Energy Optimization in Heterogenous Wireless Sensor Networks Using Hybrid Diffusion Clustering Scheme

Dr. Gurupriya M
Sr.Assistant Professor
New Horizon college of Engineering
Bangalore, India.
E-mail: nhcegurupriya@gmail.com

K C Rohit
Associate Vice-President
Standard Chartered Bank
Bangalore, India.
E-mail:rohit.kc88@gmail.com

ABSTRACT

Heterogenous Wireless sensor network (HWSN) resolves issue of unnoticeable problems in the design of real-life application with sensors and actuators. Balancing energy efficiency at cluster head (CH) using clustering algorithm is the best outcome for extending the lifetime of network. Due to excessive energy dissipation at cluster head and border nodes cannot transmit data directly to base station (BS), as they are overlapped in more than one cluster. The existing clustering algorithm faces a complicated issue in maintaining efficiency of HWSN. Inorder to overcome the drawback of isolated CH selection and manage energy efficiency in HWSN, a brand new algorithm based on TDMA-Hybrid Diffusion Clustering Scheme (HDCS) has been proposed. Communication in TDMA-HDCS is designed between neighbour CHs without any intermediate nodes. Clusters are formed by diffusing outlying nodes from base station (BS) in hop-to-hop pattern. The parameters for CH selection include residual energy, number of neighbour nodes out of clusters and depth has been considered in clustering phase. Intercluster and intracluster transmission of data happens in Time division multiple access (TDMA) pattern. The proposed protocol is compared with existing Diffusion Cluster Routing Protocol(DCRP),Energy Efficient Unequal Clustering(EEUC) and MOCH. The lifetime of TDMA-HDCS has been increased approximately by 75%

Keywords-Heterogenous wireless sensor networks (HWSN), Time division multiple access (TDMA), Hybrid Diffusion clustering scheme (HDCS), Intercluster, Intracluster.

I. INTRODUCTION

Sensing an event in remote areas is carried out by Heterogenous Wireless sensor network (HWSN), which is composed of huge number of sensors deployed randomly in remote environment. The recorded real time information obtained from sensor nodes are transmitted to base station (BS). The main demerits of WSN include less storage, decreased processing power, low energy backup or battery and low bandwidth for communication [1]. The well-known application of WSN is in surveillance, landslide detection, habitat detection in forest areas, weather forecasting, monitoring volcano activity, identifying a target in military application, inventory systems and biomedical application [1-3]. The sensor nodes act as an event detector and packet router. The sensor nodes are deployed in victim areas to collect data and monitor specified targets. The obtained data is routed to base station (BS) or sink nodes [4-5]. Designing and implementing an energy efficient clustering protocol

In real time is a risky job with limited energy resources at sensor nodes. The long-time goal of researchers is to prolong the lifetime of a network [1,2]. S.A.Nikolidakis *et al*. proposed an energy efficient clustering by initiating load balancing among all sensor nodes [3].In this paper, CH is selected based on routing energy cost available at sensor nodes after transmission of data to BS. Gaussian elimination method is used to select best path to reach the BS[3].The major criteria discussed in this paper is cluster head(CH) near to BS is nominated as first level CH and CH located away from BS is elected as lower level CH. This protocol enhances energy efficiency, improves stability and increases lifetime of a network. The major drawback of this approach is there is a high chance of unanticipated breakage of stability and hence reduces network lifetime [3].

To achieve high energy efficiency and minimize internal overhead Rana and Zaveri proposed a new approach by dividing the network into several sub-clusters [6]. In this scheme the least loss energy path is chosen for the role of CH with references to nodes. Information about energy is updated on regular basis in order to make best decisions. However, in the case of scalable routing it adds extra load. The CH may be located at greater distance in some case, as a result of BS which causes an increase in energy consumption.

To assist energy management and load balancing in clustering phase, Heinzelman *et al.*[7] proposed homogenous WSN. This is the efficient protocol for achieving load balancing in a cluster. Each node in the cluster will get a chance to become cluster head in a particular round. The node elected as a CH will never become CH in next 1/n rounds, with probability of cluster head n. A random number 0 to 1 is generated for each CH[7]. If the energy of a particular CH is less than threshold then that node is chosen as CH for that particular round. The elected CH announces its identity to other cluster members via ADV message. TDMA approach has been used in this work. Cluster members transmit data only in their allocated time slot and enters into sleep state in non-transmission phase. The main demerit of this approach is residual energy is not considered for selection and rotation of CH[7].

