Comparison of DSR and AODV Routing Ad Hoc Protocols in Robotic Management and Network Communications

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ABSTRACT

One of the most important issues in both network and robotic world is controlling and managing their communication with operators and to each other. Ad hoc networks due to their wireless technology without infrastructure has quick trigger and cost slightness which can work efficiently for this matter. Numerous protocols have been used in this field and in the recent study, two famous Ad hoc network protocols have been simulated for 4 km2 work areas with changes of the same elements in types of robots like speed, pause time, number of nodes, and key parameters that show network optimization rate including PDR, Throughput, and End-To-End Delay by using simulation in GloMoSim software. In this research, output has been calculated every time by making the same chance and then, obtained information was investigated statistically for suitable protocols. In total, AODV protocol was recognized that had higher scores than DSR and could be used as an optimum protocol in robotic industries, technically.

Keywords: *GloMoSim, Ad Hock; AODV, DSR, PDR, MANET.*

1   INTRODUCTION

Today, robotic systems have influenced extremely different aspects of human life and their footprints is visible almost everywhere. Controlling robots or machines is one the most important issues which has been investigated in robotic field. Wireless controlling and robotic communication has great benefits like better maneuverability, lower cost, and faster preparation in different area. Moreover, by using wireless facilities, a network of robots can be acted in performing the given missions as a team and by setting the wireless connection between any of robots to each other, very novel capabilities can be obtained, practically. The robots are often equipped with low-cost, low-power short-range wireless network interfaces, which only permit direct communication with their close neighbors. Therefore, it is practically impossible for each node to know the entire network topology at any given time. Under these situations the only useful approach to distributed command, control and sensing is to employ an ad hoc wireless networking scheme [1], [2].

In the present study, two major ad hoc wireless networking protocols have been studied and compared with each other in a simulation program.

2   LITERATURE SURVEY

A mobile ad hoc network (MANET) is one of the best choices to control robots. In this system a set of wireless nodes or routers coming together to form a network in which every node acts as a router [3]. In fact, any hardware that could identify radio waves and enter the network, it is taken into account as a node. Design of ad hoc networks has been to set fast communications in military and spatial that information exchange and routing between nodes have been focused based on dynamic routing protocols, ad hoc protocols can be classified inside security and searcher protocols, widely [4], [5]. Although mobility has many benefits, it also makes a number of disputes in ad hoc networks. For example, as nodes may be mobile, entering and leaving the network, which makes constant changes of the topology of the network [6]. To eliminate such problems, routing protocols using several mobility metrics have been proposed [3]. One unsolved subject in ad hoc

network is to produce a routing protocol that has almost 100 percent optimal action in all unpredicted work conditions. More than ten ad hoc protocols have been introduced and investigated their performance and capabilities.

2.1 AD Hoc Protocols

In general ad hoc wireless networks, routing protocols could be divided to proactive, reactive, both proactive and reactive, or hierarchical routing protocols. Proactive protocols which are famous as table-driven routing preserves, fresh lists of destinations and their routes by intermittently distributing routing tables throughout the network. These protocols need each node to maintain one or more tables to store routing information, and they reply to changes in network topology by propagating updates throughout the network in order to preserve a consistent network view [7]. In other words, any node has one or several routing tables (including node identifier and paths that lead to the same node) for all nodes in the network; and based on the type of protocol, a number of these tables are different and it has routed according to the same tables. In these such routings, storing the information of a network breadth, is a serious duty for nodes, when topology is mostly changed that are known as Protective Protocols [2], [8]–[11].

