INTELLIGENT OPPORTUNISTIC ROUTING IN WIRELESS SENSOR NETWORK

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Abstract: *Opportunistic Routing (OR) is an active and better routing scheme for wireless multihop environment. Opportunistic routing is based on the use of broadcast transmissions to improve the network throughput and increases transmission reliability with timely manner as compare to traditional routing. OR is an approach that selects a certain number of best forwarders (candidates) at each hop by taking the advantage of the broadcast nature of the wireless medium to reach the destination. When a set of candidates receive the packet, they coordinate with each other to figure out which one has to forward the packet toward the destination. In existing Opportunistic routing protocol mainly focus either on delay, reliability, throughput, Energy Conservation. For mission-critical applications, not only the end-to end delay constraint should be met, but also certain packet delivery reliability is expected to be guaranteed with maximum Network life time. Therefore, in this situation, it requires the more parameter. Also Existing Opportunistic routing protocol use multiple path to deliver a packet to destination which introduces more channel contentions and interference which may increase the delivery delay as well as cause transmission failures. If transmission gets failed retransmission of packet over multiple paths inevitably induces energy cost.*

we propose an enhanced OR protocol for ad hoc scenarios called as Intelligent Opportunistic Routing (IOR) protocol. We have proposed a new metric which considers the geographical position of the candidates and the link delivery probability to reach them. We have compared IOR with Multipath Routing Protocol in terms of Energy Consumption, End-to-End delay, and Throughput from source to the destination. Our simulation results show that proposed protocol has less Energy Consumption, End-to-End delay and higher Throughput as compared to Multipath Opportunistic Routing (MPOP).

Keywords: Wireless Sensor Network, Energy Conservation ,End to End Delay, Throughput, SPP.PRR

1 .INTRODUCTION

Wireless Sensor Networks (WSN) are networks that consist of sensors which are distributed in an ad hoc manner. These sensors work with each other to sense some physical phenomenon and then the information gathered is processed to get relevant results. Wireless sensor networks consist of protocols and algorithms with self-organizing capabilities. Large networks of simple sensors usually deployed randomly .It is very prone to failures. It use broadcast nature to communicate with other sensors & collect information, process it and send it to base station .Its mainly focus on power conservation, instead of Quality Of Service.

Energy conservation in Wireless Sensor Network (WSN) has always been the most crucial issue, as the sensor nodes are all powered by limited capacity battery sources which are difficult to replace or recharge due to the inherent nature and types of applications of Wireless Sensor Network [1].

Therefore, energy efficient network architecture design of WSN has drawn for saving the limited energy of the sensor nodes. And to work such network in efficient manner efficient routing protocol for Wireless Sensor Network is used. Traditional routing use predefined best path to deliver a message from source to destination before transmission start and use fixed neighbor to forward a packet to each node. Best path choose in traditional routing dependence on costs of the links that they traverse. Examples of costs are the number of hops in the path, the probability of packet loss, the estimated delay along the path. But this strategy does not work to achieve a stable performance for Wireless Sensor network.

As Wireless Sensor network is get affected by various factors, like fading, interference, and multipath effects which cause heavy packet loss. This problem is overcome by using Opportunistic Routing. Opportunistic Routing use advantages of the broadcast nature of wireless communications for communicating between source and destination [2].

2. Intelligent Opportunistic Routing

An Intelligent Opportunistic Routing Protocol (IOR) is routing method which uses an idea of Opportunistic Routing to increase the performance of the routing in terms of minimum End to End delay, higher Throughput with minimum Energy Consumption in multi-hop WSN .To achieve all parameters IOR use a simple geographical local metrics, Packet Reception Ratio (PRR) and Single Hop Packet Progress (SPP).

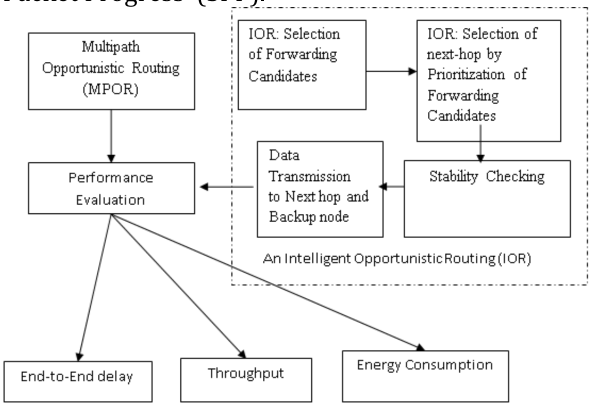

Figure 2.1: Block Diagram of IOR

2.1 Multipath Opportunistic Routing (MPOR)

Multipath Opportunistic Routing (MPOR) is based on the distance vector concept and uses hop-by-hop routing approach to discover multiple paths between the source and the destination in every route discovery. Multiple paths computed between source and destination are loop-free and disjoint[3].

