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A Reliable Network Routing Protocol Design with an Intelligent Mobile Sink and Energy Efficiency over Wireless Sensor Network

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Abstract—This is crucial for the successful operation of a Wireless Sensor Network, frequently called as WSN as each of the sensor nodes in the network's structure are in charge of transmitting the information from its original source to its final destination. Several researchers have developed a Mobile sink in an effort to enhance transmission quality. Although it has been shown to be beneficial, the network's overall reliability is compromised by the much more energy-intensive operation of the nodes. In this research, we offer a routing strategy that makes use of cluster and source portability to drastically reduce power usage. We have given this protocol its name: the Intelligent Mobile Sink Assisted Routing Protocol (IMSARP). To get started, we divide an entire sensor environment into regions, and within each of them, members cast proportional votes to choose who will serve as the Cluster-Head (CH). To determine how to choose the most efficient choice, nodes in the network evaluate the power consumption of all feasible routes. The proposed IMSARP method uses a cluster-based paradigm to construct a mobile-sink routing protocol. The standard quantity of energy within all the clusters serves as what drives the sink's motion. The outcomes section of this research proves the legitimacy and maintains the credibility of the proposed system by presenting the results, which include throughput, delay reduction, energy efficiency, and data transfer rate.

Keywords- Intelligent Mobile Sink, Routing Protocol, IMSARP, Cluster Head, CH, WSN, Wireless Sensor Network

I. INTRODUCTION

The network's sensing nodes act as data collectors as well as relay the information they gather to the Sink [1]. When data is sent to sink, it is processed and made available to users. Sensor networks are being used in a wide variety of fields, including the military, transportation, environmental monitoring, healthcare, and home/building automation. Sensing units, processing units, and transceiver units make up the nodes of a sensor network. Energy consumption has been examined as a means to increase the lifespan of Sensor networks, which are constrained by their ability to collect data wirelessly from distributed nodes. Problems arise while deploying Wireless Sensor Networks to assist in the support of applications that require mobility assistance, including disasters and seismic event recovery, military field observation, wildlife tracking and enforcement of laws. For the purpose of psychoacoustic monitoring, W.S.Ns can also be used in conjunction with 5G internet IoT systems. Thus, an Intelligent Mobile Sink Assisted Routing Protocol (IMSARP) is necessary to provide stable data transmission, consistent network connectivity, low power consumption, and a long operational lifetime for these applications. That is to say, sensor networks may supply varied data, including movies. Therefore, it's important to keep track on quality-of-service indicators like bit stream. Notably, the Quality of Service (QoS) in WSNs may be broken down into two groups: those that are application-specific and those that are network-specific [2].

In addition, sensor nodes are comprised of three distinct subsystems: interpreting, monitoring and transmission. The energy required to transmit a message from its origin to its destination is proportional to the distance between the two nodes [3][4], making the communication subsystem the primary consumer of power. Therefore, in comparison with single-hop interaction, multi-hop connectivity's latency is higher, but the length of the transmission may be reduced. To address this problem, a portable and rich in energy sinking node or networks have been created. This technique involves a mobile sink that travels about the network collecting data from fixed sensor nodes and sending it to a central location [5]. Having a mobile sink is beneficial for WSNs because it shortens the length of time the information needs to travel from a stationary node, lowers the number of intermediary nodes, increases network performance, and increases access to previously unreachable areas.

WSNs have several applications, including tracking natural disasters, monitoring military movements, observing crops, etc. For WSNs, finding strategies to save and balance energy use is a perennially popular but difficult area of study. Problems about energy gaps [6] arise from the reality that sensor networks located near to fixed sink nodes will take on a larger portion of the wireless network's transmitting burden. The Intelligent Mobile Sink Supported Networking Protocol proposes the use of mobile sink nodes to more efficiently utilize the power of each node in a network of wireless sensors and to more evenly distribute the energy consumption across the nodes. These sink nodes are mobile in the sense that they may gather data from neighboring nodes as they travel around the network at a predetermined speed along a predetermined or random path. As a result, there are no "hot spots" in the network, and the power use of nodes in the vicinity of sink nodes is evened out, as the sink locations are continually moving.

