Multipath Routing Technique for The WSN through Matlab

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Abstract - Wireless Sensor Networks (WSN) is one of the most developed technologies for all areas requiring sensitive information. However, the limitations of limited resources and the need for environmentally-related links and lifecycles have led designers to seek more efficient WSN infrastructure. Ensuring efficient and reliable data transfer in resource-limited wireless sensor networks (WSNs) is one of the primary concerns for achieving high efficiency in monitoring and control systems. Two techniques commonly used to achieve reliability in WSNs are retransmissions or redundancy. Most existing research focuses on traditional retransmission-based reliability, where reliable transmission of data packets is ensured by forwarding lost packets. This can result in additional transmission costs, which not only wastes the sensor's limited energy resources, but also causes the network to become overloaded, thereby affecting the reliable data transfer.

Keywords-WSN, sensitive information, Transmission Energy

I. INTRODUCTION

A wireless sensor network is a collection of sensor nodes with limited power supply and constrained computational and transmission capability. Due to the limited transmission and computational ability, and high density of sensor nodes, forwarding of data packets takes place in multi-hop data transmission. Therefore routing in wireless sensor networks has been an important area of research in the past few years. The sensor nodes run on non-rechargeable batteries, so along with efficient routing the network should be energy efficient with efficient utilization of the resources and hence this is an important research concern. Advances in wireless Technologies and evolution of low cost sensor nodes have led to introduction of low power wireless sensor networks. Due to multiple functions and ease of deployment of the sensor nodes it can be used in various applications such as target tracking, environment monitoring , health care, forest fire detection, inventory control, energy management, surveillance and reconnaissance, and so on [1]. The main responsibility of the sensor nodes in a network is to forward the collected information from the source to the sink for further operations, but the resource limitations [2], unreliable links between the sensor nodes in combination with the various application demands of different applications make it a difficult task to design an efficient routing algorithm in wireless sensor networks. Designing suitable routing algorithms for different applications, fulfilling the different performance demands has been considered as an important issue in wireless sensor networks.

In this context many routing algorithms have been proposed to improve the performance demands of various applications through the network layer of the wireless sensor networks protocol stack [3, 4], but most of them are based on single-path routing. In single-path routing approach basically source selects a single path which satisfies the performance demands of the application for transmitting the load towards the sink.

A. Basic Principles in Designing Multipath

i).Routing Protocols - There are several components in multi-path routing protocol to construct multiple paths and distribute the traffic over the discovered paths. The performance gains of the multi-path routing protocols are highly dependent on the ability of the proposed protocol to construct high quality, reliable paths. We describe these components in details.

ii). Routing in WSN - A wireless sensor network (WSN) can be defined as a network of (possibly low-size and low complex) devices denoted as nodes that can sense the environment and communicate the information gathered from the monitored field (e.g., an area or volume) through wireless links; the data is forwarded, possibly via multiple hops relaying, to a sink (sometimes denoted as controller or monitor) that can use it locally, or is connected to other networks (e.g., the Internet) through a gateway.

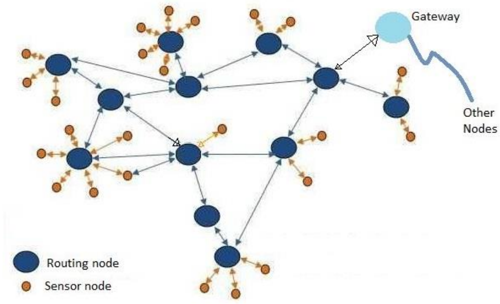

Figure 1: Typical WNS

B. Classification of sensor network

Classification of sensor network on basis of their mode of functioning and the type of target application are:

i).Proactive Networks - Nodes in this network periodically switch on their sensors and transmitter, sense the environment and transmit the data of interest. Thus, they provide a snapshot of the relevant parameters at regular intervals. These types of networks well suited for applications requiring periodic monitoring of data.

