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Energy Efficient Routing Scheme for WSN

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Abstract: ***Wireless Sensor Networks are being wildly popular for large number of applications for military healthcare, weather, etc. WSNs have promised to be one of the convincing areas of Research and Development. A variety of applications such as monitoring battlefield, medical, consumer and industrial use, etc have shown its significant contribution in WSN. Routing is one of the fundamental aspects in wired and wireless communication, which permits transfer of data from source to destination. The existing routing scheme is based upon the energy based metric calculation scheme, which carries some drawbacks. Such as, the existing scheme is based upon the energy based metric. The existing model proposes the use of tree-based routing structure. In this paper, we have proposed the use of remaining energy in terms of percentage and remaining lifetime with multiple other factors for the effective and energy efficient routing in the WSNs. The performance of the proposed scheme will be measured using the latency, load, reliability, etc.***

Keywords: WSN, routing, energy based routing, residual energy, heterogeneous WSNs

1. Introduction

Technological advancements and rapidly increasing varied needs have switched the mode of communication from wired to wireless. Though wired being still more reliable, wireless takes a step ahead with reduced cost and complexity. Today wireless is among one of the top priorities in mode of communication in various fields headed by sensing devices, collectively known as wireless sensor networks. Wireless sensor network (WSN) refers to a bunch of geographically spread sensors deployed particularly for observation and recording the physical conditions of the surroundings. The sensed data obtained from the multiple sensors as a result of observation is then collected at a central location known as base-station (BS) or sink in the form of organized information to be used later in an area of research. Factors like low cost and mobility makes WSN more suitable for use in monitoring and sensing purposes.

WSNs were at the start designed particularly for military operations to monitor the conditions at battlefield, however its application has since been extended to health, traffic, and plenty of different consumer based and industrial uses. A typical WSN consists of sensing elements as nodes ranging from hundreds to thousands depending on the size of the area to be monitored. The sensor node includes an interfacing electronic circuit to sense the analogue data and convert it into digital form, a microcontroller to process the sensed data into useful information, a radio transceiver along with an antenna to send and receive sensed digital data, and an energy source, usually a battery. These sensing elements may also vary in dimensions their costs vary from few to many bucks reckoning on the functional parameters of a sensing element like energy consumption, processing speed rate, bandwidth, and memory.

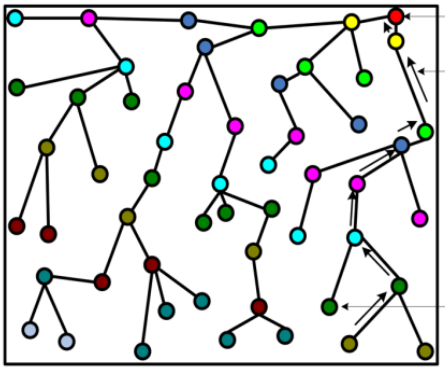
Though, WSN hosts a number of applications in the real world but some industrial applications such as BEMS (Building Energy Management System) pose certain challenges in the implementation of wireless sensor networks, where wsn's are required to monitor and control the building infrastructure. In BEMS dynamic objects such as moving bodies and things, open and closed doors cause interference in the communication leading to path instability. In order to overcome such challenges, intelligent routing techniques should be used such as tree based routing.

With the increasing adaptation of WSN in numerous areas of use as a result of its straightforward and in-budget installation, there's a requirement to attain more precise results and longer network lifetime within a similar setup. This concept will solely be conceived with the assistance of routing. By using intelligent routing techniques and algorithms we will utilize the bandwidth, network elements and residual energy of the present mounted network to attain longer network up-time alongside a reliable multi-hop communication. Since, protocols employed in wireless sensor networks are application specific, so completely different routing protocols are needed based on the type of application. These protocols are principally targeted on three areas namely: data-centric, hierarchical and location-based to attain multipath routing and quality of service (QOS).

Despite of such intelligent and energy based routing, there are some dead-ends within the network that goes un-detected throughout routing that results in packet loss and not permitting the packets to reach their destination. Some of them are caused due to:

- Routing around connectivity holes
- Resilience to localization errors
- Efficient relay selection.

