

Lifetime Maximization of Energy Constrained Wireless Sensor Networks with Mobile Agent

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ABSTRACT: In Wireless Sensor Networks (WSNs) fundamental problem is unbalance energy consumption. it will reduce the lifetime of network, by reducing the energy consumption with transmission of data among sensor nodes must be reduce remaining energy in every node. the nodes which are closer to sink node are more critical than other nodes. to leverage this problem in this paper we are working on mobile agent technology with cluster structure. we design a method to mitigate uneven energy dissipation problem by controlling the mobility of agent which is achieved by energy prediction mechanism. here we propose balancing energy consumption with mobile agent (BECM) protocol for WSNs. for better performance, cluster structure is formed based on cellular topology.

KEYWORDS: Mobile agent, Wireless Sensor Networks (WSNs), Energy balancing, cellular structure, Energy prediction, energy efficiency

I. INTRODUCTION

In wireless sensor networks (WSNs) energy efficiency is most burning issue for researchers. so it is important to design energy efficient routing protocol for WSNs[1]. sensor node is combination of three major components: sensing of DATA, processing of data and wireless communication[2].

Transmission cost of data can be different from node to another node depending on the distance between node and sink. most of the sensor nodes are unable to communicate directly to sink because of their limited communication capacity. multihop communication becomes basic routing in wireless sensor networks[3].

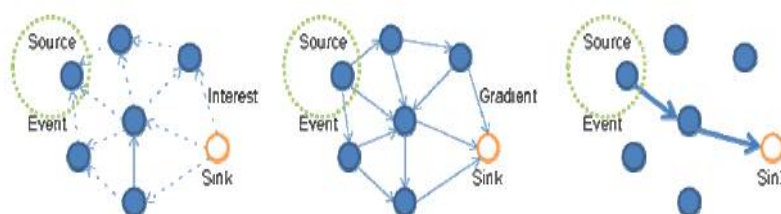


Fig. 1 Traditional Routing Scheme

Sensor node near to sink have not only to send their own data but also to transmit data from other nodes. so the nodes nearer to the sink are performing more task then other nodes available in network. as a result node nearer to the sink are draining more energy than other nodes[1]. so unbalance energy consumption is introduce. to overcome this unbalance energy consumption in network in this paper we introduce clustering algorithm, it can extend the network scale and manage the data distribution. in cluster architecture we find cluster head with maximum energy to perform data transmission task[4]. nodes with less amount of energy which are unable to send data their data to cluster head we

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introduce special node called mobile agent which is next to cluster head (CH) energy can travel over cluster to collect data from less amount of energy nodes and send to cluster head [5].

- here we introduce energy prediction mechanism to know about remaining energy of all the sensor nodes in cluster. based on this mechanism we determine position of mobile agent (MA) to address the uneven energy dissipation problem.
- form cluster structure based on cellular topology. intra-cluster and inter-cluster communication has been done.

The rest of the paper organized as follows : Section II surveys related works. Section III introduces the energy map with an energy prediction mechanism. Balance energy consumption with mobile agents is proposed in Section IV. simulation results and analysis are provided in section V. section VI concludes the paper.

II. RELATED WORK

kai lin et al. present in [1] a mobile agent paradigm is used with cluster topology for gathering data. here mobile agent act as cluster head. location of mobile agent can balance energy consumption among sensor nodes. the proposed architecture is called EBMA (energy balancing cluster routing based on mobile agent) it gives better performance than conventional architecture.

the author of [2] explain why clustering approach is used in WSNs. they proposed a methodology to implement cluster in network and elect cluster head from the residual energy of the cluster. in second phase data transmission is done to the sink node. unfortunately this methodology is difficult to use in WSN due to the limited power computation of sensors.

in article [3] author propose to implement clustering scheme for energy balancing then use TDMA method to collect data at cluster head. and for inter cluster communication use minimum spanning tree to find shortest path to reach data to sink node.

Rais Amine et al. in [4] performing multiple sink formula. in this paper mobile agent act as cluster head and cluster is subdivided in cells. here multiple sink are use to balance energy consumption in cluster.

Author of [5] explain concept of mobile agent in cluster. they proposed method in which mobile agent migrate from node to node in cluster and collect information. after collection of all the data mobile agent reach to the sink.

