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ENERGY-EFFICIENT EVENT RELIABILITY PROTOCOL FOR IMPROVED IN WIRELESS COMMUNICATION NETWORKS

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Abstract:
WSN is a network comprising of various sensor nodes that are highly energy efficient used in various applications now a days. It helps in transmitting data from sensor nodes to the base stations in a highly reliable and secured manner. One of the most important tasks of these sensor nodes is systematic collection of data and transmits gathered data to a distant base station (BS). Hence network lifetime becomes an important parameter for efficient design of data gathering schemes for sensor networks. In this paper, we benefit both cluster and tree structures for data gathering. In our proposed energy-efficient mechanism, the most appropriates hops for data forwarding will be selected whole network will be maximized. The simulation results show that by using the proposed approach, the lifetime and the throughput of the network will be increased. The simulation experiments are performed for all three models using JUNG simulator. The experimental results show that the third approach with considering energy, distance, and density for selecting the clustering head achieves the optimal results for enhancing the lifetime of the network.
Keywords: Wireless Sensor Networks, Residual Energy, Data Correlation

Introduction

Wireless sensor networks integrate sensor technology, computing, and communication technology and become an active research branch in the field of computer science. In the wireless sensor network architecture, the digital twin technology at the network layer is crucial to the life cycle of the wireless sensor network [1]. The network load algorithm has become the digital twin technology that is currently the focus of research. The digital twin protocol is the core technology of the wireless sensor network layer. While discovering a path with a smaller delay, it avoids network congestion and balances network energy consumption. For different application environments, the digital twin protocol can be divided into network access protocol, network load protocol, and geographic digital twin protocol [2]. When designing a digital twin protocol, an important challenge will be faced, that is, how to complete the sensing, communication, and control functions under the condition that the node's energy resources, computing capabilities, storage space, and communication capabilities are highly restricted. For this reason, the main goals of the wireless sensor network digital twin protocol design are establishing an energy efficiency path, forming a reliable data forwarding mechanism, and maximizing the network life cycle [3–5].

With the rapid rise of the Internet and the Internet of Things, as well as the rapid development of microelectromechanical systems (MEMS), distributed information processing, radio communications, multifunction sensors, embedded software, and hardware technologies have matured day by day, and wireless sensor networks have become a representative of emerging fields. When it was born, these software and hardware technologies have provided great help to promote the rapid development of WSN technology [6]. WSN uses a variety of highly integrated and low-cost micro wireless sensor nodes to collaborate to achieve real-time monitoring and perception in different application environments and collect relevant data or other object data of interest and then, the embedded system performs preliminary processing on the monitoring data [7], and then, the network sends these data digital twins to the control center according to the defined transmission protocol. It divides a network with a large range and nodes into multiple smaller clusters according to specified rules, making the network hierarchy clearer and more scalable [8]. Since most of the non-cluster-head nodes can close the communication module for a long time, for the traditional uniform network load protocol, due to the multihop transmission between clusters, the cluster head node near the base station takes on more forwarding tasks, which consumes more energy and causes the problem of uneven network energy consumption

ADVANTAGES

It avoids a lot of wiring.

It can accommodate new devices at any time.

It's flexible to go through physical partititons.

It can be accessed through a centralized monitor

Problem Statement:

Wireless sensor networks (WSN) influence every movement of human life. These are used to provide solutions for our daily life problems in a very efficient and effective manner. The applications of wireless sensor networks are almost everywhere. It is used in defense areas, weather forecasting, forest free detection, knowing about forest animals, sensing natural disasters, etc. Apart from these advantages, sensors are also used in home appliances, in the health care environment, and to develop Internet of things (IoT)-based applications. Furthermore, sensor networks are also used in the sensing of underwater environments. As we know, 70% of the Earth is covered with water, so sensing the underwater environment is again a big challenge and a big achievement in the field of WSN.