Wang *et al.*[8] presented a work based on LEACH as per random approach. The calculation of death troll and consideration of residual energy from BS is obtained. Final decision is made before energy gets depleted in CH thereby, increases stability and lifetime of devices. Another alternative for LEACH protocol is designed by Heinzelman *et al.*[9] widely known as LEACH-C(Centralized LEACH).This protocol reduces energy efficiency for transmitting data between cluster member and cluster head. However, nodes which lie outside the cluster does not participate in communication and hence there is a data loss and overall performance of network is affected.

The variation of LEACH-C protocol is LEACH-f (fuzzy LEACH) [10]. In this approach base station (BS) offers a generated list of CH nodes to every cluster member. Nodes are elected based on the list. There are high chances that node with less power become CH, therefore network lifetime is degraded. Energy-efficient LEACH(EE-LEACH) [11] provides better PDR (packet delivery ratio) with minimum energy consumption. This approach suffers from confidentiality issues. The clustering schemes of WSNs such as P-SEP [12-14], DEBR[15],MOCH[16],DFCR[17-18].Consider that all of sensor nodes are capable of communicating with BS directly. However, the radius, transmission power and cost of sensor nodes are limited, the protocol described above must be modified to adapt to large scale multi-hop WSN. In the above-mentioned approaches, there is a probability that isolated CH may appear in clustering phase. These CH uses relay nodes for data transmission to BS.

GADA-LEACH [19] strengthens the CH selection method by using an evolutionary genetic algorithm. The relay nodes facilitate communication between cluster head and base station. The scheme proposed in [20] split the entire hierarchical network into several inner clusters. Clusters in turn divide into cell-shaped areas, where cell nodes (CNs) act as a relay node and obtain information from cluster members and forward it to cluster head (CH).

The work represented in [21] improves network reliability and lifetime of the network by using adaptive cross-layer intra-cluster scheduling as well as inter-cluster relay nodes. The scheduling is determined by the number of available data packets and source node's energy level (SN). This helps to reduce control packet overhead by minimizing idle listening to nodes with no data to transmit.

In [17] the researchers described two distributed fault tolerant algorithm. One for clustering phase and other for routing phase. In clustering phase, cluster members select their cluster head based on cost function, distance between cluster member and cluster head, distance between cluster head and base station. If there is an isolated CH then it selects relay node with high energy and transfer via that node to BS.

By retaining k-coverage, the paper [13] identifies a number of scattered targets in the environment with a correlation between coverage nodes and sink. Nodes are split into 2 groups namely coverage nodes and communicative nodes and then they are reclassified into clustering nodes and dynamic nodes. Following that CH are chosen by considering parameters such as residual energy and distance to sink nodes. Prolong-stable election protocol(P-SEP) proposed by Paola.G *et al.* [12]. This protocol extends lifetime and maintains load in fog support sensor network. Fog nodes in the network are aware of their location to process information. The electoral algorithm works based on distance consumption and energy consumption. There are high chances that isolated nodes appear in infrastructure because of random distribution nodes.

Hybrid energy-efficient distributed clustering (HEED)protocol proposed by Younis and Fahmy [22]. This approach considers parameters such as residual energy, node degree and relative distance for electing CH. Fuzzy logic recalculates CH for every round in the network. There are 27 rounds of CH selection which increases energy consumption for CH selection. The above protocol is less faithful for HWSN. For an energy efficient IOT Shalli *et al*.[14] innovated a scheme with tiered framework.BS is positioned in higher layer for easy access of internet. Cluster members, cluster heads and relay nodes are positioned in lower layer. Communication is done through bottom-up approach. Finally a minimum energy consumption chain-based cluster co-ordinator algorithm (ME-CBCCP)[14] is executed. In a physical environment when isolated CH is about to transfer data to BS, using relay nodes it requires extra energy to forward packets. Thereby it leads to earlier death of nodes.