III. ENERGY PREDICTION MECHANISM

For balancing energy consumption we focus on the establishment of local energy map to make the mobile agent aware of the remaining energy of all nodes in its cluster which can provide necessary information for the mobile agent by determining its movement.

However to become aware of the energy among nodes is difficult to achieve in WSN because of high communication cost generated by frequently updating their remaining energy information. additionally other issue arise as network congestion and transmission delay, to address this problem we adopt energy prediction mechanism which can make the mobile agent aware of the remaining energy of all sensor nodes in its cluster by frequent information updating.

Here we use Markov Chain to simulate the working state of sensor nodes. each is working on four different state i.e. sensing, transmitting, receiving, and fusion. major factor is transmitting, receiving and fusion, here we can neglect sensing data and other simple processing . from this each node has series of random variants X_0, X_1, X_2, \dots which describe different working states. P_{ij} is defined as one step diversion probability

$$P_{ij} = P \left\{ \frac{X_{m+1}}{X_m} = i \right\}$$

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If the node is currently in state i , the number of times slots that it will stay in state S in the next T time-step can be expressed as $\sum_{t=1}^T P_{is}(t)$

We use $D_T(u)$, $D_R(u)$, $D_F(u)$ for representing the energy consumption of a node staying at state S .

$$E_T(u) = \left(\sum_{t=1}^T P_{i1}(t) \right) D_T(u)e_i + \left(\sum_{t=1}^T P_{i2}(t) \right) D_R(u)e_r + \left(\sum_{t=1}^T P_{i3}(t) \right) D_F(u)e_f$$

IV. BECM PROTOCOL ARCHITECTURE

In this section we propose balance energy consumption with mobile agent for WSN, above mansion energy prediction mechanism is used in BECM. to obtain better performance cluster structure is formed based on cellular topology the design objective of BECM is to maximize the balancing of energy consumption among sensor nodes.

A. BECM Routing in WSNs.

In BECM routing random number of node is consider as cluster and any one node available with maximum energy within cluster is consider as cluster head.

the node which is next to cluster head energy will be consider as mobile agent.

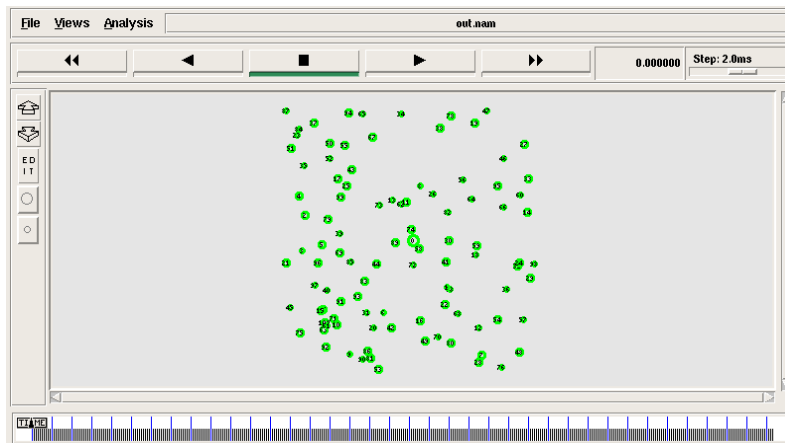
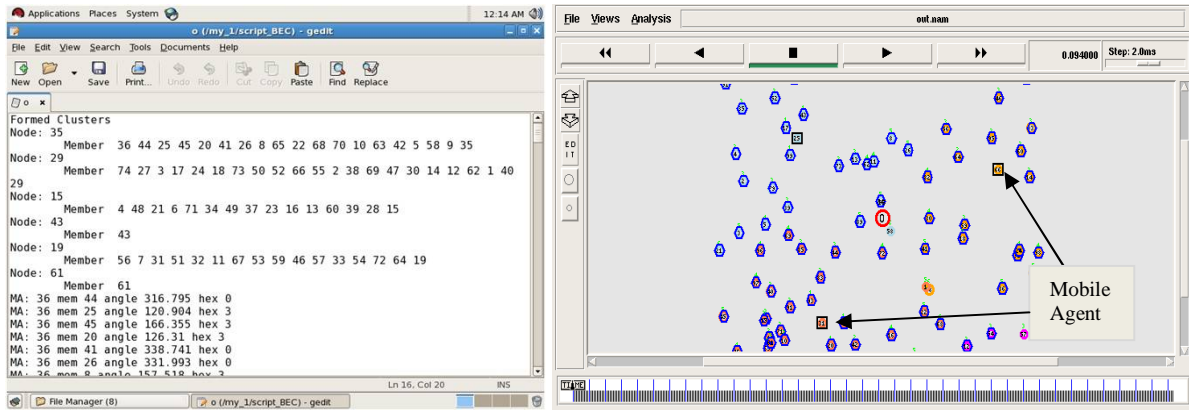


