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Comparative Analysis of Energy Efficient Routing Protocols Using GA and HSA

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Abstract: **Now days the accomplished plan and awareness of wireless sensor networks has revolved in a wide spread area of today's time, due to enormous capability of wireless sensor networks to allow the applications that join the substantial world to virtual world. Wireless sensor network (WSN) has been strained in medical examination, surveillance etc. Nodes are built with few sensors and a mote unit. Wireless Sensor is a bit of the equipment which collects the data and hands it over to mote. Wireless sensors are generally worn to calculate the changes in essential environmental characteristics such as warmth, strain, moisture, noise, and tremor. In addition to these variations in the fitness parameter of a person like blood pressure and the rate of heart beat. Therefore, in this research technique named as Energy Efficient Routing Protocol using GA (EERPGA) & HSA (EERPHSA) are demonstrated to apply Genetic Algorithm (GA) and Harmony Search Algorithm (HSA) to the problem of choosing the cluster heads in the cluster set-up phase which is based on dwindling the cluster's density/break up/compactness (intra remoteness) and expediting the cluster separation (inter remoteness) to aptly maximize the network life span and to achieve better stability time.**
Keywords: WSN (Wireless Sensor Network), GA (Genetic Algorithm), HSA (Harmony Search Algorithm)

I. INTRODUCTION

WSN is a self configuring network of tiny sensor nodes interacting amongst themselves via radio waves and positioned in number to intellect, watch and comprehend the substantial world. By grouping huge figures of small sensor nodes, it is likely to get figures about substantial event that was tricky or unfeasible to attain in more predictable behavior. In the approaching years, as progress in micro fabrication tools agree to the expenditure of developing sensor nodes to prolong to drop, growing consumptions of WSN's are predictable, with the networks ultimately increasing to hefty numbers of nodes. Probable applications for such large-scale WSN's exist in a variety of fields, including medical examination [1, 2], environmental examination [3], supervision, habitat safekeeping, armed operations, and business instrument monitoring.

The paper trails as: Analysis of earlier work is specified in Section. II. Section III focuses on the formulation of the projected algorithm. Section IV hearsay a number of tentative results to display the performance of the new algorithm. In the end, conclusions are drawn in Section. V.

II. LITERATURE SURVEY

Hoang et. al. (2014) proposed a structure that enables sensible progress of innermost cluster-based protocols reinforced by upsurge methods for the wireless sensor networks. Based on this structure, a protocol employing harmony search algorithm (HSA), was planned and realized in real world for the WSNs. From the tentative examination, it indicates that the WSNs life span has been increased via the planned HSA protocol in contrast to that of LEACH-C and FCM protocols [5].

Attea et. al. (2012) aimed to improve the unwanted activities of the EA when trading with clustered steering issue in WSN by creating a new fitness function that include 2 clustering aspects, viz. consistency and parting error. Imitation on 20 random varied WSNs shows that author's evolutionary based clustered routing protocol (ERP) at all times extends the network life span, conserves further energy in contrast to the outcome attained employing the current heuristics like LEACH, SEP, and HCR protocols. [6].

A. Zahmatkesh and M. H. Yaghmaee (2012) proposed Genetic Algorithm abbreviated as GA to reform sensor nodes' energy utilization. The authors used a multipurpose algorithm that produces most favorable number of sensor-clusters with cluster-heads and reduces the fee of broadcast. The apparatus are then utilized and the average fitness of the system is calculated [7].

Smaragdakis et. al. (2004) projected Stable Election Protocol (SEP), a heterogeneous-aware protocol to extend the life span before the first node is lost, which is vital for numerous applications where the reaction from the sensor network must be dependable. SEP is based on biased selection probabilities of each node to turn into cluster head as per the lingering energy in every node [8].

Heinzelman et. al. (2002) build up and examine low energy adaptive clustering hierarchy (LEACH), a protocol structural design for micro-sensor networks that unites the thoughts of energy efficient cluster based routing and media access jointly along with application-specific data aggregation to attain fine performance in terms of system life span, latency, and application seeming quality [9].

