An Energy Efficient Routing Protocol using ABC to Increase Survivability of WSN

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ABSTRACT
These days proficient design and realization of wireless sensor networks has turn into a hot area of research in recent time, due to the immense potential of sensor networks to enable applications that bond the substantial world to the virtual world. Wireless sensor network (WSN) is being used in surveillance, medical monitoring etc. Sensors nodes are typically built of few sensors and a mote unit. A Sensor is a piece of equipment which wits the information and passes it on to mote. Sensors are usually used to compute the changes in substantial environmental parameters like warmth, strain, moisture, noise, tremor and changes in the fitness parameter of person e.g. blood pressure and the rate at which the heart beats. In this research a technique named ABC Based Energy Efficient Protocol (ABCEEP) is projected to apply Artificial Bee Colony (ABC) to the problem of electing the cluster heads in the cluster set-up phase based on minimizing the cluster's consistency/break up/compactness (intra remoteness) and maximizing the cluster separation (inter remoteness) to proficiently increase the network life span and to get better stability period.

Keywords
WSN (Wireless Sensor Network), ABC (Artificial Bee Colony), GA (Genetic Algorithm), HSA (Harmony Search Alogrithm)

1. INTRODUCTION
A Wireless Sensor Network is a self-configuring network of small sensor nodes interacting among themselves using radio signals and deployed in number to intellect, watch and comprehend the substantial world. By networking huge figures of small sensor nodes, it is likely to get data about substantial phenomena that was tricky or unfeasible to obtain in more predictable ways. In the approaching years, as advances in micro-fabrication technology allow the expenditure of manufacturing sensor nodes to prolong to drop, growing deployments of wireless sensor networks are predictable, with the networks ultimately increasing to large numbers of nodes. Probable applications for such large-scale wireless sensor networks exist in a variety of fields, including medical monitoring [1, 2], environmental monitoring [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.

2. LITERATURE SURVEY
Hoang et. al. (2014) proposed a structure that enables sensible progress of centralized cluster-based protocols reinforced by optimization methods for the WSNs. Based on this structure, a protocol using harmony search algorithm (HSA), was planned and implemented in real time for the WSNs. From the tentative test results, it can be seen that the WSNs life span has been increased using the planned HSA protocol in comparison with 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 problem in WSN by formulating a new fitness function that incorporates 2 clustering aspects, viz. consistency and parting error. Imitation over 20 random heterogeneous WSNs shows that author's evolutionary based clustered routing protocol (ERP) at all times prolongs the network lifetime, conserves more energy as compared to the results obtained using the current heuristics such as LEACH, SEP, and HCR protocols. [6].

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

Smaragdakis et. al. (2004) proposed Stable Election Protocol (SEP), a heterogeneous-aware protocol to extend the time period before the loss of the first node, which is vital for numerous applications where the reaction from the sensor network must be dependable. SEP is based on weighted election probabilities of each node to turn into cluster head according to 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 microsensor networks that combines the thoughts of energy-efficient cluster-based routing and media access jointly with application-specific data aggregation to attain fine performance in terms of system life span, latency, and application seeming quality [9].

3. PROPOSED WORK
In the proposed work a technique named ABC Based Energy Efficient Protocol (ABCEEP) is projected to apply Artificial Bee Colony (ABC) to the problem of electing the cluster heads in the cluster set-up phase based on minimizing the cluster's consistency/break up/compactness (intra remoteness) and maximizing the cluster separation (inter remoteness) to efficiently maximize the network lifetime and to improve the

stability period. The operation of the ABCEEP protocol is broken up into rounds, where each round begins with a set-up phase, when the sink (BS) finds the locations of CHs and assigns members nodes of each CH, followed by a steady-state phase, when the sensed data are transferred to CHs and collect in frames; then these frames are transferred to the BS.

To guide the CH selection, ABCEEP uses a number of solutions that yields toward optimizing the required fitness function. Each resolution is represented as a set-length of size equivalent to the overall number of nodes in the WSN. The head and member nodes are constituted as 1 and 0 correspondingly, while dead nodes are constituted as −1. Each resolution is randomly initialized with 1s and 0s according to the optimal probability of a node to become a cluster head, p.

