2018 Joint 7th International Conference on Informatics, Electronics & Vision (ICIEV) and
2018 2nd International Conference on Imaging, Vision & Pattern Recognition (icIVPR)

A Study on DSR Routing Protocol in Adhoc Network for Daily Activities of Elderly Living

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***Abstract*—The rate of elderly people and patients is increasing day by day and they are suffering from various diseases and have become paralyzed due to delayed response to their critical health condition. To detect their movement and to monitor their physical condition, various routing protocols are proposed in the wireless sensor body network (WSBN). In this paper, we have proposed a method that uses an algorithm based on Ad hoc routing protocol to optimize the data transfer from source to destination in a wireless network route. This paper contains our experimental analysis of Dynamic Source Routing (DSR) protocol that reflects on its performance in a wireless sensor network. Simulations were done to determine the parameters, end to end delay; throughput and packet delivery ratio pertaining to DSR routing protocol which has been used to compare with two other established, proactive and reactive routing protocols namely AODV and DSDV protocols. The comparative analysis shows that the DSR routing protocol is most efficient with respect to AODV and DSDV routing protocols when detection of activities of daily living in WSBN is concerned.**

Keywords—Wireless Sensor Network; End to End Delay; Throughput; Packet Switching, PDR

I. Introduction

In recent times, fabrication of semiconductor technology and smart algorithms have allowed us to design an applied version of intelligent sensors with cognitive abilities. Recently the increasing rate of elderly people around the world is too high and they experience difficulties in daily living because of chronic diseases or illness. The situation is not going to ease in the foreseeable future. Therefore, smart sensor and IoT based intelligent systems may be incorporated for self-care of the elderly living [1].

To gather data about the elderly living, there are many existing routing protocols are used. Largely the protocols are categorized into proactive and reactive routing strategies. In proactive routing protocols, it establishes paths before it requires, that provides availability of routes whenever they are needed [2]. On the other hand, reactive routing protocols do not maintain routes until they are explicitly requested. Destination-Sequenced Distance-Vector (DSDV), a type of proactive routing, is a table-driven routing protocol where each entry in in the table has a specified sequence number. This protocols suffer from higher latency due to topological change. To mitigate the problem, instantaneous variation of the IoT sensors follow reactive routing protocols.

Since IoT devices for collecting data on daily activities from the elderly living and that are dependent on the sudden variation of their health condition, reactive routing protocols are effective to route packets from elderly patients to the sink. In Adhoc On-Demand Distance Vector (AODV), a type of reactive routing protocol, is designed for wireless sensor and IoT networks that establishes routes to destinations on demand basis. It also supports both unicast and multicast routing. However, in Dynamic Source Routing (DSR), another kind of reactive routing protocol, routing table at each intermediate device or node is not dependent on it [3, 4, 5].

Activities of daily living (ADL) refers to those activities which are normally done by a human on an everyday scale that triggers certain stimuli and response within the body that can be detected through various sensors, IoT devices and can be parameterized to identify the physical state and health of the human (target) under observation [3]. In this paper, we have studied different routing protocols to collect activities of daily living. The key contributions of the paper are summarized as follows:

- We develop a testbed consisting IoT devices for collecting sensing data to the sink
- We have compared the network performances among the protocols including proactive and reactive strategies.

The remainder of the paper is organized as follows. Section 2 contains a study on the state-of-the-art works and an explicit insight into the methodology is presented in Section 3. The simulation and testbed implementation is developed to investigate the average end-to-end delay, throughput in Section 4. The Section 5 discusses on the performance evaluation results and finally, we conclude the paper in Section 6.

II. Related Works

In the literature, we have found a good number of routing strategies for WSBN that are used in most of the hospitals to monitor the activities of elderly living people. It is investigated

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that doctors fail to recognize and identify the sudden movement of patients due to periodic nursing. Therefore, instantaneous monitoring and control of patient is challenging for the right action by the doctors.

Moreover, it is to investigate that which routing protocol is appropriate for patient monitoring is a critical issue now a days. Though AODV is one of the most important protocols for routing systems, it exhibits higher latency [3]. On the other hand DSR routing protocols requires lower delay than AODV. In DSDV, routing paths are created previously before data are transmitted.

Therefore, we have compared these routing protocols to investigate the suitability of the protocols to monitor daily activities of elderly living. Sensors are used to transmit data from human body to the router [6,7,8]. Recent systems of transmitting data are not that much effective so we have identified the appropriate protocol to optimize network performances for monitoring activities of elderly living [9, 10].

