BALANCED AND ENERGY –EFFICIENT WIRELESS SENSOR NETWORK USING A-STAR ALGORITHM

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Abstract : In Wireless Sensor Networks (WSN), there are multiple types of routing protocols are developed and designed. WSN consists of sensor nodes having energy and storage type capabilities. Sensor nodes are used to transmit the information from the area under observation to the base station, which requires some routing protocols to extend the lifetime of the sensor network.
There are multiple techniques available for the routing process in WSN. While using least transmission energy model and less hop routing model techniques, the model generally drains more energy than required, which leads to network and algorithm failure. In this paper, we have used A-Star algorithm to search the optimal path between the source and the destination by extending the network lifetime.in this algorithm, we have used predefined energy of the nodes to participate in to the communication process, the nodes having lower energy then threshold will not participate into the process and tries to find another path.

IndexTerms **- Wireless Sensor Network (WSN); Routing Algorithm; A-Star Algorithm; Dijkstra Algorithm; Energy aware routing in WSN.**

I. INTRODUCTION

In WSN, the sensor nodes are having the capabilities of sensing the environment, processing the sensed data and transmitting the data from source to destination node [1]. The sensor node senses the environment and transmits the sensed data to the base station. Base station has unlimited power and equipped with various capabilities. In WSN, there are basically two types of monitoring takes place which are Continuous Monitoring (CM) and Event-Detection Driven (EDD) Monitoring. In CM, the nodes are sensing the environment continuously while in EDD the monitoring takes place according to applications such as air pollution monitoring, landslide detection, natural disaster, forest fire detection and temperature power [2]. The power of the sensor nodes utilization is the main trend in WSN design [3].

Routing process is basically used to save the energy of the network. So, the energy efficient and reliable algorithm is the main target of the researchers [4]. There are two categories required for transmission: Direct Transmission (DT) and Multi-Hop Transmission (MH). In direct transmission, the data is directly transmitted to the base station from the source node, while in Multi-Hop Transmission, the data reaches the base station through different nodes where other nodes will behave as a relays. The total of MH is greater than DT but it is more energy efficient and reliable [5, 6]. Additionally, through the system operation, the nodes nearest to BS will be over-burden with various information messages. This causes the problem area issue which brings about a quicker deplete of their energy [5, 7].

MH ways can be assessed through a few measurements, for example, energy cost, hop count and residual energy. In terms of hop count, MH transmissions are arranged into two approaches: short-hop routing, where information is directed over numerous short hops and long-hop directing at which information is routed through less long hops. Haenggi and Puccinelli in [8] had specified a few reasons which embrace the second approach, for example, total energy consumption, overhead cost [9], unwavering quality, sleep modes, and delay. As far as aggregate energy utilization, it is frequently accepted that a lessening of the transmit (or transmitted) energy yields corresponds in reduction of total energy consumption. Indeed, even without considering received energy, this isn't valid for any practical power amplifier. Specifically, in low-power transceivers, the nearby oscillators and inclination hardware will overwhelm the energy utilization, with the goal that short-hop routing does not yield any considerable energy advantage if a more inaccessible transfer node can be come to with adequate unwavering quality. In this way, long hops directing is affirmed as more compelling, secure, and focused than the short ones.

From the perspective of the transmission run, nodes look to power the variable range transmit power [10, 11]. Something else, the nodes may communicate utilizing a similar transmission power level with no power control [12]. Unquestionably, undue high-power transmission causes the quick deplete of nodes' energy and presents pointless impedance. In [13], the most reduced conceivable transmit power while safeguarding system availability was researched. Turning to the remaining energy of nodes through the way, a power aware routing protocol was examined in [14]. Not exclusively does it limit the energy utilization per packet, however it additionally augments the normal remaining energy of the nodes. This enhances the network lifetime and keeps the fluctuation of nodes' energy at the least. The past measurements of MH ways can be considered independently or

together. In [15], a novel connection metric was intended to achieve a tradeoff between power utilization by the node and its hop distance to BS. Consequently, a power aware routing protocol based on an altered Dijkstra calculation was proposed. Chiang et al. in [16] presented energy saving-oriented least-hop routing algorithm (ESLHA). It looks for the shortest way (SP) of energy utilization with the slightest cost. Without a doubt, energy cost is an urgent metric for nodes. Nonetheless, in heterogeneous WSN, where nodes have diverse capacities of energy, figuring power, and detecting range, adjusting energy utilization is more imperative.

