

An Efficient Ant Optimized Multipath Routing In Wireless Sensor Network

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ABSTRACT

Today, the Wireless Sensor Network is increasingly gaining popularity and importance. It is the more interesting and stimulating area of research. Now, the WSN is applied in object tracking and environmental monitoring applications. This paper presents the self-optimized model of multipath routing algorithm for WSN which considers definite parameters like delay, throughput level and loss and generates the outcomes that maximizes data throughput rate and minimizes delay and loss. This algorithm is based on ANT optimization technique that will bring out an optimal and organized route for WSN and is also to avoid congestion in WSN, the algorithm incorporate multipath capability..

General Terms

Social Network

Keywords

Ant Colony, Network Animator, Wireless Sensor Network

1. INTRODUCTION

Wireless Sensor Network is made up of sensor nodes that carry sensors, processors that can be idle, active and sleep, memory that is used for program code and buffering, transceiver and power source battery. In sensor network, the processor converts the sensed information into digital form and transmitted by transceiver to the sink node either directly or by forming a sensor node network. WSN comprises of sensor nodes that forms self-configuring network communicating among themselves using radio signals. WSN sensors are deployed to monitor and understand the physical world. The limitation of WSN arises due to its power battery which are non-rechargeable and more energy is wasted due to collision, idle listening and over emitting. Therefore, a need for developing an efficient energy utilization WSN arises. Wireless Sensor Network can be of two types homogeneous or heterogeneous. Nodes are alike w.r.t battery energy and hardware complexity in homogeneous WSN. In contrast to, homogeneous WSN, heterogeneous sensor network consists

of two or more types of nodes with different battery power and functionality. The sensor due to their very small size, tend to have storage space, energy supply and communication and width so limited that every possible means of reducing the usage of these resources is aggressively required [1].

Sensor nodes are responsible for self-organizing an appropriate network infrastructure, with multi-hop connections between sensor nodes while the capability of individual sensor node is limited. From WSN, the users can retrieve information by executing the query and obtain the result from a base station or sink node. For this reason, the WSN can be considered as distributed database.

Dorigo et al [2] proposed the first ant colony algorithms for solving combinatorial problems. Later on, this algorithm is known for meta-heuristic algorithm. ACO algorithm is based on the behavior of real ants. There are two types of ants applied in the algorithms, forward ants and backward ants. Relating to a real scenario where ant find food pheromone while moving on the way to their nests some ants find food deposit pheromones and the other ants follow these pheromones deposited earlier by other ants. On a period of time when food pheromone evaporates, they cooperate to find new possibilities to choose a shortest path that lead them to a heavily laid pheromone, thus covering shortest path from their nest to the food just on the basis of pheromone information. In this way, ants converge to shortest path from their nest to a food source with only pheromone information [3]. Therefore, on the basis of this technique our algorithm works for WSN.

2. PROPOSED WORK

To simulate the scenario of self-optimized multipath algorithm we have used network simulator 2 (NS2) with C++ and OTcl programming languages based on the network topology where 4 wireless sensor nodes were arranged onto 50 x 50 m² grid as shown in Fig 1.

Here we considered each link to be bidirectional and the link's weighting value depends on the power consumption (nJ/bit), packet reception rate (PRR) and ant's moving time delay (ms). The average probability

are used to choose destination nodes randomly, after the artificial ants are produced by source nodes in quantity. In the simulation a fixed packet size is assumed.

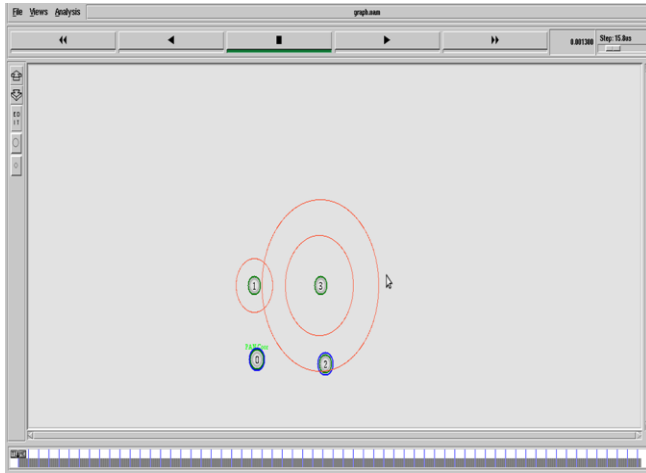


Fig 1: Graphical representation of Network Topology

In an algorithm when a packet passes by a certain speed through a node, then the first step of the node is to collect all the ant agents into storage known as buffer and then from its routing table it selects the optimal path to transfer packets. Therefore, in order to achieve load balance all the ants scatter into as many possible paths.

