INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATIONS AND ROBOTICS
ISSN 2320-7345

A ROUTING PROTOCOL BASED ON WEIGHTED MEASURE OF LOAD BALANCING FOR WIRELESS SENSOR NETWORKS

Mahbubeh sadeghian[1], Behzad Mahdavi Parchin[2]

[1] *Department of computer engineering, Komeil Higher Education Institute, Kordkuy, Iran*
[2] *Department of computer engineering, Ardebil Branch, Islamic Azad University, Ardebil, Iran*
Author Correspondence: Iran, +989111534883, m.sadeghian@komeil.ac.ir

Abstract: - A wireless sensor network consists of a large number of sensor nodes that are widely distributed In an environment that collects information from. Wireless sensor networks are networks that are used in many of the most important applications. Routing in these networks has its own challenges due to their unique properties and limitations, such as energy constraints, memory and processing capacity. Hence, the use of routing algorithms, which leads to lower power consumption and appropriate bandwidth efficiency, is essential. In this paper, taking into account multiple metrics, the remaining energy of the nodes and the number of steps provided by an efficient routing are presented. In the proposed protocol, routing uses unidirectional link. The main goal is to search for different paths during the route discovery process, but only the best route is selected based on some metrics (number of steps and remaining nodes) and used to transfer data between destination and source. The proposed protocol is implemented using MATLAB software; parameters taken in implementation are: dead and alive nodes, throughput and network lifetime are evaluated in each period. According to the results of the implementation, the proposed routing protocol improves performance parameters and increases network lifetime.

Keywords*:* wireless sensor network, load balancing, weight measure, network lifetime, routing.

1. Introduction

Wireless sensor networks include a large number of sensor nodes that are responsible for monitoring and controlling the environment. In recent years, wireless sensor networks have focused largely on the attention of researchers and the real-world users. In order to perform tasks in a wireless sensor network, we need to consider the time and energy consumption, so that the time will not be lost and the lifetime of these networks will not be significantly reduced. Activities in the sensor nodes with limited battery energy source are depleted over time by doing activities. Hence, energy conservation is a critical factor and a major challenge in designing wireless sensor networks. Therefore, the main goal of the research in this area is to find the least-power data routing protocols that lead to the design of multiple protocols with different routing techniques [1][2]. Finding an efficient energy path can play a very important role in extending the life of the network, Therefore, routing in wireless sensor networks, due to specific features that the sensor networks differ from other networks, is very challenging. First of all, Sensor nodes have severe energy constraints and hence require accurate resource management. Second, in most applied scenarios, the nodes in the wireless sensor networks are generally fixed after the expansion and very few nodes are moving, this causes the network topology to change periodically and unpredictably. A routing algorithm in wireless sensor networks can result in a low or high network lifetime. Finding a path to improving energy consumption and improving the performance and longevity of the network

can be improved by taking into account different criteria. Using clustering can increase network performance and optimize the use of limited energy resources for sensors. However, the load or energy consumed by the sensors in the network is heterogeneous, so that some of the sensors may disappear sooner than others. Using cluster heads and collecting data from a cluster and then combines them together, we can reduce the volume of data that is sent to the central station and helps to save energy in the network. Therefore, clustering methods provide fast linking, effective routing, and better topology management. In this research, we present a routing protocol to improve energy consumption for wireless sensor networks using distributed energy efficient clustering. The focus is on the technique used to route the message and how it achieves minimal energy consumption.

2. Related works

To extend the life of a wireless sensor network, a number of routing algorithms are provided. Indeed, these algorithms seek to minimize energy consumption in the network [3][4]. However, sensors are used along with minimal energy expenditure and their energy runs out quickly that leads to lengthening the life of the network. Hence, researchers have found that routing algorithms not only take overall energy consumption but also take into account the amount of energy remaining in each sensor. By giving priority to high-energy sensors along the path, power consumption peaks are flattened per node and the network life span is high. Mitra et al. provided a routing algorithm called Maxew; in this protocol, the path selection for sending a few steps, using at least a minimum energy transmission, takes place on network nodes that have a residual energy of more than one threshold. The goal is to balance the energy consumption of the entire network. In this way, the energy of the nodes is depleted in the shortest paths, so this threshold must be equal to the average energy of the network [5].

