Routing by HDF Based Optimal Path Selection in Multipath WSNs

U. D. Prasan, Gorti. Satyanarayana Murty, Ch. Ramesh, S. Vishnu Murty

Abstract:- Multipath routing (MPR) is an effectual method for routing data on Wireless Sensor Networks (WSNs) since it offers security, reliability as well as load balancing (LB) that are particularly serious in the resource-constrained scheme like WSNs. This paper proposed a selecting optimal routing path in MPR using QoS for WSN. In the First phase, the network nodes are initialized. Next, the nodes are formed as a cluster which is known as cluster formation utilizing K-Medoid clustering algorithm. In the cluster formation, the cluster heads (CH) are chosen from each cluster using Grey wolf Optimization (GWO) algorithm. In the next stage, routing operation is performed, which is bifurcated into 2 sections as, multipath route selection, and optimal path selection (OPS). For multipath route selection, AOMDV protocol is used. Using this protocol, efficient multipath routes are chosen in the network. After several transmissions, a route might lose the quality of the link. So an optimal path is chosen from the existing routes in the network using Hybrid Dragon Fly (HDF) optimization. Performance metrics of the proposed work is compared with that of existing optimal path routings techniques. Results illustrate that our model exhibited better energy efficiency along with Network Lifetime when compared to the existing routing models.

Keywords: K-Medoid Clustering Algorithm, Grey wolf Optimization (GWO), Quality of Service (QoS), Hybrid Dragon Fly (HDF).

I. INTRODUCTION

WSN largely installed and used in the various areas like military, Tsunami etc. In WSNs, the sensor nodes (SN) gather data as of physical setting, process as well forwards it to a base station (BS)[1]. An imperative challenge is the node's energy and also its restricted resources for computing in WSNs, i.e., the chief restraint on the NL [2]. To help expand the life span of SN and networks, energy conservation methods are usually employed [3]. Numerous routing protocols (RP) were posited by means of researchers to ameliorate the performance of many applications [4].

RPs considers every trait of SN. The RPs can well be classified as negotiation, query, QOS, along with multipath based [5].

To broadcast the data, the majority of them utilize a single path. Optimum path chosen based on the measures like distance to the destination, information gradient and the node residual energy level. Some additional RPs which utilizes multi-paths selects the network dependability as their design's main concern. The data transmission depends typically on the optimal path [6].MPR approach was extensively used for disparate network management purposes like enhancing data transmission dependability, congestion control, Quality of Service and fault-tolerance (FT) routing in wired as well as wireless networks [7]. Multiple paths are selected to transmit the data between the source and destination [8-10] using MPR. So if any of the paths fail, data can be sent through a different path also. This procedure boosts the reliability with least latency of the network. This inspires to apply the MPR protocol for reliable transmission which results in lesser control overhead in route discovery. In addition, increases the system's throughput [11]. Multiple paths can offer LB, FT along with high bandwidth. LB is attained by means of spreading traffic all along manifold paths [12].

II. RELATED WORK

Ren-Cheng et.al [13] proposed a practical passive cluster-centered node-disjoint many to one MPR protocol to fulfill the needs of energy effectiveness as well as QoS in realistic WSNs. They also introduced a scalable and distributed passive clustering algorithm based on smart delay strategy by using the energy levels and the distances in order to sort out the entire network into different clusters.

Hongbing et.al [14] presented an immune mechanism based multipath reliable transmission called BWAS with fault tolerance in wireless sensor networks.

Preetha and Paul [15] suggested a Cross Layer-Low Energy Adaptive Clustering Hierarchy model (CL-LEACH), which is an effective RP to improve the battery lifetime.

Hiren et.al [16] presented SHaRP, a hierarchical and also role centered RP for mobile WSN. In this framework, the sensor field was split into some logical clusters where every cluster includes nodes with disparate roles like ordinary sensor node (OSN), CH in addition to the gateway node (GN).

Geetika Dhand and Tyagi [17] suggested SMEER with MALOKSER protocol to optimize the problems in the sensor networks.

Amit and Senthil [18] implemented CH selection in WSN using FCR technique which was the extension of regularly used firefly algorithm. The CH was chosen in such a means that it is spatially close enough to the BS and also the SN.

Anfeng et.al [19] offered a 3-phase dis-joint routing system termed the Security as well as Energy-efficient Disjoint Route (SEDR).

Shancang et.al [20] devised a novel protocol for Adaptive and secure load-balance routing for service-oriented wireless sensor networks.

