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# Designing Greedy Algorithm for Aware Routing Of Energy in Wireless Sensor Networks

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**Abstract**
Today with recent advances in industry, provided sensors designing and manufacturing with low power consumption, small size, and reasonable price in different applications. These small sensors that can perform actions such as environmental information, processing and their sending, emerged new idea for the development of common networks called wireless sensor networks. One of the most important issues in wireless sensor networks is routing and how to transfer data from the network nodes to the base station. Routing, in addition to selecting the best possible route for transmission of information, has a direct impact on the life of the networks. Energy and sustainable-aware routing protocols are methods that can increase the lifetime of the network. Hence, in this paper, taking into account parameters influencing energy aware routing, presented greedy protocol in the network for routing in the network. In this regard, using sustainable restriction management strategies on the scope of energy aware routing, and apply specific parameters in the greedy algorithm proposed protocol which can improve the lifetime of the network as much as possible. According to this idea, greedy algorithm applied on AODV protocol and is provided the proposed routing protocol called GR-AODV. In protocol GR-AODV, route discovery process is aware of the energy and is done by selecting nodes with more energy and links with high stability. In this regard, the selected dynamic nodes selected by GR-AODV routing protocol of the same nodes that is selected by AODV protocol in routing with shortest distance to reach the destination. Conducted simulation in simulated environments of NS-2 shows that GR-AODV protocol has better performance than AODV protocol.

**Keywords:** Wireless sensor networks, energy-aware routing, greedy algorithms, AODV protocols.



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## 1. Introduction

A wireless sensor network consists of a large number of sensor nodes that are widely distributed in the environment and to collect information from their environment. Place of the sensor nodes is not predetermined. Such a feature makes it possible that we can leave them in dangerous and inaccessible places. Due to the design of the sensors, being embedded in the sensor energy source that is generally small batteries with limited energy and the impossibility of changing the energy source for these sensors, it is one of the major challenges in this type of networks. Due to these limitations, it is attempted to efficient algorithms is presented for energy management in order to increase the efficiency of the sensors in energy consumption and increase the lifetime of the network.

Several routing methods have been proposed for wireless sensor networks that is none of them could serve as the most complete and best under all conditions. In fact, according to what was said about these networks, should be a compromise between the various factors to select method as routing. According to the residual energy of working nodes and because the role of nodes considered energy issue and increased network lifetime in comparison with previous methods.

In this paper, taking into account parameters influencing routing aware of energy, is presented greedy protocol for routing in the network. According to the definition of greedy algorithm and the performance of these algorithms (which always choose the option that seemed the best at the moment) and an optimal locally selection (relative) to get to an answer, can be used in routing topic of wireless sensor network, select node by this algorithm feature. In other words, the node with the highest priority in terms of node energy and link stability at the moment (locally optimal choice) and greedy evaluation of neighboring nodes energy and stability in routing, raised greedy algorithm features to select node in creating transmission path of the data and the idea of using the routing algorithms in wireless sensor networks.

The paper is organized as follows. The following section different methods of routing and clustering protocols used in wireless sensor networks will be examined. The review of AODV protocol and details of the proposed method is presented in section 3. The simulation and evaluation of proposed protocol is provided in section 4. The conclusion and future work of this article is provided in section 5.

## 2. Background

Different routing methods have been proposed for wireless sensor networks that none of them is able to act as the most complete and best under all conditions. In fact, according to what was said about these networks, should be a compromise between different factors in choosing a routing method. Here are some of the most popular methods for these networks.

In Heinzelman and kulik (1999); Heinzelman et al. (2002), Handy et al (2002), Xiangning and Yulin (2007) Lindsey Raghavendra (2002), method of flood sending is provided. This routing strategy is very simple method and the maintenance of the network topology does not rely on expensive or complicated algorithms for route discovery. After the transfer, followed a all possible paths of package, unless the network is interrupted, and finally the package reaches its destination.

Kaufman et al. (2005) is provided a method. This method is also similar to the method of torrential sending, is a simple way to transfer data, similar to the previous method. But unlike torrential, in this way each node, received packets on behalf of his neighbors, one of which is selected randomly. This process continues until the packet reaches its final destination or the maximum step number is rejected.

In Abdul et al (2013) LEACH algorithm was proposed to improve energy efficiency using the protocol-based clustering. Each node on the basis of a predefined probability could play a role.

