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Optimized Dynamic Source Routing in Mobile Wireless Sensor Network in Healthcare

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Abstract: **Mobility is the major area of research in Wireless Sensor Network. Due to frequent changes in network topology the mobility has a big challenges to choose the routing in wireless sensor network. In order to improve routing in mobile wireless sensor network an optimized dynamic source routing (ODSR) protocol has been proposed in this work. ODSR uses Particle Swarm Optimization technique to select the optimal route based on average delay for data transmission. ODSR considers QoS parameter during route selection. The objective of this proposed work is to transmit data between sources and sink efficiently with increased throughput and reduced delay and packet loss. Several performance metrics have been considered to analyze the performance of proposed protocol in different mobile scenario such as average delay, packet loss and throughput. Simulation has been done by using the NS2 simulator and the obtain results have a better agreement in term of average delay, packet loss and throughput in a mobile scenario as compared to DSR.**

Keywords: **Mobile Wireless Sensor Network (MWSN), DSR, ODSR, PSO.**

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I. INTRODUCTION

Wireless Sensor Network comprises of a large number of randomly distributed autonomous small devices called nodes used to sense and collect physical or environmental condition like temperature, heat, pressure and health parameter etc. [1]. The collected data is transferred to a base station or sink node where it is analyzed. WSNs are resource constraints because of small size, limited memory size, limited energy, processing and computation capability and hardware constraints [2]. Traditional WSN consists of static nodes. Critical applications like healthcare, military, transportation system require mobility in Wireless Sensor Network [3]. Mobility of nodes in wireless sensor network can enhance network lifetime because data transfer between two nodes do not use the same set of relay nodes. Mobility can also address latency and delay problems. It can also improve connectivity between nodes as mobile node can allow communication between two isolated nodes. It also helps to improve the coverage area of interest.

Mobile Wireless Sensor Network has been chosen as an area of research because it is the major issue in the next generation of networks. Mobile support is essential in healthcare to improve fault tolerance capacity of the network and provide full access to the information irrespective of location of the patient. In healthcare monitoring of vital signs like heart rate, blood pressure, ECG of patients under treatment in hospitals is desired [4]. Mobility allows patients to go for a walk in the corridor while being monitored. Monitoring allows patients to change their rooms for tests without losing continuous monitoring.

Mobility of nodes in Wireless Sensor Network challenges routing of data due to dynamic change in topology, quality of service, security and resource management [5]. Issues occur in Wireless sensor network due to mobility are the following:

- Mobility of nodes leads to frequent route changes which in turn increase the packet delivery delay.
- Due to the mobile nodes route failure occurs which increases the overhead of initiating route discovery mechanism again and again.
- Mobility leads to deterioration in the quality of establish links, data transmission is prone to failure and therefore the rate of data retransmission increases [6].

The performance of routing protocol majorly affects by the mobility. Original Dynamic Source routing Protocol (DSR) can be used in the mobile wireless sensor network to minimize the effects which are responsible to reduce the performance. DSR discovers the route to the destination by initiating route discovery [7]. Source Node caches multiple routes to the destination ordered by hop count. DSR selects routes with minimal number of hops for data transmission [8]. But route with minimal hop does not mean the best route because shortest route used frequently and leads to congestion in the network. Hence, there is no Doubt that DSR does not consider Quality of Service (QoS) [9].

In this paper the optimized Dynamic Source Routing Protocol has been proposed to improve the routing in mobile wireless sensor network. ODSR uses Particle Swarm Optimization to select best optimal path based on average delay among multiple routes discovered during route discovery mechanism to transfer data to the destination. The routing problem can be formulated as multidimensional optimization problem where there is need to reduce delay, packet loss and improve throughput. The objective of the proposed work is to transfer

data efficiently to the sink with minimum delay, packet loss and increased throughput.

Work presented in this paper is organized as follows. Section 2 reviews the background of existing routing protocols in WSN. Section 3 depicts the proposed work in detail including the methodologies used. Section 4 describes Simulation environment and result analysis. Finally, Conclusion and future scope is presented in Section 5.

II. RELATED WORK

T. Vairam et. al[10] proposes CBMR-PSO routing algorithm which uses bio inspired algorithm such as Particle swarm optimization to enhance the performance of multiple path routing in WSN. Routes are discovered using CBMR routing protocol and discovered paths are optimized using PSO.