III. PROPOSED METHODOLOGY

In this paper, we proposed a technique for selecting optimal routing path in MPR using QoS for WSN. Our method mainly comprises 3 parts: firstly to initialize the nodes, all nodes are presented in a single section which is called Initial node pool (WSN). Then, the nodes are clustered using K-Medoid Clustering algorithm. After that, the CH is selected using GWO. Thirdly, to perform routing operation, initially find the multipath selection using AOMDV protocol. Next, from the MPR, the best optimal path is selected centered on the QoS using HDF algorithm. Finally, the source node can communicate with the destination node using this best optimal path in a secured and efficient manner.

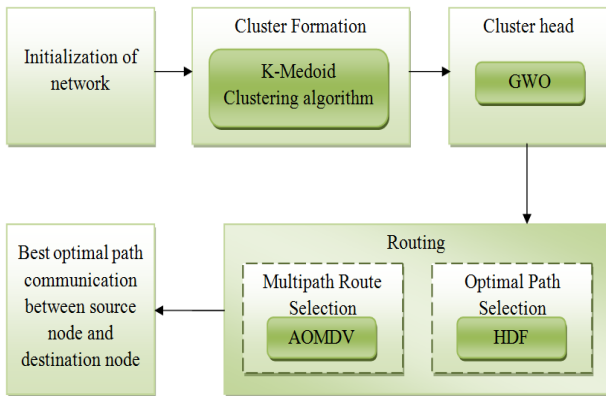The architecture of this proposed best optimal routing selection is exhibited in Fig. 1,

Fig. 1 Block Diagram for Proposed system

3.1 Initialization of Network

In this phase, the BS along with SN is installed in the WSN. WSN is made of a big quantity of SN and a BS. The entire nodes are clustered, and then from the cluster formation, select the cluster, after that the MPR is selected.

3.2 Cluster Formation

Subsequent to the initialization of nodes in WSN, the formation of the cluster is begun. This is employed for diminishing the routing path, and also to hoards the energy. This proposed method utilizes the K- Medoids clustering algorithm for clustering the SN in WSN.

3.2.1 K-Medoid Clustering Algorithm

This algorithm begins with arbitrarily selecting K-data items as first medoids to signify the K-clusters. Rest of the items is incorporated on a cluster that encompasses its medoid nearest to them. Afterward, a new medoid is ascertained that can signify the cluster better. Rest of the data items are once more allotted to the clusters with the nearest medoid. In every iteration, the medoids modify their location. The method lessens the sum of the dissimilarities betwixt each data item as well as its equivalent medoid. This cycle is recurring until no medoid alters its placement. This label the finish of the process, in addition, the resulting final clusters with their medoids are obtained. K Clusters are created that are grounded on the medoids and every data members are

located in the suitable cluster centered on closest medoid. The steps in the K-Medoids clustering algorithm are given.

Step 1: Let $C = \{C_1, C_2, ..., C_j, ..., C_8\}$ be the collection of clusters.

Step 2: Allot every cluster nodes (CN) to the nearest CHs to get the clusters. Now, Euclidean distance is utilized to compute the distance betwixt the CHs and the other CN using the equation (1).

$$D = \sqrt{(m_1 - n_1)^2 + (m_2 - n_2)^2} \qquad (1)$$

Here (m_1, n_1) and (m_2, n_2) are the co-ordinates of the CH in addition to the CN. Calculate the sum of distances for all CN to the CHs.

Step 3: Next, randomly select a cluster node C_{random} to replace CH node C_j, with the stipulation that the remaining energy of this random node must be high than average remaining energy of all nodes.

Step 4: Now, assign the CN to the nearest new CH and attain the cluster result. Then, calculate the Euclidean distance of the CHs and the other CN using the equation (1). And evaluate the sum of distances for all CN to the CHs.

Step 5: On the off-chance that the sum of distances is equivalent to the preceding one (sum of distances), then end the algorithm. Or else, jump back to Step 3.

3.3 Cluster Head Selection

In this phase, from the cluster formation, a special header is selected and that selected cluster is called CH. CH selection is vital to maximizing the NL by employing the restricted energy in an effectual manner.

3.4 Routing

In this phase, the multipath and optimal path is chosen using the AOMDV protocol and HDF algorithm. Routing is performed simply because every device is just aware of the connecting networks, so it requires discovering the remote ones, and routers are those devoted devices that play the part of handling packets dispatched by network nodes to fellow nodes. To thrive in this handling process, the routers have to be conscious of all the addresses (distant), and this is performed by building a forwarding database termed a routing table. Routing should be designed to augment the NL by minimizing the energy consumption of end-to-end transmission. In this proposed method, the routing consists of two sections, first to select the multipath route using AOMDV protocol, then from the multipath route to single out the best optimal path utilizing HDF algorithm.

3.4.1 Multipath Route Selection Using AOMDV Protocol

AOMDV is basically an MPR protocol. It is mainly used to identify a backup route in case of network path failures. When initial paths fail then the backing route is used to continue the transmission process.

