Unlocking the Potential Opportunities of Novel Routing Protocols Over Wireless Sensor Network: A Comprehensive Evaluation

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Abstract

Sensor nodes in a network often have low power needs and communicate wirelessly. The challenge of creating a wireless sensor network routing system that uses minimal energy is a significant one. Large-scale wireless sensor networks (WSNs) include hundreds or thousands of sensor nodes into a single system. They weigh next to nothing, have a short battery life, and have a low primary storage capacity and computing capability. The suggested technique is compared with the current routing protocol called AdHoc On-Demand Distance Vector (AODV) to evaluate the efficiency of the proposed scheme and the resulting part shows the right proof to it in plain manner. The goal is to reduce the amount of power used by the network by putting idle terminals into sleep mode at predetermined times. Several uses place a premium on throughput and care little about latency. Which parameter is preferred ultimately depends on what the application wants. Having a thorough understanding of network architecture and routing protocols that is tailored to the needs at hand is crucial.

Keywords

AdHoc, AODV, Routing Protocols, Wireless Sensor Network, WSN, Wireless AdHoc Routing Protocol, WAHRP, Wireless Communication, Networking

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Introduction

Wireless Sensor Networks are profoundly influenced by the rapid development of wireless communication technologies. Data transfer is a key function in WSN[1]. Many ways to boost data transmission efficiency have been presented during the past decade. Research and the real-time industry both benefit greatly from fast and reliable data transmission. The WSN has many different uses, from the military to healthcare to environmental monitoring to smart city technology. The WSN consists of a vast network of individually-operated sensor nodes. In the classic WSN, there are several tiers of interaction between nodes. In WSNs, sensor networks are utilized to keep tabs on a wide range of environmental factors. For these nodes, data transmission was extremely energy intensive[2]. The inclusion of batteries power supply has increased the performance for WSNs. Many WSNs, however, are vulnerable to energy exhaustion because of their batteries' short lifespan. The allocation of node energy is not a primary concern for most protocols. This implies that the energy consumption paths that have been decided upon may only be used for limited purposes. Incorrect network partitioning is the primary cause of packet loss, and the increased energy requirements associated with retransmitting lost packets. When it comes to the quantity of raw data generated, WSNs are a step forward. There are a number of factors, including network type, channel characteristics, and performance measures, that might complicate the operation of picking the optimal route. Data gathered by sensor nodes in a wireless sensor network is typically sent to the network's base station, where it may be collected, analyzed, and acted upon.[3,11].

Due to the many differences between WSN and infrastructure-free wireless networks, designing routing protocols for WSN is challenging[4]. There are many different kinds of routing difficulties within wireless sensor networks. The following are examples of significant obstacles:

(i) Assigning unique IDs to a large number of sensor nodes is notoriously challenging. As a result, conventional IP-based protocols are outside the capabilities of wireless sensor nodes.

(ii) Multiple sources can only communicate with a single base station if they are able to send their discovered data there. But this is not the case with the majority of internet interactions.

(iii) There is usually substantial redundancy in the generated data flow. Since the same information may be sensed by a large number of nodes, simultaneously. Therefore, it is crucial to make the most efficient use of the available bandwidth as well as energy by ensuring that the routing protocols take full use of such redundancy.

Transmission power, the bandwidth, storage capacity, and on-board energy are all severely limited in wireless motes. These variations have led to the development of many proposed novel routing methods for use in wireless sensors networks. The routing protocols determine how data will be transmitted from one node to another and where in the network it will be shared. There are a number of different methods to categorize WSN routing protocols[5,12]. The following figure Fig.1 describes categorization scheme for routing protocols.