ii). Reactive Networks - In this scheme the nodes react immediately to sudden and drastic changes in the value of a sensed attribute. These types of networks are well suited for time critical applications. Recent advances in wireless sensor networks have led to many new protocols specifically designed for sensor networks where energy awareness is an essential consideration. But approaches like Direct Communication and Minimum Transmission Energy [27] do not guarantee balanced energy distribution among the sensor nodes. In Direct Communication Protocol each sensor node transmits information directly to the base station, regardless of distance. As a result, the nodes furthest from the BS are the ones to die first [28]. On the other hand, in case of Minimum Transmission Energy routing protocol data is transmitted through intermediate nodes. Thus each node acts as a router for other nodes' data in addition to sensing the environment. Nodes closest to the BS are the first to die in MTE routing. So far, cluster-based technique is one of the approaches which successfully increases the lifetime and stability of whole sensor networks. We classified most important energy efficient routing techniques based on various clustering attributes like cluster formation and data gathering process. Figure 2 is a hierarchical diagram of different routing protocols which are widely used in WSN.

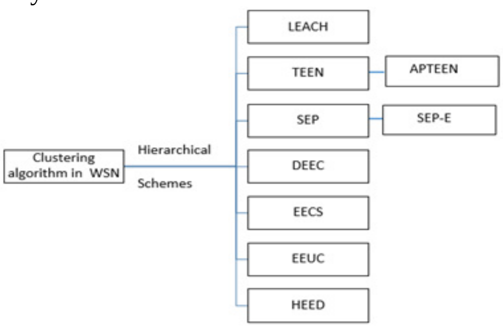

Figure 2: Classification of widely used clustering schemes in WSN

II. BACKGROUND

Hasan et al. (2017). The vision of the wireless multimedia sensor network (WMSN) is to provide real-time multimedia applications using wireless sensors used for long-term use. The quality of service guarantees for best effort data and real-time multimedia applications introduces new challenges in prioritizing multipath routing protocols in WMSN. Multipath routing methods with multiple limitations have gained great research interest. This paper proposes a comprehensive study of best-effort data and real-time multipath routing protocols for WMSN. The initial study results of the design problems affecting the development of multi-path strategic protocols that support multimedia data in WMSN are also being introduced and discussed from a network application perspective.

Zin et al. (2015). Wireless sensor networks (WSNs) face some security challenges when they record data to base stations because such networks impose resource constraints to be solved by routing mechanisms. This paper examines, explores, and informs scientists about the future of multipath routing by providing the motivation behind multipath routing implementation. Then, this paper analyzes the security requirements and the common attacks on wireless sensor networks. In addition, we provide a classification of secure multipath routing protocols based on the nature of defensive WSN attacks. Based on the classification, we study the existing safe, multi-path routing protocols in the WSN domain by discussing their benefits and limitations. Based on multi-path technology, additional security infrastructure, security requirements, similar attacks and efficiency analysis, and seeking effective secure routing in wireless sensor networks, a comparative study of proposed classification is proposed.

Anasane & Satao (2016). In recent years, the field of wireless sensor networks (WSN) has made great strides. This development is mainly due to the availability of small cameras and microphones. These devices capture multimedia data from the environment and transmit them effectively. The Wireless Multimedia Sensor Network (WSMN) is also the subject of current discussion because of its application in various fields. To improve channel utilization, the transmission delay is reduced and the transmission load in WMSN multipath routing is balanced by a promising solution. Multipath routing helps to transmit data at the same time, which reduces waiting time and overload in WMSN. This article discusses various protocols and scenarios for multipath routing strategies that will identify additional areas of development for WMSN.

