# Enhance the performance of network lifetime optimization and increase the stability period using Gravitational Energy Sensitive Energy Hierarchical Protocol

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**Abstract-Day by day wireless sensor networks necessity was increased, but when we work on it we find two well-known major issues which are cluster head selection and routing for this cause reducing their life time and increasing number of dead nodes. the energy saving of each sensor Node are associated with high computational complexity which depend on supervision of algorithms. In this research paper we developed anclustering base algorithms "A Gravitational Energy Sensitive Energy Hierarchical Protocol" which increase lot of significance butdecreasing the network life time of dead nodes of each network. technique in which every sensor node has energy levels of heterogeneity orderedprotocolwhich separately selects a (cluster head) CH based on its initial energy relative to that of other nodes in selected network. In this research paper we gives some experimental analysis result along with plotted results. The analysis and simulation will also run by using different-different case with putting the Inner Energy of Node 0.5, 1 J, 1.5 J and 2J.after getting analysis result we find our algorithm gives best results comparing then other results of different-different algorithmand also network life was increased as compared. This work is categorical and our protocol GESEHP will achieve improved results in small as well as large sized networks. All this experimental simulation was run in Matlab.**

***Keywords- Gravitational, Efficiency, Throughput, IEEE 802.11, unicast and broadcast packet, network, L-LEACH, Quality of Service, W-LEACH, routing protocol, Energy Sensitive.***

## I. INTRODUCTION

In the sensor nodes (SN) non-rechargeable batteries help to run, so along with efficient routing the network should be energy effective with efficient use of the resources and hence this is an important research concern. WSNs have been generally taken in version as a standout the most vital advancements for the 21 century [1]. SN disburse energy while processing, gathering and transmitting data. In the bigger part of the cases, these SN are furnished with batteries which are not rechargeable. Consequently, the power of the SN is to be utilized productively to the lifetime of the network.Empowered by late advances in remote communication advances, modest, and shrewd sensors sent in a physical range and the Internet give extraordinary chances to an assortment of nonmilitary personnel and military applications, for instance, natural supervision, war zone observation and control of industrial process [2].

WSNs have one of a kind qualities[3], for instance, denser level of hub organization, higher lack of quality of sensor hubs and extreme vitality, calculation, and capacity imperatives which display numerous new difficulties in the improvement and use of wireless sensor networks. It is imagined that sooner rather than advancedWSNs will be largely utilized as a part of various regular citizen and military fields and alter the way we live, work, and collaborate with the physical world [4].Cluster based plan is one of the ways to deal with tosave the energy of the SN devices. Clustering in WSNsensures indispensable execution achievement with a substantialnumber of SN. It is similarlyexpands thescalability of WSN.

In a cluster based plan, the SN are grouped together increasingly in clusters. Each cluster has a CH which is allowed to interconnectwith the BS or sink. Entire SN forward their detected information to the CH, which processes the data and sent them to anexact node called the sink [5, 6]an network model show in figure 1. The betterpart of theclustering agreement uses two policies for selecting CH with more residual energy and for rotating CHintermittently to balance energy consumptionof the SN over the network [7]. But in thesealgorithms, they do not study the distance to the BSwhich tends to die rapidly because they are located relativelyfar from the base station. With anexact end goal tocircumvent this issue, some unsatisfactory clustering

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algorithms havebeen proposed in the works [8,9]. In unfit clustering,the network is separated into clusters of different sizes.

