# Throughput and End-to-End Delay Comparison in Wireless Sensor Network using BPR

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*Abstract*— Any network should have the ability to operate in harsh environments despite of the constraints taken in WSN. One of the basic features of any sensor network is to monitor and sense the surrounding for communication between them but because of their limited capabilities, sensor nodes are susceptible to various sources of failures such as presence of anomalies, malware attacks, hardware failures and software corruption which can reduce nodes functionality and badly affect most WSN operations. The existing system methods like (BOUND HOLE and GAR)can be used to diminish these issues but their performance is bounded by some restriction, the solution is to BY-PASS the infected node dynamically using twin rolling balls technique. The identification of the infected node is done by the adopting the fuzzy data clustering approach which classify the node based on the anomaly detection with the help of threshold values. The BPR algorithm bypasses the infected node to reach the destination, increasing the performance of the network. The twin rolling ball concept is used to get the idea of stuck packets in the network. Thus, BPR provides better performance in terms of QoS parameters that is throughput, end-to-end delay and energy consumption as compared to existing system.

***Key words:*** Wireless Sensor Network, Sensor Nodes, Anomalies, Routing protocols, Fuzzy Data Clustering, Stuck Packets, Twin Rolling Balls

## I. INTRODUCTION

A Wireless Sensor Network (WSN) is a group of sensor nodes which communicates with the central station wirelessly in order to convey the message from source to destination. In most Wireless Sensor Network applications, any network should have the ability to operate in harsh environments despite of the constraints taken in WSN. The basic feature of any sensor as shown in Fig 1 networks is to monitor and sense the surrounding. The detection of the certain event is made viable through the data sensing and forwarding from the sensor node, the data sensing and forwarding from sensor node to the called sensor node so called sink node for further processing. Since wireless sensor networks are a new scientific and engineering field they are still not in a situation to decide what the best way to address a particular problem and also difficult to predict the best way to treat fault tolerance accurately within a particular WSN approach. The energy constraints and other resource limitations restrict direct communication between sensors and sink node. Communication in the wireless sensor network is affected by the proper functionality and various nodes have the intermediate node. The occurrence of any unexpected circumstance and resources limitations restrict redirect communication between sources and sink node.

The two basic components of WSN are "cluster head" which are also called as aggregation points and "Base station" which have stronger capabilities than normal sensor nodes. The cluster heads are formed to transmit the load energy equally to all sensor nodes. The manageability and scalability of WSN is mainly depends on the clustering technique. The base station analyzes and gathers the data which is sent from different sensor nodes. The parameter of wireless sensor networks varies depending on the positioning of base station and also on selection of cluster heads.

The development of WSN is motivated mainly by many military applications like battlefield, monitoring friendly forces, equipment and ammunition, chemical, biological and nuclear detection and targeting. They are widely used in many security applications, transportation applications and also in many industrial applications such as health monitoring, process monitoring etc. Tracking application may include vehicle, humans, animals, object and military enemy tracking.

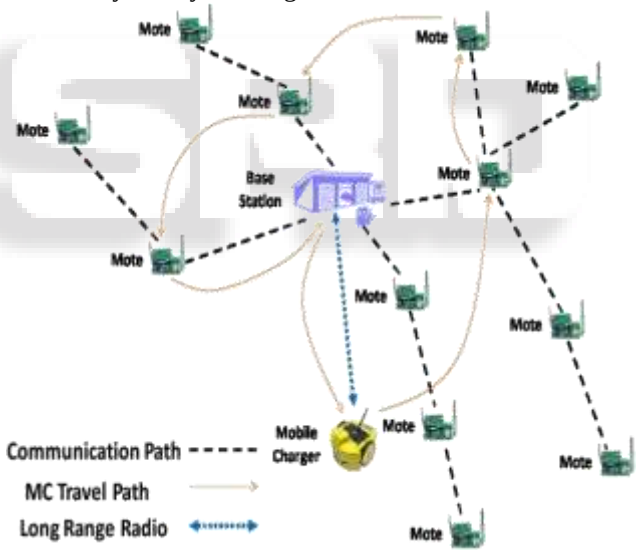


Fig. 1: Wireless sensor network

Fig 2 shows the schematic diagram of sensor node components. There are four basic elements of the sensor node which includes mainly sensing, processing, power and transceiver .Broadcast communication is being used by the sensor nodes in which sensor signals are taken for further analysis. Wireless sensor network has the inherent redundancy, so it is taken as sensor system architecture but has disadvantages due to limited operation life time.WSN are usually restricted by memory, short communication distance, energy, information flow compared to the wired networks. As sensor nodes are heavily deployed in the network it will be risk and will cost more to replace faulty sensor nodes and also they don't have global information regarding the whole network because WSN varies frequently.