In addition to improve the lifespan of network and growing stability PEGASIS(Power efficient gathering in sensor information system),a chain based clustering algorithm is introduced[23].CCM(Chain cluster-based mixed)routing[24] and CCMAR(Cluster-chain mobile agent routing)[25].The foremost advantage of chain based routing protocol is to significantly increase lifetime of network and reduce energy overhead and premature death of nodes [26].For both block clustering and chain clustering ,increasing energy efficiency is major concern. S.Rani *et al*.[27] proposed a new protocol based on cluster head rotating election routing protocol(CHRERP).

The main benefaction of this study is summarized as follows.

1.To reduce energy overhead in sensing area, the entire heterogenous network is segmented into multiple clusters from BS in hop-by-hop pattern.

2. There is no isolated CHs in clustering algorithm and border nodes can transmit packets to BS without redundancy. We propose a brand-new algorithm Hybrid Diffusion clustering Scheme (HDCS).

3.Communication in Intercluster and Intracluster is done by Time division multiple access (TDMA) fashion.

4.Node depth and residual energy is calculated for CH selection. Shortest path is selected for data aggregation and transmission from CH to BS. HDCS guarantees low delay by maintaining minimum clusters.

The rest of this paper is organized as follows .The problem statement are given in section 2.The network organization and energy consumption model are discussed in section 3.The Hybrid diffusion clustering scheme(HDCS) is proposed and discussed in section 4.Discussions about CH selection, energy consumption are conducted in section 5.Simulation and evaluation results of key parameters are presented in section 6.Finally conclusions are drawn out in section While future work is described in the end.

II.PROBLEM STATEMENT

A relay node in HWSN bridges a gap between isolated CH and other CHs in the network. Data packet from isolated CH reaches BS via relay nodes. As represented in figure 1(a) CH1, CH2and CH3 are in contact with each other whereas CH4 and CH5 are isolated CHs. They cannot forward their data packets to BS directly as they are out of coverage area.

CH4 and CH5 elect an intermediate node 2d from cluster2 and forward data packet to BS via relay node 2d. For the time being, there is no doubt that relay node can assist isolated CHs in forwarding packets to BS. However, the relay node 2d will significantly consume more energy than other nodes in order to forward these extra packets from CH4 and CH5 to BS resulting in earlier death of a node. Thereby CH4 and CH5 becomes an isolated island. Although border node improve reliability by providing multiple paths for inter-cluster communication. Large number of border nodes in same cluster can degrade overall performance of that cluster. In the figure 1(a) node 2d act as a relay node and border node. Therefore, energy level of node 2d gets depleted earlier than other nodes, resulting in extra rounds of cluster formation. The proposed clustering scheme HDCS avoids isolated CH’s and relay nodes are engaged in HWSN. Our brand-new clustering algorithm increases lifespan of the network and load is distributed evenly.

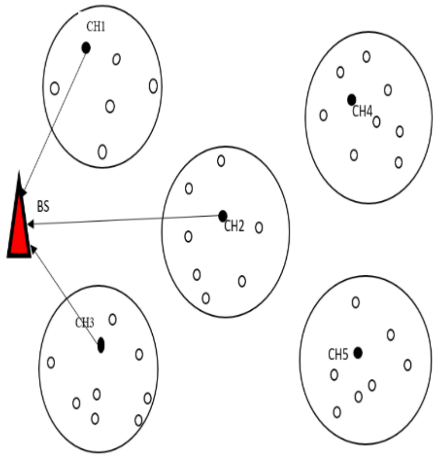

Figure. 1(a)Distribution of CH's

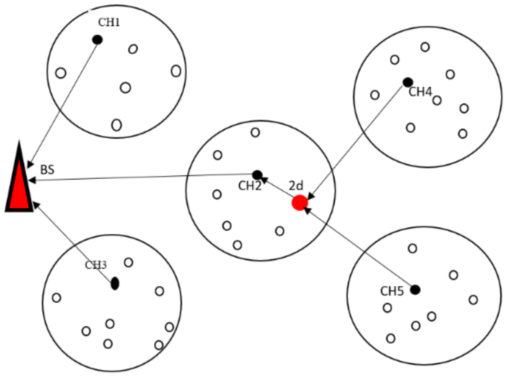

Figure. 1 (b)Selection of Relay node

III.SYSTEM MODEL

A. Network Organization

The network pattern depicted in this study is a HWSN model in which N nodes are randomly deployed MXM square area with BS. Base station has the capability to self-recharge the battery through energy harvesting mechanism.BS works continuously till death of last node in the network. The following are the assumptions about HWSN.