MPOR finds routes on demand using a route discovery procedure. In MPOR, RREQ (Route Request) propagates from the source towards the destination and establishes multiple reverse paths both at intermediate nodes as well as the destination. Multiple RREPs (Route Reply) are traverse through these reverse paths back, to form multiple forward paths to the destination

2.2 IOR: Selection of Forwarding Candidates

An Intelligent Opportunistic Routing Protocol (IOR) is use geographical distance as metric. To select the forwarding candidate from neighboring list of source the forwarding candidate should satisfy the two conditions. First it makes positive progress toward the destination, and second its distance to the next hop node should not exceed half of the transmission range of a wireless node so that ideally all the forwarding candidates can hear from one another.

2.3 IOR: Selection of next-hop by Prioritization of Forwarding Candidates

The priority of a forwarding candidate is decided by its packet speed. Packet speed is based on single hop packet progress. Single hop packet progress is based on the difference between the distance to the destination from forwarding candidate and distance to the source node from destination.The packet reception ratio (PRR) information on each link can be obtained by counting of the lost probe messages or data packets. Priority is based on the product of SPP and PRR.

Product = SPP * PRR

Higher priority forwarding candidate is selected as next hop and data is transmitted through it and remaining higher priority forwarding candidates are assigned as backup nodes. Number forwarding candidates are limited to reduce energy consumption.

2.4 Stability Checking

Even though Distance based selection of next hop and forwarding nodes selection yields less delay, it has high probability of link disconnection that leads to packet loss. To overcome this problem stability based next hop and forwarding nodes selection is contributed in which node having high stability is selected for forwarding candidates and next hop. To achieve high stability the forwarding candidate must distance from source to it is higher than transmission range and it should have highest product of SPP and PRR.

2.5 Data Transmission to Next hop and Backup node

Once stability is achieve for Next hop and backup node the data transmission is started from source to next hop and backup node . It ensures the reliability of data delivery and reducing the packet loss and increasing the throughput.

2.6 Performance Evaluation

Here we are comparing the performance of MPOP and IOR in terms of Energy Consumption, End to End Delay and Throughput.

Energy Consumption is the amount of energy consumed by the sensors for the data transmission over the network.

$$Energy\ Consumption = \sum Energy\ consumped\ by\ each\ sensor$$

End-to-End delay is the time taken for a packet to reach the destination from the source node.

$$End\ to\ End\ Delay = \sum Rec\ eiving\ Time - Sending\ time$$

Throughput is the amount of data successfully received at the destination.

$$Throughput = \sum \frac{Received\ data\ at\ the\ destination\ \ldots .}{Duration\ of\ Transmission}$$

3. Algorithm of IOR

Input: Source (S), Destination (D)

Output: Nexthop (nexthop) and Backup Nodes (b(i)) ; i=1,..m

Total number of back up nodes → m

Distance between two nodes i and j h(i-j)

h→Distance

Neighbors of Source→?n(S-m) ; m=1,2,.. count(S)

Total Neighbor → count(S)

Step1:

for {each neighbor n(i)} {

1. Hello packet transmission to n(i);

2. Packet Reception Ratio (PRR) of n(i);
   PRR[n(i)] = Received_Packets_Count / Generated_Packets_Count;

3. Single hop Packet Progress n(i);
   SPP[n(i)] = h(S-D) – h(n(i)-D);

4. Product of PRR and SPP n(i)
   Product [n(i)] = PRR[n(i)] * SPP[n(i)]

}

Step2:

for {All neighbors n(i)} {

sort Product [n(i)] in descending order;

}

nexthop = Highest Product[n(i)];

Step3:

Stability_Check {} {

while {h(S-nexthop) <Transmission_Range} {

nexthop = Next Highest Product[n(i)];

}

}

Step4:

Find_Backup_Nodes {} {

m =0;

for {each n(i)} {

if {h(nexthop-n(i)) < half of transmission_range] && h(nexthop-n(i)) !=0 && m <=2} {

b(m) = n(i)

m = m+1;

}

}

}

Step5:

Transmit data to nexthop and backup nodes

Step6:

Initialize nexthop as source (S=nexthop) and follow the steps from step1 to step6:

Continue the steps till destination is reached as nexthop.

4. Simulation Settings

In the implementation of our simulation, sensor nodes are placed in a 200 m x 200 m square area. We define the node density as the 30,40,50,60,90,100,120,200 number of nodes deployed in the field. A source node is positioned at (0 m, 0 m), and the destination node is located at (200 m, 200 m). A data packet generated by the source node is forwarded toward the destination over multiple hops. Sensor transmission range is 80m.Simulation is carried out in NS-2 .