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

$$S_j^i \begin{cases} 1 & if E(\text{node}_j) > 0 \; and \; \text{random}_j \leq p \\ 0 & if E(\text{node}_j) > 0 \; and \; \text{random}_j > p \\ -1 & otherwise \end{cases} \quad (1)$$

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

3.1 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 cluster heads, Ci is the ith cluster eminent with cluster-head CHi, and any non cluster head node, n, belongs to the cluster Ci that pleases the smallest distance between n and CHi. Also, we can quantify Separation or inter-distance as the minimum Euclidean remoteness between 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

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

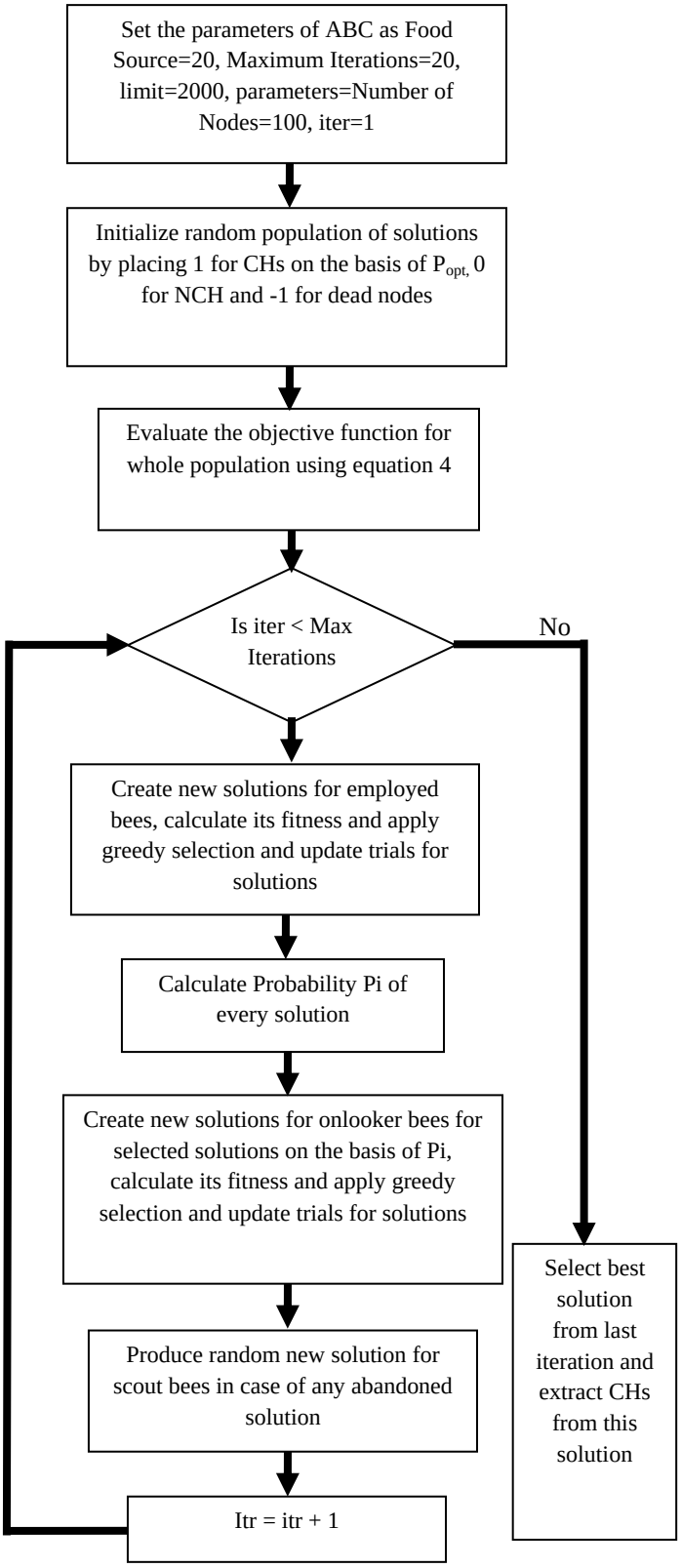

Fig 1: Flow chart of Cluster Head Selection Algorithm using ABC