II. RELATED STUDY

Data delivery performances [7] are enhanced by the use of a mobile sink in large-scale, resource-constrained wireless sensor networks (WSNs). Data transmission is triggered in query-driven mode [9] only when a sensor node receives an inquiry from the sink node. In this fashion, the power of the sensor nodes is preserved. Data transmission becomes more challenging in a query-driven environment since the insertion point of the query and the point of data accumulation in the sink are not always the same. Therefore, we suggested a query driven core based protocol for routing (QBR) that builds a virtual backbone to address this issue. Only a subset of the underlying nodes builds the tree structure, in which it stores the mobile sink's position while forwarding queries to the AoI and data from the sink. In addition, a tree management method is included in to distribute the workload across the tree's nodes. QBR reduces power consumption and boosts data transmission performance, according to simulation studies [10].

Recent years have seen a meteoric rise in the deployment of technology based on wireless sensor networks (WSN) [9]. WSN is very useful for gathering information on events [8]. Since nodes in a WSN are powered by batteries that cannot be swapped out, conserving energy is an important issue. As a result, it is crucial to develop a routing algorithm that uses as little energy as possible while yet maintaining high dependability and little data loss. This topic has been the focus of several studies. Throughout this research, we classify the most popular routing protocols as either static sink-based or mobile sink-based. We compare and contrast these two classes of algorithms based on three criteria: resource use, timeliness of information transmission, and consistency. Our study includes a table that compares and contrasts the various protocols. We conclude this research by proposing a few extensions [9] that need further study.

In wireless networks of sensors [10], nodes commonly employ multi-hop communication to relay observed information to the base station. That's why sensors in close proximity to the sink tend to lose power and disconnect from the network more soon. One solution to this problem is to relocate the sink to different parts of the network. Traditional routing techniques for wireless sensors with stationary sinks cannot be used when sinks in those networks are mobile. In this study, we presented many routing strategies for WSNs that utilize mobile sinks in order to analyze how they deal with certain challenges. We wrap up by looking at the various mobile sink routing methods.

WSNs have been widely discussed in the media as of late [11]. To put it simply, picture a system in which a group of sensors, each of which operates independently but in concert with the others, collects, processes, and transmits information about targets to a central command center. Keeping a WSN online depends on the sensor nodes' ability to efficiently transmit information collected from the point of origin to the destination while using as little power as possible. Putting up a movable sink node, which may follow specified patterns, can help alleviate this problem by reducing the concentration of nodes in hot spots. In this research, we present a routing strategy that makes use of clustering and washbasin mobility to reduce energy use. We examine the way numerous mobile sinks affect the network's lifetime by clustering the whole network. Based on our simulation results, we found that a total of four mobile sinks is optimum for a network's efficiency [12].

Wireless sensor networks are an important field of study because of the wide variety of real-world problems they may solve. Environmental monitoring, medical care, automation in factories, smart homes, and farming are just a few of the real-world applications of WSN [13]. WSN have boundless potential for novel approaches to a wide range of problems as they develop and become more advanced. However, since these sensor nodes are unattended, it is crucial to find ways to boost their efficiency without using up their most precious resource: their batteries.

Using information gathered from an existing wireless sensor network, the authors of this research present a new mobility model for sink nodes based on a bipartite network [14]. The suggested approach derives a tightly controlled movement paradigm for the mobility sink using features of bipartite graphs. To cut down on routing overhead and boost the speed of the network, static nodes will be inspected and scheduled. The features of the bipartite network allow the mobile sink node to make optimum visits to the fixed sensor nodes, maximizing the amount of data collected and sent back to the base station. We simulated the suggested method using the NS2 simulation to see how well wireless sensor networks function with this mobility model implemented. We find that the suggested method considerably improves wireless sensor network performance while reducing energy consumption at the sensor nodess.

III. METHODOLOGY

This research presents a novel method called Intelligent Mobile Sink Assisted Routing Protocol (IMSARP), in which it is used for reducing energy consumption during transmitting information in the Wireless Sensor Network. Despite producing energy-efficient outcomes, the conventional approach has drawbacks due to the ineffectiveness of the randomized installation of nodes throughout the system, the parameters utilized for CH decision-making and the method of information transfer is based on a cluster chain. This novel strategy proposes that the total amount of nodes be distributed evenly over the territory of the network. The overall number of clusters is determined by dividing by the total number of nodes.

When every cluster has the same number of nodes, it's time to choose a leader. When the distance between each CH and the sink on the move grows, this research takes a novel approach by increasing the parameters for picking CH and introducing a Cluster Controller node in every cluster in order to relay data to the mobile sink. The installation of the Cluster Controller node increased the network's efficiency since it is always connected to a power source for recharging. The suggested model's approach is laid down in a flowchart, which is shown in Fig-1 below.

