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Limiting the Sink Relocation to Enhance Network Lifetime using Secure Alternate Path

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ABSTRACT

The most important issue of the Wireless Sensor Network is to increase the network lifetime. Wireless sensor network contains one static sink node and the sensor nodes consume lot of their energy for evaluating data packets, specifically those that are available in the neighboring region of the sink node. Sensor nodes disperse their energy rapidly due to many to one traffic pattern and at the end die. This irregular transmission pattern is known as hotspot problem that happens to increase more and more as the number of sensor nodes increase. In practical, replacement of these energy sources is generally not possible. This paper presents different methods which are mostly used to enhance the network lifetime as well as we propose a new method named energy-aware sink relocation (EASR) for remote base station in WSNs. This method helps to reduce the energy utilization of sensor network and additionally has an objective to obtain a hugely secure communication between sensor nodes by implementing Elliptical Curve Cryptography. Energy consumption automatically reduces when distance between a sensor node and sink node is reduced. Sensor nodes which are closer to sink node utilize extra energy as compared to other nodes, thus the lifetime of a sensor network may decrease consequently. We propose an alternate shortest path method to solve this issue. This alternate shortest path method is implemented to enhance the energy performance as well as network lifetime. To improve energy consumptionof sensor nodes ina sensor network, EASR method is used for the remote base station. Some theoreticaland calculations are provided to represent the EASR strategy and demonstrate that the idea is practicable.

Keywords: Wireless Sensor Networks, Cluster Head, Base Station, ECC, Sensor Nodes.

I. INTRODUCTION

Network of wireless sensor nodes can be outlined by densely deploying a massivevariety of sensor nodes in a given sensing place, from where the sensed data from the different nodes are transferred to monitoring station which acts as a sink node or base station, which may be frequently placed along the way far from the sensing region. Multihop routing or flooding is used to transfer information from a source node to the monitoring station. By having more than one Base stations the average number of hops between information source sink pairs can get reduced. This will reduce the energy used by a given sensor node with the end goal of transferringinformation from different nodes towards the Base-station, which, in turn, can conceivablybring about expandednetwork lifetime as well as in larger amount of information conveyed. So the deployment of communication nodes and also the differentsink nodes are generally imperative components that have an effect on the lifetime in wireless sensor network.

The WSN has diverse applications in regions including climate observing, battle-field investigation, inventory and manufacturing progressions. In the remote network system, sensors are not available to be energized or replaced when their batteries get exhausted, which can additionally bring about some problems, for example, incurring coverage holes, low space furthermore, communication hollow space problems.Accordingly, a few WSN designsystems are busy in planning proficient strategies to hold back

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the energy of sensor nodes, as an instance, drawing schedule ofduty cycle for sensor nodes, which is used to allow some of them and enter the sleep state to moderate energy consumption. The design of efficient energy algorithms aim at balancing the depletion of the battery's utilization strength of each sensor node; or consuming a limited information aggregation methods to combination of sensory information into a single unit to reduce the quantity of transmitted messages to extend the network lifetime of the wireless network. The other methodology for energy saving purpose is used for utilizing remote sensors to maintain the locations of region with aggregating lifetime network energy of nodes.

In this paper, we propose a shortest alternate path method that is aimed to enhance network lifetime energy utilization. Additionally the information is transmitted safely from source to sink node on an alternate shortest path utilizing ECC Elliptical Curve Cryptography. Moreover the data is transferred securely from source to sink node on an alternate shortest path using ECC Elliptical Curve Cryptography. On degradation of energy level below a given threshold for alternate path, we trigger sink relocation. A sink relocation scheme is used to relocate the sink that involves when and where to move it. The mathematical performance evaluations are calculated to demonstrate the proposed sink relocating scheme is beneficial for prolonging the network lifetime of sensor network. The simulation technique used investigates the performance of the EASR method against some already available techniques. In fact this type of methodology can work to extend the network lifetime of a WSN system. The relocation of sink node will be prolonging the battery of nodes.