a. All nodes in the network are immobilized and heterogenous.BS is located at centre of MXM square area.
b. Initial energy of each node is expressed as E_0. Energy levels of each node is limited. Communication radius of CH is R.
c. Cluster member (CM) in the cluster is identified based on unique identifier (ID). Cluster head maintains cluster table.
d. BS is informed about position of every node after cluster formation. The information about ID and position of node is broadcasted through flooding mechanism in the network.
e. Medium access control methods such as TDMA (Time division multiple access) is employed for simultaneous wireless transmission in allocated time slot.

B. Energy Consumption model

In HWSN utilization of energy efficiently is main criteria for SN, as batteries have limited energy and their recharging is not a feasible solution. Most of the researcher focus only on First order radio model (FORM) for calculating energy dissipation at each node. The main drawback of FORM is it computes energy dissipation only at transmit phase and receiver phase. FORM completely ignores energy dissipation at sensing and processing. The Advanced first order radio model(A-FORM) presented in our study fills the gap in FORM. Design factor of sensor node in our novel A-FORM approach can be considered as combination of 3 modules. (a) Sensing module (b)operational module(c)Transmission module.

The total energy consumption of a sensor node is defined by following equation.

$$E_{SN}=E_{SM}+E_{OM}+E_{TM} \quad (1)$$

Where E_{SM}, E_{OM} and E_{TM} represent energy consumption cost of sensing, operational and transmission modules respectively. The tasks performed by sensing module are 1) Sampling of continuous-time signal 2) Analog to digital converter 3) Modulation of signal. Energy consumption cost at sensing module is developed by following Boolean equation.

$$E_{SM}=E_{00}+E_{01}+E_{10}+E_{11} \quad (2)$$

Where E_{00} is switching energy consumption is off (i.e. sleep state). E_{10} is energy consumption state from ON state to OFF state. E_{01} is vice-versa, E_{11} is computed by following mathematical equation.

$$E_{11}=E_{SOS}+E_{ad}+E_{ms} \quad (3)$$

Where E_{SOS} denotes energy consumption cost due to sampling of signal, E_{ad} represents analog to digital conversion, E_{ms} represents modulation of signal.

TABLE I. DESCRIPTION OF STATES

Value	**Current state**	**Next state**	**Description**
00	0	0	NIL
01	0	1	ON
10	1	0	OFF
11	1	1	ON

The second contributor of Eqn. 1 'E_{OM}' represents operational module. The tasks performed by operational module are sensor controlling, data pre-processing, state transmission. As per our assumptions there are 3 possible states; idle, sleep and active.

$$E_{OM}=\sum_{i=1}^{m} P_{OM}^{stat}(i)\, T_{OM}^{stat}(i)+\sum_{j=1}^{n} \chi_{OM}^{xion}(j)\, e_{OM}^{xion}(j) \quad (4)$$

Where i=1,2,3,4…………..m is operation state of the processor and j=1,2,3……n is type of state transistion, P_{OM}^{stat} denotes power consumption cost. T_{OM}^{stat} represents time interval. χ_{OM}^{xion} denotes state transistion frequency, e_{OM}^{xion} denotes energy consumption cost.