Related Study

Excessive attenuation, excessive noise, the limitations of the acoustic mediums, and the dynamic topology all have a negative impact on data reliability[6]. Much research was done to make data trustworthy by employing forward error correction procedure, retransmission, attenuation model, and Signal to Noise Ratio (SNR) due to the limitations of the acoustic mediums, attenuation and noise[6]. To extend the network's durability, many new routing protocols have been implemented. However, there are actually a

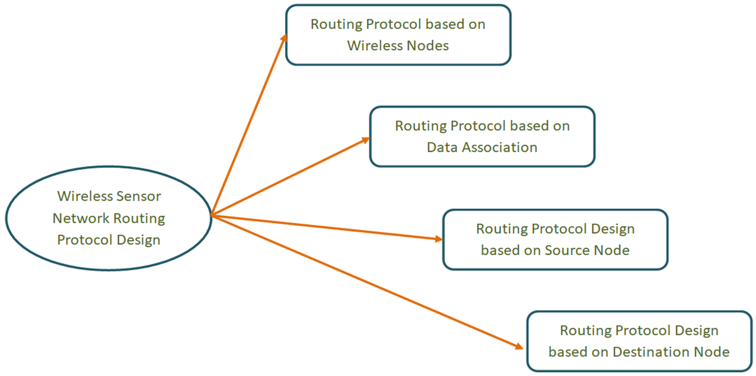

Figure 1. Categorization Scheme for Routing Protocols

lot of things that can be done to extend the network's lifespan. To make networks last longer, we created a new protocol for routing named Congruent Gravity Value. In order to identify the relay node, two distinct packet types will be broadcast. One sort of packets is hello packet that will carry the information about source node as well as sink. The second kind of packet is called a response packet, and it includes data about the next neighbor node. In the case of a hello packet, the source node will always be responsible for sending it, whereas the nearest neighbor node or the source node, depending on the conditions, will send the reply. Meeting such condition will save energy and prolong the life of a network if at all possible. The gravitational function is the most important factor in choosing the relay node. The cluster head selection method is employed to deal with the congruent gravity value. The effectiveness of CGV has been measured using Network Simulator, and the outcomes compared to those of ER2PR, VBF, as well as UFCA. These protocols used a broad region to find a suitable relay node. To get around this issue, CGV only uses the optimal region for selecting the relay node, and it minimizes the response packet transmission region whenever the conditions allow it[6].

This research[7] proposes a new generation of energy-conscious and trustworthy routing methods. With multi-hop routing systems, the objective is to maximise the lifetime of wireless sensor networks within a given set of dependability constraints. This is accomplished by having the source node send packets to the base stations via intermediate nodes[7]. The first suggested approach maximizes the path's least residual energy while satisfying stated reliability limitations, resulting in optimal energy efficiency. The second procedure is a simplified and longer-lasting variant of the first. To maximize the likelihood of a packet's successful arrival to the base station, it's best to send it over a path where the nodes' residual energies are as uniform as possible. We use a quantity analogous to entropy to assess how evenly the leftover energy was dispersed. A lookup table is used to store data regarding the network's current energy status, and this data is used by the BS to determine the most efficient paths. Following every round of packet transmission, the BS updates its broadcast of the optimum pathways to all nodes[7].

Since there are so many uses for the Internet of Things, research into wireless sensor networks is becoming increasingly vital[8]. But the WSN's distributed wireless nodes can only transmit so much before they run out of juice. The major purpose of WSNs is to gather more data from target in an energy-efficient fashion, because replacing the batteries of huge quantities of node is a labor-consuming activity.

Since nodes are inaccessible throughout the energy harvesting period, a protocol with energy-efficient route must be established for EH-WSNs even if EH technology might extend the lifetime of WSNs. If a large number of nodes within an WSN suddenly stopped working, the network's capacity to monitor its surroundings would be compromised. This paper presents an adaptive hierarchical-clustering-based protocol for routing for EH-WSNs to ensure that the specified region is always covered. First, to equalize the load on the network's energy supply, a hierarchical clustering-based route protocol is developed[8]. Then, a distributed alternating of working modes is suggested to adaptively regulate the number of node in the energy-harvesting option that might lead to unbroken target coverage. Through energy harvesting technology, the proposed HCEH-UC protocol has been shown through experimental simulations to be capable of providing continuous target coverage for substantially longer lives than the present routing methods[8].