D. Antony Arul Raj and P. Sumathi [11] discusses the use of cuckoo search algorithm to propose energy efficient multipath routing protocol. EEMRP extends AOMDV using cuckoo search.

Aliabadi et. al [12] improves quality of routing algorithm by using Genetic algorithm and fuzzy algorithms in DSR. GA-DSR routing algorithm is proposed and improvement in term of QoS is done using Genetic and fuzzy algorithm.

Deshmukh et. al [13] evaluates performance metrics using DSR,DSDV and ZRP routing Protocols. The evaluated results are optimized using bio inspired algorithm such as particle Swarm optimization and Ant Colony Optimization.

Varshney et. al [14] describes an optimized method to detect misbehaving nodes in the ad hoc network and find an optimal path between source and destination. DSR is used to find optimal path and followed by Genetic algorithm to detect misbehaving nodes.. Ant colony optimization is used to double ensure that selected path is optimal path.

Kumar et. al [15] discusses the use of Genetic algorithm to find shortest and optimal path . The path obtained using GA is consistent in spite of change in link or network.

III. OPTIMIZED DYNAMIC SOURCE ROUTING

Optimized Dynamic Source Routing (ODSR) extends the dynamic source routing protocol and particle swarm optimization algorithm. The ODSR is simple, efficient and on-demand routing protocol which is designed for mobile wireless sensor network, also ODSR allows for multiple hop communication between nodes that are not within transmission range. In mobile the WSN network topology changes frequently, therefore the route which is having the sequence of intermediate hops required to reach destinations which can change at any time. Across multiple hops the ODSR allows to find out the source route to the destination by the nodes dynamically. The each ordered data packet carries having a header which is forwarded through the nodes. Therefor by including the source route in the header of each data packet, the other nodes, which are forwarding or overhearing of these data packets can also cache this routing information for future use. There is no periodic exchange of data packets occurs in ODSR protocol. The Single Route Discovery mechanism allows of a node to cache multiple routes for any destination because the caching of multiple routes of a node is useful to find out another route if one route fail. The ODSR protocol is based on three mechanisms that work together to allow the discovery, optimization and maintenance of source routes.