The second type of protocols is source-initiated on-demand routing. This type of routing generates routes only when desired by the source node. In fact, operation of discovery of route is only being done when a path is requested from a node toward destination node and only information is stored that is required for real paths. When a node needs a route to a destination, it initiates a route detection procedure within the network. This process is finalized once a route is found or all potential route permutations have been tested. Once a route has been recognized, it is maintained by a route maintenance process until either the destination develops inaccessible along every path from the source or until the route is no longer wanted. These paths are preferred since they can decrease induced cost of a network that are known as reactive protocols [2], [7], [12], [13]. Ad-hoc On-demand Distance Vector routing (AODV) is one of the samples of this type of protocols. In AODV every intermediate node decides where the routed packet should be forwarded next. AODV uses periodic neighbor detection packets in its routing mechanism. At each node, AODV maintains a routing table [14].The Dynamic Source Routing (DSR) protocol is based on the concept of source routing [15]. Mobile nodes are required to maintain route caches that hold the source routes, of which

the mobile is aware. DSR is similar to some other protocols, however, there are a couple of important differences. The greatest notable of these is that the overhead of DSR is potentially larger than that of some of protocols like AODV, since each DSR packet must transmit full routing information, whereas in AODV packets need only hold the destination address [7].

Next class is hybrid protocols that have advantages both of proactive and reactive routing features of both protocols. A few hybrid routing protocols have been made, whereby the routing is first started with some proactive routes and then serves the demand from other nodes through the reactive flooding [3]. In large ad hoc networks, proactive, reactive and hybrid protocols can be used simultaneously [6], [7], [16]–[18]. Zone routing protocol (ZRP) and temporally ordered routing algorithm (TORA) are two typical routing protocols in this class [3].

The last class is hierarchical routing protocols. The network's capability to provide an acceptable level of service to packets even in the existence of a great number of nodes in the network is known as scalability which is one of the major tribulations in ad hoc networking [19]. With this class of protocol the choice of proactive and of reactive routing based on the hierarchic level of an existing node. The routing is principally established with some proactively prospected routes and then services the demand from additionally driven nodes through reactive overflowing on the minor levels. The choice for one or the other technique requires proper ascription for respective levels [19], [20].

3 METHODOLOGY

In the present study, Global Mobile Information System Simulator (GloMoSim) 2.03, which is anetwork protocol simulator software and has been developed by UCLA was used [21]. GloMoSim has the capacity to simulate networks with up to a thousand nodes and supports multicast, multi-hop wireless communications using ad hoc networking, asymmetric communications using direct satellite broadcasts, and traditional Internet protocols [22], [23]. GloMoSim also has support for the random waypoint mobility model. Moreover, tools are provided for generating different types of data traffic [3].

DSR and AODV protocols were simulated using GloMoSim and important parameters of network optimization including, Packet Delivery Ratio (PDR), Throughput, End To End Delay, were calculated based on changes of nodes number, movement speed of nodes, pause time of nodes in

working area of 4 km2 with array of scattering nodes as uniform in work time of 15 min and any diagram of Excel including, work curve of three protocols in the same chance conditions, was drawn, then meaningfulness of outputs difference were investigated by using SPSS 22 software by using one way repeated measures analysis of variance (ANOVA) test [24]. Differences between different protocols were considered significantly different when the P value was less than 0.05.

4   RESULTS

Difference of testing protocols was shown in figures 1 to 9. As it is shown in Figure 1 to 3, for End to End Delay factor, DSR protocol was significantly better than AODV protocol in this regard ($p<0.05$). Increasing pause time also could improve End to End delay of AODV protocol smoothly. By increasing max speed in this simulation test, End to End Delay factor increased drastically for AODV protocol at 20/ms and declined significantly at 30 m/s.

As it is shown in Figure 4 to 6, for PDR factor, AODV protocol had a significantly higher PDR than DSR protocol based on node numbers, pause time and max speed ($p<0.05$). Although increasing speed has a positive effect on PDR factor of the DSR protocol, still it was far behind AODV protocol in this regard ($p<0.05$).
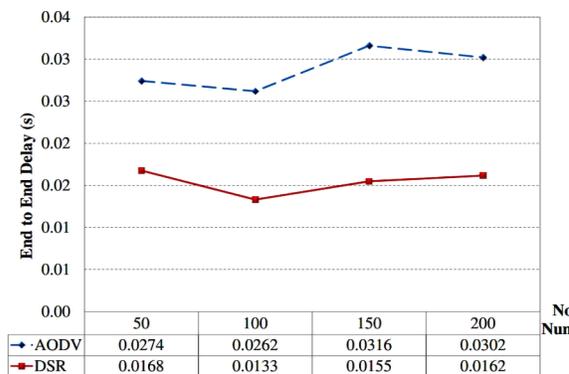