2.0 LITERATURE SURVEY

The popularity of Wireless Sensor Network (WSN) is growing now a days in a heterogeneous computing environment. The tendency of using WSN is increased due to wide area coverage, mobility of nodes, data processing capabilities and ability to work in rough environments. Sensors provides different facilities such as infrastructure, platform and applications to their users via wireless means. Wireless sensor networks are considered one of the most important technologies of the 21st century, where the distributed node automatically helps in creating a network for transmission of data and is known as the Sensor Network [8]. Many researchers have referred to different types of technology in this context. Application scenario is important when designing a specific protocol for the sensor network based on different technologies. [9] Suggested a cross-layer-low-energy adaptive clustering hierarchy (CL-LEACH) model to increase the longevity of the network and the use of batteries. The proposed work uses the remaining energy to pick a group head that offers a transaction that is energy efficient. Author has shown that the proposed work uses the node's residual energy to select the cluster head which preserves the overall energy consumption. Author demonstrated that the proposed work utilizes the remaining energy of the node for the cluster head selection that preserve the overall energy consumption [10]. It has to be cleared from the obtained result of this work, it has produced enhanced outcomes in terms of dissipation of energy, cost to transmit along with total live nodes. Introduced a novel cluster solution in distributed nature to find the best CH corresponds to every cluster from WSNs with the aim to exchange the energy consumption and the end delay [11]. It also proposes a new cost function for the multi-hop inter-cluster routing algorithm based on the current proposed delay model and offers a multi-hop routing algorithm from CHs to sinks with a minimum energy cost focused on the constraint of end-to-end delay. The result showed the proposed efficiency in terms of energy consumption and end-to - end delay much well than equivalent protocols. [12]

Suggest the P-LEACH routing protocol that was the combination of the PEGASIS (PowerEfficient Gathering in Sensor Information System) and LEACH technique for the enhancement of the energy efficiency in WSN. The proposed protocol uses the energy efficient routing scheme that utilizes the energy consumption while transferring of packet from one to another node. After the simulation on network simulator (NS2) and MATLAB, result indicate that proposed P-LEACH protocol perform better than that of LEACH. [13] Introduces a modern hierarchical approach to Wireless Sensor Networks (HEBM), called Hierarchical Energy Balancing Multiple Routing Protocol. Author has shown that the HEBM method minimizes total energy consumption, balances the distribution of energy between the sensor nodes and ultimately extends the network life. After done the simulation on Network Simulator (NS2) and MATLAB, the result shows that the proposed HEBM protocol increases the energy gain and extends the network life from 32% to 40 % compared with the DEEAC reference protocol and from 25% to 28% compared to the FEMCHRP protocol. [14] Suggested an energy-efficient observation method for the non-stop cold chain management of table grapes to reduce the average energy consumption of WSN devices and improve the operation and transmission efficiency of WSN, and finally transparency, traceability and stabilization in the continuous monitoring of cold chains. Combining the WSN and the CS transmission mode for the acquisition and transmission of sensor data, the energy-efficient observation method in monitoring cold chains has been realized. The results show that CS transmission mode can reduce the average consumption of the WSN devices and improve the efficiency of the WSN operation and transmission. [15] Introduced the PRIN MAC protocol QoS succeeds to prolong the network's life in terms of the minimum energy usage. By assigning different priorities to incoming packets according to the group's arrival priority list, the amount of energy consumed is reduced and the inter-arrival period is modified to improve the throughput.