Fig 2. Nodes With Equal Energy

The selection of mobile agent is, it is migrate from one position to another, gather data from the nodes which is unable to send their data to cluster head and finally transmit their data to cluster head.

Migration of mobile agent from one position to another is based on energy prediction mechanism.



(a)

(b)

Fig. 3. (a) Selection of Cluster Head (b) Selection of Mobile Agent

B. Energy Balancing

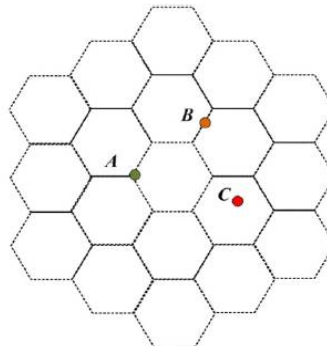
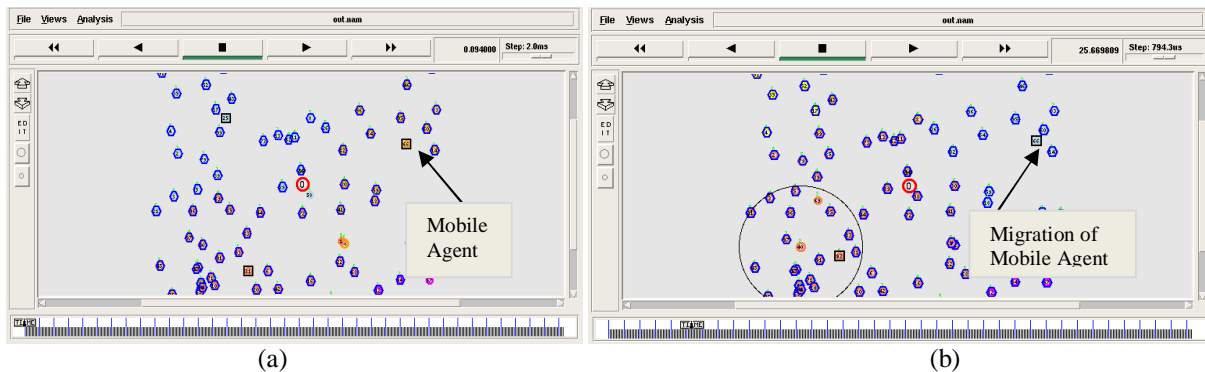


Fig 4. Different Position of Mobile Agent

The location of mobile agent can balance the energy consumption among sensor nodes to maximum at the cross point of three neighbour hexagon cells as shown in figure 4. the points A, B & C represent three different position of mobile agent. here we use S_A , S_B , S_C to represent area where energy consumption is consumed fastest in cluster. E_A , E_B , E_C represent the energy consumption of these zones.



(a)

(b)

Fig 5. (a) Mobile Agent at old position (b) Migration of Mobile Agent

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- when mobile agent at position A, which is cross point of three hexagon cells, the sensor nodes in three hexagon cell do not need to receive data and only need to send sensor data to mobile agent. there are nine hexagon cells communicate with mobile agent.
- when mobile agent at point B, Eight hexagon cells communicate with mobile agent.
- when mobile agent at point C, Six hexagon cells communicate with mobile agent.

$$\frac{S_A \rho E_0}{E_A} > \frac{S_B \rho E_0}{E_B} > \frac{S_C \rho E_0}{E_C}$$