Most energy is consumed due to the transmission of messages, such as data packets and controls. In another article, for the same reason, a new decentralized hierarchical clustering routing algorithm is proposed [6]. In the proposed method, clustering and multi-step algorithms reduce packet control in the early stages. Due to the uneven energy consumption among the nodes, the clusters are such that the cluster head is the most competent for intra-cluster and intra-cluster transport. Energy consumption, setting the precise degree and precision of the passage of each data to reach the base station of these three main parameters are considered for the cluster head. In the simulation results of this proposed protocol, the energy consumption of sensor nodes and the increase in network lifetime are significantly shown. In another study for energy efficient routing, it relates to an article in which a linear and nonlinear programming were first formulated for two major optimization issues for wireless sensor networks [7], for example, energy efficient routing and clustering. Then two algorithms for those problems are presented based on the particle swarm optimization algorithm. The routing algorithm has been developed taking into account a pending transaction between the remote transmission and the number of step counting. In the clustering phase, the cluster routing headroom has been considered to create a balance of energy consumption in the cluster headquarters. Another research [8] proposes a routing protocol, Due to the importance of energy in underwater sensor networks; it reduces energy consumption in communications between sensor nodes to the optimum level and thus increases the network life span. The proposed protocol uses the same protocol simulation software NS2 has been compared with similar protocol DBR. The simulation results show that the proposed method of overall energy consumption has greatly improved the lifetime of the network compared to DBR. In another method, first, the average of the distance between the source node and all neighbors is calculated based on the location of the nodes and then verified by their energy, In the end, those neighbors that have energy above the threshold and whose distance is equal to or less than the average of the average distance computed among all neighbors, is chosen to send data. The protocol will increase the lifetime of the network by increasing the delivery rate. Also, taking into account the two location factors and the amount of energy remaining in the nodes of the routing process reduces energy consumption [9]. In another study, a real-time X-Layer protocol (RTXP), which is a real-time communication protocol, is presented. The proposed protocol in this article is MAC routing and is not centralized, but instead relies on local information. It also describes the mechanism of the protocol [10]. In another study, an efficient energy-based routing algorithm based on harmonic search for wireless sensor networks has been proposed which is the Harmony Search Algorithm (a meta-heuristic). In this way, the harmonic memory encryption has been improved based on network routing features. Secondly, a new harmony forms [11].

3. Description of the proposed approach

In this paper, taking into account the multiple metrics, the remaining energy of the nodes and the number of steps for an efficient routing are presented. In the proposed protocol, routing uses unidirectional link. The purpose of the proposed protocol is the balanced load distribution on different nodes. In a wireless sensor network, two or more paths between the destination and source using the AOMDV multicast routing protocol [12] (The AOMDV protocol, Multipath Routing Protocol, which extends the single-path AODV protocol, is

used to compute multicast routing), and metrics by taking a number of steps and the remaining energy of nodes are discovered. The goal of having multiple paths is to increase the reliability of data transmission, or to allow load retention. Proposed protocol creates the paths with more energy-saving nodes and a smaller number of steps, resulting in better and more stable performance in the network, which will lead to a better packet delivery rate and lower end-to-end delay. In fact, the main purpose is to search for different paths during the route discovery process, taking into account the AOMDV routing protocol, but only the best route based on the criteria (the number of steps and the remaining energy of the nodes) is selected and used to transfer data between destination and source. Other routes are only used when the initial path is false. In path prediction mechanism when a link is likely to be broken, a trusted path will be selected as an alternative path. Below are the criteria for the number of steps and energy remaining used the route discovery process:

1. **Number of steps**

$$T_i = \frac{Alen_i}{Mlen} \quad (1)$$

$Alen_i$ Denotes the number of steps in path I and $Mlen$ denotes the maximum length that a path can take in the AOMDV routing protocol.

