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An effective adjustment approach of event reliability (EAAER) with mobile sink using shortest path routing for WSN

Navneet Vishnoi *
Rakesh Kumar Dwivedi †
College of Computing Sciences and Information Technology
Teerthanker Mahaveer University
Moradabad
Uttar Pradesh
India

Abstract

A crucial requirement for Wireless Sensor Networks (WSNs) is reliable data transfer. To maintain the overall reliability of the network, it is essential that the data delivered from a source node reach its intended destination without any loss or errors. In order to collect data from the sensor nodes that are deploy randomly around the sensor region, wireless sensor networks (WSNs) typically use static sinks. In the static sink-based technique, the data packets are transmitted through the network to reach the base station. The static sink is ineffective at utilizing energy as a result. This paper presents an effective adjustment approach for event reliability (EAAER) to find duplicate events using a mobile sink for homogenous wsn's. The EAAER approach improves the routing against the base model by using shortest path routing. Simulation results show that the performance of EEAER increases battery utilization and the number of received packets while minimizing duplicate packets and packets lost during transmission compared to the base model.

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Keywords: *Wireless sensor network, Event reliability, Mobile sink, Shortest path routing.*

1. Introduction

WSN has specialized application areas in the military, healthcare, and rescue efforts following natural disasters. Static sensor nodes that are

* *E-mail:* **navneetv.computers@tmu.ac.in (Corresponding Author)**
† *E-mail:* **principal.computers@tmu.ac.in**

placed inside the monitored area make up a typical WSN. The main function of a WSN is to identify an event in the area of interest [1, 2]. In single-hop static WSNs, all sensor units transmit maximum data to the sink, dramatically raising their energy utilization and resulting in their early death and network topology partitioning. As a result, nodes positioned distant from the sink won't be able to send data there, shortening the WSN's lifespan. In order to reduce the energy needed to transfer large data packets over a large region while maintaining sensor node energy utilization, it is recommended that mobile sinks be used to gather data. The mobility of the sink considerably reduces the number of hops by directly collecting packets from each node, which reduces the power consumption in data gathering. Sink mobility uses shortest path routing to achieve significant network lifetime improvements based on the relationship between mobility and data transfer delay [3, 4]. Many sensor nodes are deployed to cover the field of interest for event detection in a WSN. Different approaches are utilized for each node to surround the largest area in order to obtain maximum coverage in a network. In this case, multiple sensor nodes may have overlapping sensing ranges and detect numerous packets associated with the same event. Event duplication is the process of sending data about the same event in two or more packets. Duplicate events can lead to congestion, energy waste, and high bandwidth use. While the sink receives at least one packet with the event's sensed data, eliminating duplicate packets is necessary for event reliability [5, 6].

2. Related Work

This section provides a comprehensive analysis of numerous existing surveys, comparative studies, and reviews that are concerned with reliability from various viewpoints for WSNs. WSN has specialized application areas in the military, healthcare, and rescue efforts following natural disasters. Problems and solutions for various applications were explored and discussed. Also, energy constraints, heavy traffic, connectivity issue, insufficient coverage are major issues in different applications. Each sense-data packet will reach the sink ensure packet reliability. They explain reliability factors in terms of lost data packets by one-way hash chains (OHC), and pre-stored secret key mechanisms [7, 8]. In the same way, this research was conducted to identify parameters for a reliable network. Packet reliability and event reliability are important in both types of transmission, such as node-to-nose and source-to-destination. Redundancy-based reliability and retransmission-based reliability are two examples of the different ways that reliability in a WSN is measured. There are many techniques to ensure reliability in the fields of communication, coverage, deployment, event detection, and data aggregation. The author provides a comparison of various strategies, protocols, and methods applied to WSN to increase its reliability. However, there is still an issue with defining the relationship between security and reliability [9, 10]. On the other hand, when most researchers work with retransmission techniques to ensure event or packet reliability, some others use data redundancy to ensure reliability. This article evaluates various existing protocols for data transmission reliability. Although primary work of clustering is to reduce energy consumption, but it can also be used to resolve various issues like congestion, routing, security and mobility [11, 12]. Researchers also examine the evolution, design, and implementation of certain significant wsn approaches using various protocols and standards. The methods are separated into centralized and distributed methods. The study focuses on whether one or more sinks are utilized, whether nodes are stationary or moving, whether the formation is based on event detection or not, and whether or not the network backbone is established. [13, 14]. Energy consumption presents a substantial optimization barrier for WSN applications in general. Energy consumption directly depends on the type of application and its requirements. The article identifies the main categories of applications and their specific requirements with different energy conservation schemes. In the same way, the study examined various energy-efficient and energy-balanced routing protocols that aim to increase the network's lifespan and functioning by minimizing energy consumption [15, 16]. Furthermore, Routing protocols play an important role in providing path reliability. There are separate static and mobile homogeneous networks and static and mobile heterogeneous networks in the existing routing protocols for homogeneous and heterogeneous wireless sensor networks. The findings of the simulation as well as the analytical comparisons are summarized. A fundamental problem with wireless sensor networks is coverage. The three categories of coverage issues—area, point, and barrier coverage—were explored in this survey. A systematic discussion of the area coverage issue was made possible by the classification of research activities based on node deployment types, sensing and communication range, and positioning-based or independent methodologies [17, 18]. On the other hand, network reliability is in charge of making sure there are network connectivity, fault identification, and throughput. Techniques for maximizing network lifetime depend on a variety of variables, including opportunistic transmission schemes, routing, clustering, connectivity, coverage, optimal node deployment, and energy harvesting. Researchers categorize various WSN fault types according to their origins in a similar manner. Three steps—fault detection, diagnosis, and recovery—of a fault management system are employed to address the issue. Different fault management strategies have been systematically reviewed [19, 20]. Four functional areas—terrestrial, underground, underwater, and body—are examined in relation to the open issues like energy consumption, congestion data duplication. Similarly, data collecting and processing by large-scale WSNs present an intriguing issue. WSN and big data horizontal overviews, as well as large data collecting architectures and data-transmission systems, are discussed. Energy resources, latency, coverage, and quality of service (QoS) issues, as well as data gathering, clustering, sink placement, and storing and calculating massive volumes of acquired data, are the challenges connected with big data. [21, 22]. Several studies on WSN applications have been published. The study focuses on real-time WSN applications for control systems, environmental tracking, target tracking, and health monitoring. Several strategies based on hard and soft real-time models were adopted to address this demand. In addition, a specific use of WSNs for monitoring and observing water quality is covered in the articles [23, 24].