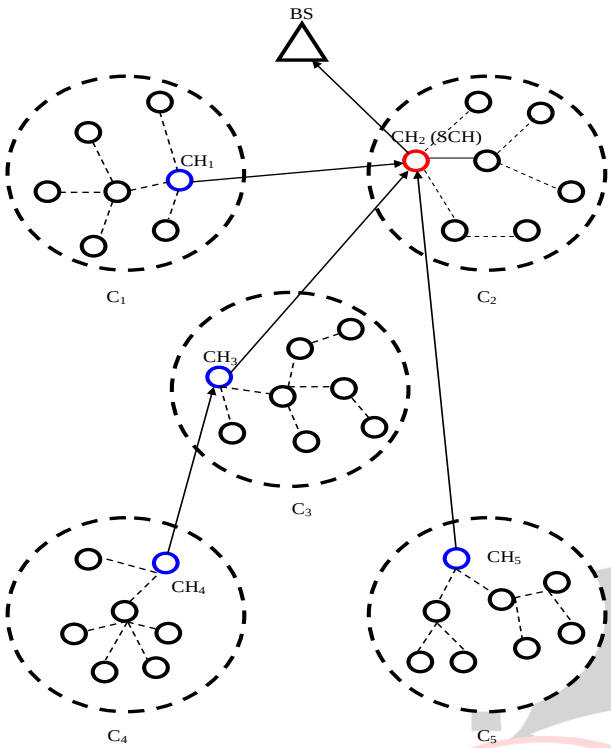


*Figure 1: Network Model*

A WSN regularly comprises of a substantial number of low cost, low control and multifunctional sensor hubs that are conveyed in an area of intrigue. Remote sensors have critical points of interest over traditional wired sensors [10]. They convey over a short separation by means of a remote medium and team up to achieve a typical errand, for instance, condition observing, front line observation, and mechanical process control. They cannot just diminish the cost and deferral in arrangement; additionally it can be connected to any condition, particularly those in which customary wired sensor systems are difficult to be deployed, for instance, unwelcoming territories, war zones, space or profound seas. In any case, the accessibility of low cost sensors and remote correspondence has guaranteed the improvement of an extensive variety of utilizations in both regular citizen and military fields. WSNs were initially inspired from substantial scale acoustic reconnaissance frameworks for sea observation to little systems of unattended ground sensors for ground target recognition [11].

## II. PREVIOUS WORK

In this research the primary challenges in R. Logambigaiet. al. paper are outlining of arranging the operations in WSNs [12]which enhance energy utilization of system lifetime. The cluster head closer sink in the given network, depletes quickly energy. they also write that clusteringis a powerful tool for arranging anassociated order of system, load adjusting for enhancing the lifetime.In this paper author focus on conquer the issue for numerous the algorithms onunequal clustering. The disadvantage of the algorithmson nodes joined with specific cluster head are bring overburden.theypropose fuzzy unequalclustering to enhance execution of thecurrent algorithms. Comparing two algorithms, with advantage and disadvantages of an equivalent clusteringcalled LEACH and another unequalclustering is EAUCF. previous

In This research paper SuneetK. Gupta and Prasant K. Jana [13] they are proposed hereditary calculation based methodologies for bunching with directing in WSNs. where grouping done in their approach of leftover vitality of the passages with separation from sensor hubs. Some advantages of this paper is Likewise directing done, in light of the lingering vitality alongside a tradeoff between transmission separation.

DervisKaraboga et al [14] he was proposed artificial bee colony algorithm which is based on energy efficient clustering mechanism. Some of the feature of this paper is productivity of WSNs which is highly dependent on routing protocols for life-time. Author is simulated the this technique with intelligent seeking behavior of HBS, and advantage of paper is they are successfully used in clustering techniques. The proposed algo outperforms the existing algorithms in PSO and LEACH.

Some of the author say the routing algorithm has been built energy efficiency and energy balancing, based clustering algorithm which are the energy consumption of gateways as well as sensor nodes. Md. Azharuddin and Prasanta K. Jana [15] are proposed this PSO based routing & clustering algorithms. The advantage of this paper are efficient particle-encoding scheme which have derived a multi-objective fitness function for clustering algorithms. some disadvantage are also of algorithm is tolerated the failure of cluster heads.

Author of this paper presented light weight dynamic TRUST model of honey bee mating for clusteringRashmiRanjanSahoo et al [16]. The main advantage of this paper to present the light weight TRUST model clustering method and energy efficient, They have also introduced a priority scheme which was more realistic.

Lalwani et al [17] have proposed Harmony search algorithm (HSA) for cluster head selection. From this article Harmony search algorithm (HSA) is used to solve a wide range of NP-Hard problems that why this also called metaheuristics,.The Author used to cluster head with routing which is done based on the parameters energy, distance and node degree. The algo derived a potential function to the CH for the assignment of non-CH nodes. A routing algorithm using the same parameters in HSA in the derivation of the fitness function.