2. **The remaining energy of the sensor nodes**

$$E_i = \frac{\sum E_{res}(i)}{N_i * \sum E_{ini}} \quad (2)$$

N_i Is the number of nodes in the path, E_{ini} is the primary energy of sensor nodes, and $\sum E_{res}(i)$ is the total amount of energy remaining in paths i.

3. **Weighting criterion:**

$$\text{Weighted criteria} = \frac{E_i}{T_i} \quad (3)$$

Among the routes discovered, according to the AOMDV protocol, the route with the highest weight criterion is selected with priority as the best route to send data from the source node to the destination node. Another route, when the first route is defeated, is chosen as the alternative route considering the weighting criterion.

4. Evaluation of results

In implementing the proposed method, the case network has 20 sensor nodes. The results of the proposed method, using criteria packet delivery ratio, packet loss rate, throughput and end to end delay are evaluated. For simulation, MATLAB software is used. For comparison, the AOMDV protocol is used. First, the network is created randomly with the number of nodes we set, and then routing between the source and destination is applied.

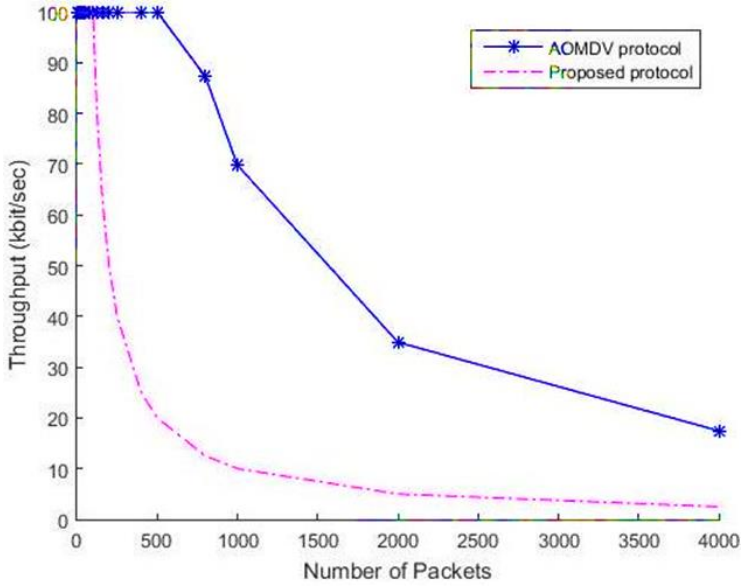

Figure 1: Comparison of the throughput of proposed protocol and AOMDV

Figure 1 shows the throughput of the proposed protocol by protocol AOMDV. Throughput acts better than others by increasing the number of rounds. The greatest loss of throughput that occurs is the use of a greater number of steps in the routing process. When the number of nodes and the speed of the nodes increase, more topology changes occur, and therefore greater control packets in the network are sent which causes a significant drop in network throughput.