III. SIMULATION WORK

Developing a self-organized node for WSN introduced the idea of multihop and multipath. Due to cluster change continuously it has to necessary for node to have the feature like multimode and multipath. This will use multi-hop and multi-path for increasing the network life and decreasing the consumption of power. The power consumption will be less due to load balancing on cluster heads of every cluster. Then Compared to traditional networks, sensor networks have rather different characteristics and quality measurements. Because of the high collaboration of sensor nodes and very specific application goals, there is no "one size fits all" solution to routing, so the specific characteristics decide what routing mechanism to use. In this thesis we have made simulations that show that asymmetric communication with multi-hop extends the lifetime of large cluster based sensor networks. We have also investigated the usefulness of enforcing a minimum separation distance between cluster heads in a cluster based sensor network to prolong network lifetime. For Above requirements we are implementing as below.

Implementation of Multi hop Communication - A large number of sensor nodes have to work together and techniques such as sending information directly from each sensor node to a base station need in many cases to be avoided. When a sensor node sends data directly to a base station, the amount of energy used by the sensor node can be quite high, depending on the location of the sensor node relative to the base station. In such a scenario, the nodes that are furthest away from the base station will run out of power much faster than those nodes that are closer to the base station, and parts of the network area will no longer be covered by functional sensor nodes. When communicating in a sensor network the amount of energy used by a sensor node depends on e.g. the size of the packet and the communication distance. The amount of energy used when communicating can be proportional to up to d4 (d = distance between the two communicating nodes), for long distance communication. To avoid problems with long distance communication, so called multi-hop communication is used. In multi-hop, information is sent from sensor node to sensor node to finally reach the base station, thus routing mechanisms/techniques are needed. We have, in thesis A, made simulations that show that multi-hop communication together with asymmetric communication between the base station and the sensor nodes are less energy consuming than not using asymmetric communication. The simulations are made in the AROS architecture where the base station acts as a master for the sensor nodes and is able to reach all its sensor nodes in one hop. However, all sensor nodes might not reach the base station in one hop, hence other nodes might need to forward information towards the base station, i.e. multi-hop. In the AROS architecture we use cluster heads to forward information.

IV. RESULT AND DISCUSSION

To evaluate the performance of our protocol, we have implemented it on the MATLAB simulator with the integrated model of Advance Clustering protocol. Our goals in conducting the simulation are as follows: Compare the performance of proposed work with earlier clustering technique SEP, LEACH and TEEN, etc. Proposed work based on clustering and self-organizing nodes through the energy dissipation give longevity of the network. The simulation has been performed on a network of 50 nodes and a fixed base station. The nodes are placed randomly in the network. All the nodes start with a some initial energy. Cluster formation is done as in the SORP(Self Organized routing protocol) protocol .However, their radio model is modified to include idle time power dissipation (set equal to the radio electronics energy) and sensing power dissipation (set the radio electronics energy).

V. SIMULATED ENVIRONMENT

For our experiments, we simulated an environment with varying temperature in different regions. The sensor network nodes are first placed randomly in a bounding area of 100x100 units. The actual area covered by the network is then divided into four quadrants. Each quadrant is later assigned a random temperature between 0F and 260F every 15 seconds during the simulations. It is observed that most of the clusters have been well distributed over the four quadrants.

- **Experiments -** We use two metrics to analyze and compare the performance of the protocols. A common parameter for both the protocols is the attribute to be sensed, which is the temperature. The performance of TEEN is studied in two modes, one with only the hard threshold (hard mode) and the other with both the hard threshold and the soft threshold (soft mode).
- **Average energy dissipated -** This metric shows the average dissipation of energy per node over time in the network as it performs various functions such as transmitting, receiving, sensing, aggregation of data etc.
- **Total number of nodes alive -** This metric indicates the overall lifetime of the network. More importantly, it gives an idea of the area coverage of the network over time. We now look at the various parameters used in the implementation of these protocols. The hard threshold is set at the average value of the lowest and the highest possible temperatures. The soft threshold is set at for our experiments.