	0	10	20	30
AODV	0.0297	0.0295	0.0279	0.0274
DSR	0.0224	0.0174	0.0173	0.0168

Fig. 2. Comparison of different protocols in End to End Delay based on pause time

	0	10	20	30
AODV	0.0069	0.0274	0.0340	0.0334
DSR	0.0069	0.0168	0.2083	0.0180

Fig. 3. Comparison of different protocols in End to End Delay based on max speed

	50	100	150	200
AODV	0.0274	0.0262	0.0316	0.0302
DSR	0.0168	0.0133	0.0155	0.0162

Fig. 1. Comparison of different protocols in End to End Delay based on node numbers

	50	100	150	200
AODV	0.7644	0.8544	0.9455	0.9577
DSR	0.5077	0.4733	0.5088	0.5566

Fig. 4. Comparison of different protocols in PDR based on node numbers

Fig. 5. Comparison of different protocols in PDR based on pause time

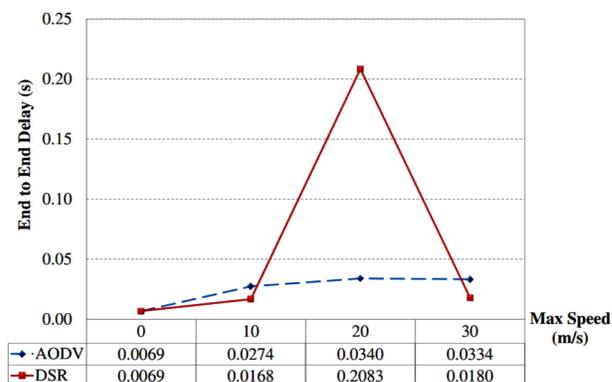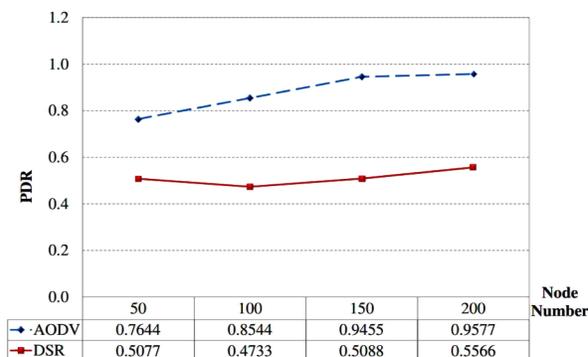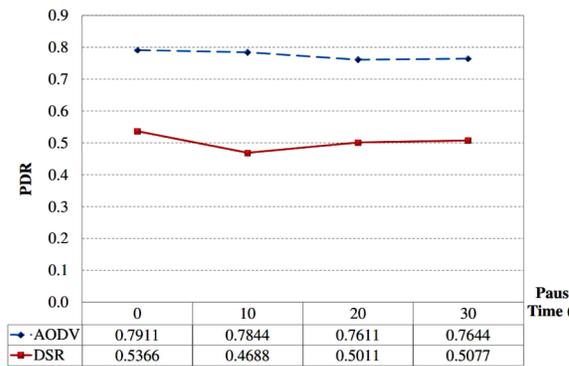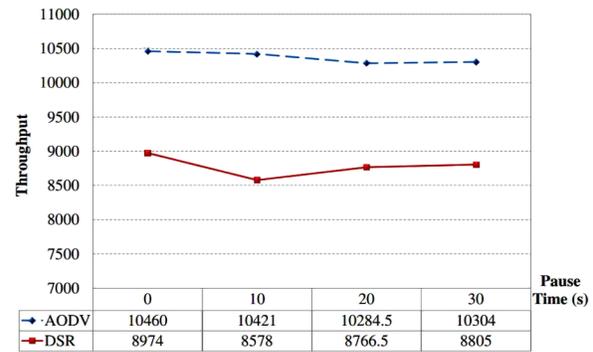|	0	10	20	30
AODV	0.7911	0.7844	0.7611	0.7644
DSR	0.5366	0.4688	0.5011	0.5077