3.0 Data Compression with Conditional Entropy

The goal of data compression is removing the data overhead of sensors and reducing the correlations of data for achieving beneficial information for the base station. Data source of each sensor node is illustrated with a discrete random variable. The entropy of discrete random variable of X is illustrated with H(X) that is equal to minimum number of bits which are required for coding X without losing any information The common entropy of two random variables of X and Y is equal to the minimum number of bits which are required for coding X and Y together. If X includes some information from Y, then the common entropy is equal to H (X|Y) and H (X|Y) ≤ H (X) which ensure a considerable reduction in the volume of coded data. In The proposed approach, the conditional entropy is used for coding the data of sensors. For modeling the data correlations, we have used the model in In fact, the data correlation of the nodes is a function of distance. Thus, with a network of N nodes (X1, X2, ⋯, XN) in which the data production of each node is equal to H (Xi) = H1{i = 1, 2, ⋯, N}, we have:

$$H\left(X_j \middle| X_i\right) = \left(1 - \frac{1}{\frac{d}{c}+1}\right) H_1 \ \{i = 1,2,\cdots,N\} \qquad \text{(1)}$$

In this equation c is a constant which presents the amount of data correlation and d is the distance between nodes and.

Proposed Approach:

We assume that the whole network is divided in to several clusters; each cluster has a cluster-head (CH). The clustering and the selection of cluster-head (CH) can be done by using any existing protocol like LEACH, or the optimized versions of LEACH such as and the proposed algorithm works in each cluster independently and performs in two phases.

Information Packet Flow In this phase, the cluster head transmit the information packet to its neighbors.

The information packets include the information below:

• Node's location: Each node should now it location in prior
• Current Energy: Remaining energy of a node
• Hop count: Number of hops from cluster head
• Data Label: Data value which is sensed by a node.

When a node receives the information packet, it considers the sender as one of its possible parents and stores its information. Then, it updates the node location, current energy and data label fields of the packets with its own, increments the hop count and transmit the packet to its neighbors. This process will be done until all the nodes in the cluster receive the information packet.

Energy Based Cluster Routing

The suggested protocol is a clustering algorithm that consists of setup stage and steady-state performance. Firstly, in set-up procedure, sensor nodes are distributed all through the infrastructure and separated into clustered led by a CH who is responsible for data gathering from sensing nodes. The content is fused to decrease the quantity of data by deleting any superfluous bits. This transpires even during relatively stable stage, and it is during this period that data is actually routed to the BS by the network's CHs. After a first round of generation using the usual LEACH method, cluster and Cluster Head is selected using the following equation

$$k_{opt} = \sqrt{n/2\pi}\,\sqrt{\frac{E_{fs}}{E_{amp}d^4(2m-1)E_0-mE_{DA}}}\,M \qquad \text{……………………….. (2)}$$

The network diameter is represented by the letters "M" and "E0," and the value of each node's initial supply of energy deduced from the number. The CHs that are participating in the current round of the program distribute notifications to the clusters that are part of their respective clusters. The signal intensity of the request is evaluated by the sensing nodes before it is sent to the central hub. This ensures that the CHs are only sent to the appropriate areas.

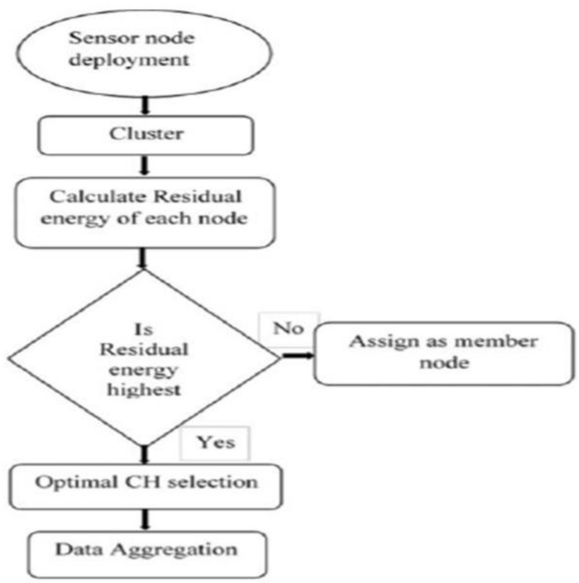

Figure 1: Flowchart of energy-based cluster routing

CHs receive data within the time slot that has been allocated to every single node in the network. Because of the need to conserve energy, just the transmitting node is kept active, while the other nodes in the cluster turn down their radios. Following the completion of data transmission by all of the cluster's nodes, the CH will begin processing of the data received from them. It collects data and aggregates that to remove redundancy before compressing it to the greatest extent possible to maximise bandwidth utilization