Motivated by the above challenges to monitor the daily activities of elderly living, in this paper, we have studied the network performances among the routing protocols and investigated efficient routing protocol for monitoring activities of elderly living. What we unfold in the next section is the detail methodology of the work.

III. Methodology

The detection, monitoring and surveillance of the physical condition and state of elderly people and patients in an efficient way is a challenging issue. With the aim of solving this problem, we have studied various networking protocols and systems. After conducting considerable research on the matter, we came across DSR routing protocol. Theoretically, we found it to be the most efficient and effective out of all the protocols. Then we wanted to find the effectiveness of this protocol experimentally by creating a virtual environment corresponding to that of elderly people and patients. So, we used Network Simulator 2 (NS2) for this purpose. So, we emulated the scenario of patients and elderly people in the NS2 environment and used an Ad hoc network based routing protocol namely DSR routing protocol to determine important parameters relating to the performance analysis of the protocol. In addition to that, we used several calculation techniques in our algorithm to characterize the communication within the wireless network framework used. For analysis purpose, we tried different spatial arrangements and fragmentations, we used various packet sizes, time intervals and modes of data transfer in NS2. Afterward, we made an extensive analysis of PDR, end to end delay and throughput for different criteria mentioned. Finally, we observed and noted the packet switching of data due to change in location of the patient (target) or due to any dislocation of the body sensor. We obtained numerous parameters and were able to successfully characterize the networking protocol [11, 12, 13].

The formula we have used to calculate the average end to end delay during data packet transmission is as follows:

$$aed = \frac{1}{N}\sum_{n=1}^{N}(T_{rn} - T_{sn}) \qquad (1)$$

where, *aed* is the average end to end delay, N is the number of data packets received, T_{rn} is the time at which n^{th} data packet is received and T_{sn} is the time at which nth data packet is sent.

The formula used for determining average throughput is as follows:

$$th = \frac{1}{N}\sum_{n=1}^{N}(P_n * 8)/T_n, \qquad (2)$$

where, *th* is the average throughput, N is the number of data packets transmission, P_n is the data packet size during nth transmission and T_n is the total time required to complete nth transmission [14].

The formula used to find out packet delivery ratio (PDR) is as follows:

$$PDR = \frac{N_{rn}}{N_{sn}} * 100, \qquad (3)$$

where, *PDR* is the packet delivery ratio in percentage (%), N_{rn} is the number of data packets received during nth data packet transmission and N_{sn} is the number of data packets sent during nth data packet transmission [15].

The method proposed to simulate the environment and analyze the parameters mentioned is shown in Figure 1.

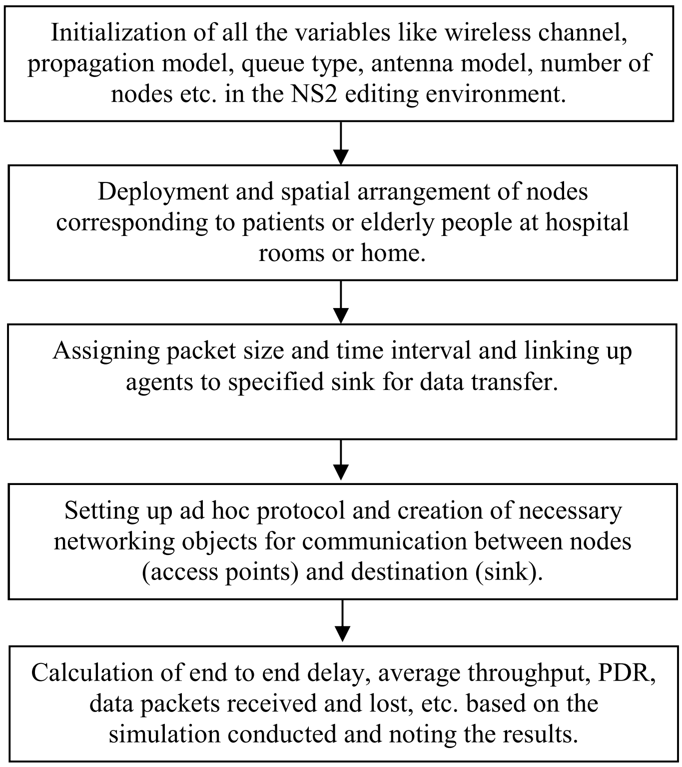

Figure 1. Flowchart of the proposed method for simulation in NS2.