The third contributor of Eqn1, E_{TM} is derived from First order radio model. If k bit data packet is used for transmission over a distance d, then energy is formulated as follows.

$$E_{TM}=E_{TX/RX}(k,d)=\begin{cases} kE_{elec}+k\mathcal{E}_0 d^2 & d<d_0 \\ kE_{elec}+k\mathcal{E}_1 d^4 & d\geq d_0 \end{cases} \quad (5)$$

IV.DETAILS OF HDCS

We introduce certain definitions to represent our routing scheme clearly.

a. Level-1 nodes: Nodes which communicate with BS directly.

b. Isolated CH: If a CH lies outside the communication radius of nearby neighbor CH then it is called an isolated CH.

c. Depth of CH: When a CH follows direct transmission routing to BS then depth of CH is defined as one.CH which transfers data packet via one depth node to BS is defined as CH-two.

d. Node depth: If a node wishes to join a specific cluster, their depth D(i) is denoted as one plus the CH depth.

e. Network Lifetime-Time until the first node exhausts its energy in the network.

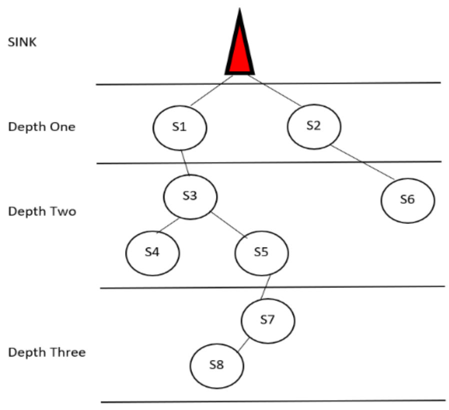

Figure 2: Depth of nodes in the network

A. Cluster Head Selection Strategy

Selecting an CH plays a vital role in the heterogenous network. A well-advanced scheme increases energy efficiency and lifetime of the network in HWSN. The 3 parameters for CH selection include number of neighbor nodes which do not participate in intracluster communication, residual energy and depth of any node in the network. To predict whether node k can become CH or not, a weight function W(k) is calculated.

$$W(k)= \alpha \frac{N(k)}{\text{Nmax}} + \beta \frac{1}{D(k)} + \gamma \frac{E(k)}{\text{E0}} \quad (6)$$

In equation (6), N(k) denotes number of neighbor nodes which do not participate in intracluster communication. N_{max} is maximum of N(k). D(k) represent depth of node k. E(k) is the residual energy of node k.E_0 is the initial energy of each node.

To make the value of W(k) between 0 and 1, we let $\alpha+\beta+\gamma=1$.In HDCS if weight of a node k is high, then there is a probability that node k will become a CH in next round. If depth of a node (k) is low then node k is more likely to become CH. If node k has more residual energy, then it is possible to become CH. The different ranges of α, β and γ determine the efficiency of HWSN. If α range is very small, the number of sub clusters in HWSN will be too larger. If β and λ are too small it worsens the energy efficiency of HWSN.

B. Data Packet Format

The format of packets are demonstrated in table2 and table3.Table2 depict the clustering packet and table3 illustrates data packet.

TABLE II. CLUSTERING PACKET

Type	**Source ID**	**Destination ID**	**Depth**	**Residual energy**	**Neighbor nodes out of cluster**
2 bits	16 bits	16 bits	6 bits	16 bits	8 bits

TABLE III.DATA PACKET

Type	**Depth**	**Source ID**	**Destination ID**	**Data**
2 bits	6 bits	16 bits	16 bits	512 bits

The clustering packet from CH is sent to BS via multihop in HWSN. Clustering packet holds 64 bits of storage and 6 fields: type, source ID, destination ID, Depth, residual energy, neighbor nodes out of cluster. Two bits are assigned for type field to differentiate type of packets:"00" denotes clustering packet and "10" denotes data packet. The source ID, Destination ID and depth of both packets are 16 bits,16 bits and 6 bits respectively. Residual energy and neighbor nodes out of cluster holds 16 bits and 8 bits. The data field in data packet uses 512 bits of storage.

C. Algorithm for Routing

The steps involved in clustering phase and data transmission phase are represented in detail.

a) Clustering Phase

Input: Cluster nodes and their ID's in HWSN, Base station radius R.

Output: Clusters are formed with CH and W(i) of each CH is calculated.

Initialization: BS broadcasts start signal to indicate clustering phase.

if(d<R) then

Form first cluster with BS as cluster head.

CH_depth=0

else

Obtain residual energy, depth, neighbor nodes out of cluster information and transfer to BS.