In mobile sensor networks, the sink node keeps track of its own networking events, whereas the sensor node sends a message when it comes across an event that sink node should care about[9]. Data flow from the application scenario's communication process has a burst nature, which might cause bottlenecks in the network. This means that successful query rates and network communication overhead should both be taken into account during the design of the data routing system. In order to solve this problem, a content-based publish/subscribe routing protocol tailored specifically for use in mobile sensor networks is proposed in this paper. Routing protocols for content-based publish/subscribe are based on the principle that all sensor nodes in a network should be partitioned into various clusters, from which sensing events may be sent. Publish, subscribe, match, and unsubscribe are the protocol's constituent parts. Inquirers provide subscription details, which are stored at the cluster networks' epicenter[9]. The published events are sent to the cluster network's head node, where the matching calculation is carried out. In the case of a successful match, events will be delivered to subscribers, increasing the query hit rate. Based on the simulation results, the content-based publish/subscribe routing protocol is more efficient than conventional methods, using less energy to transmit matching events. For content-based publish/subscribe protocols, increasing the number of published events can extend the network lifespan by 28%-54%, while maintaining a subscription success rate of over 80%[9].

Physical environments may be monitored and managed with the use of sensors. In mobile sensor networks, nodes can be self-propelled using mechanisms like springs and wheels, or they can be coupled to larger transport mechanisms like trucks. For the sensor network to function for a significant amount of time, it is essential that the energy consumption of the sensors be optimized[10]. In static sensor networks, sensors closer to sinks are more likely to fail than those furthest from them. Sensors close to the washbasin relay information from other sensors, as well as providing their own data. This inconsistency in energy consumption hinders network segmentation and shortens the longevity of the network. The usage of wireless sensor networks is on the rise in various NWGN use cases. Major considerations for these networks are energy savings and data consolidation. As a result of data aggregation, both the number of data transmitted and the amount of energy utilized are decreased. The responsibility for optimizing network performance while minimizing energy consumption and other negative effects falls on routing protocols. Using a mobile data collector with several hops, this study provides a new routing system for effective data aggregation[10]. Therefore, when compared to the present state-of-the-art hybrid multi-hop routing protocols[10] for Wireless Sensor Networks, the proposed technique is the superior option.

Methodology

Sensor nodes inside the WSNs are linked together and exchange data with one another in order to conduct environmental monitoring. In a wireless sensor network, the sensor node runs in a decentralized, low-power mode. There are numerous new uses for WSN, including healthcare networks, factories, the environment, and even the military. Base station, cluster head, and sensor node are the three levels of operation in a conventional WSN. Nodes equipped with sensors relay environmental information to a central hub. However, the cluster's epicenter is constantly bombarded with multimedia data for a predetermined length of time, and its behavior shifts as it rotates. Energy is wasted when the cluster head rotates, and time is lost while data is sent. To solve the constraints of the present state of the WSN, in this study article developed a Wireless AdHoc Routing Protocol (WAHRP) with closest path selection that derives using the current AdHoc On-Demand Distance Vector (AODV) method. When it comes to transmitting multimedia data, the conventional WSN has many drawbacks[13]. The sensor nodes' computational and communicative capacities are quite limited. The communication performance between sensor nodes is hampered by their short range. The following figure Fig.2 framework for WSN design model.

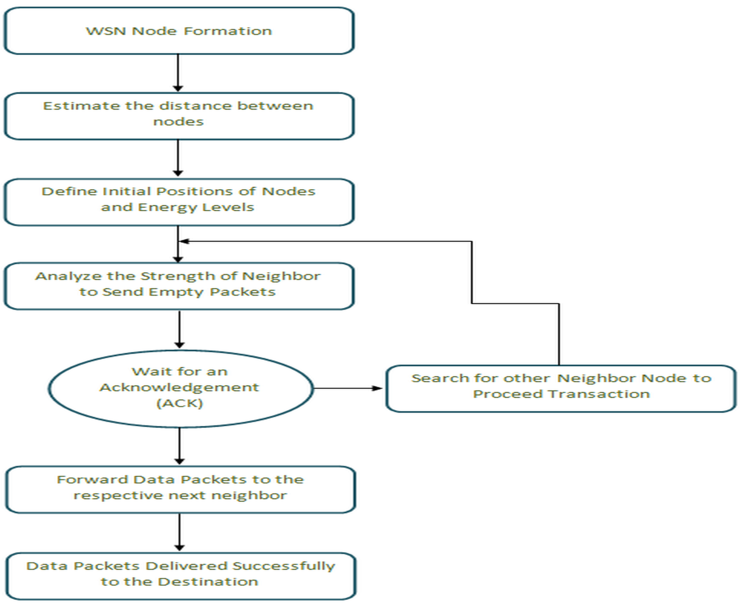

Figure 2. Framework for WSN Design Model

The quantity of energy used by each node in a WSN is a crucial factor in the system's overall lifetime. The nodes consume less power while they are idle but significantly more when they are actively doing operations like transferring data to a cluster head. To make WSNs last longer, it's important to restrict how much power individual sensor nodes may use. In order to lessen the burden on the network's power supply, this study introduces the Wireless Ad-Hoc Routing Protocol (WAHRP) algorithm. The following figure Fig.3 describes the flow diagram of WAHRP.