4.0 Tree Construction and Data Forwarding

When the entire nodes received the information packet, each node selects it parent which should sent its data to it. This selection will be done based on the filters below: First, among the possible parent, the one which has the least hop distance from the cluster head (Closest node to cluster head) will be selected. If there is more than one node with the least hop distance, the nodes which have the most current energy will be selected as the parent. If there is more than one node with the least hop distance and the most current energy, the node which has the least data correlation will be selected as the parent. All the above conditions lead to the best parent selection. Filter 1, selects the shortest path from a node to cluster head. Filter 2, increases the network lifetime by participating most durable nodes. Filter 3, reduce the networks overhead by checking the data correlation of the nodes.

. Energy Model Our energy model is like the energy model in this model energy consumption for transmitting K bit is equal to:

$$E_{TX}(K,d) = E_{elec} \times K + \varepsilon_{amp} \times K \times d^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

And the energy for receiving K bit is equal to:

$$E_{RX}(K) = E_{elec} \times K$$

n these equations, d is a constant value which relates to the distance between two nodes and the parameters below are the constant values which are defined previously and they are equal to:

$$\varepsilon_{amp} = 100 \text{ pJ/bit/m}^2 \quad E_{elec} = 50 \text{ nJ/bit}$$

Performance Evaluation:

The proposed approach is simulated and evaluated with J-Sim (Java-Based simulator) J-SIM is simulation software selected to implement the model. It was chosen because it is component-based, a feature that enables users to modify or improve it. J-Sim uses the concept of components instead of the concept of having an object for each individual node. J-Sim uses three top level components: the target node which produces stimuli, the sensor node that reacts to the stimuli, and the sink node which is the ultimate destination. For stimuli reporting, each component is broken into parts and modeled differently within the simulator; this eases the use of different protocols in different simulation runs. In our simulation analysis, sensor nodes are randomly distributed in a 160 m × 160 m area. The radio range of each node is 40 m and the default parameters for radio communication model of J-sim are used. The cluster-head is formed by the sink. Source node randomly sends packages with constant bit rate (CBR) to the sink. Packet size is 64 bytes and package rate is 5 pkt/s. We have compared our approach with LEACH as an innovative Energy-Efficient clustering approach and VLEACH as a modern Energy-Efficient clustering approach. As it has mentioned before, our idea is not related to clustering and the selection of cluster-head (CH) and they can be done by using any existing protocol like LEACH, or the optimized versions of LEACH. Therefore, For Clustering, we have used the mechanism of VLEACH in our simulation which is more energy-efficient in comparison to LEACH.

5.0 RESULTS AND DISCUSSIONS:

The simulator used for analysis of the system is JUNG, which gives us the number of functionalities for generating and managing the network. The results obtained from the simulation are presented below:

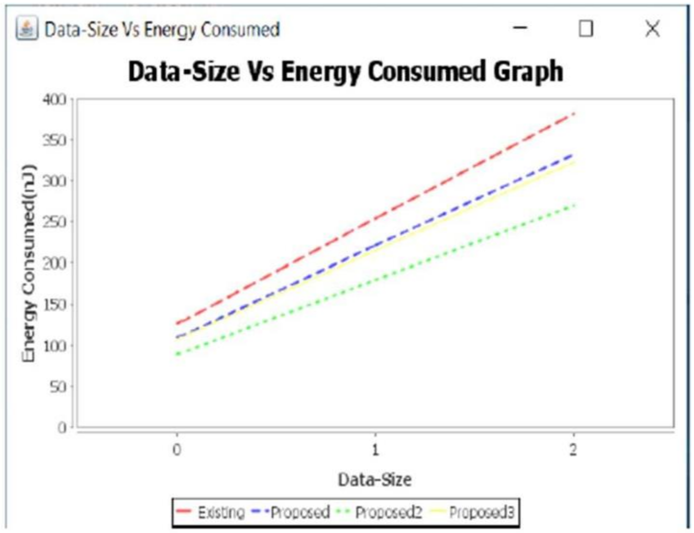

Figure 2: Energy consumption for sending the data with variable data size

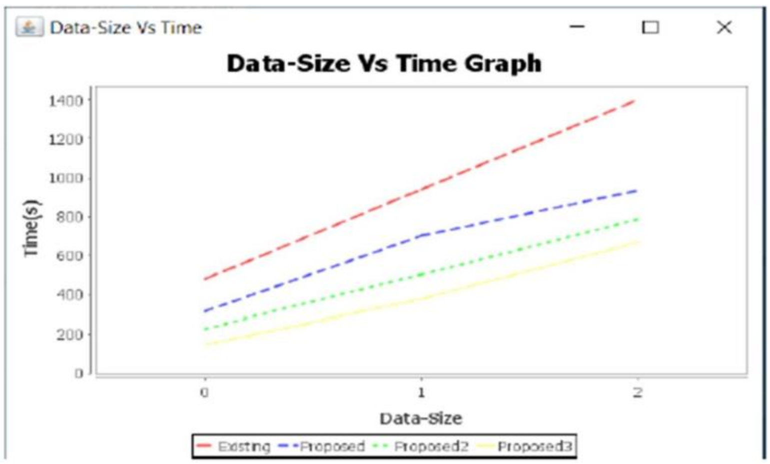

Figure 3: Time consumption for sending the data with variable data size

Figure 2 depicts the outcomes, and Figure 3 depicts the amount of energy and time expended during the transmission of the information. We illustrated the outcomes of all five approaches in addition to allowing for a more in-depth study of the results. At the moment, the number of resources consumed during transmission contain the properties that are utilised to delay the transmission. Handling delay can be defined as the length of time it takes for component nodes to generate their encrypted messages and compare marks, among other things. The calculation of the aggregation delay involves tracking down the time it takes to test the marks that have been received from various components. It also involves collecting ciphertexts and marks. The average time spent at the end of the process on obtaining the first knowledge for the BS by checking accumulated markings and decoding collected ciphertexts is referred to as the unscrambling delay.

In this structure, it is simple to retrieve information about cluster centroids and their locations. The proposed method is based upon that Distance function between both the nodes, as well as the number of sensor nodes that come together to create a new cluster must be more than a particular threshold in order to be considered successful. Actually, the points are subjected to a DBSCAN-based preprocessing step, during which the points are sorted relying on its accessibility by that of the core points, after which the Density - based algorithm is performed to the ordered points, and lastly the points are clustered. Table 1 gives use the summary of the evaluation based on the energy consumption during the data transmission.

Table 1. Energy consumption for all the three methods

Initial energy	Number of nodes	ES	PS1	PS2	PS3
1825	20	712	590	502	548
3616	40	760	555	598	636
5457	60	870	870	680	748
7223	80	953	1129	925	820
8944	100	974	1152	924	822
10847	120	1401	1304	1192	1026

Table 2. Remaining energy after the data transmission for all the three models

Initial energy	Number of nodes	ES	PS1	PS2	PS3
1825	20	1102	1232	1321	1269
3616	40	2849	3056	3018	2979
5457	60	4585	4569	4777	4710
7223	80	6302	6087	6302	6405
8944	100	7969	7781	8020	8122
10847	120	9441	9539	9655	9821