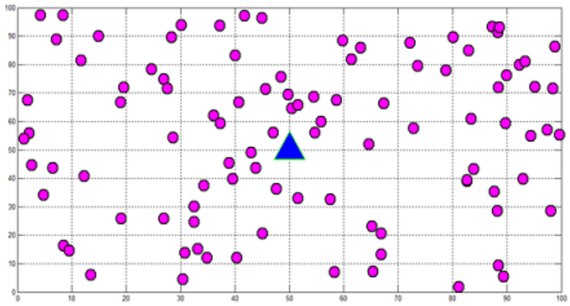

Figure 3: A WSN with random node deployment

In this thesis line function is used for showing the data transmission path from source to sink. Figure 5.2 shows data transmission paths following which event information reached to sink.

- **Grid -** Grid on adds major grid lines to the current axes. Grid off removes all grid lines from the current axes. In this work the grid function is represented like Figure below

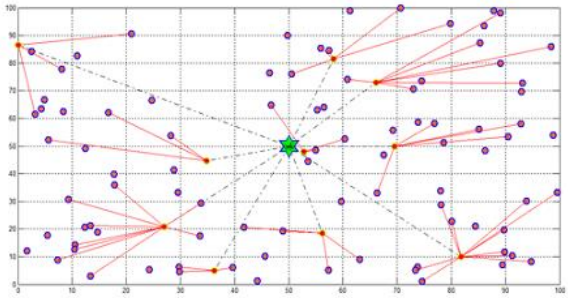

Figure 4: Mathematical Functions

- **Rand () -** rand(): generates uniformly distributed pseudo random numbers. This function has various forms. In this work rand(1,n) is used. It generate a one dimensional array of n random numbers, where n is the number of nodes. This function is used to generate coordinates of n nodes. X collects the x coordinates of n nodes whereas Y collects y coordinate of n nodes. x_m and y_m is the length of the network field along with the x and y coordinate in which the nodes will be deployed.

- **Convhull() -** Convhull(x,y): Returns indices into x, y vectors of the points on the convex hull. In the algorithms discussed in subsequent chapters convhull is used in conjunction with plot function to roughly define the area under each cluster .A partitioned WSN via clustering. Here each clustering area is bounded using convhull and plot functions.

A. MATLAB Code Segments

MATLAB is a high level programming language and it include matrix based data structures. The data types, built in functions enables the user to write their own functions, Scripts etc.

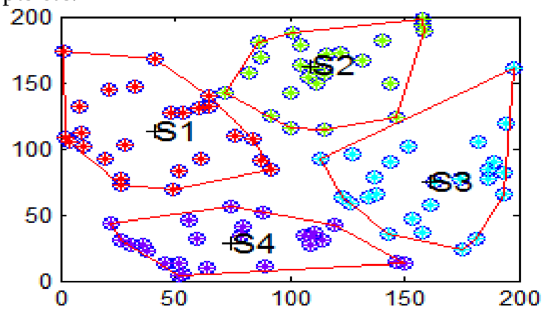

Figure 5: Partitioned WSN using clustering

It also provides object oriented programming capabilities, error handling etc. Some of the MATLAB code segments used in the implementation of algorithms in this thesis is presented in this section. All algorithms of this thesis consider random deployment of sensor node. These random deployments are done in MATLAB by generating the x and y coordinate of a node randomly. Figure 5 shows a code segment for random deployment of 100 sensor nodes in a 100 m*100 m area and also calculate the location of sink. In WSN data packet delivered to the sink using multi-hop path. Therefore each intermediate node transmits and receives the data packet. After transmitting and receiving each data packet every node lost some of its energy. The energy calculation using MATLAB programming is depicted code segment which calculates energy consumption for transmitting and receiving a packet.

```
n = 100;                    %%number of nodes%%
Eo=0.5;                     %%initial energy of each node%%

ETX=50*0.000000001;         %%Transmiter energy per node%%
ERX=50*0.000000001;         %%Reciever energy per node%%

Efs=10*0.000000000001;        %%amplification energy when distance < threshold
distance(do)%%
Emp=0.0013*0.000000000001;  %%amplification energy when distance >= threshold
distance(do)%%
EDA=5*0.000000001;            %%Data Aggregation Energy%%

do=sqrt(Efs/Emp);             %%threshold distance%%
figure(1);
for i=1:1:n
    S(i).E=Eo;               %%% for homogenous energy distribution %%%
end

 for i=1:1:n
        if(S(i).E>0)
             dis=sqrt( (S(i).xd-(S(n+1).xd) )^2 + (S(i).yd-(S(n+1).yd) )^2 );
            if (dis>do)
                        S(i).E=S(i).E- ( (ETX+EDA)*(4000) +
Emp*4000*(dis*dis*dis*dis ));
            end
            if (dis<=do)
                        S(i).E=S(i).E- ( (ETX+EDA)*(4000)  + Efs*4000*(dis *
dis ));
            end
        end
 end
```