3. Proposed Methodology

With a mobile sink for WSN, the EAAER protocol employs a novel single-hop communication method for data collection. This method

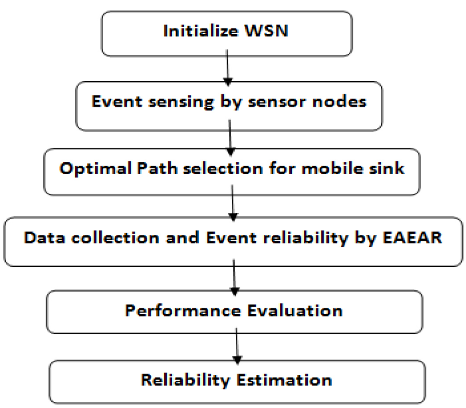

Figure 1

The flowchart for the event reliability mechanism with mobile sink

generates random packet locations for each event and calculates the distance between the packet location and the sensor nodes using the Euclidean formula. It determines whether the distance falls inside each sensor node's transmission range. It is discarded as a duplicate packet if the packet is already listed in the node's list of received packets. If not, the node includes the packet in its list of received packets. This method keeps track of the total number of packets received, duplicate packets, unique packets, lost packets, and battery consumption for each event. The flowchart for the event reliability mechanism with mobile sink of the EAAER protocol is shown in Figure 1.

4. System model and Performance Parameters

4.1 *Network Model*

Network model assume that all sensor nodes will be randomly placed in a M x M-square region, and that all of them will interact with the mobile sink using the single-hop communication as shown in Figure 2. Mobile sink create shortest path by selecting the nearest node . The mobile sink collects data while travelling at a constant speed along the shortest path.

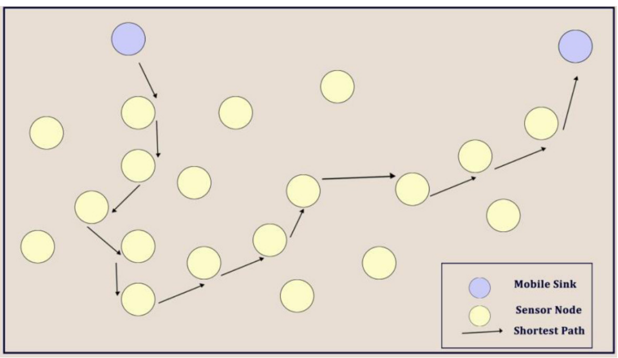

Figure 2

Data collection process with mobile sink

4.2 *Performance Parameters*

- The performance of the proposed technique is compared to the baseline protocol, which is based on single-hop communication with static WSN, using the following metrics.
- **Total Packets Received:** Determine how many packets were altogether received at the sink.

- **Unique Packet Received:** Determine how many unique packets were altogether received at the sink.
- **Duplicate Packets Received:** Determine how many duplicate packets were altogether received at the sink.
- **Lost Packets:** Determine the overall number of lost duplicate packets.
- **Energy Consumption**: Calculates total energy consumption during the process.

5. Simulation Parameters and Performance Evaluation

We evaluated the performance of the EAAER via simulations using MATLAB and compared it with single-hop communication with a static sink. The proposed algorithm is compared with the simple baseline static WSN data gathering approach, which uses the static sink for data collection. For each grid and random topology, sensor nodes are deployed at 100 different node densities. We simulate six random sensing events occurring periodically. Performance metrics such as packet received, duplicate packet, lost packet, and energy are analyzed. The simulation parameters are listed in Table 1.