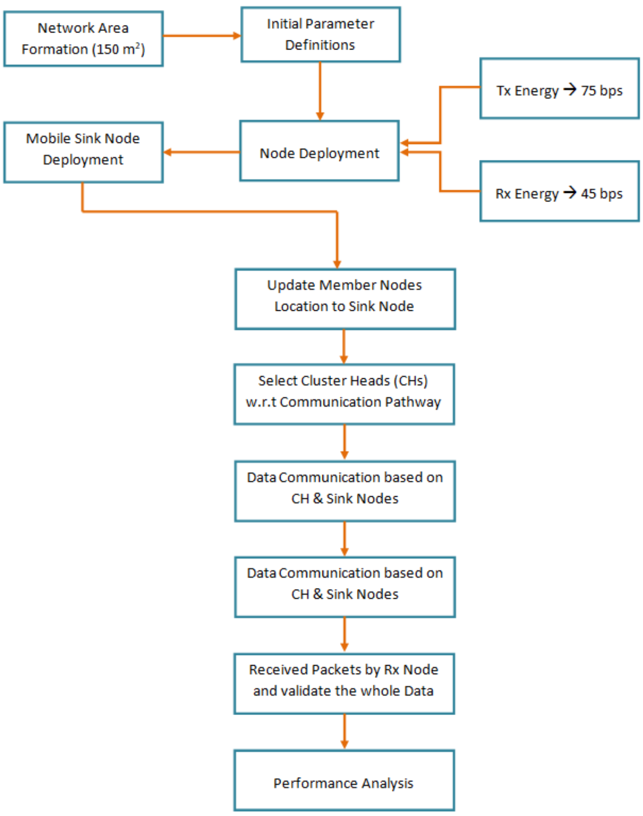

Figure 1. Proposed Model System Flow

The following table, Table-1 illustrates the proposed approach of IMSARP simulation parameters in detail with proper specification.

TABLE I. : INPUT PARAMETERS

S.No.	Parameter	Value/Range
1.	Simulation Region	150 m^2
2.	No. of Nodes	110
3.	Initial Energy	0.75J
4.	Transmission Energy (Tx)	75 bps
5.	Reception Energy (Rx)	45 bps
6.	No. of Idle Nodes	10
7.	Packet Size	1000 bits
8.	Data Rate	250 bps
9.	Avg. Delay	1000 ms

The first-order equations based wireless simulation is analyzed here with the goal to ascertain the energy needs that must be met. Transmission and reception both contribute one half to the whole that is the energy usage. In the course of this investigation, we will be making our decision on where to put the sink that is mobile based on two factors. Both the standard deviation of the power of all clusters and the total maximum-distance (Md) traversed by the mobile sink during each iteration are equally important factors to consider. The value of the variable Ad corresponds to the typical distance that the sink in motion traverses from cluster head to clustering head. We refer to the collection of cluster-heads that are contained within the mobile sink's maximum motion as (X Ad), where S refers to the current position and Ad refers to the set of locations that the movable sink will visit during the subsequent iteration. When it is time for the mobile sink to migrate, it will make its choice of new location based on the options given by (X, Ad).

$$Ad = \frac{\sum(i=0-m^{-1})\pm\sqrt{m^{Md}-(X(i)+Threshold)}}{X + CH(i)} \quad (1)$$

A. *The Phase of Clustering*

The network has been sectioned up into N sections, and each part will have its own cluster inside it. The location of each sensor node is used to determine which cluster it belongs to. The first round of cluster head reconfiguration will be undertaken depending on the remaining power of each of the nodes and the distance that exists between node x and the mobile sink. This will be done in order to maximize efficiency. The node that is physically closest to the mobile sink is the one that contributes its weight to the cluster and is awarded a provisional CH. In the end, the node in each cluster that has the greatest total weight is chosen to serve as the CH. Both direct communication and multiple hop communication are the two methods that the members of the cluster can use to interact with its CH. The other option is to use multi hop transmission. Members of the cluster that are accessible over the network are able to directly interact with the cluster head, and the energy consumption may then be determined using the method shown in equation 1.

The nodes' residual energies are taken into consideration while determining the cluster head; nevertheless, the nodes themselves are often selected in order to keep them at a safe distance from mobile sinks that have significant residual energies. Because of this, both the distance between the cluster head and the mobile sink as well as the energy utilization of the network as a whole are raised. As a result, in order to maintain an equitable distribution of the remaining power and the distance from the cluster head to the mobile devices and to extend the overall lifespan of the network, it is necessary to determine the capacity of each node by dividing the residual energy by the separation between the node and the mobile devices sink. This can then be used as a standard for choosing a cluster head.