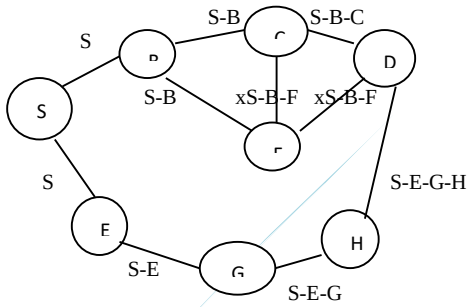


Fig 3.1: Broadcast Route Request

× Route Request Dropped

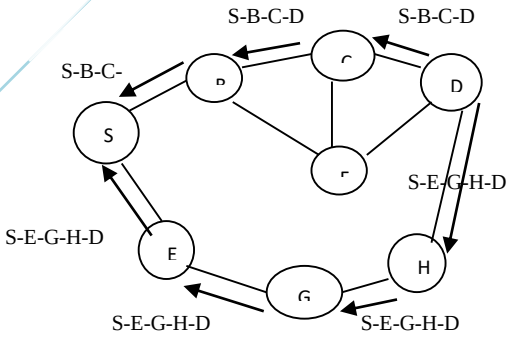
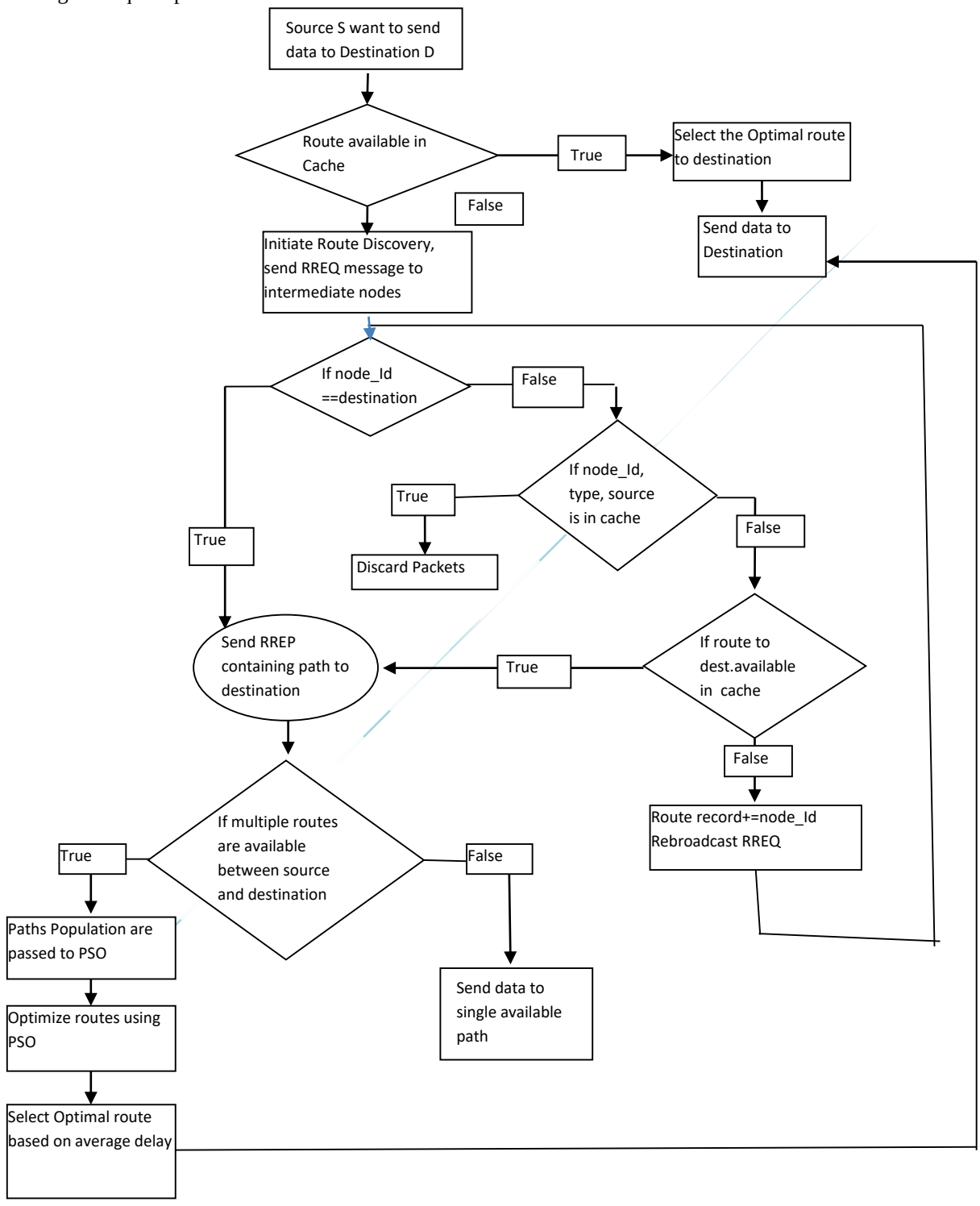


Fig 3.2: Send Route Reply

Discovery of Multiple Routes- When a source S sends the data to destination D, so a source route will be appear as a header of the data packet, which indicates the sequence of hops and packet should follow its way to reach the destination **D**. By searching the Route Cache **S** can obtain the source route of the destination, if there is no route found in the cache, then it will start the Route Discovery mechanism to discover a route of **D**. Each RREQ data packet contains the source and destination information with unique request id, which is very helpful to determine the source of the RREQ. Similarly each RREQ contains the address of each intermediate node because the data packet will forward through the intermediate node only. When a RREQ reaches to intermediate node, then it will checks repetition of RREQ message from the source which is having same request id, if repetition is found in the route record then it will discard the RREQ. Otherwise, this node adds its own address to the route record of the RREQ message and rebroadcast it to its intermediate neighbor's nodes with the same request id. If receiving node is the destination of the Route Discovery, RREP message containing copy of route

record is returned to the source node. Source node on receiving these RREP, store these multiple routes in its Cache for transmitting subsequent packets to this destination.