In 2004 HEED algorithm was presented by Bsoul et al (2013), which is another common algorithm. This algorithm uses the residual energy mix and the cost of communication as a criterion to select cluster nodes. It is notable in HEED design that the algorithm assumes that nodes vary in energy usage and head have been distributed well across the entire network.

EAC algorithm that Ducrocq et al (2013) provided is a clustering algorithm based on energy and distance, the sensor nodes based on their residual energy, selected as cluster heads-up. . As well as non-cluster nodes, select cluster based on the distance to the neighboring cluster. EAC algorithm with load balancing energy between network nodes increases the network lifetime.

Goel and Aujl (2013), designed BLAC algorithm that battery level and other merits, mean density and temperature, can select the cluster. For energy balancing, the role of head alternately is available by each node.

ECLEACH protocol of John et al. (2012) is a threshold-based protocol that is based on three factors: residual energy, distance with other sensor nodes, and other residual energy of sensor nodes. The clusters should be properly distributed in sensor network. So this Protocol considers a minimum distance between each cluster and the next cluster to better distribute cluster throughout the network.

Protocol based on chain that presented Younis et al (2006); Lindsey and aghavendra (2002) is another useful techniques was proposed to reduce energy consumption in wireless sensor networks, was a way that operate on a chain structure. The first performance of the network, all the nodes formed a chain structure with at least length and then a node is selected as the leader of the chain. This node is responsible for the transmission of information to the base station.

## 3. Introduction of AODV Routing Protocol to Implement Greedy Algorithm

AODV routing protocol is a dynamic routing protocol on demand where all paths are discovered only when they needed and are kept only during usage time. In This protocol discovered paths during flooding a release which the network nodes in the process questioned to search a route to the destination. When a node is discover with a path to destination, that track reports back to the source node that request his way.

In the route discovery process, the destination node with a route reply message in response to the origin route request message, ask the directions. Sequence path record at destination and counter specifies the registered number of steps to get to the node. It should be noted that in releasing route request packet by each node to neighboring nodes add a unit to step counter.

AODV protocol discovers route based on the requested message. The central nodes keep demand route request message to reach the destination or keep the existence of a node with valid path that answered with response packet. In this protocol is not used Hello packet to discover an error in communication links, but explicitly used broad casting in the work. The next protocol support aforementioned nodes and used feedback layer connection in routes that has high risk to loss packet. According to the protocol technologies, AODV protocol is cost, in terms of energy consumption, which can serve as the basic protocol to solve the problem of delays.

It is necessary to mention the fact that the AODV protocol is based on DSDV algorithm. The difference is in routing only when necessary and this reduces the broadcast. In this protocol, discovery algorithm starts to works when there is no way between two nodes. This protocol by minimizing overhead control, minimizing overhead processing, increasing several-routing, increasing dynamic topology power and avoidance to create a loop provide appropriate conditions to discover shortest route.

According to the greedy algorithm implementation in the context of AODV protocol and implementation ideas of GR-AODV algorithm require communication between the two nodes to send data and Choose a stable and higher energy of neighbor nodes (the greedy selection) And selection shorter route and to minimize failure in routing and prevent the re-election of the track, which fulfill these depend on the strength of the said Protocol and it is imperative to do the proposed idea. Figure 1 shows the proposed method of flowchart.

### 3.1. Design of GR-AODV routing protocol

The energy-aware routing and selecting nodes with more energy and high stability in GR-AODV protocol is in order to achieve the optimal selected path by AODV protocol that is the shortest route to the destination node, a special formula should be evaluated in relation to neighbor nodes energy and link sustainability in routing, in order to select node with higher energy, select links with high stability and also is selected shorter route.

Equation 1 of Wang et al., (2007) is used to evaluate the next node as greedy. In this respect, Energy, residual percent of node energy, surveyed link stability of LLT between the current node and check node and Hop Count is the distance of node with source (step counters).