III. PROPOSED WORK

In the proposed work a technique named as Energy Efficient Routing Protocol using GA (EERPGA) is projected to apply Genetic Algorithm (GA) to the issue of selecting the cluster head nodes in the cluster set up phase which is completely based on dwindling the cluster's consistency/break up/compactness (intra remoteness) and maximizing the cluster separation (inter remoteness) aptly maximize the network life span and to achieve better stability time. Another technique is also proposed for the same purpose but using Harmony Search Algorithm (HSA). This technique is named as EERPHSA. The process of the both protocols is split into rounds, where every round begins with a set up phase, when the sink (BS) locates the locations of CHs and allocates members nodes of each CH, trailed by a steady-state phase, when the sensed data is shifted to CHs and gathered in frames; then these frames are shifted to the BS.

To guide the CH selection, EERPGA and EERPHSA uses a number of solutions that yields toward optimizing the required fitness function. Each resolution is symbolized as a set length of size equivalent to the overall number of nodes in the wireless sensor network. The head and member nodes are constituted as 1 and 0 correspondingly, while dead/expired nodes are constituted as −1. Each resolution is arbitrarily initialized with 1s and 0s according to the probability of a node to become a cluster head, p.

$$\forall i \in \{1, \ldots\ldots, n\} \text{and } \forall j \in \{1, \ldots, \infty, N\}$$

$$S_j^i \begin{cases} 1 & if\, E(\mathrm{node_j}) > 0 \; and \; \mathrm{random_j} \le \mathrm{p} \\ 0 & if\, E(\mathrm{node_j}) > 0 \; and \; \mathrm{random_j} > \mathrm{p} \\ -1 & otherwise \end{cases} \quad (1)$$

where n is the amount of individual solutions and N is the amount of sensor nodes in the network.

Fitness Function:

To improve the clustering solution and to elect CHs provided by the existing algorithms two distance functions are used to form the fitness function. Cluster's consistency or break up or compactness (intra remoteness) is computed as

$$\text{Compactness} = \sum_{i=0}^{CHs} \sum_{\forall n \in C_i} d(n, CHi) \quad (2)$$

where CHs amounts to the quantity of group heads, C_i is the i^{th} group eminent with group head CH_i, and any non group head member, n, belongs to the cluster Ci that pleases the least distance between n and CHi. Also, Separation or inter-distance can be quantified as the minimum Euclidean