Table 1 lists some experimental parameters with its values, in order to configure system for WSN. We have initialized variable τ_0 just to avoid routing cycles as in [4].

Table 1. System Properties

Parameters	Values
Channel Type	Wireless Channel
Radio-propagation model	TwoRayGround
phyType	Phy/WirelessPhy/802_15_4
Mac Type	Mac/802_15_4
Interface queue type	Queue/Drop Tail/PriQueue
link layer type	LL
Antenna model	Antenna/Omni Antenna
Max packet in ifq	500
Number of mobile nodes	4
Routing protocol	AODV

Frequency	2.4e+9
Animator(Nam)	Graph.nam
Traffic	CBR,FTP,POISSON
Nam playback rate	3ms
CSThresh	8.54570e-07 (15m)
RXThresh	8.54570e-07 (15m)

When the loads of network traffic change and the congestion weakens, the ant agents can adjust them to the more efficient path. AntNet Simulation methods were attempted in [5] where the parameters such as nodes (3, 0, 1, 2), destination (10.0 20.0 50.0, 20.0 25.0 50.0, 25.0 30.0 50.0, 19.0 14.0 50.0) respectively.

3. RESULTS

The results are presented, through the logical implementation using Graphical network animator under NS2 as in fig 1. We can examine the following output of network produced by network animator.

- The cbr traffic is produced first from node 0 to node 4
- Ftp traffics from then the Poisson traffic from node 0 to node 1.
- Each node contains a table with the pheromone value. This table contains information about the neighboring nodes towards the required destination.
- The routing table is automatically built up through a process of pheromone table exponential transformation

3.1. CBR Traffic

Table 2. CBR Traffic

CBR Traffic	Node Traffic	Node Color	Protocol	WPAN Flow
Application 1	0 to 2	Node(0),	AODV	s-0 to d-2
		Node(2) blue circle	Tomato circle	blue circle
Application 2	0 to 3	Node(0)	ARP	s-0 to d-3
		,Node(3) green circle	green circle	green circle

Application 3	1 to 2	Node(1), Node(2) green circle	MAC Navy circle	s-1 to d-2 red circle
Application 4	1 to 3	Node(1), Node(3) green circle		s-1 to d-3 black circle

3.2. FTP Traffic

Table 3. FTP Traffic

FTP Traffic	Node Traffic	Node Color	Protocol	WPAN Flow
Application 1	0 to 2	Node(0), Node(2) blue circle	AODV Tomato circle	s-0 to d-2 blue circle
Application 2	0 to 3	Node(0), Node(3) green circle	ARP green circle	s-0 to d-3 green circle
Application 3	1 to 2	Node(1), Node(2) green circle	MAC Navy circle	s-1 to d-2 red circle
Application 4	1 to 3	Node(1), Node(3) green circle		s-1 to d-3 black circle

3.3. Throughput

The vertical axis shows the throughput, measured in kilobytes per second, which should be maximized using a given formula below:

$$\text{Throughput} = \frac{\text{Received byte}}{\text{Time of simulation}}$$

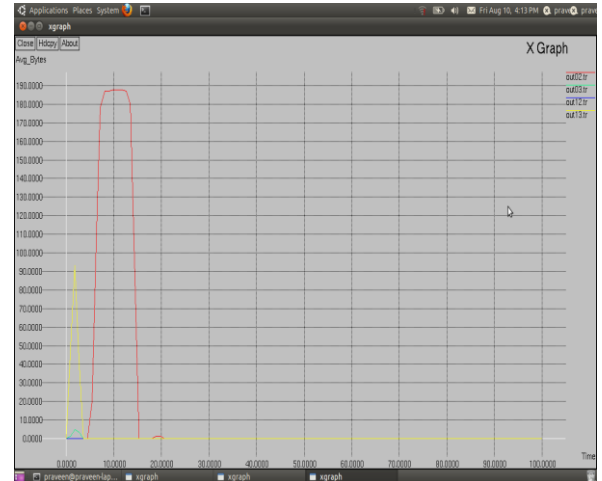


Fig 2. Throughput graph

Table 4. Throughput kb/s

Time in second(s)	Avg-Byte, Node 0 to 2 (app 1)	Avg-Byte, Node 0 to 3 (app 2)	Avg-Byte, Node 1 to 2 (app 3)	Avg-Byte, Node 1 to 3 (app 4)
5 sec	19.91	NO	NO	NO
10 sec	187.73	NO	NO	NO
15 sec	NO	NO	NO	NO
18 sec	1.422	NO	NO	NO