$$RQ = \frac{Energy*LLT}{HopCount} \quad (1)$$

According to equation (1)

$$M = \frac{E \times S}{D\_S} \quad (2)$$

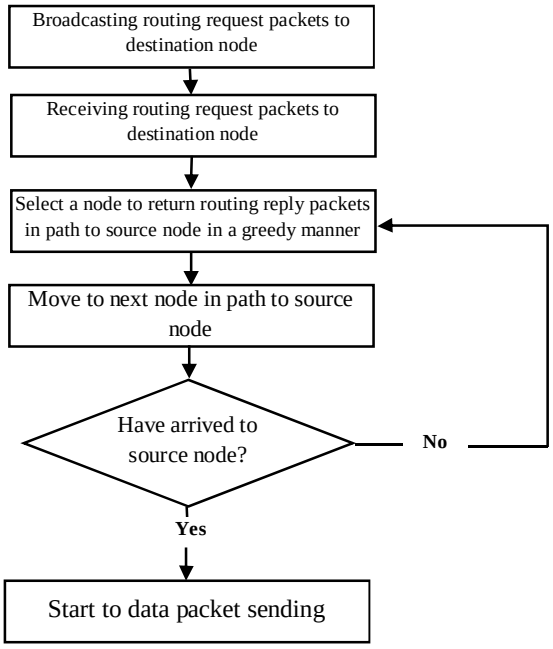



**Figure 1:** The proposed method of flowchart

Where, M is criterion for next node selection, E energy, S stability and D_S distance from origin. Counter step in this formula increases with increasing distance from the source. By increasing the step counter, negligible amount of node energy release in accordance with the above formula. To calculate the lifetime of route links has been used Wang et al (2007), equation (3):

$$LLT = \frac{-(ab+cd)+\sqrt{(a^2+c^2)r^2-(ad-cb)^2}}{(a^2+c^2)} \quad (3)$$

In this regard:

$$a = v_A \cos\theta_A - v_B \cos\theta_B$$
$$b = x_A - x_B$$
$$c = v_A \sin\theta_A - v_B \sin\theta_B$$
$$d = y_A - y_B$$

It should be noted that after the route request message by the node and receiving the route answer of neighbor node consumed some of node energy to routing by AODV protocol. The formula considers the amount of energy in percentage of residual. This means that for the percentage of residual energy of a node, obtain the current primary energy and residual energy, then remaining energy divided in the primary energy of nodes and obtain the amount of energy. This is shown in Equation (4).

$$E = \frac{E_2}{E_1} \quad (4)$$

Due to this relationship;

$$P_E = \frac{RCE}{IntE} \quad (5)$$

Where, PE is percent of efficient energy, RCE current node residual energy and primary energy IntE node. In figure 2, 3 and 4 is shown routing, and how to change the energy of each node in the AODV protocol.

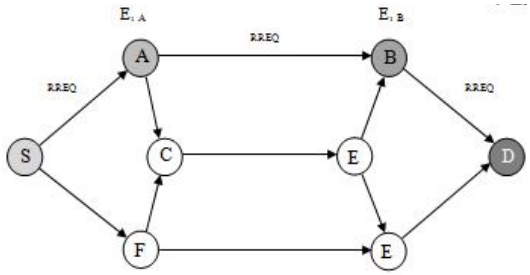



**Figure 2:** Node energy in routing request message by AODV protocol

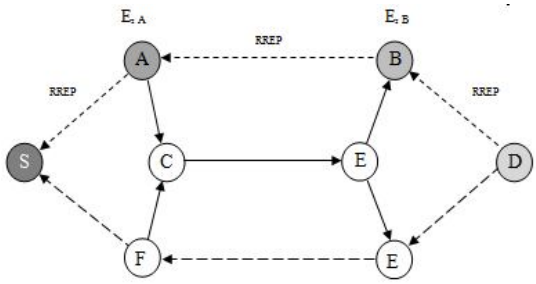



**Figure 3:** Node energy in routing answer message by AODV protocol

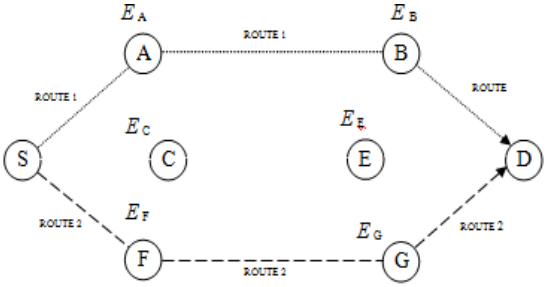



**Figure 4:** Efficient energy of nodes after routing by AODV protocol

If S is the source node and D is the destination node and B and A and C and F and G and E are central nodes, according to the method of operation and routing by AODV protocol, choose shortest route as possible. That means two possible paths create by AODV protocol y; The SABD and SFGD route. However, in order to implement and show how the proposed GR-AODV protocol implement, as shown in Figure 5, Assuming node energy of B with E, B and with LLTB sustainability and step counter Hop Count and node energy of G with E, G and stable LLTG and Hop Count step counter, We show that the algorithm how to select neighbor nodes for data transmission.