 

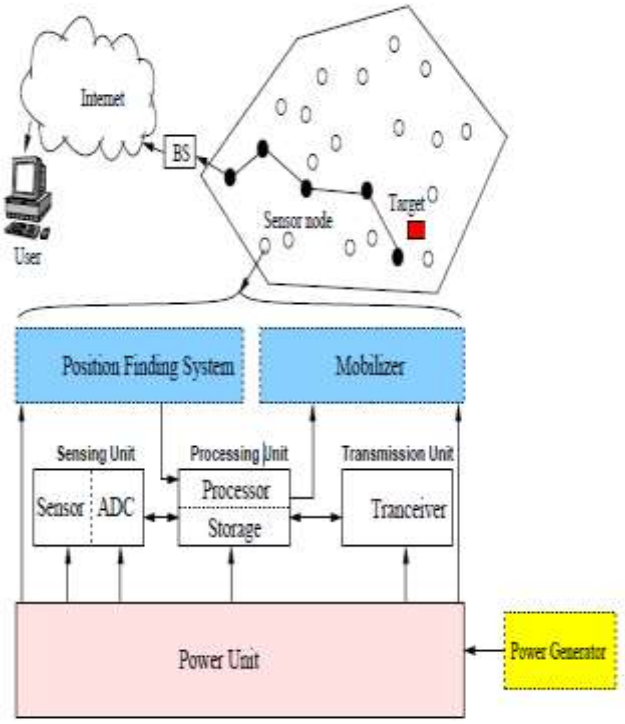


Fig. 2: Sensor node

### A. Challenges and Design Issues in WSNs

One of the main design goals of WSNs is to carry out data communication while trying to prolong the lifetime of the network and prevent connectivity degradation by employing aggressive energy management techniques. The design of routing protocols in WSNs is influenced by many challenging factors like Node Deployments, Energy consumption without Losing Accuracy, Data Reporting model, Node/Link heterogeneity, Scalability, Coverage, Data Aggregation, Quality of service. Sensor nodes are vulnerable to various sources of failure due to their limited capabilities. These include malware attacks, hardware failures and software corruption which can reduce nodes functionality and badly affect most WSN operations.

The nodes experiencing failures are classified as infected or malfunctioned which have high tendency to produce faulty data, data generated by this kind of node may contain anomalies. Packets containing anomalous data can result in false analyses and in-correct decision making at the end system, thus degrading the performance of the system. Such problems will arise other side effects like packet loss rate and higher consumption of energy.

## II. Related Work

In [2] the author explains how to overcome the sink node isolation problem by introducing the power –aware routing algorithms in WSN's for the prolong lifetime of sensor nodes, since sensor nodes are powered by batteries which have finite energy. The prime function of sensor nodes is to collect important data from its surrounding nodes. The sink node act as the network gateway through which the sensor nodes can collect the data. The sensor nodes are motorized by batteries. Hence a battery has limited energy, it is impractical to replace a huge number of batteries. So Hybrid Multi Hoping Routing(HYMN) is introduced, is the fusion of 1).Flat multi hop routing algorithms.2).Hierarchical multi hop routing algorithms (Leach).

### A. Flat Multi-hop Routing:

The flat multi-hop routing algorithms intend to reduce the entire power conservation intended for transferring data to sink node from distinct senor nodes. Every node will be able to set up communication with sensor nodes that are within its maximum transmission range. The individual link operation changes depend on routing algorithm is being used.

### B. Hierarchical Multi Hop Routing:

Even though flat multi-hop routing algorithms makes possible for steering of information in a manner that reduces the power consumption of the WSN, it falls short to utilize the data aggregation prospect from data collected in the WSNs. So to overcome such scenario, hierarchical multi hop is used like LEACH(Low-Energy Adaptive Clustering Hierarchy ).In Leach, node are taken into two level hierarchy, in which roles of nodes diverges corresponding to the level they belong. Here node will be either Cluster Member (CM) or a Cluster Head(CH), but the roles to which they belong are variable in time with respect to as round.