B. *Selection of Cluster Heads (CHs)*

Choosing a CH is critical since it is the CH's job to disseminate data to the other nodes. Multiple criteria are used to determine CH. The study investigation takes into account the following three criteria to identify the cluster leader:

- The distance between each node and the mobile-sink node
- The residual energy of a node
- The distances between individual nodes in the cluster

Based on these criteria, we rank the nodes in terms of their significance. The CH network should include nodes that are as near as possible to the mobile-sink and as many as possible. Each node's weight may be calculated using the aforementioned factors, and the node with the lowest weight can be chosen as the cluster's leader.

IV. Results and Discussions

The proposed approach is validated within an NS2 environment, which stands for a Network Simulation tool. Changing the radius of the movable sink in order to examine performance and achieve a greater degree of operational optimality. The Intelligent Mobile Sink Assisted Routing Protocol (IMSARP) is a proposed method that has been tested around fifty times using a variety of WSNs topologies. In this research, we use simulation to investigate how the number of mobile sinks influences the lifetime of a network and provide our findings. At initially, it will only employ a single mobile node, but eventually, the number of mobile sinks will expand. The functionality of the network, such as its response speed, is being enhanced in order to raise the total number of mobile sinks. The results of the simulation are presented in figure 1. In addition, this research draws attention to the fact that the life duration decreases with an increasing mobile sink. Due to the higher cost of mobile sinks in comparison to those of regular sensor nodes, the three mobile sinks are the ones that work best. The effectiveness of the suggested method is shown graphically in Fig. 2, which shows the results of a throughput assessment using cross validation with a traditional routing protocol termed Dynamic Source Routing (DSR).

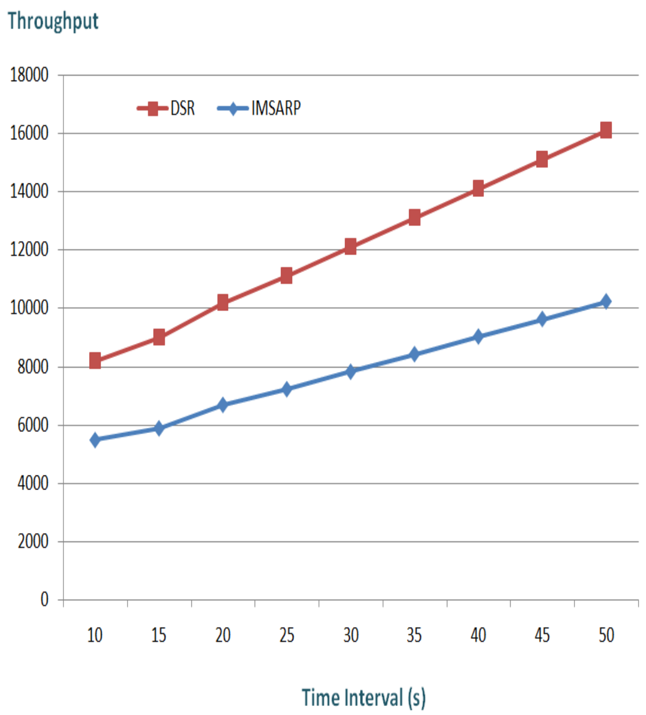

Figure 2. Throughput Evaluation

The effectiveness of the suggested technique is graphically shown in Fig. 3, which shows the results of an assessment of the total network latency using a cross-validation using a traditional routing protocol called DSR.

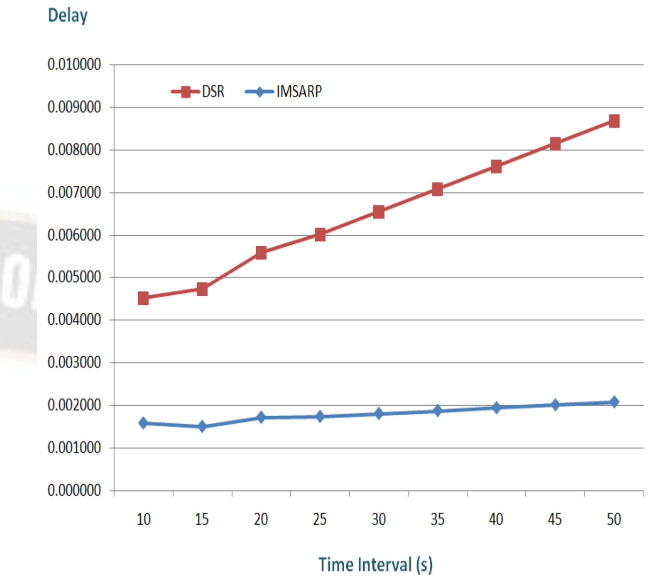

Figure 3. Overall Network Delay Analysis

The energy efficiency of the proposed technique is shown graphically in Fig. 4, which illustrates the IMSARP network energy efficiency assessment by cross validation with the standard routing protocol termed DSR.