IV. Simulation Model and Implementation

We have successfully used NS2 (NS 2.35 precisely) to create a virtual environment identical to our target networking. Architecture for detection of the physical condition of the patients. In this environment, we have deployed nodes corresponding to the patients, a sink corresponding to the access point or server [16]. We have grouped a number of nodes under one server to represent the scenario of patients within a room. The program consisting of the commands that drive the simulation has been written to get the networking characterizations and results from the virtual environment [17]. The algorithm we have implemented gives us the accurate output of packet switching. In addition to that, the algorithm provides us with an optimized route for data transfer from source to access point. Finally, using the mentioned algorithm we have determined the packet loss, end to end delay, throughput, etc. For our proposed algorithm, we have used Ad hoc routing protocol that has yielded us with satisfactory results [18].

The simulation parameters that were specified in the program code is shown in Table 1. Evidently, we have selected IEEE802.15.4g MAC layer and shadowing propagation model as it is similar to the specifications required for Ad hoc network.

TABLE I. SPECIFICATION OF SIMULATION PARAMETERS

Parameter	Value
Channel Type	Channel/WirelessChannel
Propagation Model	Propagation/Shadowing
Network Interface Type	Phy/WirelessPhy/802_15_4
MAC Type	Mac/802_15_4
Interface Queue Type	CMUPriQueue
Link Layer Model	LL
Antenna Model	Antenna/OmniAntenna
Max Number of Queue	500
Number of Nodes	30
Routing Protocol	DSR, DSDV, AODV
Traffic Type	CBR

In order to implement the scenario of activities of daily living (ADL) detection and monitoring of patients and elderly people, we have used a wireless network in 3 groups of 10 nodes emulating a hospital or nursing home. The nodes resemble patients. The nodes were defined to have mobility or speed so that they can move from one room or area to another room or area. Each room consists of a sink which is the destination for all the nodes within the room concerned. Upon entering a new room, the nodes are able to transmit data to the new sink and thus enable monitoring of their activities even outside their assigned rooms.

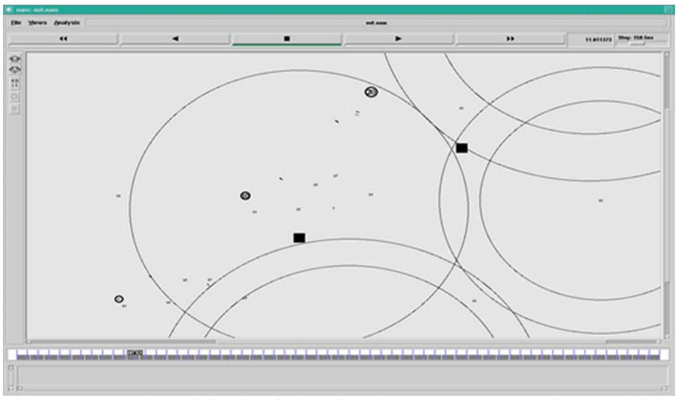

Figure 2. A portion of the simulation showing agents (access points) and sinks (large circles) with data packet transfer (dots) and data packet loss (squares) along with acknowledgment calls (loci) at 11.01s after starting the simulation.

The mobility of nodes makes the simulation more relatable to the practical application. The simulation provides a comprehensive picture for the body sensors to interact with the sink and body movements of the patients or elderly people. We have used 3 rooms to depict the scenario in hospitals. But in reality, more rooms can be used in the same way to have more accurate analysis and results [19]. Figure 2 manifests a portion of the simulation during 11.01s from the start in Network Animator (NAM). The nodes within the environment have been moving continuously and transmitting data to the sink.

V. EXPERIMENTAL RESULTS AND ANALYSIS

A number of experiments have been conducted using the NS2 environment as the sole platform for accumulating data on different situations and criteria. The experimental data will be manifested in this section and their interpretation will be made analytically.

A. Experimental Results of End to end Delay for varying Time Interval

The time interval between successive transmissions of data packets was varied from 0.1ms to 1ms. The end to end delay in milliseconds (ms) were obtained for DSR, DSDV and AODV routing protocols. Figure 3 shows the result of this experiment.

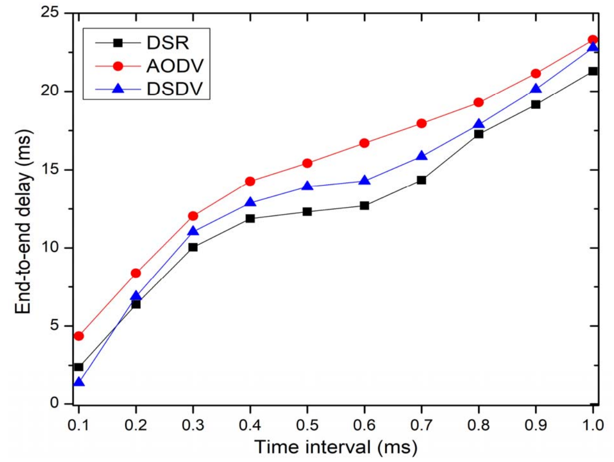

Figure 3. Effects on end-to-end delay for varying time interval

From Figure 3, we see that the end to end delay of each routing protocol shows a general increasing trend or rise with the increasing time interval. It is clearly evident from the figure that with the increasing time interval, the end to end delay is maximum for AODV protocol, is moderate for DSDV protocol and is minimum for DSR protocol. So, DSR routing protocol shows the best result as the end to end delay is minimum at any instant within the scope of chosen time interval.