In [3] the authors explain, the position information is used for routing in Geographic ad-hoc networks, which utilizes stateless greedy forwarding algorithms and when greedy algorithm fails there is a necessity to use of recovery algorithms. So virtual positioning of nodes came into exists with introduction of NEAR(Node Elevation ad-hoc Routing) that significantly increases the success of the recovery algorithm and effectiveness of greedy routing is enhanced depending on local information only that include routing algorithm and virtual positioning.

A main problem with greedy routing algorithms is to know how to progress when the concept of concave node comes into picture that is, a node will not be having any of its neighbour other than its destination. One of the solutions is to use the recovery algorithm that guarantee the packet delivery like greedy/flooding algorithm which is classified based on memory and memory-free. The problem with recovery protocol is the packet constantly need to reach a concave node before recovery algorithm is used to deliver the packet to specific sink node.

In [7] the creators clarify, in WSN's holes are essential topological components needed to be mulled over. In directing, holes acts as voids that causes the avaricious sending to come up short and they can likewise called as "hotspots" which may be made by activity clogging or force lack. The gaps are thought to be as district encased by polygonal cycle containing every one of the hubs in which nearby minima issue is taken. The routines utilized here are TENT standard and BOUND HOLE to recognize the gaps and manufacture courses around these openings.

The stuck hubs are portrayed first, where bundles can possibly get stuck in insatiable multi-bounce sending which demonstrates the presence of gaps. So TENT tenet is created for this circumstance which just requires every hub to its one-jump neighbor's area. To get the stuck packets, the BOUND HOLE is utilized, which portray the limit of the hole, i.e. shut cycles which have no self-crossing points that will cutoff points shut district where boundary data are

 

required at the hubs on the limit to backing take after on packets.

## III. EXISTING SYSTEM

### *A. Local Minima Problem*

Several routing protocols in wireless sensor networks uses Greedy Forwarding(GF) algorithm which forwards a packet to a destination node via 1-hop neighbour. The neighbour that receives the packet will repeat the process until the packet reaches the destination. This technique is proven to be efficient in reducing energy consumption since it does not incur additional routing overhead. But it suffers from the local minima phenomenon or holes problem which has attracted much attention now a days.

A Local minimum problem refers to the classic situation where packets cannot be forwarded to the next hop since there exists no other node that has shorter distance than itself. Some of the methods employ a graph-based technique**,** which require the entire network graph to be stored, thus leading to poor scalability. Some of the advantages of this method are: Good quality results, Flexibility, Intuitive, Simplicity, and Interactivity. Disadvantages are High running time and poor local minima. On the other hand, non-graph-based technique will results in long routing paths and high expenditure, and hence not suitable for wireless sensor networks. Holes can be inferred as 'hot spots' caused by traffic congestion or the phenomenon where the sensor nodes are destroyed due the natural disasters such as forest fire or the node failure. One way to handle this problem is multiple path approach and thus need to divert the traffic from infected region and routing towards unaffected region. The local minima problem illustrated in Fig 3.,in which the node forwards the packet to sink can fail at node A; there are no direct neighbor which is closest to the destination than node A itself.

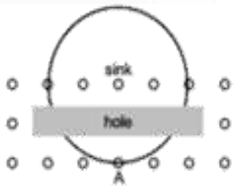


Fig. 3: Local minima problem

### *B. Boundhole*

This algorithm BOUNDHOLE is use to find the boundary of the hole or infected region and establishes an alternative routes to by-pass the identified infected nodes. This algorithm routes the packets based on GF algorithm.

### *C. GAR (Greedy Anti Void Routing)*

Greedy Anti-Void Routing (GAR) has been designed to tackle the issue of the false boundary detection in the Bound hole method. The protocol of greedy anti-void routing protocol is mainly based on Unit Disk Graph (UDG) setting that was proposed to guarantee packet delivery to specified destination by totally resolving the void trouble in order to increase the routing efficiency. The permutation of both conventional Greedy Forwarding algorithm and the rolling-ball UDG boundary traversal (RUT) scheme results in designing of GAR protocol, where the Greedy Forwarding method is implemented by the GAR algorithm without including the void trouble and the RUT scheme is used for resolving the void trouble, providing the guarantee of packet delivery to the destination.