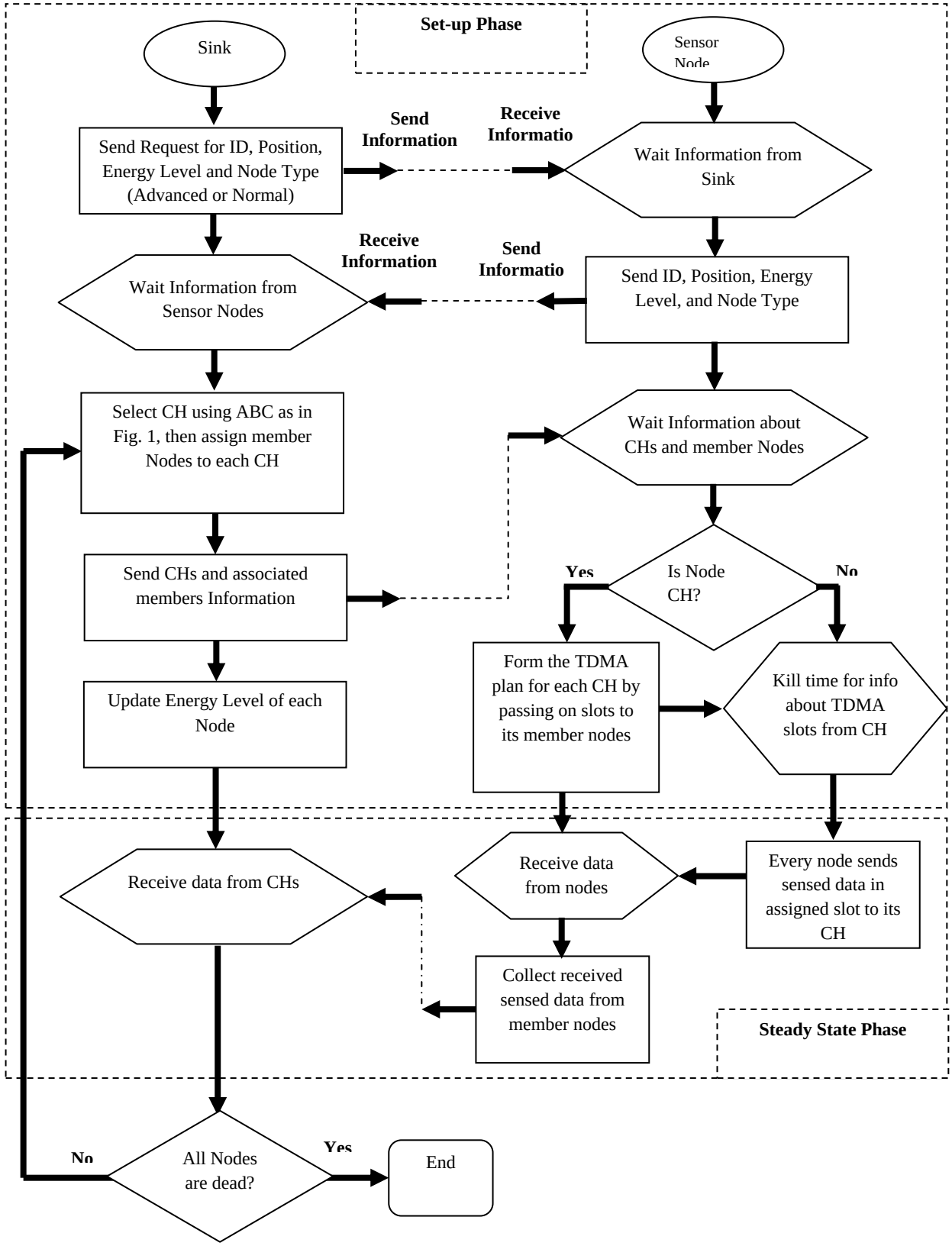

Fig 2: Operation of Proposed ABCEEP Protocol

4. RESULT AND DISCUSSION

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

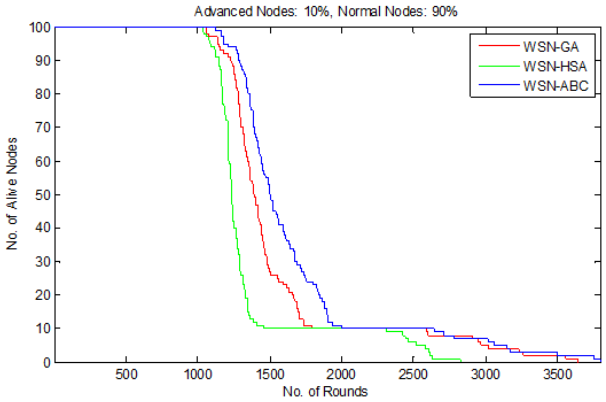

Fig. 3: Overall alive nodes in the network against rounds. Results with 10% node heterogeneity shows dominance of ABC in growing network life span. Furthermore, it outperforms GA and HSA in growing the stability period

The figures portray the number of alive nodes against protocol rounds. Moreover, to give a thorough insight into the performance of these algorithms, quantitative results are also incorporated summarizing network life span (Tables 1 and 2) and the energy left in the network while protocol rounds proceed (Tables 3 and 4). Make a note that in each table, the best performance values are specified in bold.