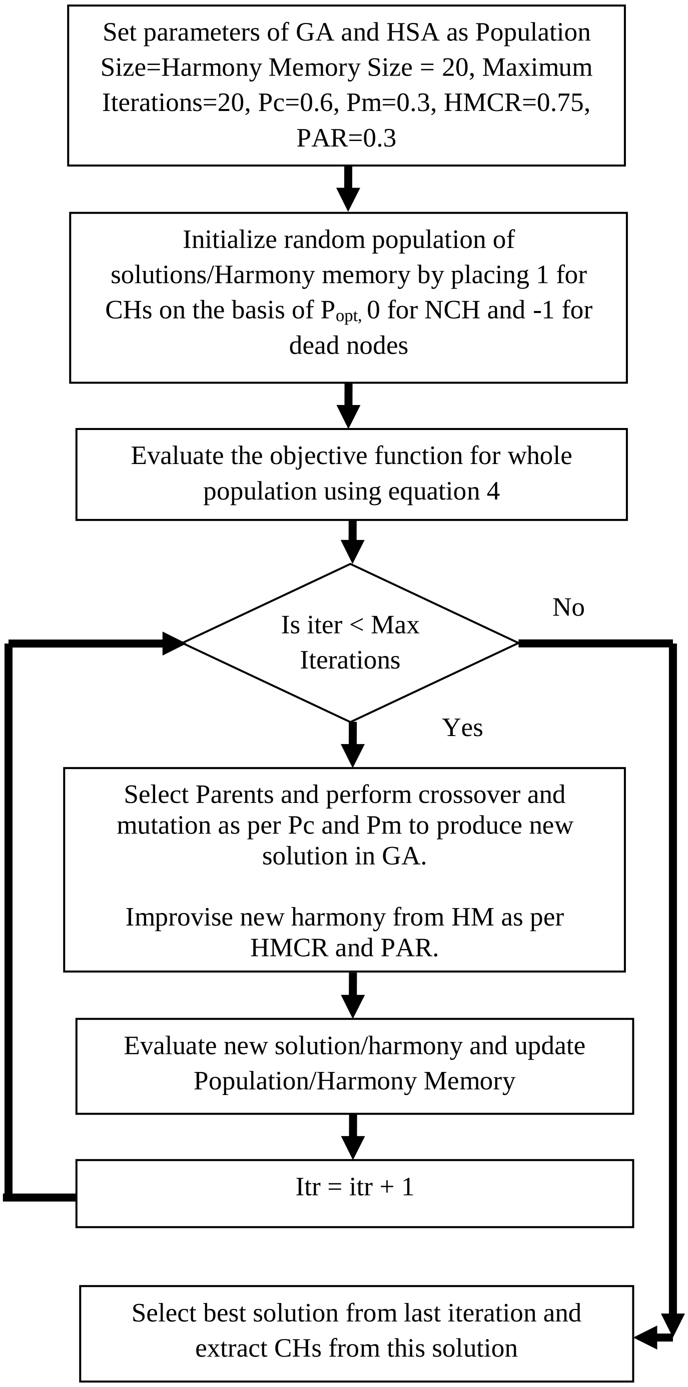

Fig. 1. Flow chart of Cluster Head Selection Algorithm using GA/HSA

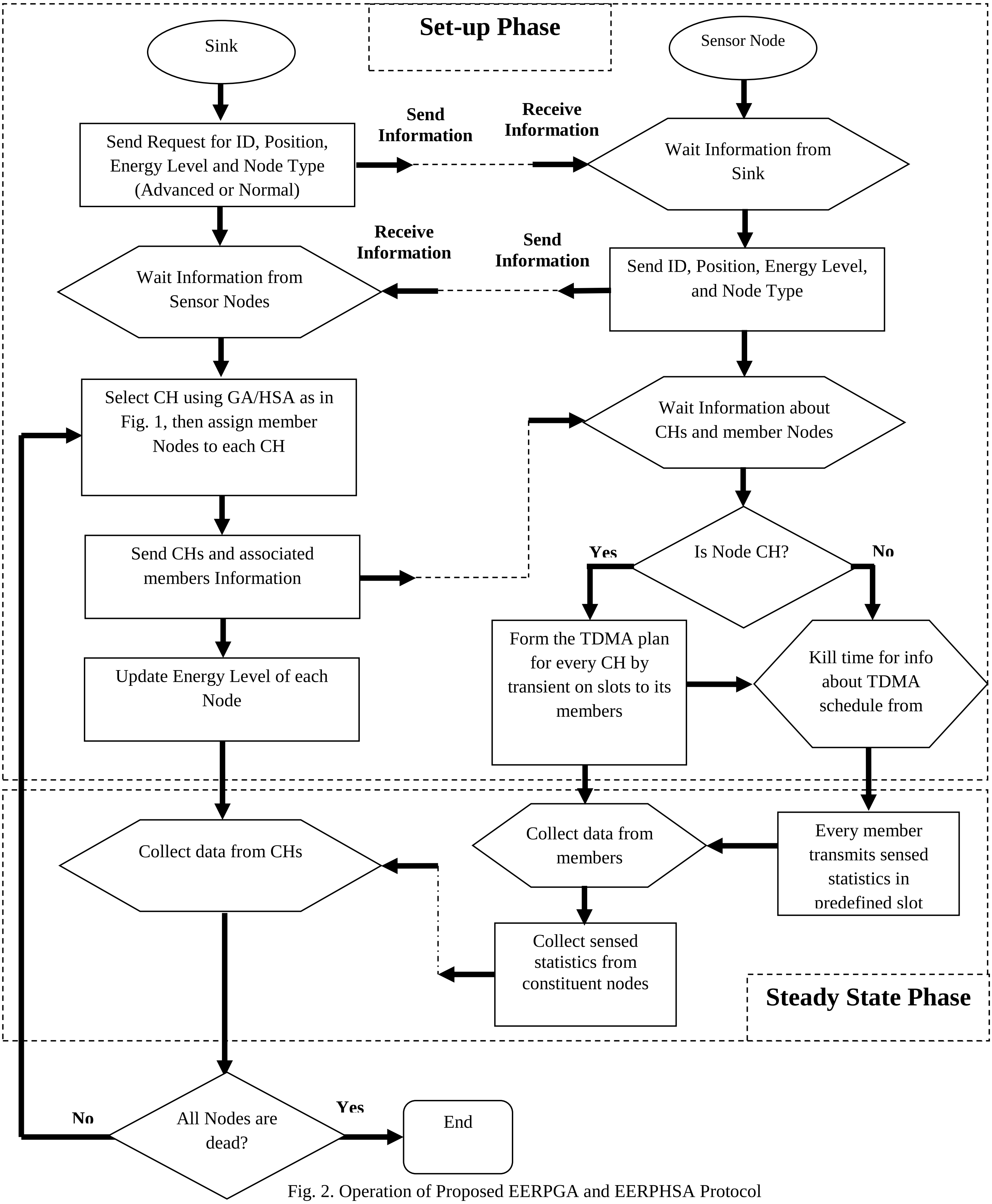

Fig. 2. Operation of Proposed EERPGA and EERPHSA Protocol

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remoteness among any pair of cluster heads is computed as

$$Seperation = \min_{\forall C_i, C_j,\ C_i \neq C_j} \{d(CH_i, CH_j)\} \quad (3)$$

Then the fitness function is to minimize the following function

$$\text{Fitness} = \text{Compactness/Separation} \quad (4)$$

IV. RESULT AND DISCUSSION