Figure 6: Energy Consumption of a node in WSN

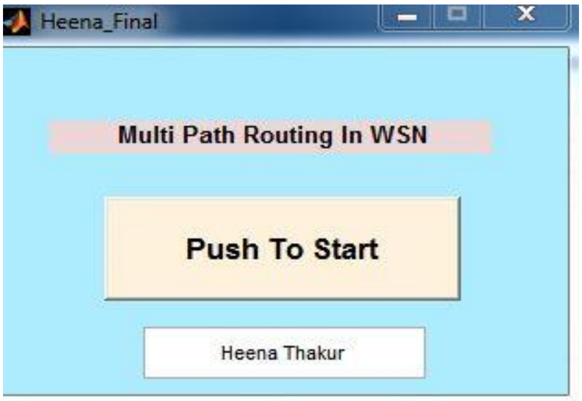

Figure 7: Basic Layout of Project

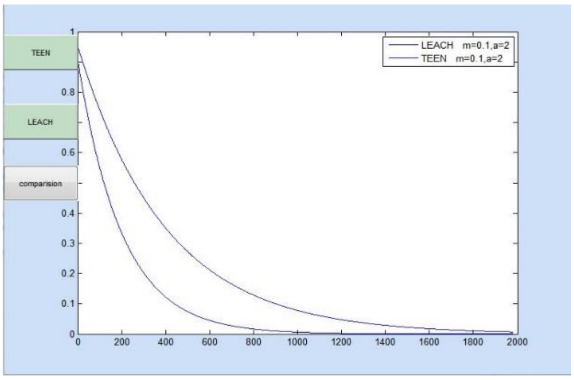

Figure 8: Comparison of LEACH and TEEN

VI. CONCLUSION AND FUTURE WORK

In WSNs, sensors can be deployed either randomly or deterministically. A random sensor placement may be suitable for battlefields or hazardous areas while a deterministic sensor placement is feasible in friendly and accessible environments. In general, fewer sensors are required to perform the same task with a deterministic placement. WSNs are typically deployed in hazardous or inaccessible environments and hence the sensor nodes' energy supply is usually limited and cannot be renewed. Due to these limitations, the nodes' energy consumption must be minimized, while still maintaining the network's connectivity to maximize its useful lifetime. The nodes communicate wirelessly and often self-organize after being deployed in an ad-hoc fashion. These self-organizing sensor networks have limitations of system resources like battery power, communication range, memory space and processing capability. Low processing power and wireless connectivity make designing such networks a real challenge. Self-organization can be defined as the process by which systems tend to reach a particular objective with minimal human interference. The mechanisms dictating its behavior are internal to the system. Network self-organization: Given the large number of nodes and their potential placement in hostile locations, it is essential that the network be able to self-organize; manual configuration is not feasible. Moreover, nodes may fail (either from lack of energy or from physical destruction), and new nodes may join the network. Therefore, the network must be able to periodically reconfigure itself so that it can continue to function. Individual nodes may become disconnected from the rest of the network, but a high degree of connectivity must be maintained. Scalability requires that any configuration process be completely distributed and use only local information, which presents the classic problem confronting all self-organized systems that how to obtain global optimality from local adaptation in future.

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