Calculate $W(k)=\alpha \frac{N(k)}{\text{Nmax}} + \beta \frac{1}{D(k)} + \gamma \frac{E(k)}{\text{E0}}$

if W(k)=max

Form one depth cluster with nearby nodes.

CH_depth=CH_depth+1.

end if

Repeat the process until all cluster nodes are assigned to respective cluster.

end if

end

b) Cluster Formation and Clustering Period

The communication radius of each node is R (500 m). The coverage area of cluster is given by πR^2.Overall network size is 5000mX5000m. If a network holds m cluster head which means m clusters are available in the network.

$$T_{network}=\pi n R^2 - T_{overlap} \qquad (7)$$

Where the $T_{overlap}$ is overlapping area of two clusters. $T_{network}$ is 5000mX5000m.The intersection area of two clusters is given by.

$$T=2R^2\cos^{-1}\left(\frac{d}{2R}\right)-d\sqrt{R^2-(d^2/4)}) \qquad (8)$$

Where d denotes distance of two clusters. The mathematical expectation of d [29] is given by.

$$E[d]=\int_0^R x\, f(x)dx \qquad (9)$$

$$\text{Where } f(x)=F'(x) \qquad (10)$$

$$F(x)=P(x\leq R)=\frac{x^2}{R^2} \qquad (11)$$

From equations (9), (10), (11) we get $E[d]=\frac{2R}{3}$ and $S\approx 1.83R^2$

$$T_{overlap}= S(n-1) \qquad (12)$$

From equations (12) and (7) we get n=85.So the number of clusters is 85.

The lifespan of HWSN depends on energy consumption of one depth nodes.

$$E_{per\_round}=(N-m)E_{RX}(k)+kE_{elec}+k\mathcal{E}_1 d^4 \qquad (13)$$

Where N is number of sensor nodes, m is one depth nodes in the network. Nodes near to BS receive packets from other nodes in the network. It is denoted by $E_{RX}(k)$. In clustering phase $E_{per-round-max}$ is 0.007210J and at transmission phase 0.06316J. The energy consumed in the network depends on sensing the data, processing, clustering and data transmission phase.500 nodes are distributed uniformly in the network. One-depth nodes are divided into 3 clusters with 5 nodes in each clusters. The initial energy of these nodes is 30J(E_0=2J). The total rounds for data transmission are 30J/0.06316J≈474 rounds. On average, the one-depth clusters in the network undergo 474/3≈158 rounds of data transmission. Any clusters which consume 20% of initial energy is defined as cluster restarting point.

c) Data Transmission phase

(1) BS broadcasts start signal to inform all nodes in HWSN that data transmission phase begins.

(2) Based on TDMA. Cluster member sense the data and transfer to CH in their respective time slot.

(3) CH transfers data in their allocated time slot to BS hop by hop.

(4) Repeat steps 2 and 3 until residual energy of node exceeds 20% of initial energy. In the above scenario data transmission phase is over and clustering phase begins.

V.SIMULATION RESULTS

500 sensor nodes are deployed randomly in square area of 5000mX5000m with BS. The major parameters of simulation are listed in Table 4.

TABLE IV. SUMMARY OF PARAMETERS

PARAMETER	VALUE
Type of Node	Heterogenous
No. of nodes	500
Network size	5000mX5000m
BS location	(500m,500m)
Initial energy of node E_0	2J
R(Communication Radius)	500m
$\mathcal{E}_0$	10pJ/bit/m^2
$\mathcal{E}_1$	0.0013pJ/bit/m^4

A.Value of N_{max}

The max neighbor nodes out of cluster is represented by N_{max}. The simulation graph is shown in figure 4, where x-axis denotes number of clusters and y-axis represents the neighbor node out of each cluster. From the figure the value of N_{max} is 16. The mean and standard deviation of n(i) are calculated as follows.