Retrieval Number: B3713078219/19©BEIESP
DOI:10.35940/ijrte.B3713078219.098319
Journal Website: www.ijrte.org

1436

Published By:
Blue Eyes Intelligence Engineering
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Source node request for routes repeatedly by way of RREQ messages to the destination. The intermediate nodes pass on this message except if it contains a genuine as well as new route toward the destination, then it transmits a RREP message towards the source node's directions.

RREQ messages are refused by intermediary nodes. Once the 1st RREQ message reaches the destination node, it transmits back a RREP message to the source node through the reverse path created by the intermediate nodes earlier. AOMDV aims to set up several routes to the destination with a similar type of route detection process. AOMDV builds several paths within the source by using the duplicate RREQ messages, in addition to the intermediate nodes. Destination node transmits RREP message to every RREQ message received from different hops. AOMDV uses HELLO messages to identify breaks in the links.
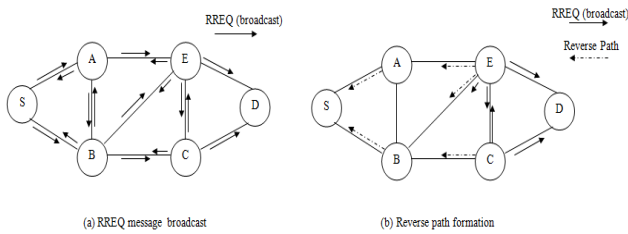

Fig. 2 The AOMDV route Discovery

IV. RESULT AND DISCUSSION

The outcomes of the experiment for the CH selection and the routing are evaluated. The performance of the proposed OPS on multipath using QoS aimed at WSN is performed utilizing MATLAB. AOMDV protocol is used to select multipath routes from the network. After repeated transmissions, a route might lose its link quality. Thus, an optimal path is chosen from the recognized routes using HDF algorithm.

4.1 Comparative Analysis

Table 1: Performance comparison of the proposed HDF method with the existing methods

Performance Metrics	Number of Nodes	Proposed HDF	Existing Tabu PSO	Existing PSO
End-to-End delay	100	22	29	32.3
	200	21.5	30.6	31.65
	300	20	31.3	31
	400	19.05	26.23	29.75
	500	18	22.45	29.43
Delivery Ratio	100	0.12	0.09	0.04
	200	0.2	0.1	0.08
	300	0.3	0.15	0.01
	400	0.35	0.2	0.1
	500	0.4	0.21	0.13
Energy Consumption	100	7.5	10	8.5
	200	7.5	10	8.5
	300	7.5	10	8.5
	400	7.5	10	8.5
	500	7.5	10	8.5
Throughput	100	1400	1200	1100
	200	1500	1350	1000
	300	1700	1600	1400
	400	2200	2000	1600
	500	2500	2100	2000

Network Lifetime	100	79	70	54
	200	60	56	32
	300	59	43	20
	400	61	38	19
	500	43	30	20

Discussion: table.1 demonstrates the proposed OPS's performance with that of the existent techniques in respects of End-to-End delay, delivery ratio, throughput, NL, and also energy utilization. All the methods are compared depending on the no of nodes; the node value is presented between 100-500 nodes. From the above table.1 comparison, the proposed OPS using HDF gives a better result than the existent methods. Graphical illustration of this table.1 value is represented in the below Figs. 5-9.
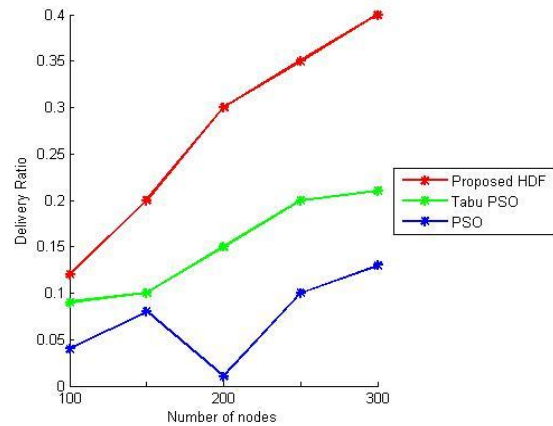

Fig. 3 Performance comparison of the proposed method with the existing OPS technique.