Due to limited resources, such as power, data transfer rates, and computing capacity, wireless sensor networks provide significant design issues.

(i) Conservation of Energy: Most wireless sensor networks rely on battery operation to function. Lack of energy is a significant problem for these sensor networks, especially in hostile settings like the battlefield. If the battery level on a sensor node drops below a certain threshold, the node's performance will suffer. When planning sensor networks, power consumption is a major consideration for designers. Because of the uneven distribution of power, each node within this network has limited access to energy. Therefore, the routing protocol needs to minimize power consumption.

(ii) Complexity: The efficiency of a wireless network as a whole might be hampered by the complexity of its routing protocol.

(iii) Scalability: With the falling cost of sensors, wireless sensor networks may easily accommodate hundreds or even thousands of sensors. Therefore, the routing protocol must support expansion of the network.

(iv) Delay: Some uses, like temperature sensors or alarm monitoring, need immediate reply as well as response without any significant delay. Therefore, minimal latency should be provided by the routing protocol.

(v) Robustness: Wireless networked sensors are employed in very essential and loss contexts regularly. It is possible that a sensor node in a wireless sensor network will die or disconnect at some point. Therefore, the protocol for routing should be robust enough to function under extreme and lossy conditions.

(vi) Transmission of Data: There are four unique data transmission types in wireless sensor networks, and they are event driven, query driven, hybrid and continuous. How well a routing protocol functions depends on factors like network size and the medium it uses to transmit data. Therefore, high-quality transmission medium has an immediate and positive effect on network performance.

(v) Location: The majority of routing protocols make use of some sort of localization method to learn where they are. In some situations, it might be helpful to have a global positioning system receiver.

Results and Discussions

The metrics are evaluated based on three aspects of the network: throughput, latency, and communication efficiency. The concluding section of this study provides a clear demonstration about the installation and effectiveness of the Wireless Ad Hoc Routing Protocol (WAHRP), which was recommended. The efficiency of WAHRP is evaluated by assessing its performance across a number of different metrics, with the AODV routing protocol always being kept in mind during the process. The amount of time that it takes for an envelope to make its way from its point of origin to its final destination is referred to as the network delay. It includes not only the delays associated with route finding and conservation but also those associated with retransmission on the media access layer. The proposed system is helpful to transmit high volume of data that may be sent from one node of a network to another node within a specified amount of time. Regarding the number of bytes per second, it is satisfactory. The communication efficiency parameter displays the amount of network traffic in terms of bytes per second. The condition known as network congestion happens when the amount of data that is being transmitted across a network's links is greater than the capacity of those links. Congestion is another name for work load. During the simulations, many sensor nodes are represented inside the WSN environment; initially, fifty nodes are assessed within a small network made up of a single, fixed wireless sensor node area. The network extends across a space that is 1500 X 1200 meters in size. On each and every node is an implementation of the widely known IPV6 protocol, and the FTP protocol is the principal traffic generator. There is a 20 Mbps data transfer rate for each unique wireless sensor node. The threshold for a medium-sized network is 50 nodes, whereas a large-scale network has 100 nodes or more. Following the completion of the simulations, the following conclusions may be drawn. Figures 6-8 present the results of running simulations using WAHRP and AODV. These figures illustrate latency, communication efficiency, and throughput respectively. Latency, on the other hand, is measured in terms of seconds as opposed to bits per second for transmission speed.

The following figures, Fig-3, Fig-4 and Fig-5 represents the histogram representation of throughput, latency, and communication efficiency outcome attained from the proposed WAHRP and AODV models. These illustrations are properly depicted into the following tables, Table-1, Table-2 and Table-3.