Table 1
Simulation Parameters

Parameter used	Value
Number of nodes	100
Transmit range	10
MAC Protocol	802.11 collision free
Total Simulation Time	300 s
Grid size	100 × 100 mts
Number of packets	100
Initial Energy	2.5 J
Sink node	1
Sink speed	10 m/s

6. Result Analysis

The proposed EAAER protocol is compared with the baseline protocol, which uses the static sink for data collection.

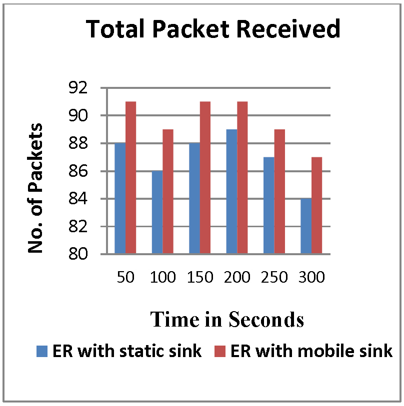

Figure 3

Total Packet Received

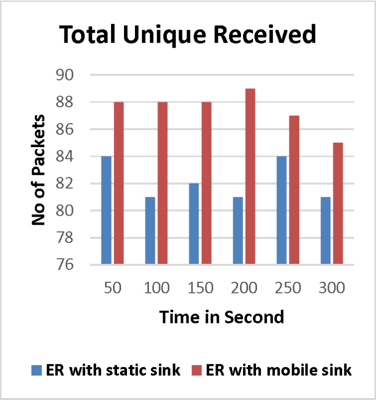

Figure 4

Total Unique Packet Received

- **Total Packet Received:** Figure 3 shows the total packets successfully received. When compared to the baseline protocol, it is shown that as the time increase, more packets are received at the sink through the EAAER.
- **Unique Packet Received:** Figure 4 shows the total unique packets successfully received. When compared to the baseline protocol, it is shown that as the time increase, more packets are received at the sink through the EAAER increases compared to the existing baseline protocol.

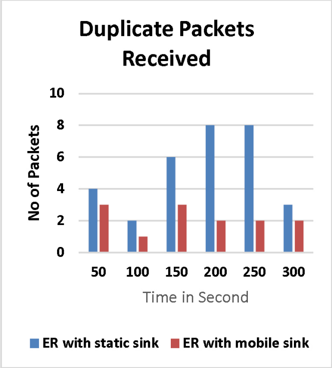

Figure 5

No. of duplicate packets received

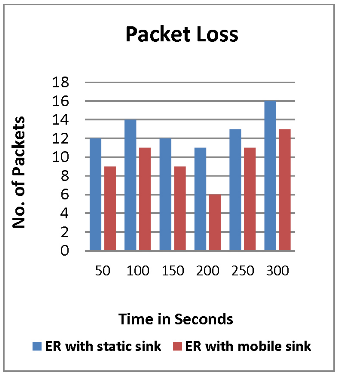

Figure 6

Packets loss during transmission

- **Duplicate Packets Received:** Figure 5 shows the total number of duplicate packets identified. It is noticed that the number of duplicate packets received at the sink through the EAAER is reducing compared to the existing baseline protocol.
- **Lost Packets:** Figure 6 shows the total number of lost packets during transmission. It is noticed that the number of lost packets received at the sink through the EAAER is reducing compared to the existing baseline protocol.

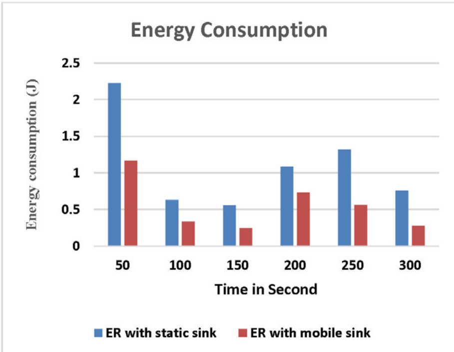

Figure 7

Compare of Energy Consumption

- **Energy Consumption**: The figure 7 shows a comparative chart of energy consumption. It is observed that as time increases, energy consumption is minimized through the proposed algorithm compared to the existing baseline protocol.

7. Conclusion

In this study, the EAAER protocol employs a cutting-edge data collection technique based on a single-hop communication strategy with a mobile sink for WSN. The creation of duplicate packets has a significant impact on the throughput and lifespan of the entire network. The simulation results of the EAAER protocol are implemented using MATLAB, which compresses the baseline approach with a static sink. This approach improves event reliability by minimizing the number of duplicate packets compared to the baseline protocol. Mobile sinks use shortest path routing, which reduces battery consumption and increases network lifetime. The EAAER protocol approach improves routing against the base model by using shortest path routing. According to the simulation results, the EEAER protocol performs better than the basic model in terms of battery usage and the number of packets received, while reducing duplicate packets and packets lost during transmission.

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