II. RELATED WORK

In [17], the author has used Dijkstra algorithm for finding the shortest path between the source and the destination node. Dijkstra algorithm uses the greedy approach for finding the shortest path. It finds the minimum costs from the starting node in other words it chooses the nearest node for making the communication possible.

$$f(x) = g(x) \quad (1)$$

Dijkstra would be less efficient when all you need is the minimum distance from one node to another. Dijkstra is an uninformed algorithm. This means that it does not need to know the target node beforehand. For this reason it's optimal in cases where you don't have any prior knowledge of the graph when you cannot estimate the distance between each node and the target.
Since Dijkstra picks edges with the smallest cost at each step it usually covers a large area of the graph. This is especially useful when you have multiple target nodes but you don't know which one is the closest.
But Dijkstra algorithm has also some disadvantages as Dijkstra cannot evaluate negative edge weights and whatever path it chooses never always be the shortest. Dijkstra algorithm chooses the nearer nodes and connects them to form a network.

III. A-STAR ALGORITHM

A-Star Algorithm is used to find the shortest path between source and the destination node. A-Star algorithm uses Heuristic function for decision making. In A-Star algorithm, it uses the energy of the sensor nodes and the distance between the nodes for considering the path to be followed.

$$f(x) = g(x) + h(x) \quad (2)$$

H(x)= Heuristic function
The distance-plus-cost heuristic is a sum of two functions: (i) The path-cost function, which is the cost from the source node to the present node (denoted by g(x)) and (ii) an acceptable "heuristic estimate" of distance to the goal (denoted by h(x)).
A-Star algorithm makes two list of the nodes present in the network which are OPEN and CLOSED. OPEN nodes are the nodes which are yet to be examined for taking participation in the network and CLOSED nodes are basically nodes which are already examined.

IV. EXPERIMENTAL RESULTS

For the experiment we have used following simulation parameters:

Parameters [18]	**WSN-I [18]**	**WSN-II [18]**	**WSN-III [18]**	**WSN-IV [18]**
Number of nodes	50	75	100	150
Field Dimensions	100x100 m^2	200x200 m^2	400x400 m^2	600x600 m^2
Node density x10^3	40/8 m^{-2}	15/8 m^{-2}	5/8 m^{-2}	3.33/8 m^{-2}
Initial Energy E_o	($0.5<E_o<1$)			
E_{elec}	50nJ/bit			
ε_{fs}	10pJ/bit/m^2			
ε_{mp}	0.0013pJ/bit/signal			
E_{DA}	5nJ/bit/signal			
Data packet size k	4000 bits			

Table No. 1

We have considered four scenarios of the WSN [18] having different number of nodes and area. After applying different scenarios to A-Star Algorithm and Dijkstra Algorithm it is found that in fig 4(a) the path average residual energy of proposed A-star algorithm is better than BEERAD which uses Dijkstra algorithm, as the Dijkstra algorithm uses nearer distance algorithm and A-star uses energy and distance both simultaneously and it also uses the heurisitic function which helps in deciding the nodes will help into deciding a particular path which ultimately chooses the highest energy nodes and causing the higher path average residual energy then BEEMH.

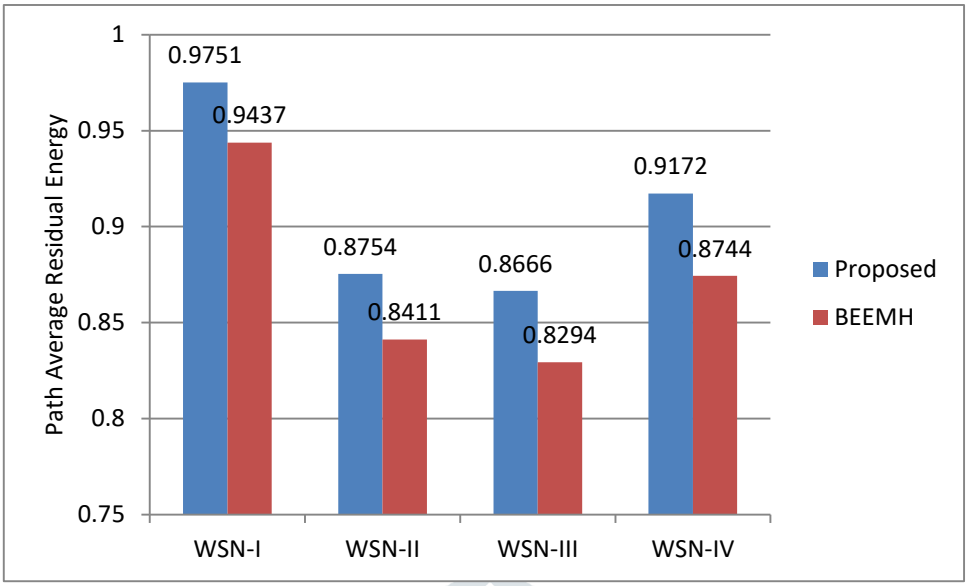

Figure 4(a)

	Proposed	BEEMH [18]	%age improvement
WSN-I	0.9751	0.9437	**3.14%**
WSN-II	0.8754	0.8411	**4.07%**
WSN-III	0.8666	0.8294	**4.45%**
WSN-IV	0.9172	0.8744	**4.89%**

Table No. 2

In figure 4(b), due to the availability of the heurisitic function in A-Star algorithm, it chooses the path to be followed in advance and the nodes participating into the network formation so the other nodes are in inactive state making their energy unutilized but in BEERAD, a new path into the network is formed after every successful communication process so every node has to be remain active to participate into the network formation. In figure 4(b), the first node or source node dies (FND) in case of BEERAD earlier than A-star and also Half nodes alive (HNA) is also lower in the case of BEERAD.