Section II describes the related work surveyedfor our research work. Section III shows the detailsof project implementation, definitions of termsand Section IVincludes conclusions and somefuture scopes available.

II. LITERATURE SURVEY

This section demonstrates some of the work that is previously available on the enhancement ofnetwork lifetime in wireless sensor networks.

G. S. Sara and D. Sridharan [2] presented a survey of routing protocols in remote sensornetworks. Authors outline the difficulties for routing protocol designs in WSNs that are followedby the complete investigation of individual routing techniques sorted into three levels depends on the system structure, for example, flat, hierarchical and location-based routing and so on.

Somasundara *et al.* [3] researched a network system on the use of versatile elements. To reduce the consumption of the energy of participating nodes at the time of communication and improve lifetime of network, their methodology obtains the benefit in sensor networks. They show how their strategy supports to reduce energy utilization at energy controlled nodes. Secondly, they depict their system model which utilizes their proposed approach,managing to improve the energy efficiency.

Sensor network implementation is extensively challenging because of unpredictable and unreliable nature of operating environments in which these nodes operate. Mousavi et al., [4] proposed two schemes for the self-implementation of versatile sensors. A randomized solution is implemented that provides both straightforwardness and pertinence to different situations.

Akyildiz *et al.* [5] describes concept of network design of wireless sensors. These sensors have blended micro-electro-mechanical systems methodology, wireless communications and digital physics. To start with, the sensing assignments and the potential uses of sensor networks are investigated and afterward a review of items impacting the deployment of sensor networks is provided. The fundamental advantage of sensor networks is there self-adjusting nature and their autonomous operation as well as potential architectural choices make proper for a number of data-centric applications.Their acknowledgment gets more extensive with emerging not too far off.

D. Tian and N. D. Georganas [7], presented, a node scheduling plan, which can decrease the energy utilization of complete system, thus expanding network lifetime, through implementing excessive nodes concerning sensing scope of network, consequently dispersing them to an on off-duty operation mode that has less energy utilization than the typical on-duty one. The principle goal of proposed plan is to completely shield unique sensing scope in theory.

Hong *et al.* [8], proposed a proficient routing setup for Mars sensing component networks exhibiting the similarity of operations between the wireless, multi-hop communication networks associating tools (sensors) as well as router(s) and along these lines the packet radio network is used as a specific ad-hoc networking environment.

S. C. Huang and R. H. Jan [9], proposed an Energy-Aware, Cluster-Based Routing Algorithm (ECRA) for wireless sensor networks to expand the network lifetime. The ECRA picks couple of nodes as cluster-heads to develop Voronoi design moreover, rotate the cluster-head for adjusting the load in every cluster. A two tier like architecture (ECRA-2T) is proposed to redesign the execution of the ECRA. The reproductions display that both the ECRA-2T and ECRA algorithms show improvement over other routing schemes such as, direct communication, static clustering and LEACH.

R. C. Shah and J. Rabaey [10] proposed a new system called energy aware routing that is based on sub-optimal paths that provide significant results. Simulation outcomes are additionally presented that show increase in network lifetimes on all intents and purposes indistinguishable arrangements like directed dispersion routing. The more rich degradation of service is with time in a more attractive way to solve the burning energy of nodes.

Sensor implementation is a critical problem in outlining strategy of wireless sensor networks. Wang *et al.* [11], condensed and evaluated dispersed self-sending protocols for versatile sensors. After recognizing scope gaps, the protocols are directed to calculate the target positions of the sensors in network where the sink is prepared to move.

III. IMPLEMENTATION DETAILS

This section describes the system overview in detail, proposed algorithm and mathematicalrepresentation of the proposed system.