$$E[n(i)] = \frac{n(1)+n(2)+\cdots n(74)}{74} \approx 8 \qquad (14)$$

$$\sigma=\sqrt{D[n(i)]}=\sqrt{E\{[n(i)-E(n(i))]^2\}}=4.49 \qquad (15)$$

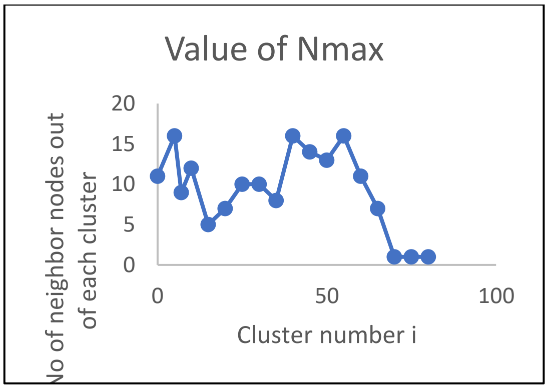

Figure 3: Maximum neighbor nodes out of cluster.

B. Performance analysis of α, β, γ

The network lifetime and delay in the HWSN is based on values of α, β, γ. On the one hand, the lower the mean number of clusters, the less energy is consumed by CHs to construct clusters, which benefits network endurance. On the other hand, the shorter the transmission delay, the lower the mean depth of CHs. The values of α, β, γ varies from 0.1 to 0.5. Several NS2 simulation investigation is carried out with different values of α,β,γ to manifest the mean number of clusters and mean depth of CHs.

In DCRP [29] the residual energy ,number of neighbor nodes, depth are considered for CH selection strategy. In DEBR, each CH holds a table where hop number and remaining energy of sensor node are updated in equal time intervals.CH which needs to transmit data will select nodes with lower hop and more residual energy for transmission. In EEUC, the cluster size optimization formation algorithm[29] is deployed with parameters such as edge of annular region ,distance between nodes and residual energy. EEUC extends network lifetime but produces isolated CH. In MOCH the energy distribution is based on optimal number of CH. The time complexity is $O(N^2)$ for above all algorithm has same time and space complexity but it prolongs network lifespan and reduce transmission delay.

TABLE V. PERFORMANCE ANALYSIS OF Α, Β, Γ

Values of α, β, γ	Mean no of clusters	Mean depth of CHs
α=0.2, β=0.4, γ=0.3	75.6	5.94
α=0.5, β=0.3, γ=0.2	72.8	6.37
α=0.4, β=0.3, γ=0.2	74.8	6.31
α=0.3, β=0.5, γ=0.2	77.0	5.96
α=0.5, β=0.2, γ=0.3	72.0	6.73
α=0.4, β=0.4, γ=0.3	74.8	6.47

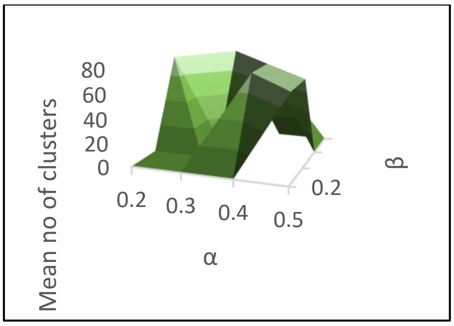

Figure 4: Mean no of clusters

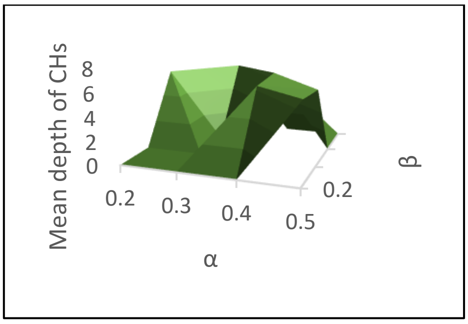

Figure 5: Mean depth of CHS

C. Network Lifespan

Two sets of simulation experiments N=500,700 are calculated to evaluate the network lifespan of HDCS, where results are shown in Figure 8 and 9. The horizontal axis denotes the rounds of data transmission and vertical axis represents number of one depth nodes.

BS broadcasts start signal to all nodes in the network. The nodes on receiving the signal calculate distance from BS based on Received signal strength intensity (RSSI). The clustering phase begins and one-depth cluster if formed with BS as cluster head. When there are 600 rounds of transmission the HDCS prolongs network lifespan by 75%.