By considering performance of AODV routing protocol selected two head nodes as greedy selection, the node B and node G. The proposed formula for calculating efficient energy (RQ) and application components, the nodes energy, sustainability and the way of this formula ,the highest obtained energy owned to Node B and selected by GR-AODV algorithm (used numbers are hypothetical numbers, but the obtained results have been calculated in accordance with the proposed formula).

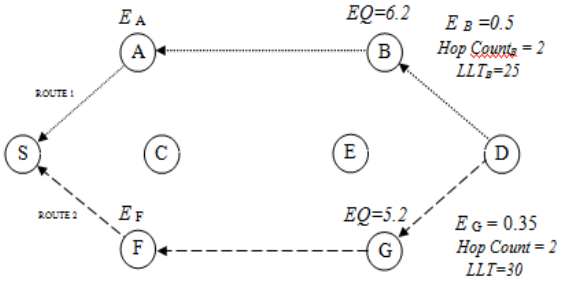



**Figure 5:** Suggested energy of nodes to select greedy

Greedy method according to efficient residual energy of nodes and sustainability of link in the first node, the node will choose the highest quality at the moment. In the neighboring node to continue the process of transferring by GR-AODV protocol and subsequent energy of nodes and sustainability of link to select, in terms of GR-AODV algorithm, will select the node with the highest energy and links with high stability and the more ready node to transfer the selected data to destination. The process is shown in Figures 6 and 7.

Perhaps selecting GR-AODV protocol is due to usage of sustainable nodes that if it use in route to send information with low quality, it was possible that evacuate the energy of route and die nodes along that path and result will be the end of path life through the network.

## 4. The performance simulation of GR-AODV protocols

Idea discussed in the previous section imposed in the NS-2 simulator of AODV protocol and simulated under various scenarios of GR-AODV protocol performance. In order to simulate the performance of proposed GR-AOD protocol and compared the performance with three scenarios of AODV protocol: the number of variable nodes, nodes with variable speed and nodes with variable stop time. In the first scenario, the number of variable nodes, the parameters of throughput, packet delivery ratio, average delay of AODV and AODV protocols simulated in NS-2 software and analyzed changes of mentioned parameters.

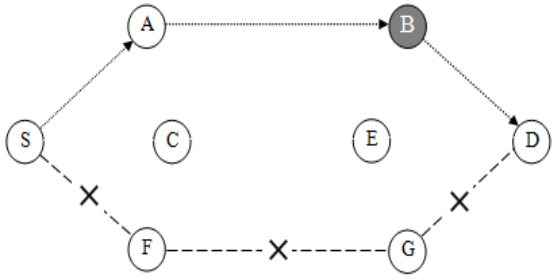



**Figure 6:** Select the node B by Protocol GR-AODV

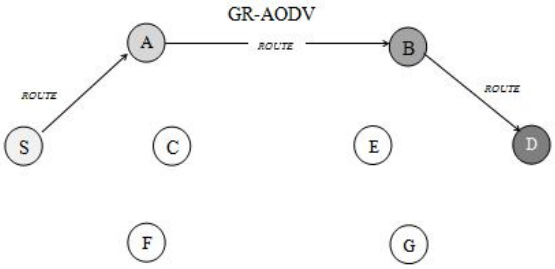



**Figure 7:** Created route to reach the destination by Protocol GR-AODV

In the second scenario, nodes with variable speed, change of behavior parameters, number of packet delivery based on the speed of delivery, performance against speed and the average delay in the third scenario, nodes with variable dwell time, change of

behavior parameters; delivery rate , throughput and latency simulated in AODV and GR-AODV protocols.

In the simulation environment, simulation time, nodes number, stop time and node speed are different in terms of the proposed scenarios. In all mentioned scenarios, Drop Tail queue with equal capacity, CBR type of traffic, AODV routing protocol and MAC layer standard is 802.11.