To confine the performance of projected GA and HSA in the network test instances and to study its actions of both algorithms, Figs. 3 and 4 statistically qualify them with 10% and 20% of node heterogeneity.

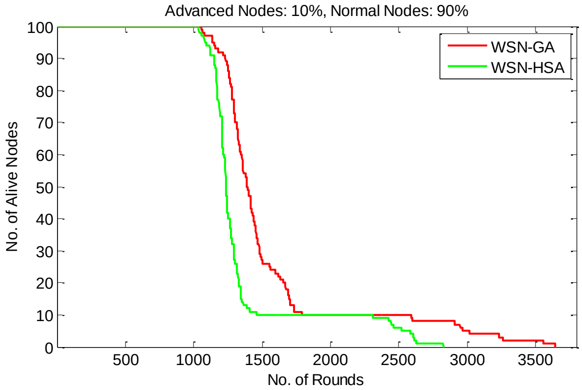

Fig. 3. Overall living nodes in the arrangement against rounds. 10% node heterogeneity confirms dominance of GA over HSA in growing network life span. Furthermore, it outperforms HSA in growing the stability period

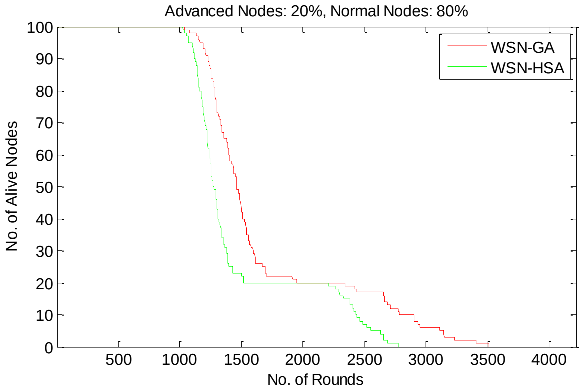

Fig. 4. Overall living nodes in the arrangement against rounds. 20% node heterogeneity confirms dominance of GA over HSA in growing network life span. Furthermore, it outperforms HSA in growing the stability period