The results in Tables 1 and 2 witness the round number where a given proportion of nodes die for the compared algorithms. Results clearly demonstrate the positive impact of the projected ABC for falling number of dead nodes while the algorithm rounds continue, and hence, rising the network life span. In Table 1, the increase in life span was 11.5% and 37% as compared with GA and HSA, correspondingly. Besides, in Table 2, the gain was 20%, and 52% as compared with GA and HSA respectively.

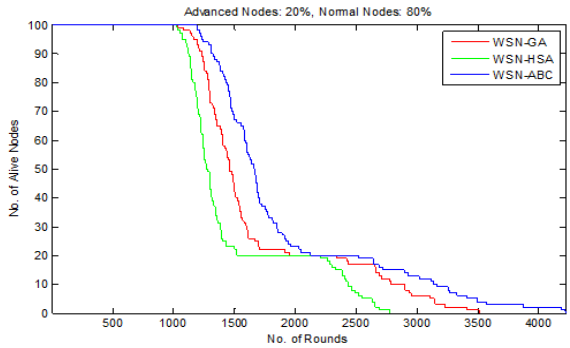

Fig. 4: Overall alive nodes in the network against rounds. Results with 20% node heterogeneity shows dominance of ABC in growing network life span. Furthermore, it outperforms GA and HSA in growing the stability period

Table 1: Round past of dead nodes over simulation of WSNs (with 10% advanced nodes)

% dead nodes	GA	HAS	ABC
10	1230	1149	**1282**
20	1279	1171	**1348**
30	1304	1206	**1391**
40	1346	1221	**1442**
50	1388	1236	**1501**
60	1440	1254	**1589**
70	1482	1295	**1677**
80	1652	1330	**1840**
90	1792	1458	**1998**
100	3640	2825	**3797**

Table 2: Round past of dead nodes over simulation of WSNs (with 20% advanced nodes)

% dead nodes	GA	HAS	ABC
10	1226	1117	**1312**
20	1283	1156	**1430**
30	1333	1201	**1479**
40	1398	1235	**1584**
50	1462	1272	**1662**
60	1508	1312	**1696**
70	1593	1379	**1848**
80	1948	1520	**2122**
90	2779	2429	**3132**
100	3512	2775	**4217**

Table 3: Residual energy over protocol rounds for overall 3797 rounds (with 10% Heterogeneity)

%rounds	GA	HAS	ABC
10	41.3282	39.6279	**42.1218**
20	27.7297	24.3058	**29.4027**
30	14.1412	9.1843	**16.6889**
40	5.5703	4.0556	**7.0626**
50	3.6004	2.5215	**3.8366**
60	2.3788	0.9874	**2.6009**
70	1.2059	0.0397	**1.4058**
80	0.4001	^0	**0.5726**
90	0.0890	-	**0.1993**
100	^0	-	**0**

Table 4: Residual energy over protocol rounds for overall 4217 rounds (with 20% Heterogeneity)

%rounds	GA	HAS	ABC
10	44.8818	43.1685	**46.6988**
20	29.7884	26.3537	**33.2793**
30	15.1006	11.2711	**19.9485**
40	7.9213	6.5423	**10.1893**
50	4.8550	2.9077	**6.5095**
60	2.1073	0.2664	**3.7804**
70	0.4660	^0	**1.7363**
80	0.0396	-	**0.5955**
90	^0	-	**0.2042**
100	-	-	**0**

Tables 3 and 4 illustrate the constructive impact of ABC for discounting more energy in the network at a selected round period. All clustering protocols consume the entire energy. HSA wastes the network energy faster than other algorithms. And ABC preserves more energy than other two algorithms in addition to longer stability period.

Added remark can be drawn from these tables, which reveal the actions of ABC next to GA as well as HSA. ABC outperforms GA & HSA by maintaining the alive nodes larger than that of these algorithms during the network life span. As clear from Fig.5 and Fig.6, ABC 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 number of rounds at FND, HND and LND for all the algorithms from these figures it can be observed that ABC algorithm in both cases outperforms the other algorithms in terms of stability period as well as network life span. The ABC algorithm extends the stability period by 68 and 89 rounds as compared to GA and HSA respectively in case of 10% heterogeneity. And it extends the stability period by 150 and 164 rounds as compared to GA and HSA respectively in case of 20% heterogeneity.