(A) System Overview

Figure 1 demonstrates the architecture of the proposedsystem. Description of the system is asfollows:

- Network Generation: In the beginning network is created with vertices being nodes that are connected with the edges as communication links.
- Path Generation: After selecting the source and sink node, we create every possible paths from source to sink node.
- Get Shortest Path: Search shortest path from available created paths from source to sink node.
- Key generation and distribution: Key Generation node creates the keys as well as distributes the keys to every node. Perform the route generations from source to the sink node.
- Data Encryption: Information is sensed at every node. The sensed information is encrypted at respective nodes using the ECC algorithm.
- Energy Consumption: Compute energy consumedfor every sensor node on the shortestpath.
- Data Authentication: After calculating the hash value at sourcenode, sink node confirms the authenticationof sensed information.

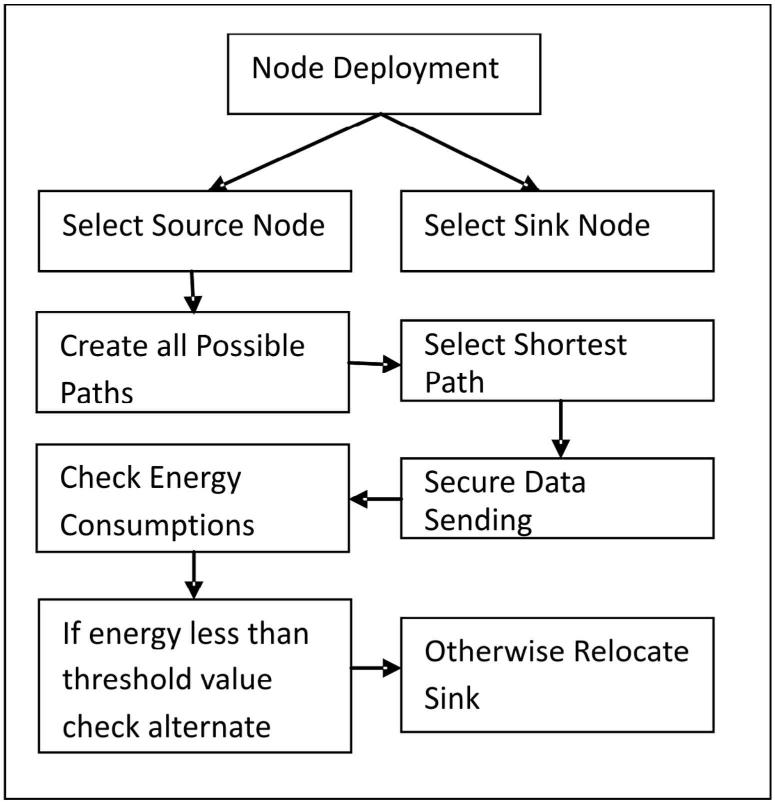

Figure 1: System Architecture

- Data Decryption: Sink node collects the information from sourcenode and decrypts the information by the properkey.

(B) Mathematical Representation

System S is represented as

S= {N, S, D, P, Sp, K, d}

1) Deploy nodes

N = {N1, N2, ... ,Nn}

N is set of all deployed nodes.

2) Create Source

S = {S1, S2, ,Sn}

Where, S is a set of all Sources.

3) Create Sink Node

D = {D1, D2, ...,Dn}

Where, D is a set of all sink node.

4) Find all Paths

P = {P1, P2,....,Pn}

Where P is a set of all Paths.

5) Select Shortest Path
Sp = {Sp1, Sp2, Sp3, ...,Spn}
Where Sp is the set of all Shortest Path.

6) Generate the keys for authentication
K = {K1, K2,....,Kn}
Where K is a set of all Keys.

7) Send the data from source to sink node.
d= {d1, d2, d3,...dn}
Where, d is a set of all data transmitted.