GAR employs a rolling ball method which is attached or hinged at the node having the local minima problem and rotate counter clockwise with R/2 radius. The first node that intersects with the rolling ball and which is closer to the destination node is selected as the next hop. The ball will then continue the rotation until the next node is hit and the process continues until the packet safely arrives at destination node. To solve the boundary finding trouble the rolling-ball UDG boundary traversal (RUT) scheme is used.

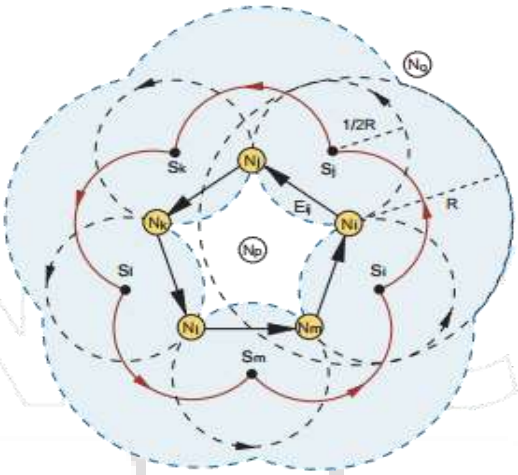


Fig 4.Rolling ball

The RUT scheme is shown here : for given Si and Ni ,the RUT method turns the rolling ball RBNi (Si, R/2) counter clockwise and builds the easy closed curve (i.e. the flower-like red solid curve in the above figure). The Boundary Set B ={Ni, Nj, Nk, Nl, Nm}is recognized as a easy unidirectional ring by making use of RUT method.

### *D. Disadvantages:*

- GAR visits unnecessary nodes, thus resulting in higher energy consumption
- BOUNDHOLE approach is subjected routing loops due to false boundary detections. Other side effects due to this problem include higher delays, communication overheads and high energy consumption.

## IV. BY-PASSED ROUTING SYSTEM

The By-Passed Routing (BPR) technique comprises two parts

- Infected area detection
- By-passed routing.

First part identifies the occurrence of infected nodes by Fuzzy Data Clustering approach to detect anomalies. Fuzzy clustering is suitable while evaluating whether a node is infected or not, and is it through a hardware malfunction, malware attack or software corruption.

The second part uses the information obtained on infected nodes/areas and diverts the incoming traffic to unaffected areas and by-passed the routing.

 

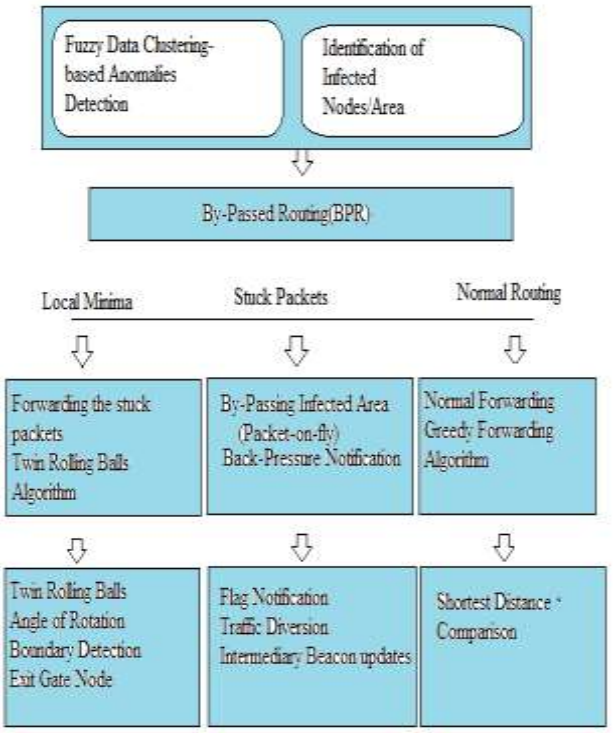


Fig 5: The architecture view of proposed BPR technique.

*A. Fuzzy Data Clustering*

Infected nodes in communication space identified via Fuzzy Data Clustering method. This approach uses Fuzzy C algorithm to detect anomalies in sensor measurements. In this algorithm based on some criterion an attempt is made to partition a finite collection of 'n' elements X={x1, x2, x3, x4.....xn into collection of 'c' fuzzy cluster. In a given finite set of data, the FCM will return us a set of 'c' cluster centre C={c1, c2, c3, c4.....cc} and also partition matrix W=wij $\epsilon$ [0,1] with i=1,2,3,4.....1, j=1, in which each elements wij tells the degree to which elements xi belongs to cluster cj.