## III. PROPOSED TECHNIQUE

We present Energy efficient Gravitational search algorithm (GSA) and Fuzzy based clustering with Hop count based

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routing for WSN. Contribution of this work is described as follows.

- Cluster formation and cluster head selection are done using the Gravitational search algorithm (GSA).
- Based on fuzzy inference system, Super cluster head (SCH) is selected among the CHs in the network.
- After the cluster formation, efficient route is established based on the hop count of the sensor nodes.

**Cluster head selection using GSA:**

Gravitational Search Algorithm (GSA) performs depend on the gravity law. Solution of this algorithm is the position of the CHs which are to be selected. Now, let us assume a scheme with $ith$ agents (masses) i.e.,

$$A_i = \lfloor X_{i,1}(t), X_{i,2}(t), \ldots\ldots, X_{i,D}(t) \rfloor \quad \text{Equation-1}$$

Where $X_{i,d}(t)$ denotes the position of the $ith$ agent or CHs in the $dth$ dimension.

The force on the $ith$ mass from the $jth$ mass at time $t$ is well-defined

$$F_{ij}^{d}(t) = G(t) \times \frac{Mass_{PG_i}(t) \times Mass_{AG_j}(t)}{R_{ij}(t) + \varepsilon} \times \left( x_i^d(t) - x_j^d(t) \right) \quad \text{Equation-2}$$

Where $Mass_{AG_j}(t)$ represents the active gravitational mass associated with the $jth$ agent at time $t$. $Mass_{PG_i}(t)$ denotes the passive gravitational mass associated with the $ith$ agent at time $t$. $\varepsilon$ and $G(t)$ represent a small constant and gravitational constant correspondingly. $G(t)$ is well-defined as follows

$$G(t) = G_0 \times \exp\left(-\gamma \times iter / \max iter\right) \quad \text{Equation-3}$$

Where, γ and $G_0$ represent descending coefficient and initial value respectively. Current iteration is represented as *iter* and $\max iter$ maximum number of iteration is represented as $R_{ij}(t)$ denotes the Euclidian distance between the agents $i$ and $j$.

By mapping the fitness, the inertial mass of each agent is designed as follows

$$mass_i(t) = \frac{Fit_i(t) - worst(t)}{best(t) - worst(t)} \quad \text{Equation-4}$$

Where, $Fit_i(t)$ signifies the fitness value of the $ith$ agent at time *t*. In this work, the fitness value is calculated using the parameters average distance and residual energy. the fitness value is derived as An agent with minimum fitness value has heavier mass and has better position, i.e., the better is the cluster head selection.

The values *best (t)* and *worst (t)* are well-defined as

$$best(t) = \min_{j \in \{1,\ldots N\}} Fit_j(t) \quad \text{Equation-5}$$

$$worst(t) = \max_{j \in \{1,\ldots N\}} Fit_j(t) \quad \text{Equation-6}$$

Thus, the acceleration of $ith$ agent at time *t* is calculated. $a_i^d(t)$ calculated as

$$a_i^d(t) = \frac{F_i^d(t)}{Mass_i(t)} \quad \text{Equation-7}$$

The iteration counter is repeated until we obtain the optimal solution.

Nearly there are n*(1+α*m) Nodes with energy equal to theinitial energy of a Regular Nodes. In direction to maintain the lowestenergy consumption in each round within an epoch, the usualnumber of cluster heads per round per epoch must be constant andequal to $n*P_{opt}$. In the heterogeneous scenario the average numberof cluster heads per round per epoch is equal to $n*(1 + \alpha*m) *P_r$(because each virtual Node has the initial energy of a RegularNode). The weighed probabilities for Regular and SmartNodesare, respectively:

$$P_r = \frac{P_{opt}}{1+\alpha*m+l*\mu} \quad \text{Equation -8}$$

$$P_s = \frac{P_{opt}*(1+\alpha)}{1+\alpha*m+l*\mu} \quad \text{Equation -9}$$

Here replace $P_{opt}$ by the weighted probabilitiesto obtain the threshold that is used to elect the cluster head in eachround. We define as $T_r$ the threshold for Regular Nodes and$T_s$ the threshold for Smart Nodes. Thus, for Regular Nodes,

$$T_r = \begin{cases} \frac{P_r}{1-P_r*(Cr*\,mode\,\frac{1}{P_r})} & if\ n_r \in G' \\ 0 & otherwise \end{cases} \quad \text{Equation -10}$$

$$T_s = \begin{cases} \frac{P_s}{1-P_s*(Cr*\,mode\,\frac{1}{P_s})} & if\ n_s \in G'' \\ 0 & otherwise \end{cases} \quad \text{Equation -11}$$

G′ and G″ are the set of Regular Nodes and set of Smart Nodes not become CHs inthe last $\frac{1}{P_s}$ respectively, so ensuring that the eqn. 3 and 4 are working for rounds of the epoch, and $T_s$ is the thresholdapplied to a population of n*m Smart Nodes. This guaranteesthat each Smart Node will become a CH exactlyonce every $\frac{1}{P_{opt}} * \frac{1+\alpha*m}{1+\alpha}$ rounds. Let us define this period as sub-epoch.

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*Table 1: Clustering objectives*

| Objective name | Description |
|---|---|
| CH Remaining Energy | Choice of a node as CH that has the higher remaining energy with respect to memberNodes |
| Cluster Quality | Expand the quality of clustering by reducing the cluster consistency and maximizingthe cluster parting |
| Scheduling time | Reduce the round trip delay in intra-cluster communication by decreasing the size ofcluster |
| Energy ingesting | Reduce the total energy consumption of the network |

**Issues and challenges in designing WSN:**

- In light of the applications, sensor hub must be selected regarding computation rate.
- Sensor networks don't fit into any normal topology, on the grounds that while sending the sensor hubs they are scattered [8] [9] [10]
- unreliable correspondence
- Hub failure, topology changes and including of hubs and termination of hubs is another testing issue.
- Extremely constrained assets
- It goes under fewer frameworks and furthermore support is exceptionally troublesome.
- Accomplishing synchronization among hubs is likewise another issue.Sensor hub depends just on battery and it can't be energized or supplanted. Equipment plan for sensor hub ought to likewise be considered.
- Unattended operations
- In view of its transmission nature and antagonistic condition, security is a majorly complicated issue.

From source through equation -1 Check destination average distance from

$$d_{ev} = \sum_{1}^{N} d(i) \qquad \text{Equation -12}$$

Where i=1,

**Calculate Threshold Sensitive Value (by equation 10, 11) $T_r$, and $T_s$**

*Every Node Generate value Ngv*

*If $T_r$>= Ngv*

*Reg. Nodes Become CH (G')*

*Else if $T_s$>= Ngv*

*Smart Nodes Become CH (G'')*

*Else*

*Re-Calculate NgvUntil Node Energy <=0*

*End if*

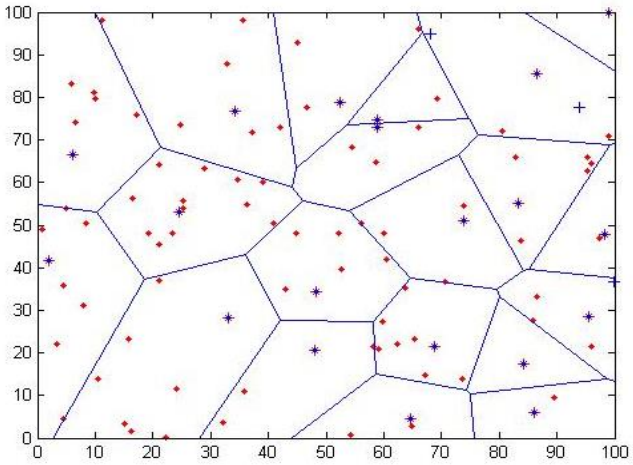


*Figure 2: Wireless Sensor Node Arena 100 X 100 Meters with Cluster Head Selection*