Fig. 6. Comparison of different protocols in PDR based on max speed

	0	10	20	30
AODV	1	0.7644	0.8233	0.8311
DSR	1	0.5077	0.4466	0.5166

Similar to PDR factor, as it is illustrated in Figure 7 to 9, for throughput factor, AODV protocol had a significantly higher throughput than DSR protocol based on node numbers, pause time and max speed ($p<0.05$). Also based on the present study, increasing speed has a minor positive effect on throughput factor of DSR protocol.

	50	100	150	200
AODV	10304	10830	11362	11433
DSR	8805	8604	8811.5	9090.5

Fig. 7. Comparison of different protocols in throughput based on node numbers

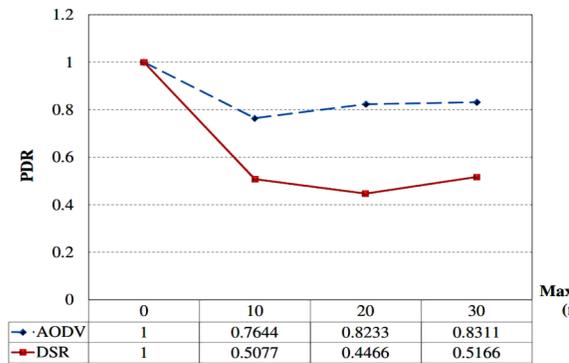*Fig. 8. Comparison of different protocols in throughput based on pause time*

	0	10	20	30
AODV	10460	10421	10284.5	10304
DSR	8974	8578	8766.5	8805

Fig. 9. Comparison of different protocols in throughput based on max speed

	0	10	20	30
AODV	11680	10304	10648	10693.5
DSR	11680	8805	8448.5	8857

As Table 1 shows, End to End Delay rate in sending data in AODV protocol was significantly more than DSR protocols based on the pause time factor ($p<0.05$). Although in first glimpse, End to End delay of AODV protocol was significantly higher than DSR, it has shown better results in both PDR and throughput significantly ($p<0.05$).
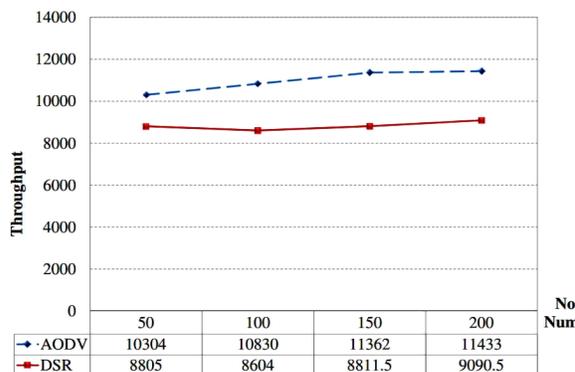
Table 1: Comparison of the mean and standard deviation of different protocols based on key elements of pause time changes on the network nodes.

Factor	Mean±SD	
	AODV	**DSR**
End To End Delay	0.0286±0.0011[a]	0.0185±0.0027[a]
Throughput	10367.3750±86.2935[a]	8780.8750±162.5261[b]
PDR	0.7753±0.0148[a]	0.5036±0.0278[b]

[ab] *Values with the different superscripts in same row are significantly different at $p<0.05$ based on one way ANOVA test.*

As displayed in Table 2, End to End Delay has not shown a meaningful difference between tested protocols. Though in first view, values of DSR were less than AODV, due to high standard deviations, this difference has become meaningless. Both throughput and PDR of AODV protocol showed significantly better outcomes than DSR protocol.