To determine the shortest route between nodes in the network, an algorithm is used called as Dijkstra's algorithm. In the given network for any provided source node, the algorithm detects out the shortest route by taking x and y co-ordinate of it along with the threshold value of that node and process continues till the destination is reached.

*B. By-Passed Routing (BPR)*

This technique aims at two things .First, getting the stuck packets out of infected region and forwards these packets to their destination on time. Secondly, we are concerned about divert the incoming traffic away from such infected region to avoid packets from being sent to the infected region.

Given a set of sensor nodes N= [N1,N2,N3,N3.....Nn] on a WSN, a particular node Ni is considered as infected node if it satisfies threshold value which is given based on the energy value. If it is above threshold value which is random value here, then considered as infected node. Infected nodes are those which violate normal function of the network so it has to be detected and by-passed. Given a subset(n) of WSN sensor nodes(n $\epsilon$ N), which are over a particular spatial area A, that area is considered as an infected area if and only if it satisfies above condition and each node is within one hop communication distance of at least one other node in ' n'.

When nodes are infected, some packets are trapped inside the region and cannot be forwarded to the next hop simply because there is no available node to do so, such that these packets have a high possibility of being dropped if no alternative paths are made to get out of it. So the method called Twin rolling ball came into exists which gets activated when there is stuck packets condition. Stuck packets are identified if the node is out of the transmission range to send the packet to next node due to local minima problem. Thus the twin rolling ball concept can be used.

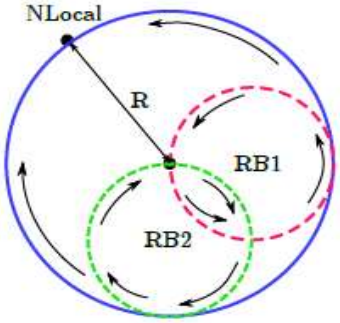


Fig 6.Two rolling operation

The identical rolling balls also known as twin rolling balls can be cleared as two identical balls RB1 Ni(Si, R/2) and RB2 Ni(Si, R/2) each with radius R/2 hinged at Nlocal and turn around in two directions at once until the first node is hit. As shown in above fig 6 the twin rolling balls is used for the BPR. Instead of rotating in just one direction may take a longer time if node is located far away from the ball, so this problem is encountered by using two different balls that are attached to the same point (N local) and rotate the balls in different directions. This proposed algorithm considers the intersection between the rolling ball(RB Ni(Si, R/2)) and node as the next corresponding boundary node.

After infected node and twin rolling operation is done, the back trace message must be send to the source node that the node is infected so that it stops sending the packets to that node. Thus to by-pass the node and take the alternative route. This alternate path again depends upon the parameter taken for the other nodes to satisfy the condition and taken in the loop with normal forwarding algorithm.

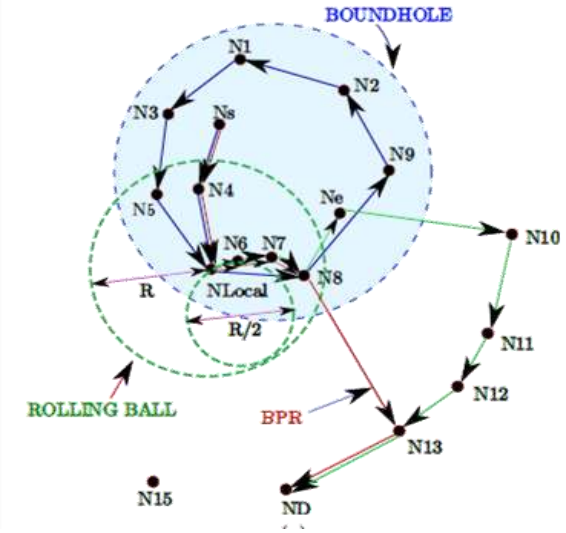


Fig 7: Example of constructing path using Rolling Ball technique.

 

In fig 7 as the ball will attach at Ne, it will roll and hit N10. This process continues till the packet is reached its destination node ND. This method unnecessary visits to other nodes (Ne;N10;N11;N12) while there is another shorter route to the destination. In contrast, the BPR method will choose N8 as an exit gate node. The selection of this exit node is based on the transmission range covered by NLocal. Ne node is excludes as exit gate node avoiding taking longer routes. From Node 8 it will proceed with normal forwarding using GF algorithm.