Table 1. Throughput Analysis

Time (s)	AODV (bps)	WAHRP (bps)
5	3563	4674
7	3679	4738
11	3891	4927
15	4261	5033
18	4425	5159
21	4656	5286
25	4886	5412
29	5117	5539
32	5347	5665
36	5578	5792

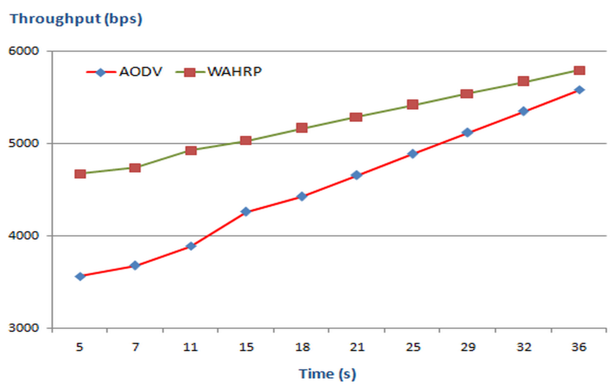

Figure 3. Throughput Analysis

Table 2. Latency Analysis

Data (bps)	AODV (ms)	WAHRP (ms)
1000	3899	1654
1500	4115	1823
2000	4569	1938
2500	4864	2089
3000	5199	2231
3500	5534	2373
4000	5869	2515
4500	6204	2657
5000	6539	2799
5500	6874	2941

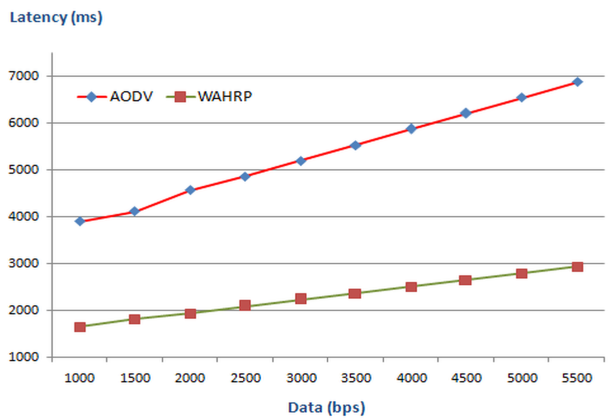

Figure 4. Latency Analysis

Conclusion

WSNs find applications in a wide variety of real-world settings, ranging from smart cities and agriculture to the military and healthcare. When it comes to the transport of data, the WSN performs quite well. The sensor nodes' functional capacity is based on circumstances that occur in the actual world. Because of the nature of WSN, the resources available to the sensor nodes are quite limited. In this paper, we use a hierarchical approach with a new component for selecting collection heads and primary nodes on the hierarchy in order to optimize the network's lifetime. This was done so that we could use it to its full potential. As an extra step towards conserving energy, we have implemented a new coverage strategy for the sensors that belong to member organizations. According to the results of simulations, WAHRP is preferable than other topologies in terms of prolonging the lifetime of wireless sensor networks by reducing the amount of power that is consumed at nodes that are inert.

Table 3. Communication Efficiency Analysis

Data (bps)	AODV (%)	WAHRP (%)
1000	90.63	96.67
1500	89.54	96.89
2000	90.18	96.54
2500	90.56	96.87
3000	89.28	96.81
3500	89.53	96.83
4000	89.37	96.86
4500	89.20	96.88
5000	89.03	96.91
5500	88.86	96.93

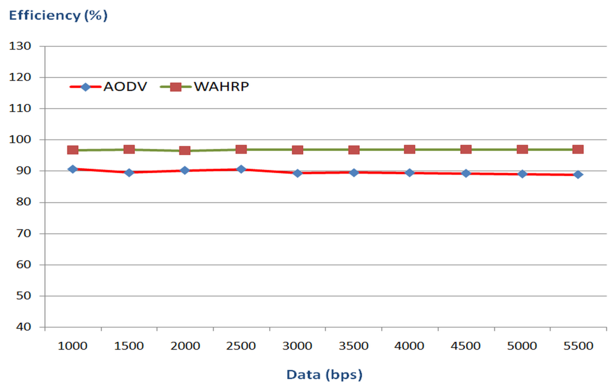

Figure 5. Communication Efficiency Analysis

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