Equation for Energy Consumption

The energy spent of a node that transmits l-bits packet over distance d is:

$$E_{Tx}(l,d) = E_{Tx-elec}(l) + E_{Tx-amp}(l,d) = E_{elec} * l + \varepsilon_{fs} d(2) * l \quad (1)$$

Where,

$$d_0 = \sqrt{\frac{\varepsilon f \delta}{\varepsilon_{mp}}} \quad (2)$$

and the energy consumption of receiving this message is:

$$E_{Rx}(l) = E_{elex} * l \quad (3)$$

Equation for Latency

T1 = Start Time;
T2 = End time;
Latency = $T_2 - T_1$ (4)

(C) Proposed Algorithm

The implementation details of proposed algorithm are:

Algorithm 1: Proposed algorithm

1) Generate a network graph as Graph G(V,E)where; V are vertices/nodes and E areedges.
2) Choose Source and sink node from all sensornodes.
3) Generate all paths from source to sinknode.
4) Select shortest path from all generatedpaths.
5) Generate public/private keys and distributesto source and sink node.
6) Generate the data at source and send tosink node via shortest path.
7) Encrypt the data with the private key.
8) Calculate energy consumption of eachnode which is present in shortest path.
9) Decrypt the private key and Authenticatereceived data at sink node.

10) If energy of sensor nodesgoes below a given valueon the selected path then select Alternate path.

11) Send the data from source to sink nodethrough alternate path and calculate energyconsumption.

12) Again if energy of sensor nodes onalternate path goes below a given value perform sink relocation.

Description: Algorithm 1 explains thesteps of system implemented. First, networkis generated with sensor nodes, source and sinknode. After that, we create all paths from sourceto sink node and choose the shortest pathfor data sending purpose. Sensor nodes arenot effective if energy utilization increases.Thus system chooses alternate path forcommunication within source and sink nodes,together computing energy utilization as well as residual energy levels at every sensor node.Encryption algorithm encrypts the informationusing ECC algorithm that provides the private key necessary for encryption.Information is validated by its hash value. Only validated information is accepted by sink node. Decryption ofthe information is performed at receiving sensor nodewith the proper keys. Again sensor nodesof alternate shortest path are assumed to getreduced and at the end we trigger the processof sink relocation.

Algorithm 2: Algorithm used for Encryption

1) Sender and Receiver Calculate $B = S = (S_1, S_2)$
2) Sender sends a message M E to Receiveras follows:
3) Calculate $(S_1 * S_2) \bmod N = K$.
4) Calculate $K * M = C$, and send C to Sender.
5) Receiver receives C and decrypts it asfollows:
6) Calculate $(S_1 * S_2) \bmod N = K$
7) Calculate $(K–1) \bmod N$.
8) (Where $N = E$)
9) K – 1 * C = K – 1 * K * $M = M$

(D) Experimental Setup

The system is developed using Java framework(version jdk 8) on Windows platform. The Netbeans(version 8.1) is used as a developmenttool. Jung tool is used for the generationthe network which contain sensor nodes. Thesystem doesn’t need any specific hardware torun; any standard machine is able of runningthe application.

IV. RESULT AND DISCUSSION

For analysis we create a simulation environment in which the proposed algorithm performance is evaluated against the already available energy aware sink relocation algorithm.

Figure 2 demonstrates the comparison graph betweenthe proposed Algorithm andResidual Energy. Clearly the residual energy in proposed scheme is more than already available technique. Increased residual energy means increased lifetime as sensor nodes have enough energy to sustain for more time now.

Figure 3 demonstrates the comparison graph between data-size and latency. As the graphical representation shows the proposed scheme takes less time in communicating the sensed information from source node to sink node. Also increase in data size has very less effect on latency that is not the case in already available technique.

Figure 4demonstrates the comparison between data-size and energy consumed.The energy consumed by proposed EASR using alternate path is lower as compared the energy consumption of the previous Traditional EASR method.