Table 1: Round past of expired nodes over model of WSNs (with 10% Heterogeneity)

% dead nodes	GA	HSA
10	1230	1149
20	1279	1171
30	1304	1206
40	1346	1221
50	1388	1236
60	1440	1254
70	1482	1295
80	1652	1330
90	1792	1458
100	3640	2825

Table 2: Round past of expired nodes over model of WSNs (with 20% heterogeneity)

% dead nodes	GA	HSA
10	1226	1117
20	1283	1156
30	1333	1201
40	1398	1235
50	1462	1272
60	1508	1312
70	1593	1379
80	1948	1520
90	2779	2429
100	3512	2775

The records portray the amount of alive nodes against protocol rounds. Moreover, to provide a thorough insight into the performance of these algorithms, quantitative results are also incorporated summing up network life span (Tables 1 and 2) and the remaining energy in the network while protocol rounds continue (Tables 3 and 4). Make sure that in every table, the finest values are specified in bold.

The outcomes in Tables 1 and 2 witness the round number where a known proportion of nodes die/expire for the compared algorithms. Outcomes clearly demonstrate the positive impact of the GA for falling number of dead/expired nodes while the algorithm rounds continue, and hence, rising the network life span. In Table 1, the increase in life span of of network using GA was 28.8% as compared with HSA. Besides, in Table 2, the gain was 15.5%, in contrast to HSA respectively.

Table 3: Residual energy over protocol rounds for overall 3640 rounds (with 10% Heterogeneity)

%rounds	GA	HSA
10	41.3282	39.6279
20	27.7297	24.3058
30	14.1412	9.1843
40	5.5703	4.0556
50	3.6004	2.5215
60	2.3788	0.9874
70	1.2059	0.0397
80	0.4001	^0
90	0.0890	-
100	0	-

Table 4: Residual energy over protocol rounds for overall 3512 rounds (with 20% Heterogeneity)

%rounds	**GA**	**HSA**
10	**44.8818**	43.1685
20	**29.7884**	26.3537
30	**15.1006**	11.2711
40	**7.9213**	6.5423
50	**4.8550**	2.9077
60	**2.1073**	0.2664
70	**0.4660**	^0
80	**0.0396**	-
90	**0.0015**	-
100	**0**	-

Tables 3 and 4 illustrate the constructive blow of GA for discounting further energy in the network at a chosen round period. Both clustering protocols consume the total energy. HSA wastes the network energy more rapidly than GA. And GA preserves more energy than HSA algorithm in addition to longer stability period.

Added remark can be worn from these tables, which reveal the actions of GA as well as HSA. GA outperforms HSA by maintaining the alive nodes superior than that of these algorithms during the network life span. As clear from Fig.5 and Fig.6, GA keeps from 90% nodes to LND for longer number of rounds in both the scenarios (10% and 20% heterogeneity). This study can be quantitatively accessed in Tables 1 and 2 for the two groups of WSNs.

Fig 5 and Fig 6 shows the amount of rounds at FND, HND and LND for all the algorithms from these figures it can be observed that GA algorithm in both cases performs better than the HSA algorithm in terms of stability period as well as network life span. The GA algorithm lengthens the stability period by 21 rounds in contrast to HSA in case of 10% heterogeneity. And it lengthens the stability period by 14 rounds in contrast to HSA in case of 20% heterogeneity.

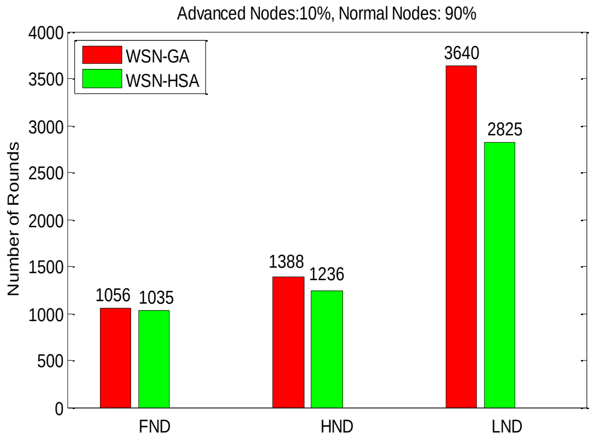

Fig 5. Quantity of rounds at LND, HND, FND (10% Heterogeneity)