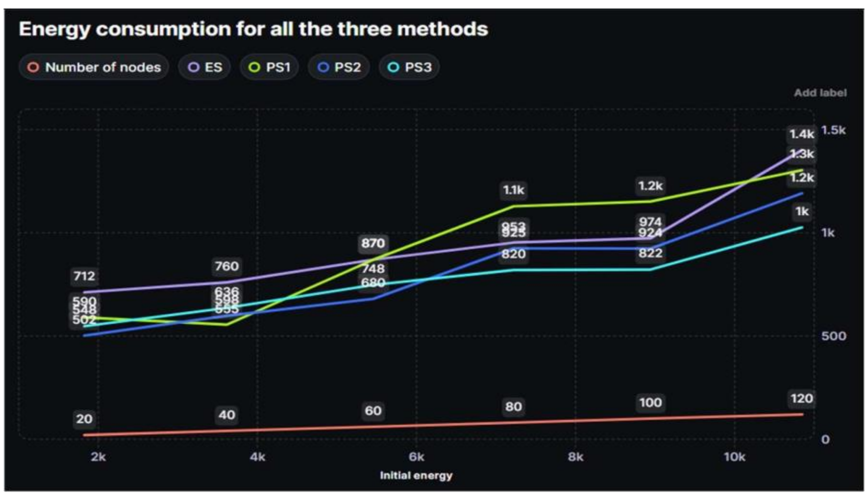

Figure 4: Utilizing energy for energy, distance and density-based routing

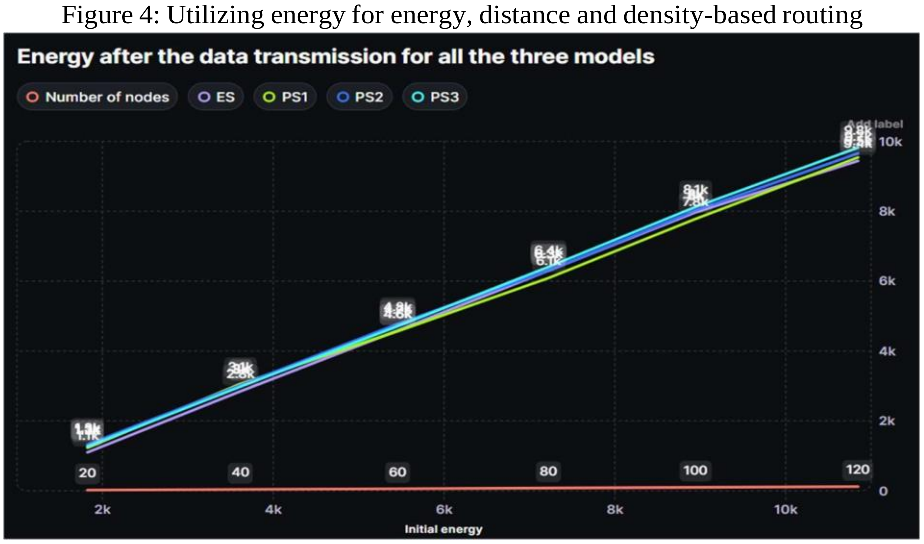

Figure 5: Data transmission energy for energy, distance, and density-based cluster routing

CONCLUSION

To make wireless sensor networks (WSNs) more sustainable and to improve their operation, a unique energy efficient routing protocol that is based on energy, distance, and density has been suggested in this study. As a solution to LEACH's drawbacks, this protocol incorporates a cluster head selection metric that considers battery life, base station distance, and network density. In terms of the obtained network lifetime, the speed at which residual energy is depleted, and the amount of traffic load generated on the network, the suggested method outperforms both the LEACH protocol and the transmitter and receiver protocol, according to the tests of performance. More importantly, the results show that as the network grows larger, the suggested algorithms become more effective. Nodes in the network are becoming more densely packed, which is the reason behind this phenomenon. The next step in this research is to put the suggested method into action on a hardware platform and evaluate its performance in a real-time setting. There is optimism that the technology presented here can handle the many potentials uses in intelligent transportation systems, and it has already shown some positive results.

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