5.Results

5.1 Energy Consumption

Table 5.1 Energy consumption in Joules for IOR and MPOP

No. of Nodes	IOR	MPOP
30	29.681615	73.067518
40	34.340107	63.535672
50	86.172866	171.25353
60	155.824021	186.899078
90	307.204208	350.662042
100	336.983457	362.645277
120	389.047151	402.44896
200	495.25958	536.053592

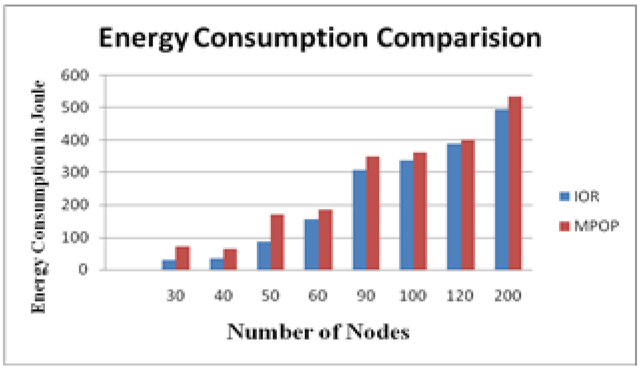

Figure 5.1 Energy Consumption Comparisons between IOR and MPOR

Table 5.2 shows that for 30 nodes MPOP consume 24.61 % more energy for data transfer from Source to Destination as compare to IOR with fixed location of Source and Destination. This happens due to in MPOP forwarding or next hop is get selected on the basis on PRR .The node which has higher PRR among the neighbors of source is get selected as next hop for packet delivery towards the node. The node which has higher PRR means its location or position from the Source is near as compare to node which has less PRR hence to deliver packet from source to destination MPOP required more number of Hop. As more number of Hop involved more energy consume to find next hop till Destination achieve .Also MPOP use multipath transmission to deliver data from Source to Destination means same data packet is travel from multiple path to reach to nexthop which induces significant energy cost. Hence in MPOP more energy consumes.

In IOR for 30 nodes 24.61 % less energy consume for data transfer from Source to Destination as compare to MPOP with fixed location of Source and Destination. This is happens due to IOR use two metric for selection of next hop .One is PRR and second one is SPP. We are taking product of PRR and SPP .The node which has higher product of PRR and SPP among the neighbors is consider as nexthop for forwarding a packet from Source to Destination. SPP is nothing but distance difference between distance of Source to Destination and distance of Current node to Destination. If SPP of a node is high among the neighbor means its location from Destination is closer compare to other nodes.

When we are choosing a node which has higher product of SPP and PRR as forwarding node or next hop we required less number of next hop to deliver a packet from Source to Destination hence less energy consume.

We can achieve less energy consumption in IOR as compare to whatever energy consume in current scenario of IOR ,if we do not use backup node .Here in this work we consider backup node to transmit data to next hop in case of current forwarder node is get fail due to energy problem. This scenario we are not implemented in this work.

In IOR, Source transmits data to next hop as well as backup node so some more energy get consumed. Table 5.1 shows comparison of Energy Consumption between IOR and MPOP .It show that for 40 nodes MPOP consume 18.50% more energy, for 50 nodes MPOP consume 19.87 % more energy, for 60 MPOP consume 11.99% more energy, for 90 nodes MPOP consume 10.71% more energy, for 100 nodes MPOP consume 12.22% more energy for 120 nodes MPOP consume 10.34% more energy, for 200 nodes MPOP consume 10.82 % consume more energy by MPOP as compare to IOR respectively. From Table 5.2 it is clear that when nodes are less MPOP consume more energy as compare to IOR.But when node are increasing MPOP consume slightly more energy as compare to IOR. This is due to number of nexthop are nearly equal but as MPOP use multiple path for transmitting packet energy consume more as compare to IOR .As IOR use only Single path for transmission of packet.

The variation in percentage of Energy Consumption occurs due to random deployment of nodes between Source and Destination for each scenario. Also number of nodes also varies and number of nexthop also gets change.

5.2 End to End Delay

Table 5.3 End to End Delay inmsec for IOR and MPOP

No. of Nodes	IOR	MPOP
30	195.646	307.538
40	402.929	572.561
50	707.378	845.846
60	763.359	904.321
90	854.627	1339.53
100	944.256	1113.64
120	1125.12	1140.12
200	1113.55	1278.916