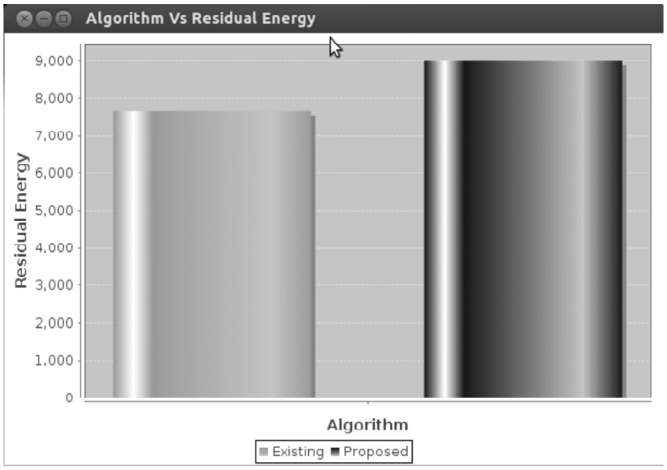

Figure 2: Algorithm Vs. Residual Energy Graph Comparison

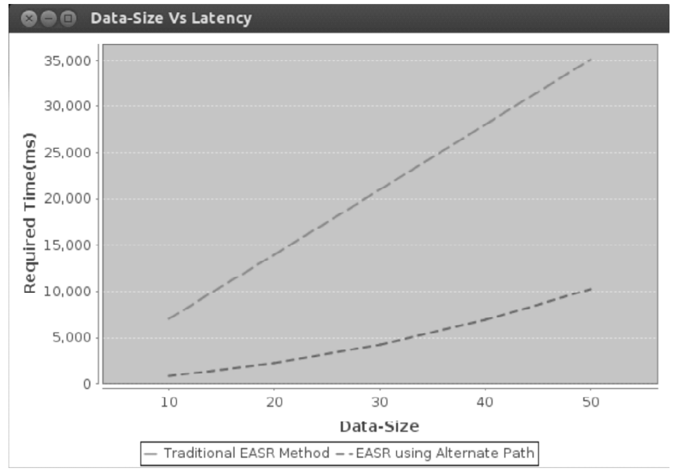

Figure 3: Data-Size Vs. Latency Graph Comparison

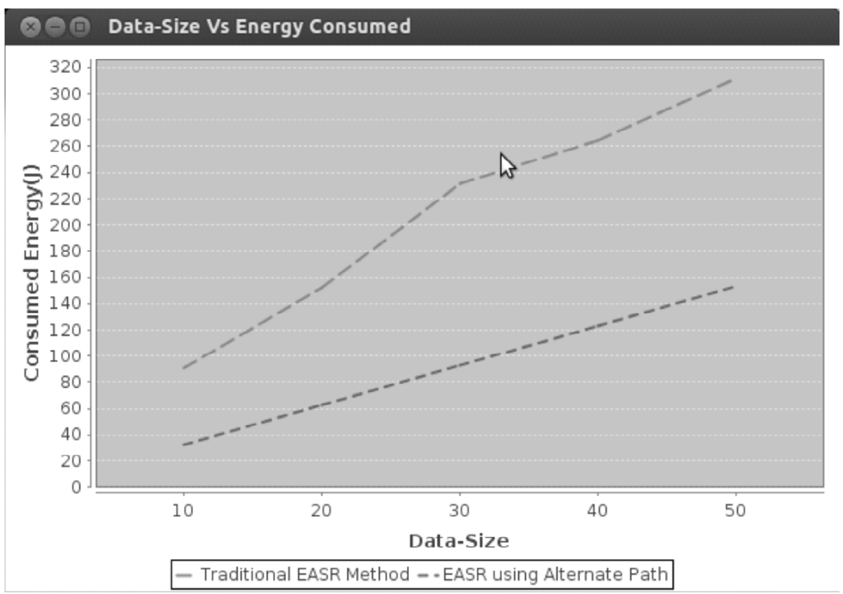

Figure 4: Data-Size Vs. Energy Consumed Graph Comparison

CONCLUSION

In this paper weimplemented a newtechnique to enhance the lifetime of wireless sensor network.A relocatable sink is one of approaches to increase the network lifetime but this approach suffers from some drawbacks as sink relocation consumes moreenergy.We proposed an alternate shortestpath method for minimum energy consumption.This method takes energy of every node into consideration and increases network lifetime through restrictingnumerous sink relocating activities.Also we enable secure datatransmission as well as node authentication for preventingall types of external malicious exposures or attacks. One of maincontribution to network improvementin future might be storing the sensed informationon a cloud. So,the already constrained sensor node will be relieved of having extra storage.

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