B. Experimental Results of Average Throughput for varying Time Interval

The time interval between successive transmissions of data packets was varied from 0.1ms to 1ms. Then average throughput in kilobits per second was obtained for DSR, DSDV and AOD routing protocols. Figure 4 shows the result of this experiment.

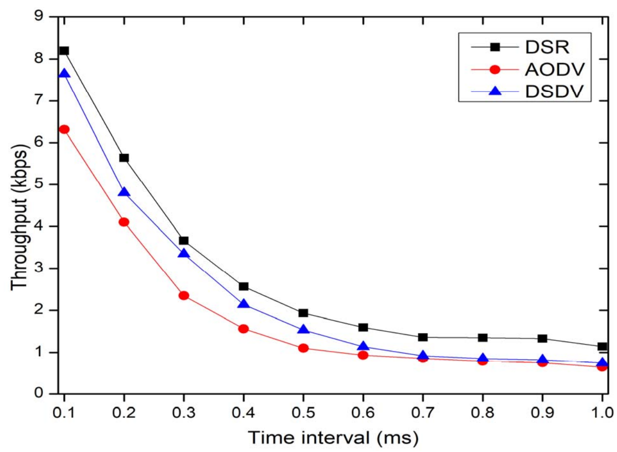

Figure 4. Effects on throughput for varying time interval

From Figure 4, we see that the average throughput of each routing protocol shows a general decreasing trend or fall with the increasing time interval. It is clearly evident from the figure that with the increasing time interval, the average throughput is minimum for AODV protocol, is moderate for DSDV protocol and is maximum for DSR protocol. Hence, DSR routing protocol shows the best result as the average throughput is maximum at any instant within the scope of chosen time interval.

C. Experimental Results of End to end Delay for varying Packet Size

The packet size of data to be transmitted was varied from 10 byte to 100 byte. The end to end delay in milliseconds (ms) were obtained for DSR, DSDV and AODV routing protocols. Figure 5 shows the result of this experiment.

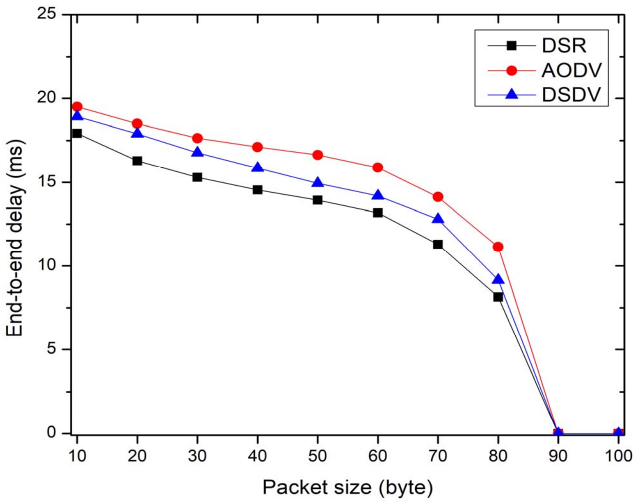

Figure 5. Effects on end-to-end delay for varying packet sizes

From Figure 5, we see that the end to end delay of each routing protocol shows a general decreasing trend or fall with the increasing packet size. It is clearly evident from the figure that with the increasing packet size, the end to end delay is maximum for AODV protocol, is moderate for DSDV protocol and is minimum for DSR protocol. Therefore, DSR routing protocol shows the best result as the average throughput is maximum at any measure within the scope of chosen packet size.

D. Experimental Results of Average Throughput for varying Packet Size

The packet size of data to be transmitted was changed from 10 byte to 100 byte. Then average throughput in kilobits per second was obtained for DSR, DSDV and AODV routing protocols. Figure 6 shows the result of this experiment.

From Figure 6, we see that the average throughput of each routing protocol shows a general increasing trend or rise with the increasing packet size. It is clearly evident from the figure that with the increasing packet size, the average throughput is minimum for AODV protocol, is moderate for DSDV protocol and is maximum for DSR protocol. Henceforth, DSR routing protocol shows the best result as the average throughput is maximum at any measure within the scope of chosen packet size.