Flow chart of ODSR routing protocol is shown in fig-3.3

Optimization using PSO- Single route discovery process of ODSR results in multiple routes between source and destination. Objective is to improve routing in WSN by using PSO to select optimal route based on average delay for data transfer. Population of multiple paths discovered is passed to PSO. PSO comprises of swarm particle, where each node in a

path signifies a particle. Fitness value of each particle is evaluated based on average delay.

$$v_i(t+1) = \omega v_i(t) + c_1 r_1[pBest_i - x_i(t)] + c_2 r_2[gBest_i - x_i(t)] \quad (1)$$

$$x_i(t+1) = x_i(t) + v_i(t+1) \quad (2)$$

Where c1 and c2 are constants, and r1 and r2 are random numbers uniformly distributed between 0 and 1, pBest is personal best, gBest is global best, ω is weight. In each iteration l, velocity *v*, and position *x* are updated using Eqs. 1 and 2. pBest indicates best fitness value a particle achieved so far and gBest is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population. If f(pBest)>f(gBest) then, gBest is updated using pBest. The update process is iteratively repeated until an acceptable global best (gBest) indicating optimal path is achieved.

Route Maintenance- Source node is able to detect the data packets but it cannot use longer to route for D because route can be broken due to topology change. When any neighboring node is found disconnected where the data can be send, then immediately an error message RERR will generate send to route source node. After receiving this error message the source node deletes all the routes as invalid link from the cache, and starts a new route discovery process

IV. SIMULATION AND RESULT ANALYSIS

4.1 Simulation Scenario

The simulation of proposed protocol (ODSR) is performed in NS2.35. NS2 is an open source discrete event simulator written using C++ and OTcl scripting language. The simulation network consists of 50 mobile nodes randomly scattered in 670x670m area at the starting time of the simulation. Nodes communicate with one another and exchange of data packets takes place. To provide efficient routing in mobile scenario Optimized Dynamic Source Routing protocol is used. For the performance analysis of ODSR in mobile wireless sensor network we have created different mobility scenarios. For each mobility scenario, during Simulation, different movement and communication pattern files are given as inputs. The movement scenario files are created using setdest program installed in NS simulator. The result of the simulation is a trace file which is used to calculate average delay, packet loss and throughput using awk script. The performance of Proposed Protocol is analyzed and compared to original DSR protocol in different mobile scenarios using performance metrics like average delay, packet loss and throughput. Different Mobility scenarios used during Simulation are:

Scenario1-In Scenario 1 movement scenario file named scen-670x670-50-600-20-0 is used where 670x670 is the size of simulation area, number of mobile nodes are 50 roaming with maximum speed 20m/s and pause time is 600 seconds. Communication pattern file named cbr-50-10-4-512 is used to enable cbr communication among the 50 mobile nodes with maximum 10 connections, transmission rate of 4 packets per second, number of sources are 6 and packet size is 512.

Scenario 2 -In this scenario movement scenario file named scen-670x670-50-600-20-1 where 670x670 is the size of simulation scen, number of mobile nodes are 50 roaming with maximum speed 20m/s and pause time is 600 seconds. Communication pattern file named cbr-50-10-4-512 is used to enable cbr communication among the 50 mobile nodes with maximum 10 connections, transmission rate of 4 packets per second, number of sources are 6 and packet size is 512

Scenario 3-In this Scenario movement scenario file named scen-670x670-50-600-20-0 is used where 670x670 is the size of simulation area, number of mobile nodes are 50 roaming with maximum speed 20m/s and pause time is 600 seconds. Communication pattern file named cbr-50-20-4-512 is used to enable cbr communication among the 50 mobile nodes with maximum 20 connections, transmission rate is 4 packets per second, number of sources are 14 and packet size is 512.

Scenario 4- In this scenario movement scenario file named scen-670x670-50-600-20-1 is used where 670x670 is the size of simulation area, number of mobile nodes are 50 roaming with maximum speed 20m/s and pause time is 600 seconds. Communication pattern file named cbr-50-20-4-512 is used to enable cbr communication among the 50 mobile nodes with maximum 20 connections, transmission rate is 4 packets per second, number of sources are 14 and packet size is 512.

Table 1: Simulation Parameters

Parameter	Value
Simulation Area	670X670
Number of nodes	50
Simulation Time	1000
MAC Type	IEEE 802.11
Propagation Model	Two Ray Ground
Channel Type	Wireless
Network Interface Queue Type	CMUPriQueue
Traffic Pattern	CBR/UDP
Antenna	Omni Directional Antenna
Mobility Model	Random Way point
Number of Mobility Scenario	4

3.2 Performance Metrics

Packet Loss- measures the number of packets that are not successfully transmitted to their destination**.** Packet Loss=Packet Sent-Packet Received

Throughput-measures number of packets transmitted in a given amount of time. Throughput is measured in bits per second (bps), megabits per second (Mbps).