### 4.1. The First Senario with Variable Number of Nodes

In this scenario, the number of nodes considered variable to evaluate how the protocol will do in terms of density. The impact of increasing number of nodes in this Scenario and changes in throughput is shown GR-AODV and AODV protocol in Figure 8 (a). According to Figure 8 (a) can be said that due to number of nodes in simulation place, increase GR-AODV throughput and is far better than AODV. Figure 8 (b) shows the effect of node changes on packet delivery ratio of AODV and GR-AODV protocol. According to Figure 8 (b) it can be said that the number of nodes in simulation environment improved packet delivery ratio of GR-AODV and is more than AODV. Figure 8 (c) show the effect of node changes on rate of packet delivery in GR-AODV and AODV protocol. According to Figure 8 (c), it can be said that the average delay in the proposed protocol of GR-AODV is less with increase of nodes when compared with AODV protocol.

### 4.2. Second Scenario, Nodes with Variable Speed

In this scenario nodes speed considered variable. The impact of increased speed on delivery number of GR-AODV and AODV protocol is shown in Figure 9 (a). According to Figure 9 (a) can be said that increasing the node speed on simulation environment, delivery number of packets in GR-AODV protocol is higher than AODV. The impact of changes on the speed and efficiency of AODV protocol and GR-AODV is shown in Figure 9 (b). According to Figure 9 (b), it can be said that with the accelerating nodes in simulation environment, throughput and efficiency of proposed GR-AODV protocol is better than the AODV. The impact of changes in velocity on delay of GR-AODV and AODV protocol is shown in Fig. 9 (c). According to Figure 9 (c), it can be said that with the increase speed of nodes in simulation place, delay of proposed GR -AODV protocol is less than AODV.

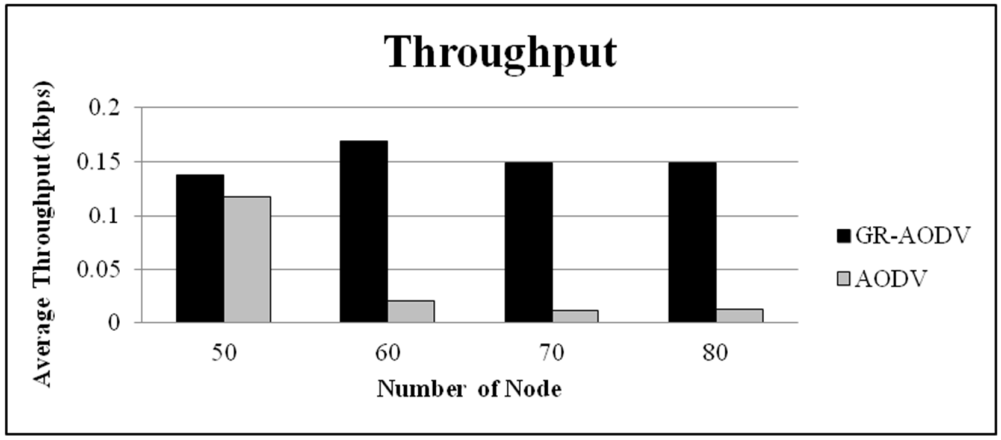
### 4.3. Third Scenario, Nodes with Variable Time

In this scenario, the stop time of nodes is intended variable to evaluate the performance of protocol at different dynamic modes. Figure 10 (a) is shown packet delivery in scenario with variable stop time of nodes in GR-AODV AODV protocol.