	Proposed	BEERAD [18]	%age improvement
FND	170	166	**2.40%**
HNA	283	272	**4.04%**

Table No. 3

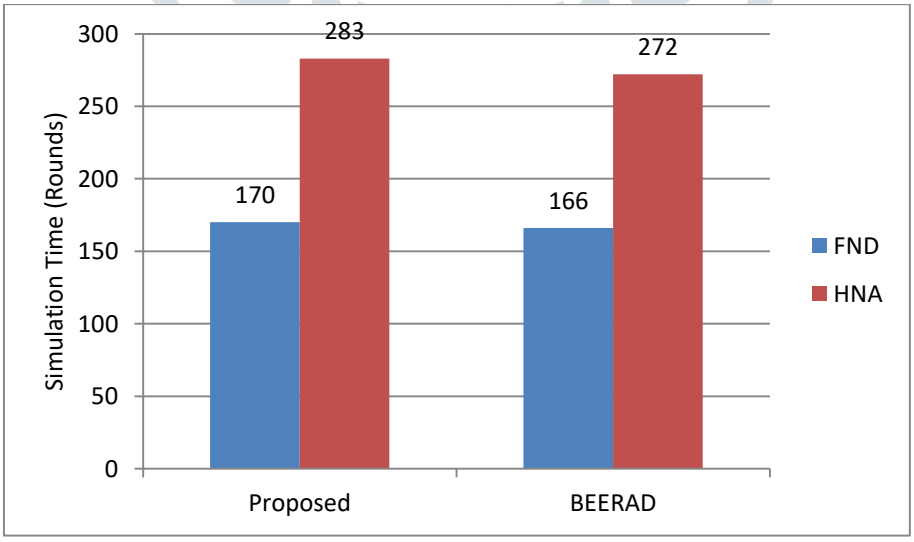

Figure 4(b)

In figure 4(c), since the energy consumption of the BEERAD is more as it is using Dijkstra algorithm so the total residual energy of BEERAD is lower as compare to the Proposed A-Star Algorithm. The nodes of the network, in case BEERAD, get loose there energy because they remain active through the communication process but in case of A-star Algorithm, the nodes which are not participating in the network remains inactive making the whole network alive for more time.

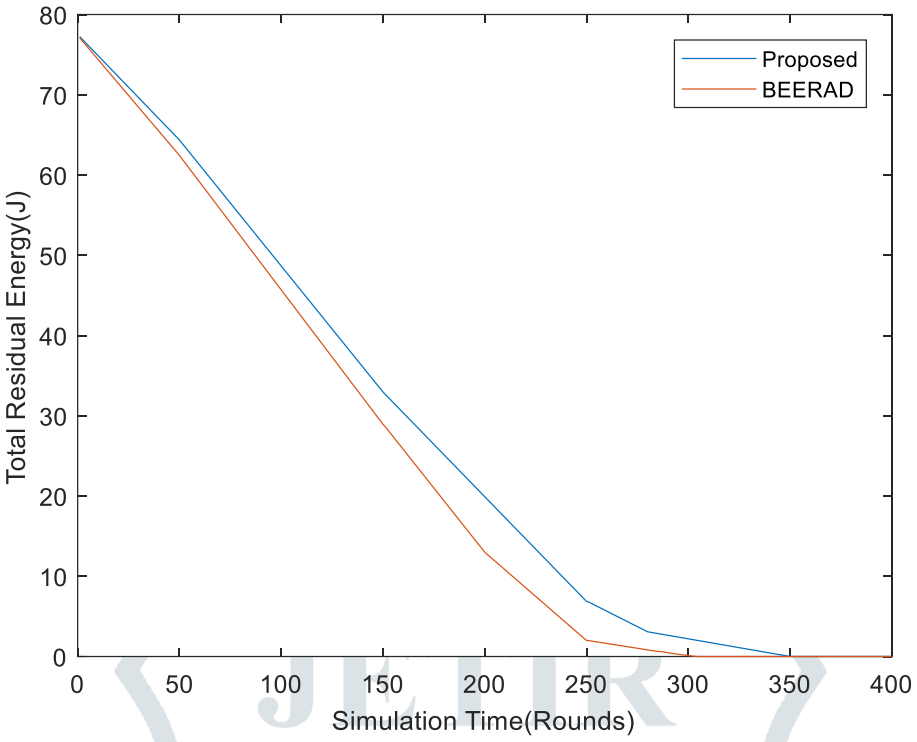

Figure 4(c)