## IV. ALGORITHM

**Input:** n numbers of Sensor Nodes randomly distributed
**Output:**Node Generated Identified Value and

*Node N start sending Advertisement Packet to destination*

*Check destination average distance from source through equation -1 and equation 12*

*Compute $T_{time}$*

*Where $T_{time}$ is transmitting time interval of a packet from source to destination*

*Find Neighbor Discovery*
*Identify nonstop value*
*Calculate Optimal Probability of Nodes $P_{opt}$*
*Make clusters base on energy of Nodes (by eqn. 3,4), $P_r$, and $P_s$*
*Initialize the Agents i.e., m number of CHs.*

*Evaluate the fitness function for each agent using (10).*

*Update G (t), best (t) and worst (t) using (3), (5) and (6) respectively.*

*Calculate the total force using (1).*

*Calculate inertial mass and acceleration using (4) and (7) respectively.*

*Update velocity and position using.*

*Process continued until get the optimal solution.*

*The agent with optimal solution is selected as a number of CHs.*

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**Calculate Average numbers of Cluster Head per Round by eqn. 7**

*Algorithm Periodic Updates*

*Identify nonstop value (AT and DAT) Value Int*
*Int = store new value*
*If AT >=$T_r$ Or $Int_x$>= $Int_y$*
*Transmitter ON*
*Else if AT >= $T_s$Or$Iv_x$>= $Int_y$*
*Transmitter ON*
*Else*
*Transmission will decreased*
*End if*
*Repeat until node died.*

**Nodes Sleeping until not identify greater than Int or Active Threshold value**

## V. EXPERIMENT AND PERFORMANCE ANALYSIS

Aimed at performance evaluation by using MATLAB. In this research paper objectives is doing simulations was to compare performance of A Gravitational Energy Sensitive Energy Hierarchical Protocol (GESEHP), with LEACH, HCR, ERP, EAERP, GAR, DRESEP, TEDRP, and GESEHP protocols on the root of energy dissipation and durability of network.

The performance of our algorithm protocol has been analyzed in terms of energy saving live time in the network, stability period and network lifetime with LEACH, HCR, ERP, EAERP, GAR, DRESEP, TEDRP, and GESEHP protocols using MATLAB. Parameters and setting used in our simulations used for the protocol simulations are summarized in Table 2.

A network residing of 100 nodes, sited randomly in anarena of M x M and a Base Station (BS) located in the center is careful show in figure 2. All over this area with an initial energy of E0 = 1 J. In setup, the proportion of advanced and super nodes is set to 20% of the total nodes. The initial energy of advanced and super nodes is set to 2 and 3 times that of normal

nodes.

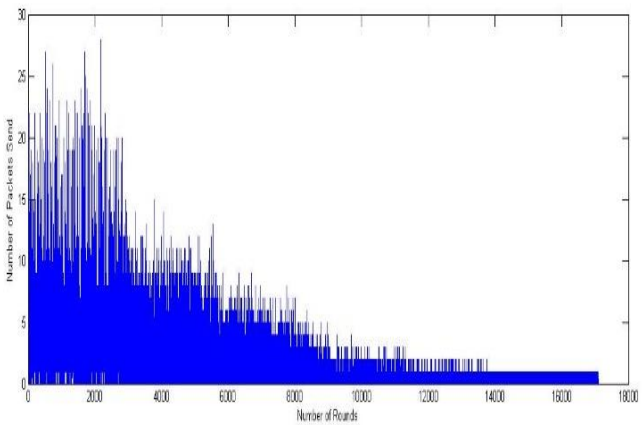


*Figure 3: Number of packets transmitted through CH to BS as per numbers of Round*

Nearly some areas hold only one big cluster and some areas comprise several minor clusters. consequently, energy feeding in LEACH network is non uniform and side EAERP and TEDRP allocate the clusters transversely the network more evenly,although the quantity of clusters is more. This causes energy feasting in these protocols to be difficult to some degree. The energy feeding in the network increases whenthe extent of cluster is not set properly. the clusters are properly and uniformly distributed across the network using the impartial purpose concerned with the superiority of cluster as a function of cluster parting andcohesion. Therefore, energy feeding across all the clusters is fairly same because of almost similar sized clusters.