Table 5.3 shows that for 30 nodes MPOP take 15.71 % more End to End delay for data transfer from Source to Destination as compare to IOR with fixed location of Source and Destination. Similarly for 40 nodes delay is more in MPOP by 14.20%, for 50 nodes delay is more in MPOP by 11.95 %, for 60 nodes delay is more in MPOP by 11.99%, for 90 nodes delay is more in MPOP by 10.71%, for 100 nodes delay is more in MPOP by 11.79%, for 120 nodes delay is more in MPOP by 10.34, for 200 nodes delay is more in MPOP by Table 5.3 shows that for 30 nodes MPOP take 15.71 % more End to End delay for data transfer from Source to Destination as compare to IOR with fixed location of Source and Destination. This happens due to basic reasons which mentioned earlier for selection of forwarding node or nexthop in earlier discussion. Apart from basic reason MPOP take more End to End delay because it use multipath transmission to forward a packet from source to destination .Due to channel interference problem packet take time to reach at destination. Another reason is MPOP does not check stability of nexthop before start transmission of data to nexthop which cause transmission failure or retransmission of data this also increase delay.

10.82%respectively.

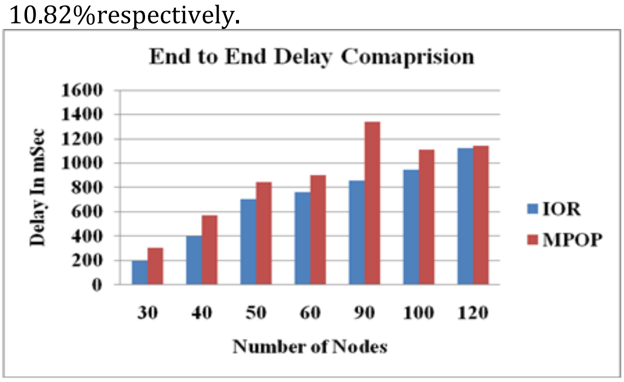

Figure 5.2 End to End Delay Comparisons between IOR and MPOR

IOR check the stability condition before Source start the transmission to next hop and to backup node as mentioned in algorithm because of stability data is accurately and timely deliver to nexthop or Destination which reduce delay.

5.2 Throughput

Table 5.4 Throughput in Kbps for IOR and MPOP

No. of Nodes	IOR	MPOP
30	124.064	32.8427
40	125.024	33.2053
50	126.152	34.2933
60	128.624	35.9307
90	144.496	37.1813
100	158.128	40.8427
120	170.156	43.4781
200	196.896	45.0187

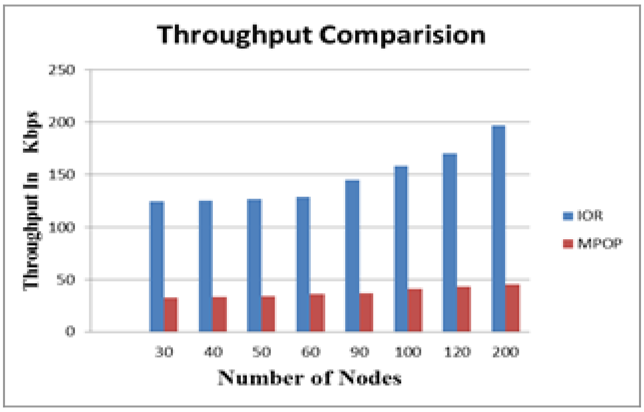

Figure 5.3 Throughput Comparison between IOR and MPOR

Table 5.4 shows comparison between IOR and MPOP for Throughput ,that for 30 nodes IOR increases Throughput by 37.77 % more compare to MPOP with fixed location of Source and Destination. Similarly for 40 nodes IOR increases Throughput by 37.65 %, for 50 nodes IOR increases Throughput by 36.78 %, for 60 nodes IOR increases Throughput by 35.79 %, for 90 nodes IOR increases Throughput by 38.88 %, for 100 nodes IOR increases Throughput by 38.71%, for 120 nodes IOR increases Throughput by 39.13, for 200 nodes IOR increases Throughput by 43.73% delay taken by as compare to MPOP respectively.

Throughput increases in IOR as Compare to MPOP due to IOR choose only those nexthop or forwarder who has highest product of SPP and PRR.MPOP select forwarding or next hop only upon PRR.IOR also check the stability of nexthop before starting transmission of packet from Source to Destination so that less packet get drop.

6. CONCLUSION

Energy Consumption is more in multi path routing approach as we have to send same packet over multiple path. Also multiple paths introduces more channel contentions which significantly degrades end-to-end delay performance.

We also observed that multiple routing protocols are influenced by different node densities, and its end-to-end delay is much higher than others. But for Higher node density IOR and MPOR has not much change in the end-to-end delay. This is partly because the node density setting is high, and there are enough forwarding candidates at each hop.

We also observed that Throughput is less in multipath routing as compared to IOR .It is because in IOR packet is forwarded to only those node whose has high product of packet reception ratio and single-hop packet progress. Single–Hop packet progress is depending upon node closer to destination. In multipath Routing Forwarding node is depend upon only packet reception ratio.

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