In figure 4(d), since most nodes in the A-Star algorithm are alive upto the end of the network due to the heurisitic function making its graphs stands more as compare to the BEERAD [18]. As in A-Star Algorithm the nodes are not using their respective energy when they are in inactive state but in BEERAD, all nodes

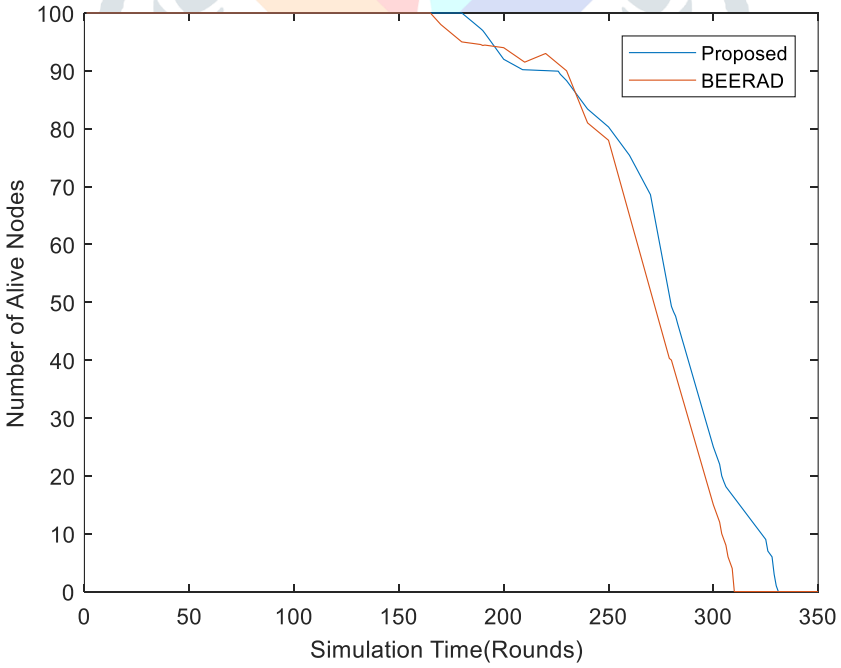

Figure 4(d)

take participation in to the communication process. So, when the number of rounds are increasing the nodes in BEERAD depletes there energy and dies fast as compare to A-Star algorithm.

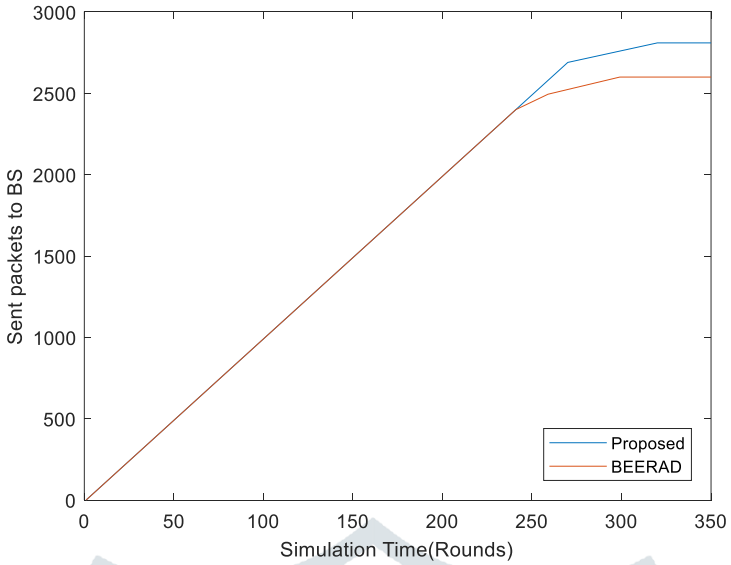

Figure 4(e)

In figure 4(e), more nodes are active and alive in A-Star Algorithm making the network always online and sends more packet to the base station on comparison with the BEERAD

V CONCLUSION

Stability of the network is the most important thing in WSN along with the lifetime of the nodes. The death of the source node in the WSN make the whole network unstable and no further data is being sent to the base station from the network. This paper is using both algorithms, which are Dijkstra and A-Star algorithm, are energy efficient and finds the shortest path to the base station from the source node. Here the proposed A-Star algorithm is more efficient then the BEERAD. BEERAD is also using the shortest path and using the energy of the nodes but since it is based on dijkstra algorithm makes every node in the network active which is not in the case of A-Star Algorithm.

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