The amount of packet loss can still be avoided to some extent by using advanced load balancing algorithms that involves splitting of packets and equally distributing the load inside the network or either distributing the load based on the link quality and remaining energy.



The most popular routing technique that makes the utilization of load-balancing is tree based for lower energy and lossy networks where the concept of neighborhood heuristics (NH) is employed to combine the current node's routing metric with its neighbor to spot the quality of the route and another alternative obtainable to be used once primary link fails. In Tree based routing, all the sensor nodes are represented as leaf nodes that choose nodes above them as parent nodes to forward the sensed data to single collection point called the root or the sink node.

2. Literature Survey

Delaney, et.al. [1] have worked on a stable routing framework for tree-based routing structures in WSNs. This paper involves the use of neighborhood heuristics (NHs), a method that combine sensor's routing metric with its neighboring nodes which spotlights on current route aspects as well as quality of the routing choices convenient to the sensor so that best alternative can be used when its current route become inaccessible. The New combined metric grant sensors to prefer good quality routes that are more superior despite the degradation of an upstream link. The NHs framework is enforced with the routing protocol for low power and lossy networks routing protocol.

Ghadimi, et.al. [2] have projected opportunistic Routing in Low Duty-Cycled Wireless Sensor Networks. In this paper the authors introduced ORW, a practical opportunistic routing theme for wireless sensor networks. ORW uses a unique opportunistic routing metric, EDC, that gives back the expected number of duty-cycled wakeups that are required that successfully deliver a packet from source to destination. Distributed algorithms notice the EDC-optimal forwarding and demonstrate using analytical performance models and simulations that EDC-based opportunistic routing leads to considerably reduced delay and improved energy efficiency compared to the normal unicast routing.

Sahin, et.al. [3] has worked upon QoS differentiation in single-path and multi-path routing for wireless sensor network-based smart grid applications. In this paper, the utilization of multi-path and single-path QoS-aware routing algorithms beneath harsh SG environmental conditions is investigated to check out their service differentiation capabilities in trustworthy and timeliness domains. in this regard, this study is a crucial step towards developing novel routing protocols specifically designed for smart grid environments.

Singh, et.al. [4] has developed an energy efficient source based tree routing with time stamp in WSN. Totally different routing protocols and topologies transmit data from source to sink or route. A tree based routing technique relies on tree topology where parent-child relationship is employed to forward the packet. Security is of serious concern in transmission that ought to be thought-about. A packet that's transmitted from source ought to be reached to destination in pre-specified period. Some security mechanism should be applied and a few parameters should be added with every data packet that is transmitted.

Kwon, et.al. [5] has worked upon the state less point to point routing protocol supported shortcut tree routing algorithm for IP-WSN. To deal with the routing challenges, the authors have planned the stateless P2P Routing protocol (SPR) based on short cut tree routing algorithm. SPR delivers a packet to the node having the smallest remaining hop count among neighbors without further management overhead, rather than always delivering a packet to a parent or children tree routes. SPR additionally contributes stateless routing therein SPR acquires a route through hierarchical address structure and one hop neighbor information without having to store global routing state.

The authors have enforced SPR in our IP-WSN platform named SNAIL and conduct a simulation and a measurement to verify the performance of SPR. The simulation results show SPR provides improved hop count compared to Hi-Low and RPL. It additionally provides reduced memory usage and also the variety of control packets compared to RPL.

Tunca, et.al. [6] have proposed a survey upon distributed mobile sink routing technique for WSN. In this paper, the authors have presented a survey of the present distributed mobile sink routing protocols. In order to provide awareness to the explanation and the considerations of a mobile sink routing protocol, design needs and challenges related to the matter of mobile sink routing are determined and explained. A definitive and elaborated categorization is formed and also the protocols' benefit sand downsides are determined with reference to their target applications.

Bechkit, et.al. [7] has worked on a new weighted shortest path tree for converge cast traffic routing in WSN. This paper presents a new weighted path cost function and displays how that the cost function is more appropriate for WSN. With this cost function, the authors have projected a straightforward and efficient weighted shortest path tree construction that doesn't introduce new overheads. They have most likely considered the actual case of energy-aware routing in WSN and applied it within the new solution so as to construct more applicable energy aware SPT.