Discussion: Fig. 3 presents a comparative performance analysis of the proposed and existing techniques using delivery ratio. From the 500 nodes, the proposed HDF has 0.2 high delivery ratios when weighted against the existent approaches. Similarly, for all the nodes, the proposed HDF achieve high delivery ratio. Thus, it concludes that the proposed HDF has a high delivery ratio.
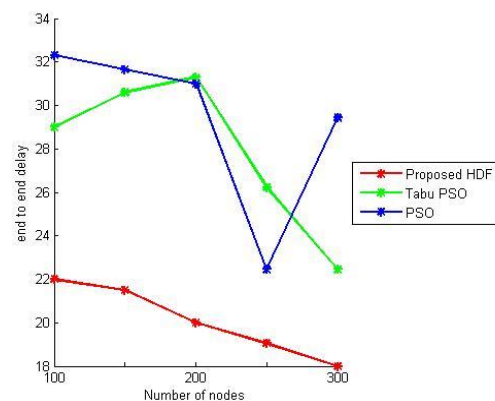

Fig. 4 Graphical representation of end-to-end delay for proposed and existing OPS techniques

Discussion: Above Fig. 4 demonstrate the proposed OPS using HDF's performance with the existent OPS techniques like Tabu PSO, and PSO. The HDF has a low delay in transmitting data as of source to destination. For 100 nodes, the HDF has 22 delays but the existing Tabu PSO technique has slightly 7 percentage delays high than the proposed method. Similarly, for all nodes, the proposed work attains low delay.

Hence from this graphical representation, it is apparent that the proposed work is better when weighted against the existent techniques.
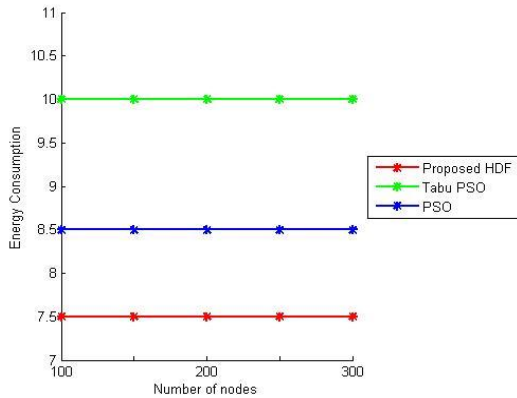

Fig. 5 Performance demonstration of HDF, Tabu PSO and PSO based on energy consumption.

Discussion: Fig. 5 shows the proposed OPS technique's performance with the existent techniques centered on energy consumption. The proposed process obtained 7.5 of energy consumption which is 2.5 and 1 percentage low than the existing Tabu PSO technique and PSO technique for all nodes. Hence, it is observed that the proposed HDF is better when compared to the existing methods.
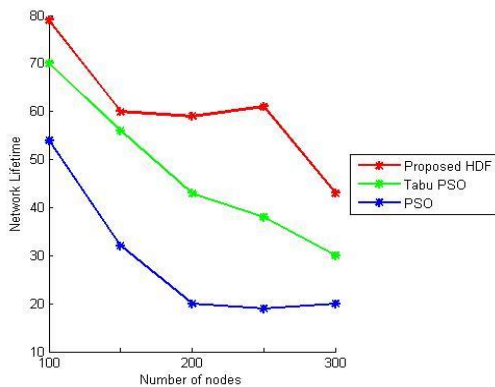

Fig. 6 Comparison graph of NL

Discussion: Fig. 6 exhibits the proposed technique's NL with that of the existent technique. For 100-500 nodes, the proposed HDF achieves high lifetime when weighted against the existing methods. The above figure.8 clearly described that the proposed OPS using HDF technique's performance is superior to other existing techniques.
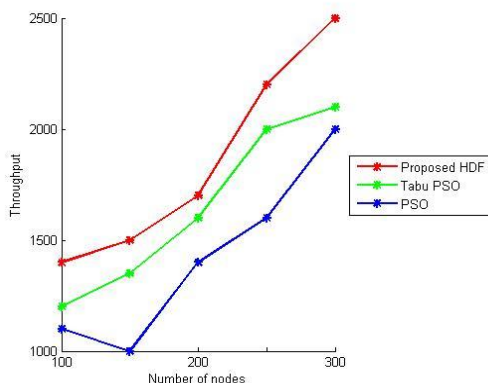

Fig. 7 Illustrate the performance of the proposed with the existing technique based on throughput.

Discussion: Fig. 7 exhibits the throughput comparison of our method and the existing techniques. The proposed work has attained high throughput when weighted against the existent techniques. From this graphical representation, it is proved that the proposed OPS using HDF is much superior to the existent methods.

V. CONCLUSION

WSN became a trend in the current communication systems. Routing plays a significant role in WSNs, as normal IP based routing is not sufficient. A number of parameters are involved in the design of routing protocols such as security, energy awareness, QoS requirement etc. This paper proposed OPS in MPR using QoS intended for WSN. The proposed system's performance is analyzed using SN. The comparison result demonstrated that the proposed OPS have higher through-put, high NL, high delivery ratio, along with low delay. In delivery ratio level, the proposed work is 0.4 ratios for 500 nodes which are high than the existent techniques. Also, in energy consumption level, the proposed work is low. Hence this proposed OPS system is energy efficient, and in response to the network than the other methods. In the upcoming future, the results may be enhanced by advance optimization algorithms.

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