## V. SIMULATION RESULTS

### *A. Scenario 1:*

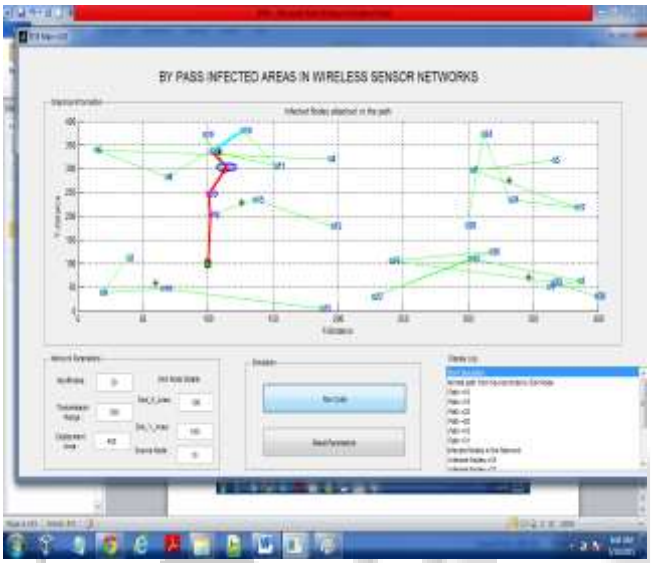


Fig 8. Affected areas in wireless sensor networks

In this first scenario we have set of wireless sensor nodes communicating each other with an presence cluster formation by green color, infected nodes(pink),back trace message (light blue) and operation of the rolling ball(dark blue).

### *B. Scenario 2:*

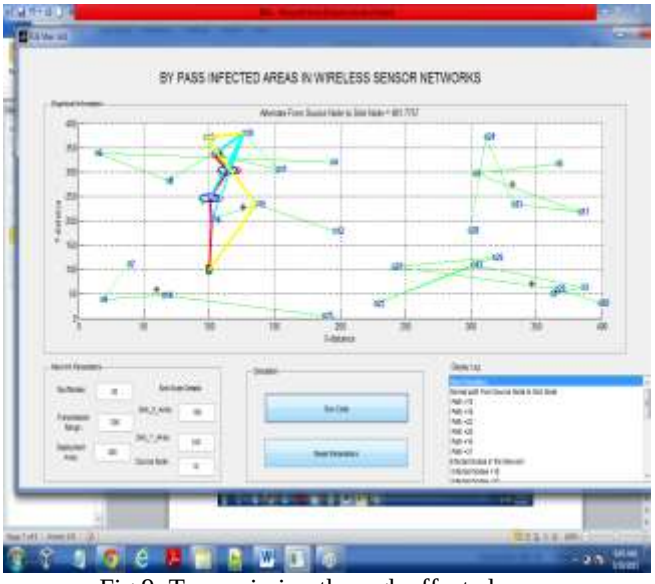


Fig 9: Transmission through affected areas

The second scenario explains the by passing of the affected nodes for transmission with the implementation of the BPR shown in yellow color.