3.4. Lost Packets

According to definition packet lost is the percentage of packets that were sent by the sender nodes, but were not received by receiver nodes along all simulation time. This value should be minimized by using the formula below:

$$\text{Lost_packets} = (\text{sent Packets} - \text{received Packets})$$

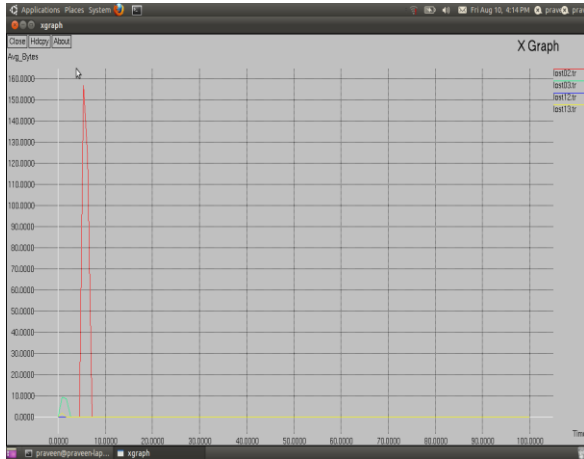


Fig 3. Packet Lost Graph

Table 5. Packet Loss kb/s

Time in Second (s)	Avg-Byte, Node 0 to 2 (app 1)	Avg-Byte, Node 0 to 3 (app 2)	Avg-Byte, Node 1 to 2 (app 3)	Avg-Byte Node 1 to 3 (app 4)
5 sec	156.80	NO	NO	NO
10 sec	NO	NO	NO	NO
15 sec	NO	NO	NO	NO
18 sec	NO	NO	NO	NO

3.5. Packet Delay

The time it takes the packet to reach the destination after it leaves the source is known as a packet delay.

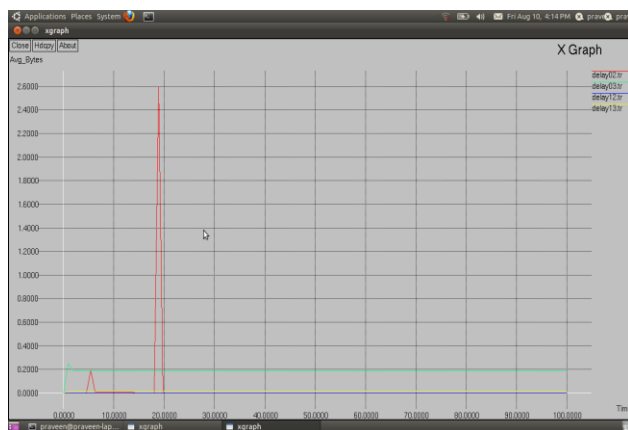


Fig. 4. Packet Delay Graph

Table 6. Packet Delay kb/s

Time in	Avg-Byte,	Avg-Byte,	Avg-Byte,	Avg-Byte

Second (s)	Node 0 to 2 (app 1)	Node 0 to 3 (app 2)	Node 1 to 2 (app 3)	Node 1 to 3 (app 4)
5 sec	0.1965	0.1879	NO	0.0114
10 sec	0.0068	0.1879	0.1879	0.0114
15 sec	NO	0.1879	NO	0.0114
18 sec	2.599	0.1879	NO	NO

We can elicit that for Application 1, 2, 3, 4, 5, 6 in 10 sec. Application 1 provides maximum throughput and minimum loss and delay. Taking account the results obtained we can also analyze distinct states of a network such as idle, sleep or active. The studying of these states will help to minimize energy consumption.

4. CONCLUSION

The algorithm proficiently avoids permanent loops which simulates deadlock problem in the running networks. This problem is alleviated by assigning every forward ANT a unique sequence ID and also to search ANT. Hence the results of simulation evidently show the efficiency of the protocol and proved that the protocol is realistic. Furthermore, the multipath feature of the algorithm reduces the congestion conditions in WSN. In conclusion, this automatic routing mechanism enables to maximize data throughput and minimizes packet loss and packet delay.

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