*Table 2: Parameters and setting used in our simulations*

| S. No | Parameters | Value |
|---|---|---|
| | Network size | **100x100** |
| 1 | Radio electronics energy, $E_{elect}$ | 50nJ/bit |
| 2 | Energy for data-aggregation, $E_{DA}$ | 5nJ/bit/message |
| 3 | $\varepsilon_{fs}$ | 10pJ/bit/m2 |
| 4 | Radio amplifier energy,$\varepsilon_{mp}$ | 0.0013pJ/bit/m4 |
| 5 | Initial energy, $E_o$ | 1J |
| 6 | k | 20000 |
| 7 | Probability of CH selection, $\rho_{opt}$ | 0.05 |
| 8 | Number of nodes,n | 100 |
| 9 | α | 2 |
| 10 | m | 0.3 |

First we taken some Cases, in which we put α= 2, and m = 0.3 after it we simulate our algorithm and analysis the result which are given below.

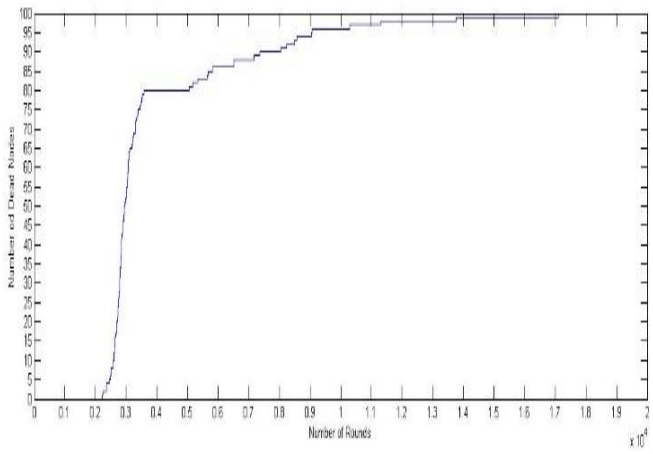


*Figure 4: Shows behavior in the presence of heterogeneity with α = 2 and m = 0.3 of Number of dead nodes per Round*

In our GESEHP, the initialization of populace be governed by only on the probability of CH selection and is self-governing of the residual energy of nodes. It may be possible

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that a lowenergy node may get a chance to become a CH and this may curtail the stability period. From this experiment results analysis it was clear that the network lifetime of GESEHP is much advanced than other simulated protocols. As CH nodes bear extra load for data aggregation, data processing and transmission to distant CH or BS, where CH nodes obligation which have higher outstanding than associate nodes show in figure 3.

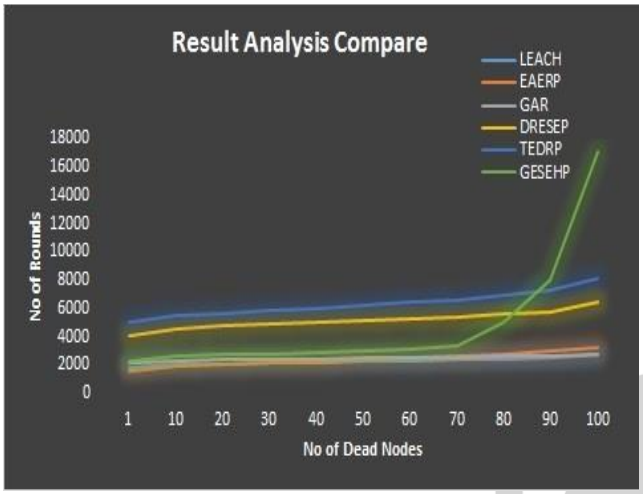


*Figure 5: Show Comparison of protocols LEACH,EAERP, GAR, DRESEP, TEDRP, and GESEHP.*

Therefore, in instruction to balance the load efficiently, outstanding of node may be active as a factor for CH selection. So lifetime in GESEHP is amplified stability period which is needed for the proper operative and preserving the coverage properties in any network. Number of dead nodes are after completing of simulation in which we put α= 2, and m = 0.3 after it we simulate our algorithm and analysis the result which are given below in figure 4.