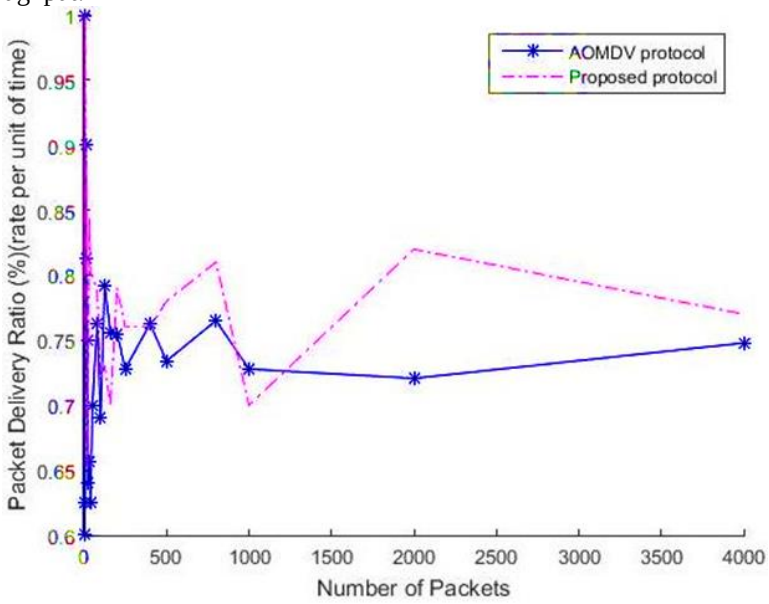

Figure 2: Comparison of the packet delivery rate of proposed protocol and AOMDV

Figure 2 shows the comparison of the packet delivery rate of the proposed protocol and AOMDV. The rate of the number of packets successfully received at the destination has been sent to all packages by destination, say the success rate or packet delivery ratio. By increasing the number of nodes, packet delivery ratio is not reduced at the destination. This high scalability diagram of the proposed protocol is clearly seen. According to the results, the proposed protocol packet delivery rate is better than the AOMDV protocol.

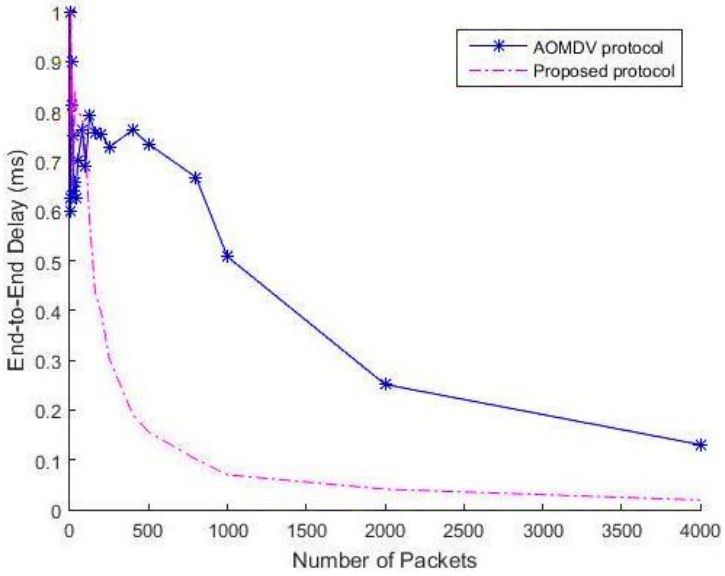

Figure (3): Comparison of the end-to-end delay of the proposed protocol and AOMDV

Figure 3 shows the comparison of the end-to-end delay of the proposed protocol and AOMDV. End to end delay, i.e., the total time when a packet passes from the source node to the destination node, depends on this path and the physical properties and processing time of the nodes. The proposed protocol has a lower delay than the AOMDV protocol, which indicates a delayed latency when sending packets at higher rates. Because of the time interval between the productions of a packet in the source node, the packets pass through the number of nodes that have a higher amount of energy, which means the delay in packet delivery decreases.