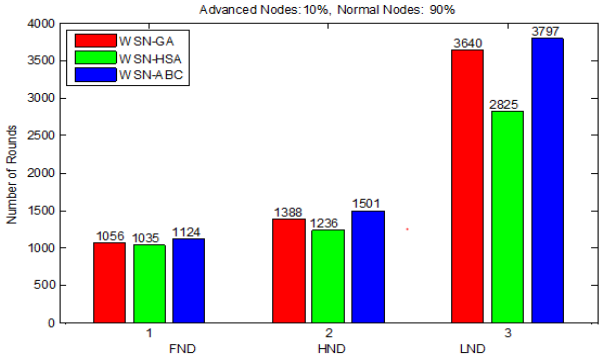

Fig 5: Number of rounds at FND, HND, LND (10% Heterogeneity)

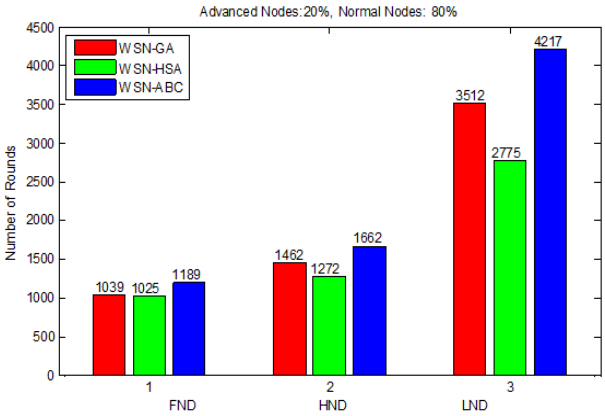

Fig 6: Number of rounds at FND, HND, LND (20% Heterogeneity)

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

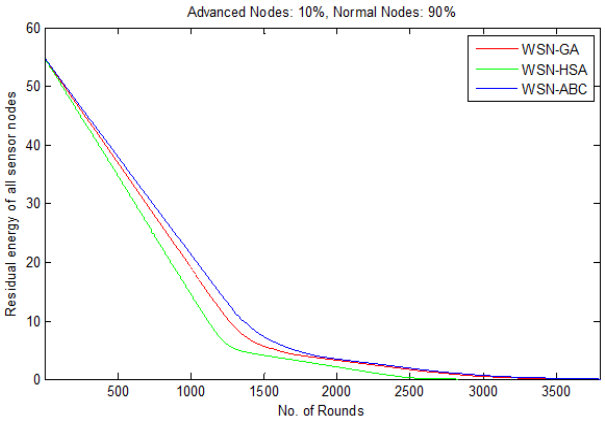

Fig 7: Residual energy of network with rounds (10% Heterogeneity)

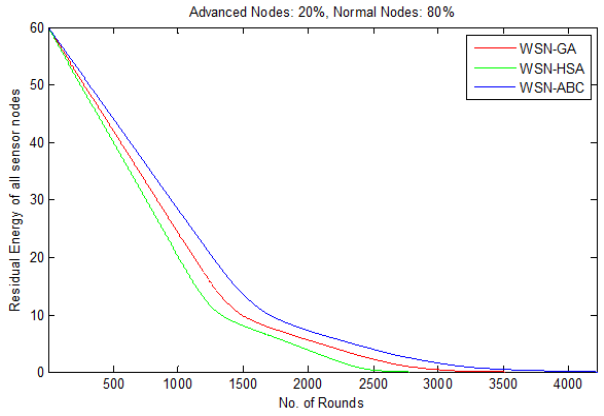

Fig 8: Residual energy of network with rounds (20% Heterogeneity)

5. CONCLUSION

In the presented research, a new Artificial Bee Colony based Energy Efficient adaptive clustering hierarchy Protocol (ABCEEP) is proposed to proficiently lengthen the life span and stability period of WSNs. MATLAB simulation outcome showed that the proposed ABCEEP protocol is further energy

efficient and more unswerving in clustering method as compared to ERP (WSN-GA) as well as WSN with Harmony search algorithm for heterogeneous networks. The throughput of ABCEEP is always more than the previous algorithms so it can be said that more data is transferred in the network using the proposed technique in comparison to previous techniques with same or less amount of energy consumption. So Proposed routing protocol ABCEEP performs better almost all aspects of a WSN.

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