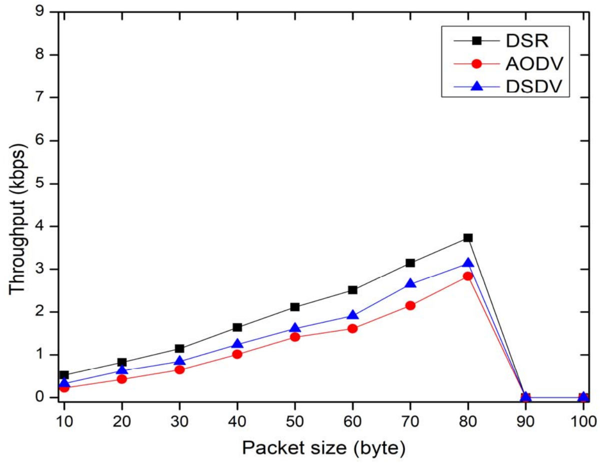

Figure 6. Effects on throughput for varying packet sizes

E. Experimental Results for PDR for varying Time Interval

The results of packet delivery ratio, PDR (in percentage) of DSR, AODV and DSDV routing protocols for varying time interval were obtained in this experiment. Table II outlines the results of this experiment.

TABLE II. PDR RESULTS FOR VARYING TIME INTERVAL

Interval (ms)	DSR	DSDV	AODV
0.1	38.28%	36.35%	34.75%
0.2	35.08%	34.12%	32.43%
0.3	33.32%	32.54%	31.95%
0.4	30.74%	29.31%	27.64%
0.5	27.97%	25.73%	23.11%
0.6	26.39%	22.40%	21.25%
0.7	25.37%	21.84%	20.96%
0.8	24.81%	20.62%	17.97%
0.9	22.22%	18.16%	17.29%
1	20.12%	17.83%	15.66%

Table II shows us that generally the PDR has been found to decrease with the increase in time interval. Now if we observe the values it becomes clear that at any instant of time interval chosen, the PDR is maximum for DSR protocol and is minimum for AODV routing protocol. The PDR is moderate for DSDV protocol. So, in terms of PDR, DSR protocol shows the best result while AODV shows the worst result.

F. Experimental Results for PDR for varying Packet Size

The results of packet delivery ratio, PDR (in percentage) of DSR, AODV and DSDV routing protocols for packet size were obtained in this experiment. Table III outlines the results of this experiment.

Table III shows us that generally the PDR has been found to increase with the increase in packet size. Now if we observe the values it becomes clear that at any measure of packet size chosen, the PDR is maximum for DSR protocol and is minimum for AODV routing protocol. The PDR is moderate for DSDV protocol.

TABLE III. PDR RESULTS FOR VARYING PACKET SIZES

Packet size (Byte)	DSR	DSDV	AODV
10	25.45%	21.65%	20.29%
20	27.88%	24.43%	21.66%
30	29.29%	25.72%	21.45%
40	32.32%	29.18%	23.98%
50	32.32%	30.04%	25.65%
60	33.54%	31.23%	28.38%
70	37.37%	33.55%	29.16%
80	49.70%	35.05%	30.81%
90	0.00%	0.00%	0.00%
100	0.00%	0.00%	0.00%

Hence, in terms of PDR, DSR protocol shows the best result while AODV shows the worst result. Furthermore, when the packet size is 90 byte and 100 byte the PDR is found to be 0.00% for all the protocols. This occurred due to the fact that 90 byte and 100 byte are very large packet sizes for the network and nodes to handle and transmit. So, although the data packets are generated by the target nodes, they are never received by the sink or receiver nodes as they are never able to be transmitted.

It is evident from tables that DSR routing protocol outperforms AODV and DSDV protocols in terms of end to end delay, average throughput and PDR. Hence, it is experimentally verified that DSR routing protocol has the best attributes in terms of performance analysis in comparison to DSDV and AODV routing protocols.

VI. CONCLUSION AND FUTURE WORK

This work investigated the suitability of routing protocols to monitor the activities of elderly living real time basis so that end-to-end data delivery delay is reduced, network throughput is increased. The IoT devices on the patient's body route data over DSR protocol significantly outperforms to provide the network performances for all experimental results. The scalability of DSR protocol is determined for varying packet size and the number of intervals during data transmission to the sink. Comparing the performance issues among energy aware protocols such as LEACH, LABILE, REL will be an interesting research problem for future work.

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