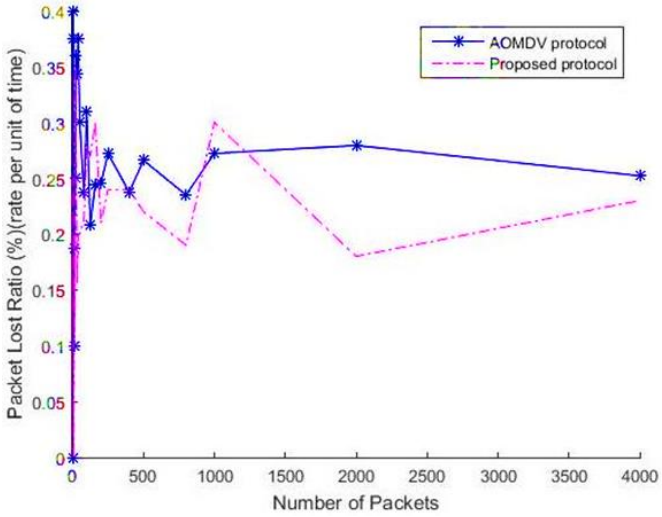

Figure 4: Comparison of the packet loss rate of the proposed protocol and AOMDV

Figure 4 shows the comparison of the packet loss rate with the proposed protocol and the AOMDV protocol. In the first step, the packet loss rates for the proposed protocol and the AOMDV are higher, but with the passing time, the packet loss rate of packets lost in the AOMDV algorithm becomes more than the proposed algorithm. In the AOMDV routing protocol, the packet loss rate increases with further growth; the reason for the increase in the packet loss rate in the AOMDV routing method is because of the loss of packet in sending after each packet failure. While in the proposed method due to failure, it tries to find another route to its destination. By increasing the number of nodes in the network, each node finds many neighbors, As a result, after a failure, a new route reaches the destination node, therefore, the packets will not be dropped, and so, a high percentage of packets arrive at their destination.

5. Conclusion

In this paper, we presented a routing protocol based on a weighted measure of balance load for wireless sensor networks. In the proposed method of searching for different paths during the route discovery process, only the best route is selected based on the weight criterion (number of steps and energy remaining nodes) and is used to transfer data between destination and source. To implement the proposed method, MATLAB software was used. Implementation of the proposed method was done by creating a sample space, with 20 nodes in it. The results of the implementation showed that the proposed algorithm has a low delay, reliable reliability and high efficiency compared to the AOMDV protocol, and can better serve the purpose of better load balancing in wireless sensor networks.

REFERENCES

[1] Gupta, V and Pandey R. 2016. An improved energy aware distributed unequal clustering protocol for heterogeneous wireless sensor networks. Engineering Science and Technology, an International Journal, Volume 19, Issue 2, June 2016, PP. 1050–1058.
[2] Thulasiraman, P and White, K. 2016. Topology control of tactical wireless sensor networks using energy efficient zone routing. Digital Communications and Networks Volume 2, Issue 1, 2016, PP. 1–14.
[3] Amgoth T., K. Jana P. 2015. Energy-aware routing algorithm for wireless sensor networks. Journal of Network and Computer Applications, PP. 357–367.
[4] Elhabyan, R, Yagoub M. 2015. Two-tier particle swarm optimization protocol for clustering and routing in wireless sensor network. Journal of Network and Computer Applications, PP. 116–128.
[5] C-S. Ok, S. Lee, P. Mitra, S. Kumara. 2010. Distributed routing in wireless sensor networks using energy welfare metric. Inform. Sci. 180, PP. 1656–1670.
[6] Maryam S, Reza N. 2014. A decentralized energy efficient hierarchical cluster-based routing algorithm for wireless sensor networks. Computers and Electrical Engineering, PP. 1-14.
[7] Azharuddin M.D, Kuila P,. 2014. Energy efficient fault tolerant clustering and routing algorithms for wireless sensor networks. Engineering Applications of Artificial Intelligence33 (2014), PP. 127–140.
[8] Chen, C. 2013. A grid-based energy efficient routing protocol in wireless sensor networks. in: International Symposium on Wireless and Pervasive Computing (ISWPC), IEEE, 2013, pp. 1–6.

[9] Thakkara, A and Kotecha, K. 2015. A new Bollinger Band based energy efficient routing for clustered wireless sensor network. Applied Soft Computing, Volume 32, PP. 144–153.
[10] Mouradian A, Augé-Blum I, Valois F. 2014. RTXP: A localized real-time MAC-routing protocol for wireless sensor networks. Elsevier, Computer Networks 67, PP. 43–59.
[11] Zeng, B and Dong Y. 2016. An improved harmony search based energy-efficient routing algorithm for wireless sensor networks. Applied Soft Computing, Volume 41, April 2016, PP.135–147.
[12] Mahesh K. Marina, Samir R. Das, "Ad hoc on-demand multipath distance vector routing", WIRELESS COMMUNICATIONS AND MOBILE COMPUTING, Wireless Communication & Mobile Computing. 2006; 6:969–988.