Table 2: Comparison of the mean and standard deviation of different protocols based on the variation of the number of nodes on the main elements of the network

Factor	Mean±SD	
	AODV	**DSR**
End To End Delay	0.0289±0.0025	0.0154±0.0015
Throughput	10982.2500±526.1776 [a]	8827.7500±199.9027 [b]
PDR	0.8805±0.0901 [a]	0.5116±0.0342 [b]

[ab] *Values with the different superscripts in same row are significantly different at $p<0.05$ based on one way ANOVA test.*

As Table 3 illustrates, the effect of changes in node speed on optimization elements of the network did not show a meaningful difference which was due to high fluctuations in tested elements ($p>0.05$). Though a meaningful difference was not seen, like two previous tests, AODV protocol has a better situation in Throughput and PDR, practically ($p<0.05$).

Table 3: Comparison of the mean and standard deviation of different protocols based on key elements of speed changes on the network nodes

Factor	Mean±SD	
	AODV	**DSR**
End To End delay	0.0254±0.0127	0.0625±0.0973
Throughput	10831.3750±591.8684	9447.6250±1499.2836
PDR	0.8547±0.1013	0.6177±0.2567

5   DISCUSSION AND CONCLUSION

End-to-End delay means the average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission as well as containing all possible delays affected during route discovery latency, propagation and transfer times, and retransmission delays at the MAC. Only successfully delivered data packets to destinations would be counted. Therefore, higher end-to-end delay indicates weakness of performance of the protocol due to network congestion. In the present study, DSR protocol showed significantly better performance than AODV protocol which was in line with other studies [25], [26]. Number of nodes in this issue is an important factor and likewise previous studies [6], [26], the present study showed that by increasing the node numbers, AODV had similar results like DSR. Although few studies have shown lower End to End delay of AODV than DSR [25], [27], this difference might be due to number of testing nodes in different studies and overall, it also proves that increasing node numbers lead to decreasing End to End delay. The PDR displays how effective a protocol performs delivering packets from source to destination. It measures the loss rate as seen by transport protocols, and as such, it characterizes both the correctness and efficacy of ad hoc routing protocols [6]. A high packet delivery ratio is desired in any network. The higher in the value gives us better results. The result of the present study was supported with some of previous studies [28], [29]. Throughput is given as the actual amount of data is being transmitted in a given time. Therefore, high throughput gives better performance for protocol. The present study showed not only significantly higher throughput of AODV protocol than DSR which was similar to previous studies [29], [30], but also constant level which is a desirable factor. Even increasing node numbers did not have significantly different positive effect of the DSR protocol. Overall, AODV protocol could be a suitable for wireless robotic systems.

Scalability and throughput are two very important factors for mobile ad-hoc network protocols, as it determines if a protocol will function or fail when the number of mobile users increases and also shows the performance of the ad hoc network [26]. Surely, increasing movement speed of the robot, or in other words, more softness in movement of robot in response to commands in different conditions needs higher speed of the robot processor unit which improve efficiency of the network and help the performance of protocols. Even in this case, by increasing the speed of robot movement consequently network topology will change faster, which might cause errors in robot movement management. Moreover, possible breaking connection links due to robots breakdown by a crash with objects will increase End to End

Delay in sending data, decrease throughput, decrease PDR, and hence increase network scoria and decrease network efficiency. To prevent such crises choosing correct network protocols will be very effective in managing them. Even though, on simulation basis, it was concluded that the AODV routing protocol gives the best performance compare to DSR routing protocol, unfortunately, no one solution fits all criteria of an ideal protocol. Study on both massive number nodes as well as little number nodes with different protocols and new algorithm which can decrease errors and improve the simulation test is recommended.

This paper assessed the performance of AODV and DSR routing protocols for MANET using GloMoSim simulator. Based on the present study, AODV routing protocol recognized with higher scores than DSR for both PDR and throughput and could act better than DSR in MANET or robotic industries, technically.

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