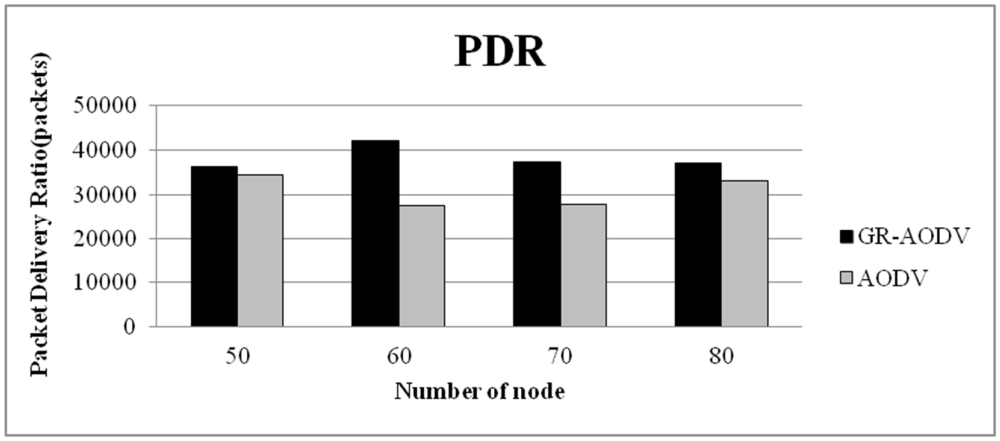
According to Figure 10 (a) and packet delivery ratio in AODV and GR-AODV protocol, it can be concluded that packet delivery is more in first stop of GR-AODV proposed protocol. In Figure 10 (b) throughput is shown in nodes scenario of GR-AODV and AODV protocols with variable stop time. According to Figure 10 (b) and comparison the throughput of AODV and GR-AODV protocols, it can be said that the GR-AODV proposed protocol show better throughput than AODV protocol. Figure 10 (c) the average delays in the nodes scenario with variable dwell time is shown in AODV protocol and GR-AODV. According to Figure 10 (a) it can be concluded that the proposed GR-AODV protocol show less delay in stoppage time than AODV protocol.

## 5. Conclusion

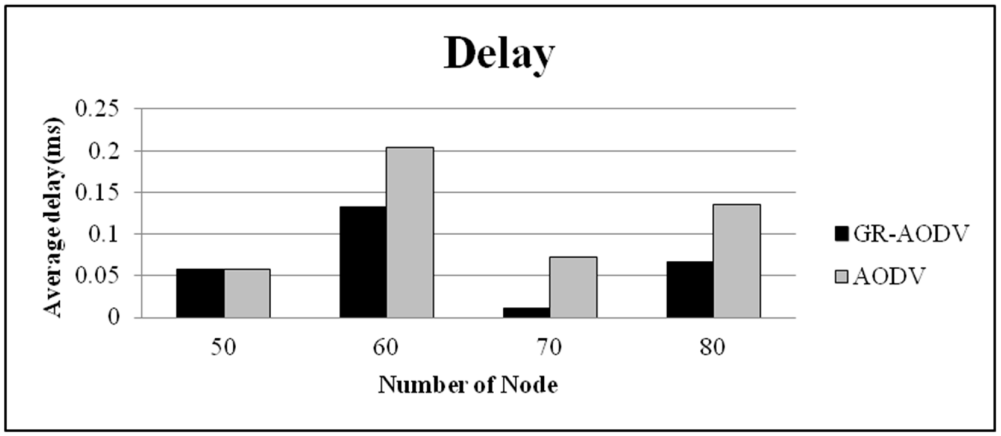
Wireless sensor network consists of many small nodes. Networks, through sensors obtain environmental data and show reaction through the actuator. Communication between nodes is wireless. Each node works independently and without human intervention, and typically is physically very small and has restrictions in processing power, memory capacity, and power supply and so on. These restrictions create problems that are source of many of the issues raised in this field. One of the important areas of research in these networks is the energy-aware routing. Given the importance of this issue in this article is provided GR-AODV routing protocol. This protocol uses the greedy idea and improves AODV routing protocol so that in the discovery path, discovers optimal path in terms of node energy, link sustainability and distance of path. The simulation results show that, in overall glance, considering various scenarios and the quality and quantity evaluating of protocol in different conditions can be said that the performance of the proposed GR-AODV is more and better than AODV protocol.




(a)

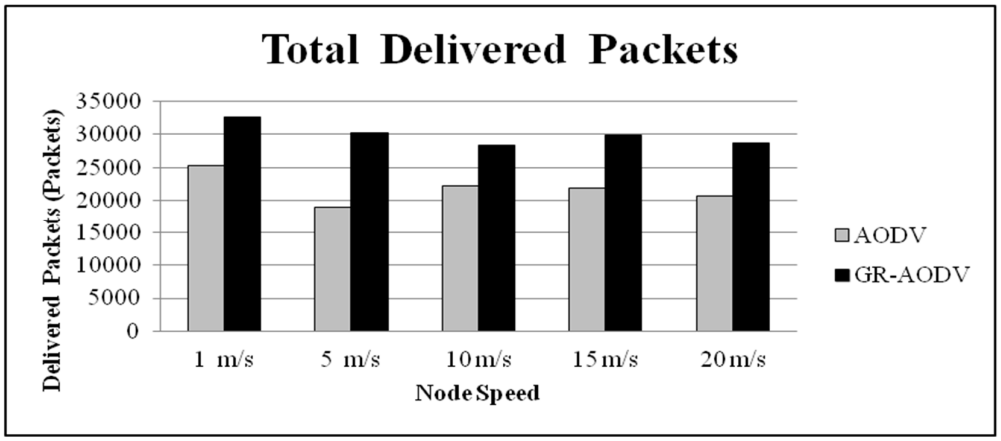



(b)