The time period from primary time to first node dead (FND) is termed the stability period of the network. Last node dead (LND) is the network lifetime from start to the time when no alive node residual in the network. another measure of network lifetime is Half node dead (HND). well-defined as the time from initial to the time as soon as there is half number of nodes residual in the network. In the Tables 3 show the rotund history of dead nodes for network. It demonstrations the network lifetime in relations of number of rounds it takes while waiting for FND, HND and LND. The time difference between LND and FND is called as instability period.

From the table 3, it is strongly that the network lifetime of GESEHP is much higher than TEDRP and also then other simulated protocols.

*Table 3: Show Rounds History Comparison of different algorithmswith our GESEHP.*

| % Dead Nodes | LEACH | HCR | ERP | EAERP | GAR | DRESEP | TEDRP | GESEHP |
|---|---|---|---|---|---|---|---|---|
| 1(FND) | 1805 | 1726 | 2113 | 1578 | 2139 | 4102 | 5051 | 2217 |
| 10 | 2023 | 2049 | 2276 | 1889 | 2295 | 4504 | 5516 | 2602 |
| 20 | 2069 | 2190 | 2364 | 1997 | 2346 | 4770 | 5664 | 2704 |
| 30 | 2141 | 2315 | 2438 | 2086 | 2386 | 4881 | 5812 | 2791 |
| 40 | 2169 | 2420 | 2510 | 2199 | 2423 | 4984 | 5996 | 2849 |
| 50(HND) | 2215 | 2525 | 2580 | 2332 | 2470 | 5127 | 6210 | 2952 |
| 60 | 2280 | 2630 | 2649 | 2445 | 2519 | 5294 | 6423 | 3075 |
| 70 | 2346 | 2752 | 2745 | 2597 | 2551 | 5395 | 6565 | 3304 |
| 80 | 2395 | 2917 | 2837 | 2776 | 2590 | 5621 | 6874 | 5065 |
| 90 | 2486 | 3107 | 2983 | 3005 | 2628 | 5771 | 7291 | 8051 |
| 100(LND) | 2764 | 3574 | 3306 | 3191 | 2777 | 6402 | 8174 | 17099 |

GESEHP is spreads the network lifetime by utilizing threshold judgment based transmission and dual-hop inter-cluster communication. But, the network lifetime in GESEHP is amplified at the charge of stability period which is important for the proper functioning and maintaining theattention properties of the network. In result analysis after comparing with some protocols we identify that our algorithm is best because no of dead nodes or LND in 17099 round where LEACH 2764 round to reach LND, 3574, 3306, 3191, 2777, 6402, HCR, ERP, EAERP, GAR, DRESEP, respectively and TEDRP completed his round 8174 so when comparing with our algorithm, show in figure 5. So we identify that difference is 8925 its mean 209% more effective than other.

## VI. CONCLUSION

The major projectionin the research challenges of routing protocols for WSNs are energymanagement, network lifetime optimization and the constancy period will increasing. This research paper proposed “A Gravitational Energy Sensitive Energy Hierarchical Protocol” (GESEHP) protocol technique in which every SN has energy levels of heterogeneity ordered network which autonomouslyselects itself as a cluster head CH based on its preliminary energy relative to that of other nodes. “A Gravitational Energy Sensitive Energy Hierarchical Protocol” which increase lot of significance but decreasing the network life time of dead nodes of each network. method in which every SN has energy levels of heterogeneity ordered protocol which

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separately selects a CH initial energy of other nodes in selected network. To balance the energy consumption in the network, an auction mechanism was introduced to the cluster formation process, which helps the SN with low energy to prolong their lifetimes. cluster members join the cluster head based on distance and cluster head degree to utilize the energy efficiently and to extend the network lifetime. In this research paper we gives some experimental analysis result along with plotted results. Also Considering the detection errors, an improved trilateration method was used to gain high localization accuracy for the target tacking. The analysis and simulation will also run by using different-different case with putting the Inner Energy of Node 0.5, 1 J, 1.5 J and 2J. Through simulations using MATLAB, the proposed algorithm is evaluated. after getting analysis result we find our algorithm gives best results comparing then other results of different-different algorithm. This work is settled that our protocol GESEHP will attainimproved results in minor as well as bulky sized networks. So from it is clear that our planned protocols GESEHPwill be superior than all other protocols discussed.