3. Problem Formulation

In the existing scheme in the base paper, authors have used Tree-Based metric calculation mechanism, collectively called Tree-Based, together to solve the problem of energy efficiency by using energy based routing to avoid the connectivity holes and the dead ends. The Tree-Based routing mechanism is capable of solving the problem of

energy efficiency up to level but can't be considered efficient enough because it does not track the energy levels for metric calculation. There is a strong requirement of bypassing the connectivity holes effectively by calculating accurate and balanced paths to minimize the energy efficiency. The Tree-Based is based on proactive routing scheme for its resource based scheduling. Tree based mechanism uses multiple path calculation to send the data by route other than direct route with connectivity holes to avoid the data loss. The data is sent through relay nodes among other paths rather than sending it via flawed sink. Tree-based routing in the existing scheme is either not capable of selecting an alternative path on the basis of the energy residual and life estimation. The Tree-Based is not an intelligent algorithm and can choose longer path than usual even while using geographical location because Tree-Based uses route cost/route metric to evaluate the best alternative path. The route cost calculation depends upon the usual routing protocol algorithm. However if the route cost computations process can be made independent of usual routing protocol algorithm on lower layer, it will become more efficient.

4. Proposed Model

The existing system will be improved and enhanced for its metric calculation to elect the best route and route for load balancing while sending the data towards the BTS. The BTS will be receiving the data from the cluster heads in the wireless networks. The metric calculation would be improved by combining the values of the next hop energy, hop count, all hop energy (all hops in the link), node id and bandwidth between the source and destination node. The adaptive load balance balancing rainbow protocol will use this new metric route to find the shortest route with balanced energy and higher bandwidth. The route cost calculation for load balancing will be based on the individual load on the relay node/s, the alternative routes with the minimum load will be also considered to find the alternative route. Among the shortlisted routes using the load as metric, the route with minimum total route cost will be used to forward the data. The existing algorithm will be compared with our proposed algorithm using end to end delay/latency, packet delivery ratio, network/route load and packet Efficiency of the alternative route. The project will be developed using NS2 simulator. The algorithm to detect the connectivity hole or link failure will be used to update the routing table while the primary route becomes unavailable. We will be using pushback algorithm to detect the link failure, and to execute the backup and load balance route finder event based improved adaptive load balancing rainbow protocol for WSNs.

In the nutshell, instead of rainbow method, the cost calculation would be done on the basis of new metric parameters in the newer combination and weight-age. The new metric or cost calculation will be primarily based upon the energy threshold, residual energy, consumption prediction and next hop energy to make the final decision of path selection. The new algorithm will be capable of selecting the paths dynamically by automatically finding the neighbor nodes and the paths towards the destination. Among all of the paths, the best path is found on the basis of the new metric calculation method based on the energy levels among the nodes in the whole path and the next hop neighbor node.

5. Methodology

At very first step, the literature on the routing algorithms in wireless sensor networks would be studied in detail in order to understand their working, advantages and demerits. Then the algorithm flow would be reviewed and the possible solution in order refine their performance would be evaluated. Afterwards, the algorithm would be programmed in NS-2. The experiment results would be thoroughly analyzed and compared with the existing algorithm results. This is also very important to get the information about the parameters used for collecting the routing algorithm results in wireless sensor network simulations. This proposed model under the research project would be implemented in the NS-2 simulator. A thorough performance and feature testing model would be formed and utilized to analyze the performance of the simulated clustering protocol, to detect the flaws and to recover them. Afterwards, the experiment results would be thoroughly analyzed and compared with the existing routing algorithms to examine the performance of the new routing algorithm for WSNs.

6. Conclusion

The proposed scheme will be entirely based upon the energy efficient routing for the wireless sensor networks. The proposed scheme will be adaptable for both homogenous and heterogeneous wireless sensor networks, because it will take residual energy percentage and remaining lifetime in to the account along with several other properties of metric calculation. The metric parameters other than energy percentage and lifetime will be based upon bandwidth, hop count, link stability, link uptime, etc for the purpose of finding the most possible effective route from source to the sink. The proposed model will be implemented using the NS 2 simulator along with variety of performance parameters of latency, load, throughout, data drop rate, packet delivery ratio, etc.

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