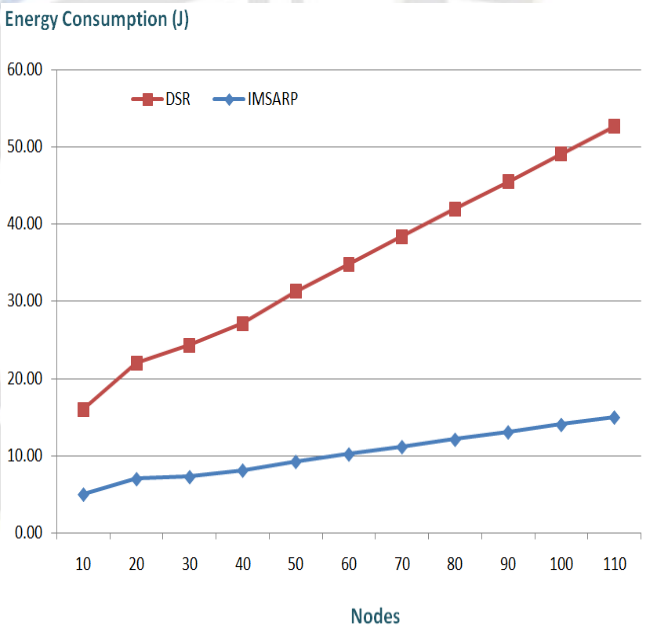

Figure 4. Data Transfer Rate

Fig. 5 shows the IMSARP Data Transfer Rate (DTR) assessment, in which the suggested technique is cross verified with the standard routing protocol termed DSR to demonstrate the DTR effectiveness of the proposed approach.

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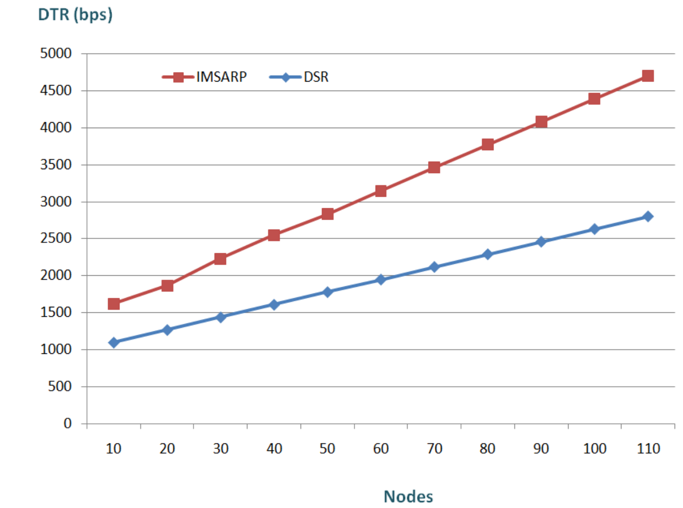

Figure.5 Data Transfer Rate

V. Conclusion and Future Scope

In this research, we present the Intelligent Mobile Sink Assisted Routing Protocol (IMSARP) for wireless sensor networks (WSNs) that allows for mobile sinks to be used. We examine the system model and the hierarchical routing algorithm, and we analyze the simulation results obtained from the NS2 network simulation tool to determine how well the suggested method performs. Each member of the cluster, whether linked to just one CH or many, chose the path that required the least amount of energy to deliver the data to its destination CHs. After that, the CHs formed a chain using an aggressive strategy to facilitate communication across clusters. Throughput, latency, energy efficiency, and DTR are only a few of the metrics used to clearly express and illustrate the effectiveness of the suggested strategy in the subsequent portion of this study. Compared to more traditional routing methods, IMSARP is the most effective of the presented approaches. Adding a deep learning model to anticipate network frequency and node failures would significantly improve the work and the overall performance of wireless networks in the future.

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