## VII. REFERENCE

[1] Hanfi ,, Rabiya, and Yogesh rai. "Wireless Sensor Network". International Journal of Engineering and Computer Science (2016): n. pag.

[2] "Micro Climate Monitoring-Web Application Using Wireless Sensor Network". International Journal of Science and Research (IJSR) 5.4 (2016): 104-106.

[3] Qu, Ming Zhe. "Research On The Applications And Characteristics Of The Wireless Sensor Network". Applied Mechanics and Materials 538 (2014): 498-501.

[4] Bekmezci, Ilker, and Fatih Alagöz. "Energy Efficient, Delay Sensitive, Fault Tolerant Wireless Sensor Network For Military Monitoring". International Journal of Distributed Sensor Networks 5.6 (2009): 729-747.

[5] Kuila, P., Gupta, S. K., & Jana, P. K. (2013). “A novel evolutionary approach for load balanced clustering problem for wirelesssensor networks. Swarm and Evolutionary Computation,” 12, 48–56.

[6] Kuila, P., & Jana, P. K. (2014). “Energy efficient clustering and routing algorithms for wireless sensor networks: Particle swarmoptimization approach. Engineering Applications of Artificial Intelligence”, 33, 127–140.

[7] Lee, J.-S., & Cheng, W.-L. (2012). “Fuzzy-logic-based clustering approach for wireless sensor networks using energy predication”, IEEE Sensors Journal, 12(9), 2891–2897.

[8] Li, C., Ye, M., Chen, G., & Wu, J. (2005). “An energy-efficient unequal clustering mechanism for wireless sensor networks. In IEEE international conference on mobile adhoc and sensor systems conference”, 2005 (pp. 8-pp). IEEE.

[9] Bagci, H., & Yazici, A. (2013). “An energy aware fuzzy approach to unequal clustering in wireless sensor networks”, Applied Soft Computing, 13(4), 1741–1749.

[10] Arebi, L, F Gu, and A Ball. "A Comparative Study Of Misalignment Detection Using A Novel Wireless Sensor With Conventional Wired Sensors". Journal of Physics: Conference Series 364 (2012): 012049. Web.

[11] DING, Xiaoyang, and Xiaoyan LI. "Target Tracking Algorithm Of Information Detection For Wireless Sensor Network". Journal of Computer Applications 33.4 (2013): 939-942.

[12] R. Logambigai, A. Kannan, “Fuzzy logic based unequal clustering for wireless sensor networks”, Springer Science+Business Media New York 09-07-2015. DOI 10.1007/s11276-015-1013-1.

[13] Gupta, Suneet K., and Prasanta K. Jana. "Energy Efficient Clustering And Routing Algorithms For Wireless Sensor Networks: GA Based Approach". Wireless Personal Communications 83.3 (2015): 2403-2423.

[14] Karaboga, Dervis, Selcuk Okdem, and Celal Ozturk. "Cluster Based Wireless Sensor Network Routing Using Artificial Bee Colony Algorithm". Wireless Networks 18.7 (2012): 847-860.

[15] Azharuddin, Md, and Prasanta K. Jana. "PSO-Based Approach For Energy-Efficient And Energy-Balanced Routing And Clustering In Wireless Sensor Networks". Soft Computing (2016).

[16] Sahoo, Rashmi Ranjan et al. "A Bio Inspired And Trust Based Approach For Clustering In WSN". Natural Computing 15.3 (2015): 423-434.

[17] Lalwani, Praveen et al. "CRHS: Clustering And Routing In Wireless Sensor Networks Using Harmony Search Algorithm". Neural Computing and Applications (2016).

 DOI : 10.35291/2454-9150.2019.0246 