### *C. Scenario 3:*

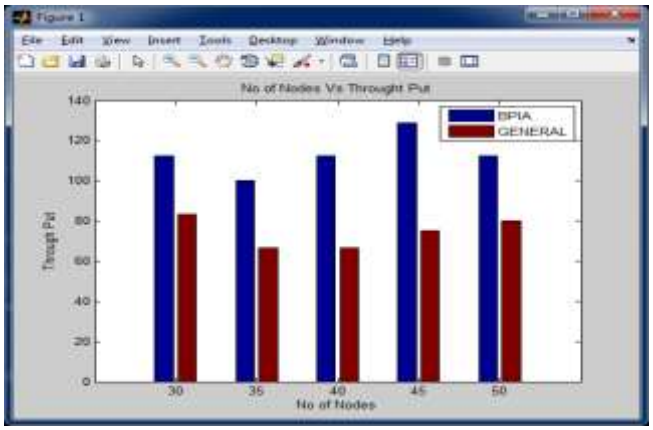


Fig. 10: Throughput comparison

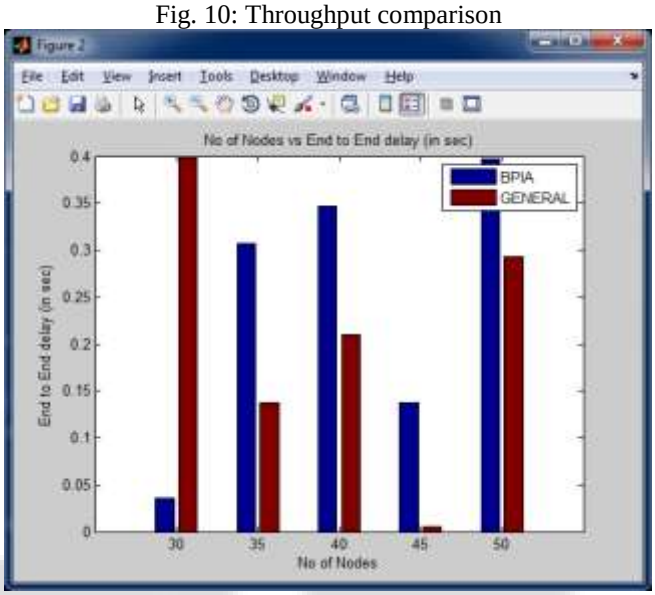


Fig 11: End-to-End Delay comparison.

In the third scenario it clearly shows that BPR technique is better than general technique for transmission in wireless sensor networks.

## VI. CONCLUSION AND FUTURE WORK

In this work, the efficiency of the By-Passed Routing technique where it avoids the infected nodes in network is seen thereby improving the overall performance of network. The infected area comprising of infected nodes called also as anomalous nodes are detected by fuzzy data clustering technique in which first clustering is performed and infected node is calculated based on threshold value in energy model. This information is used by the BPR technique where it finds the alternate path to transfer of packets from source node to destination node with the help of twin rolling balls which define the next forwarding node and reduces the false boundary detection seen in existing rolling ball technique. Comparison results is taken with the leach clustering where can see BPR have good performance in throughput and end to end delay parameter. Thus one can conclude that performance analysis of network is improved by BPR when compared to existing system like BOUNDHOLE, GAR etc.

As a future scope the concept of cryptography can be added to this technique by adding encryption and decryption to the packets which are transferred from source to destination. Thus providing the security to the network.

REFERENCES

[1] I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," IEEE Communications Magazine, Vol. 40, No. 8, pp. 102–114, 2002.
[2] A. Abdulla, H. Nishiyama, J. Yang, N. Ansari, and N. Kato, "HYMN: A novel hybrid multi-hop routing algorithm to improve the longevity of wsns," IEEE Transactions on Wireless Communications, Vol. 11, no. 7, pp. 2531–2541, July 2012.
[3] N. Arad and Y. Shavitt, "Minimizing recovery state in geographic ad hoc routing," IEEE Transactions on Mobile Computing, Vol. 8, No. 2, pp. 203–217, 2009.
[4] D. Chen and P. K. Varshney, "On-demand geographic forwarding for data delivery in wireless sensor networks," Computer Communications, Vol. 30, No. 1415, pp. 2954 – 2967, 2007.
[5] M. Ahmadi Livani and M. Abadi, "An energy-efficient anomaly detection approach for wireless sensor networks," Proceedings of 5th International Symposium on Telecommunications, pp. 243–248,2010.
[6] N. Ahmed, S. S. Kanhere, and S. Jha, "The holes problem in wireless sensor networks: a survey," Association for Computing Machinery Special Interest Group on Mobility of systems, Users, Data, and Computing (ACM SIGMOBILE ), Review 9, No. 2, pp. 4–18, April. 2005.
[7] Q. Fang, J. Gao, and L. Guibas, "Locating and bypassing holes in sensor networks," Mobile Networks and Applications, Vol. 11, No. 2, pp. 187–200, 2006.
[8] S. Lai and B. Ravindran, "Least-latency routing over time dependent wireless sensor networks," IEEE Transactions on Computers, Vol. 62, No. 5, pp. 969–983, 2013.
[9] W. Liu, H. Nishiyama, N. Ansari, J. Yang, and N. Kato, "Cluster-based certificate revocation with vindication capability for mobile ad hoc networks," IEEE Transaction on Parallel Distributed System, Vol. 24, No. 2, pp. 239–249, Feb. 2013.
[10] S. Chen, G. Fan, and J. hong Cui, "Avoid 'void' in geographic routing for data aggregation in sensor networks," International Journal of Ad Hoc and Ubiquitous Computing, Vol. 1, pp. 169–178, 2006.

 