of wireless links. This problem can be overcome by using multipath routing.

3. EERRP: DISTRIBUTED ENERGY EFFICIENT AND RELIABLE ROUTING PROTOCOL

3.1. Classifications of the sensor nodes

In this paper, we divide the specially-functional sensor nodes into three categories:

- BN (Branch Node): BNs are the one-hop neighbors of the BS. Each BN represents one branch. The nearer to the BS, the node has more burdens on data transmission. The BN acts critical role in the network, because once it's exhausted the whole branch is separated and the downstream paths are correspondingly failed. In order to conserve energy, the BN doesn't join the cluster formation and data sense. It just acts as a router in the network. Furthermore, if its energy is below a limitation value, it should announce that it abandons the role of branch node and transforms to a normal node.
- CH (Cluster Head): In our approach, cluster heads are elected distributed based on the parameters of the residual energy and the number of neighbors. CH is in charge of data receive, data process, data aggregation and data transmission. The energy consumption of CH is much quickly than normal nodes.
- SN (Substitute Node): The substitute nodes for CHs. This strategy guarantees the data could be transmitted correctly even if the cluster head is exhausted. This could improve the reliability and fault tolerance of the system. The remained nodes are normal nodes.

3.2. Process of EERRP

The operation of EERRP is divided into rounds. The BS periodically collects the sensed data and initializes a new round by sending a request message. In every round, EERRP runs the following three phases:

3.2.1. Phase one: Broadcast

This phase starts from the BS broadcasting a request message. The format of this message is {REQ, RID, BID, SID, Ere, HCount, Eto, N}, where REQ indicates the type of message is request; RID is the round identifier, which is generated by the base station; BID is the identifier of the

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branch, i.e., identifier of the branch node; SID is the identifier of the sender node; Ere is the residual energy of the sender node; HCount is the hop counts from the sender to the base station; Eto indicts the total energy of all nodes, it's calculated by the base station; Finally N is the sum of nodes after last round. Here Eto and N are prepared for the election of cluster heads. The BS initially broadcasts the message {REQ, RID, Φ, BS, ∞, 0, Eto, N}.

After this phase, every node decides whether it is a Branch Node, stores the parameters (Eto, N) for the next phase, and records the neighborhood information, which provides a primary path and a few alternative paths to the BS. Each node rebroadcasts once and only once.

3.2.2. Phase Two: Cluster Formation

- After previous phase, every node has the information about the total energy Eto and sum of nodes N. Each node decides whether to be a cluster head.
- Once the node has elected itself to be cluster head, it broadcasts an advertisement message (ADV) using a non-persistent carrier-sense multipath access (CSMA) MAC protocol . Each non-cluster head node determines its cluster for this round by choosing the cluster head that requires the minimum communication energy, based on the received signal strength of the advertisement from each cluster head.
- After each node has decided to which cluster it belongs, it transmits a join-request message (Join-REQ) back to the chosen cluster head using a CSMA MAC protocol.
- The cluster head node sets up a TDMA schedule and transmits this schedule to the nodes in the cluster.
- Besides, in order to improve the fault tolerance of the cluster, CH need elect one node as the substitute of the cluster head. CH will choose it from the nodes whose Join-REQ messages are heard by CH with the larger signal strength, i.e., they are closer to CH than others. Then CH compares the energy and neighbor number among these node, finally elects one node with higher parameters. CH sends a announcement message (SNANN) to nodes. This message consists of the SN-ANN header, the node's ID and the CH's ID. The ID matched node marks itself as a Substitute Node after hearing the message.

3.2.3. Phase Three: Data Propagation

This phase mainly consists of two steps: first the data propagation within a cluster, then the data propagation from the cluster head to the BS, which is along multi-hops.

- In a cluster, nodes send their data to the cluster head during their allocated transmission slot time. Once the cluster head receives all the data, it performs data aggregation to enhance the common signal and reduce the uncorrelated noise among the signals. In our approach, after every round, BS needs to know the whole residual energy of all nodes and the sum of nodes alive.
- During this process, if the residual energy of the cluster head is below a limitation value Eurgent, it will broadcast an energy-urgent announcement message, and send the received data to the substitute node. The remaining nodes which haven't yet sent data change the cluster head correspondingly. It's a very reliable and flexible fault tolerant scheme.
- Then the resultant data are sent from the cluster head to the BS. Since the BS may be far away and the data messages are large, this is a multi-hop and high-energy transmission. The cluster head firstly checks its neighborhood. The node marked with "parent" is the next hop and the path is the primary path along it. Then CH continuously looks for the neighbors with different BID value from its parent. After comparing the energy and number of neighbors, the CH chooses the next hop nodes (more than one).
- After the next hop nodes are chosen, the CH (intermediate node) transmits data along the primary path at first. If the data is successfully sent to the next hop, the next hop will response a SUCCEED message. After a certain threshold time, if CH didn't get the response message, it will send the data along another next hop.

The message sent from CH includes message type (DATA), next hop ID, BID, aggregated data, Ncluster and Ecluster. For inter-media nodes, it checks the BID, finds next hop with the same BID in its neighbors and transmits data to it. Similar to

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last step, it waits SUCCEED message from the next hop for a certain threshold time. If it can't get the response message, it will send a FAILURE message back to its last hop. If any inter-media node receives the FAILURE message, it will notice its last hop till CH gets the information.

4. CONCLUSIONS

We studied the different routing protocol .Routing in wireless sensor networks has attracted a lot of attention to the researchers in the recent years. Routing in sensor networks is a new research area, with a limited but rapidly growing set of results. We proposed a cluster-based multipath delivery scheme for WSNs, which integrates the advantages between hierarchical routing and multipath routing. Hierarchical routing maintains the energy consumption of sensor nodes and performs data aggregation which helps in decreasing the number of transmitted messages to base station. Single-path routing approach is unable to provide efficient high data rate transmission in wireless sensor networks due to the limited capacity of a multi-hop path and the high dynamics of wireless links. This problem can be overcome by using multipath routing. EERRP uses distribute probability algorithm to group network into clusters, which reduces the number of message that need to be delivered in the network. The methods in turn result in load balance and fault tolerance, finally prolong network lifetime. This paper presented a comprehensive analysis of multipath routing protocols in wireless sensor networks. In Green Wireless Networks" we propose a new routing protocol that optimizes energy consumption and bandwidth. Using less energy in routing protocols reduce nature pests.

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