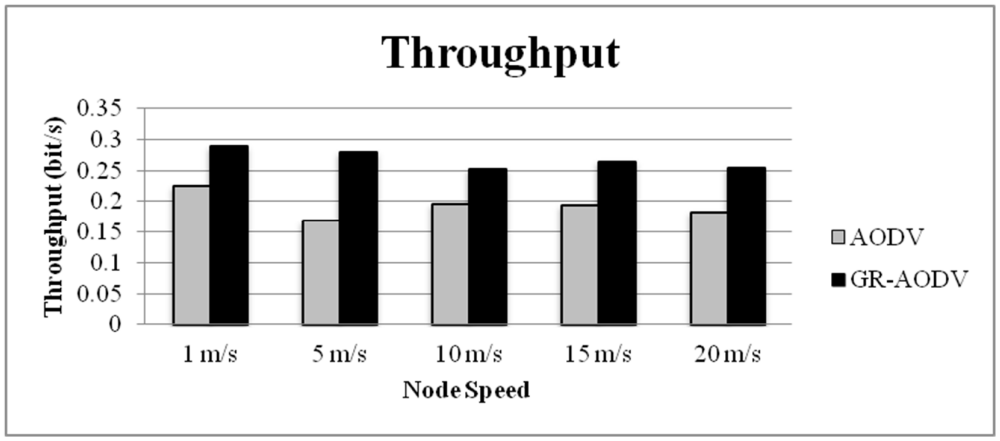



(c)

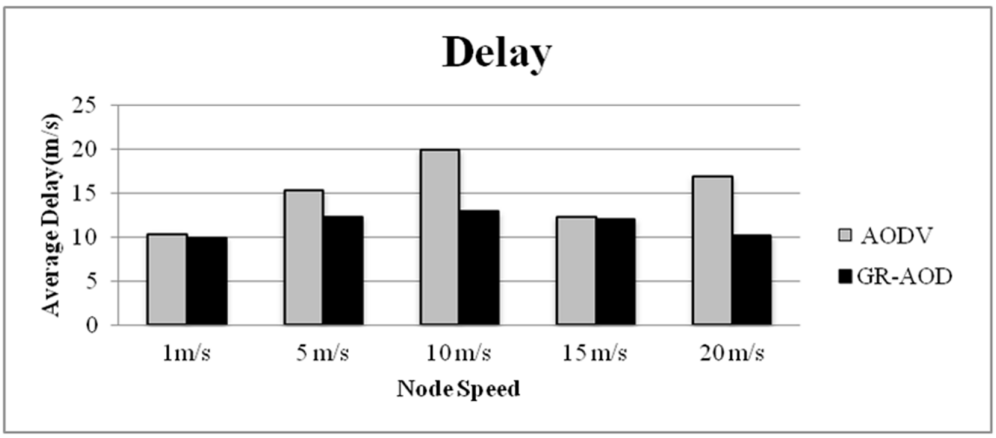
**Figure 8:** Comparison two AODV and GR-AODV protocols in nodes scenario with variable number in aspects of (a) the throughput (b) packet delivery ratio, (C) the average delay




(a)