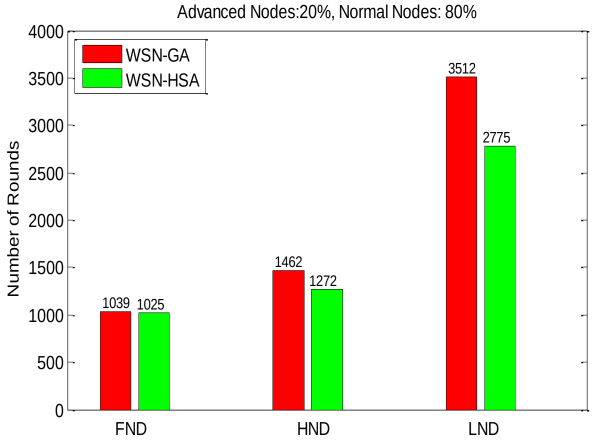

Fig 6. Quantity of rounds at LND, HND, FND (20% Heterogeneity)

Fig 7 and Fig 8 exhibit the residual energy of network as it proceeds towards final rounds and is very clear that remaining energy reduces with rounds but GA algorithm outperforms the HSA by having more residual energy at any time of network for both the cases of heterogeneity.

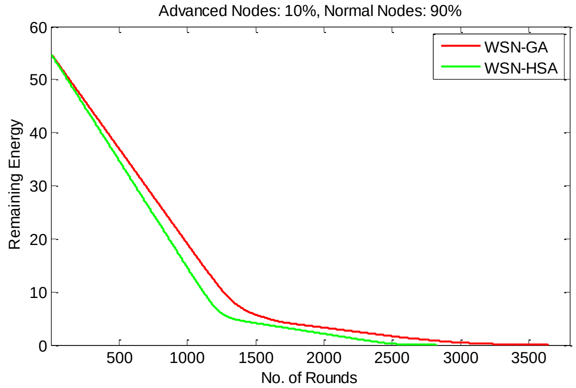

Fig 7. Residual energy of network with rounds (10% Heterogeneity)

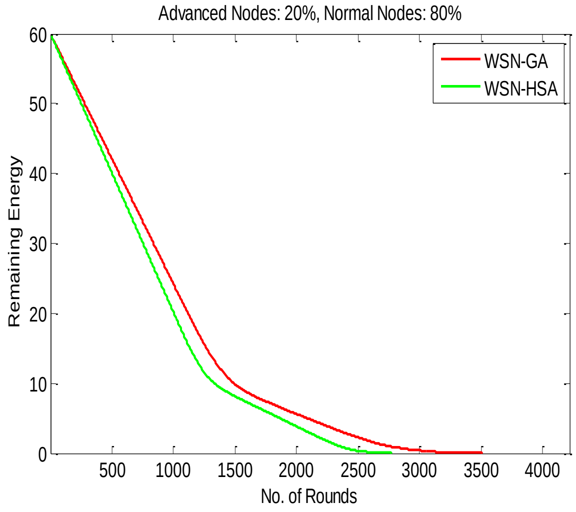

Fig 8. Residual energy of network with rounds (20% Heterogeneity)

V. CONCLUSION

In the presented research, a new Genetic Algorithm based Energy Efficient adaptive clustering hierarchy Protocol (EERPGA) is proposed to proficiently lengthen the life span and stability period of WSNs. MATLAB simulation outcome illustrated that the proposed EERPGA protocol is further energy proficient and added unswerving in clustering method in contrast to WSN with GA i.e. EERPHSA for heterogeneous networks. The throughput of EERPGA is always more than the other algorithm so it can be said that more data is transferred in the network using the proposed technique in comparison to other technique with same or less amount of energy consumption. So Proposed routing protocol EERPGA performs better almost all aspects of a WSN.

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