TABLE VI. OVERALL NETWORK LIFETIME

Network Lifetime	100	200	300	400	500
EEUC	3000	2980	2400	1720	900
MOCH	3780	3090	2500	1850	1000
DCRP	4000	3340	2600	1900	1085
HDCS	4400	3500	2750	2000	1300

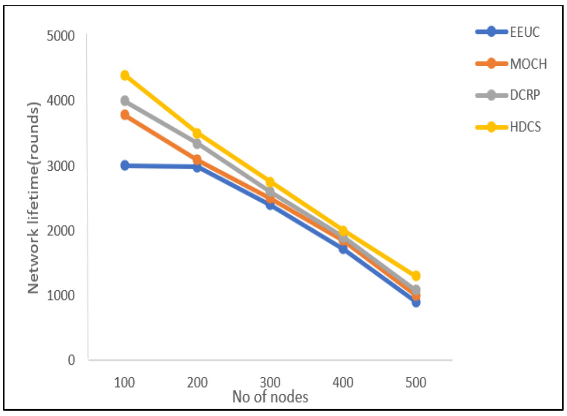

Figure 6: Overall Network lifetime

TABLE VII . NETWORK LIFESPAN (N=500)

PROTOCOL	No of one depth nodes	No of Rounds
EEUC	14	450
MOCH	14	325
DCRP	14	425
HDCS	14	486

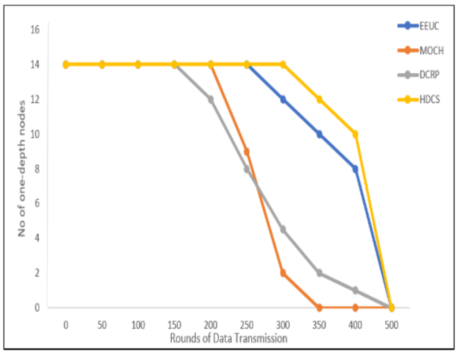

Figure 7: Network Lifespan N=500

TABLE VIII. NETWORK LIFESPAN (N=700)

PROTOCOL	No of one depth nodes	No of Rounds
EEUC	23	550
MOCH	23	375
DCRP	23	525
HDCS	23	657

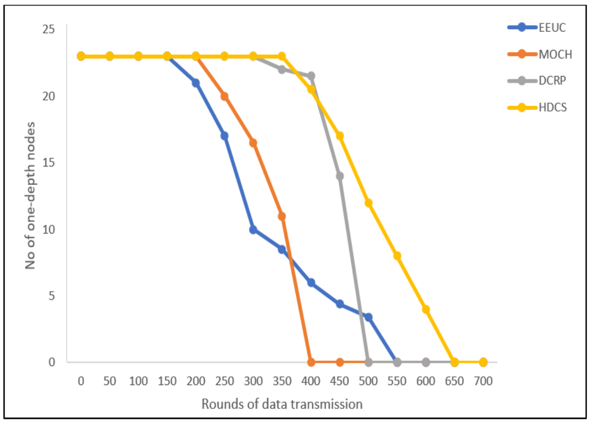

Figure 8: Network Lifespan N=700

VI.CONCLUSION AND FUTURE WORK

In proposed TDMA-HDCS, we use a new perception to create clusters, in which cluster is formed by diffusing outlying nodes from BS in hop by hop pattern. Relay nodes are not equipped in HWSN as the new CH is elected from cluster members of existing clusters. Isolated CHs can be averted because there are high chances that atleast one neighbor CM lies within the transmission radius(500m) of each Cluster head. Border nodes maintains border table to avoid redundancy data transmission. Residual energy, depth, neighbor nodes out of cluster are the parameters considered for CH selection. In transmission phase TDMA approach is used for intercluster and intracluster communication. HDCS approach balances energy dissipation and lowers transmission delay. Analysis and simulation results shows that HDCS assures no isolated CH and no redundant data transmission. The lifespan of our novel brand new HDCS is 75% compared with DCRP, EEUC, MOCH. In malicious nodes detection schemes, HDCS can be introduced to ensure neighbor node monitoring and information exchange.

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