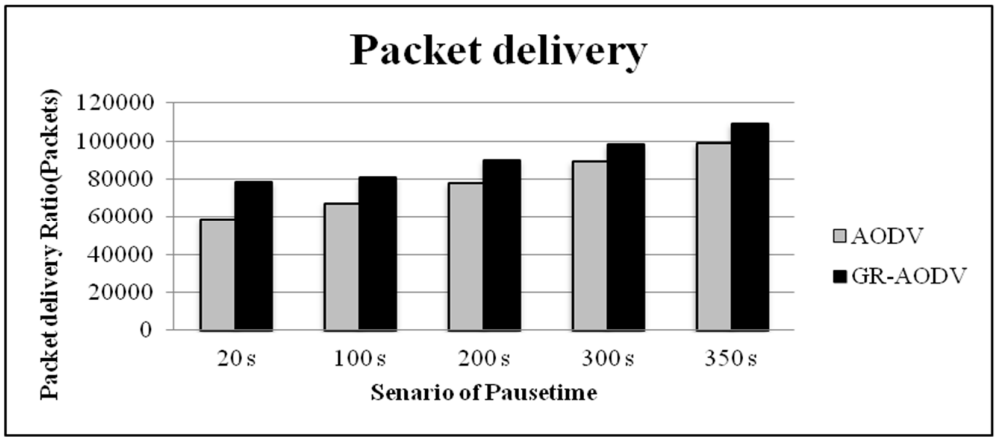



(b)

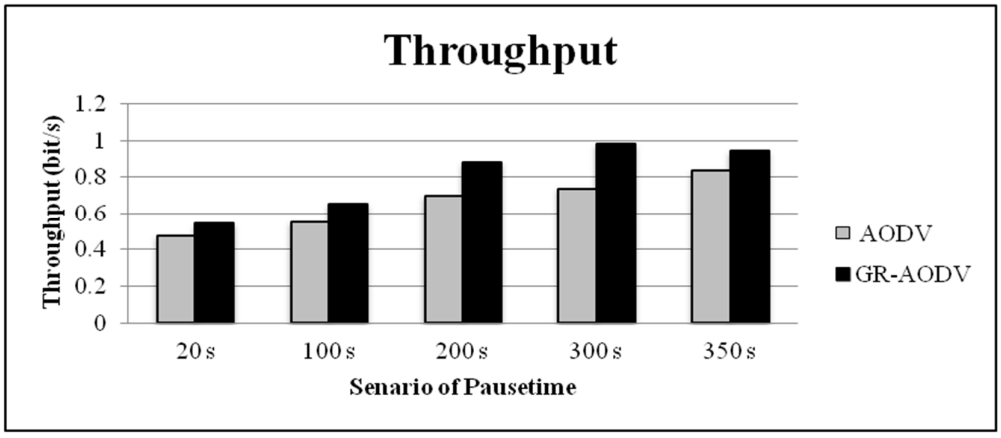



(c)

**Figure 9:** Comparison two AODV and GR-AODV protocols in nodes scenario with variable moving aspects in terms of (a) delivery rate (b) throughput, (C) the average delay




(a)

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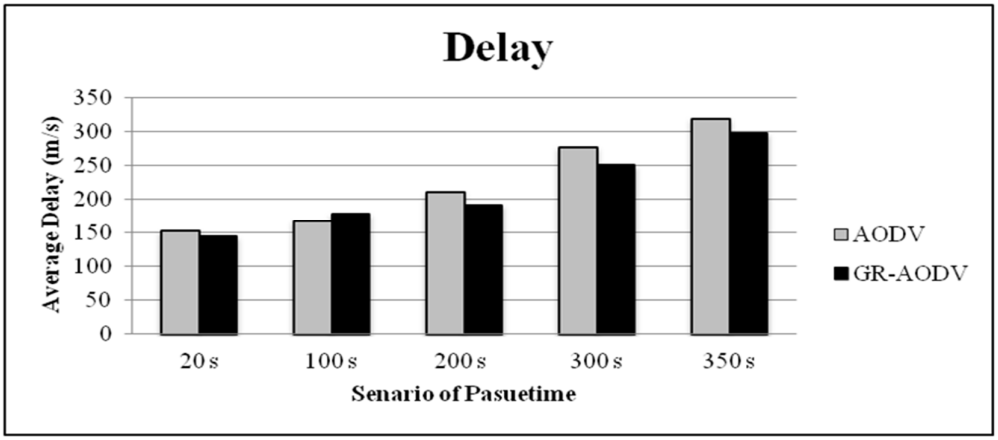


(c)

**Figure 10:** Comparison two AODV and GR-AODV protocols in the nodes scenario with variable aspects of downtime (a) delivery rate (b) throughput, (C) the average delay

## 6. Future work

In this article, GR-AODV protocol is presented that uses greedy idea for optimal routing. It seems that this idea could be implementing based on other routing protocols in wireless sensor networks, including DSDV, DSR and TORA and also provide high-efficient protocols.

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