Average Delay-measures amount of time a bit of data takes to travel across the network from one node or endpoint to another. It is measured in multiples or fractions of seconds

3.3 Result Analysis

1) Throughput –Figure 4.3 shows the comparison of throughput between ODSR and DSR in mobility scenario. According to simulation results, throughput of ODSR is high as compared to DSR because optimal route having less congestion is used to transfer data to the destination. Therefore, packet drop in ODSR is less and more number of data packets can be transferred per unit of time than DSR.

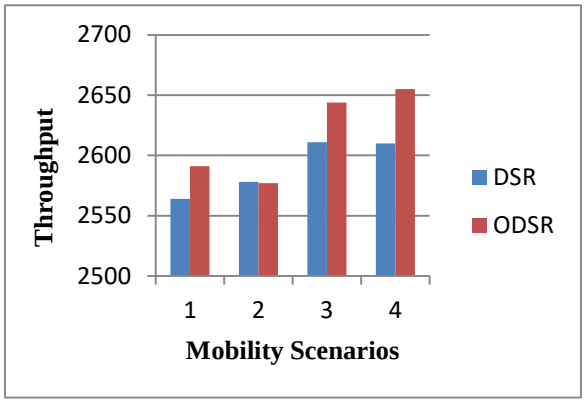


Fig 4.1: Comparison of throughput in mobility scenarios

2) Packet Loss -Figure 4.4 shows the comparison of packet loss between ODSR and DSR in mobility scenarios. According to following graph it is observed that the packet loss in ODSR is less as compares to DSR in mobile scenarios because the optimal route having less congestion is used to transfer the packets to intended destination, therefore, more number of packets are transfer safely results in reduction in the number of packet loss in ODSR.

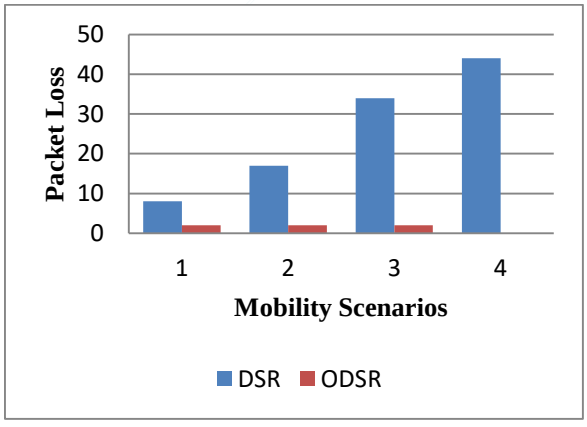


Fig 4.2: Comparison of Packet Loss in mobility scenarios

3) Average Delay-The following figure 4.5 shows the comparison of average delay between ODSR and DSR. The average delay occurs in order to transfer packets to the intended destination in ODSR is less as compares to DSR in different mobility scenarios because optimal path having less average delay is used to transfer data to destination

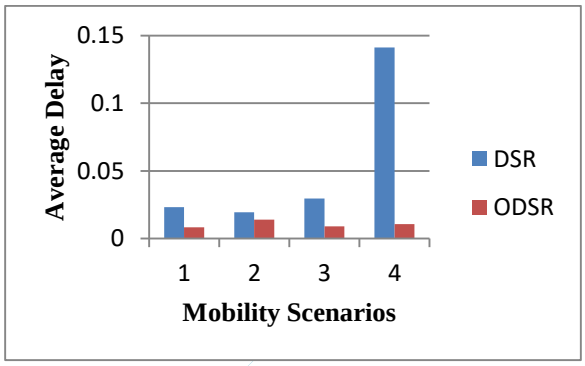


Fig 4.3: Comparison of average delay in mobility scenario

V. CONCLUSION AND FUTURE SCOPE

In this paper, routing in Mobile Wireless Sensor Network is improved by introducing Particle Swarm Optimization in original Dynamic Source Routing. We have proposed ODSR which uses PSO to select optimal route based on average delay among multiple discovered routes to transfer data to destination. ODSR considers QoS during route selection which is not considered by DSR. Simulation of the proposed protocol is analyzed and compared with DSR in different mobile scenarios using various performance metrics like packet loss, average delay and throughput. Simulation results show that ODSR improves packet loss, average delay and throughput as compares to original DSR. In future, we can use swarm optimization technique like Particle Swarm optimization or ant colony optimization to select optimal path considering residual energy of nodes to transfer data from source to destination.

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