C. Balance Energy Consumption in Mobile Agent

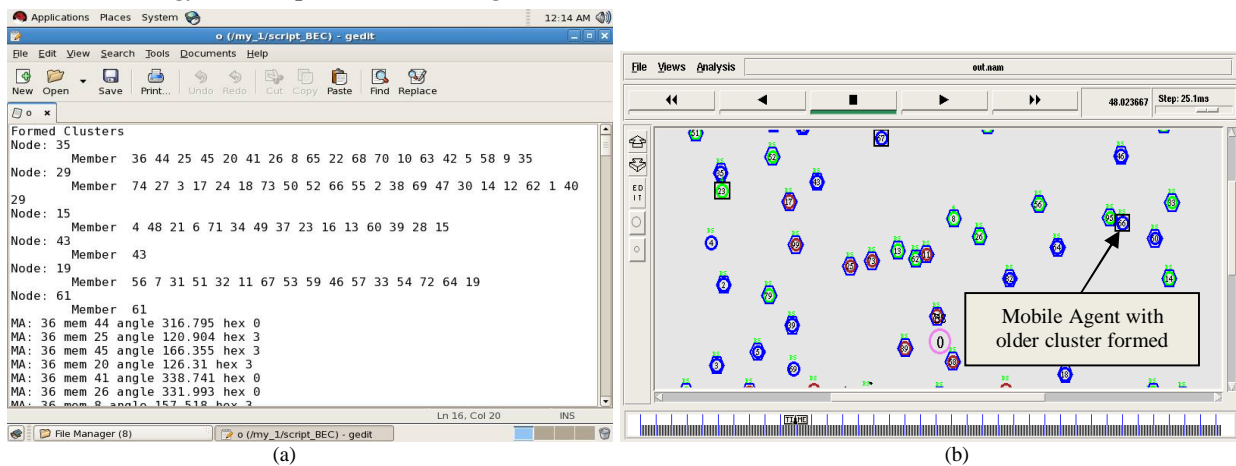


Fig 6. (a) OLD Cluster data (b) Mobile Agent with old Cluster data

in above figure older cluster is described, according to that mobile agent and Cluster head will be work after Energy Prediction Mechanism applied according to that energy available in another node is greater than cluster head so new cluster is formed with new Cluster Head and mobile agent.

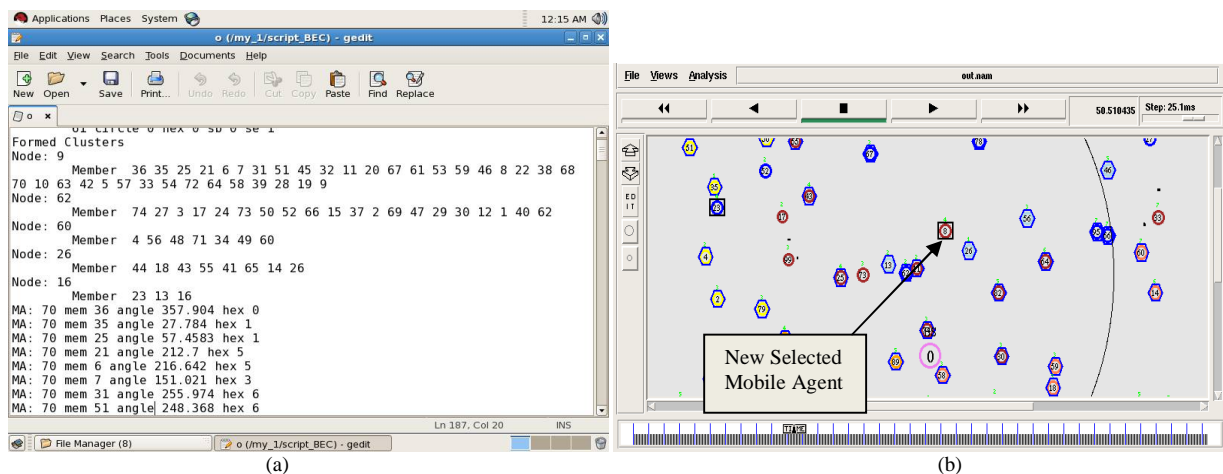


Fig 7. (a) NEW Cluster data (b) Mobile Agent with new cluster data

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Above figure describe new Cluster selection with Cluster Head. according to new cluster, energy available with Cluster head is maximum compared to another nodes available in that cluster. this process has been occurred number of times in network. and for that network will be work for long lasting.

D. Balance Energy Consumption in Mobile Agent

time slot allocation can effectively reduce the probability of communication collision, which can save energy based on this there is four working states in this model.

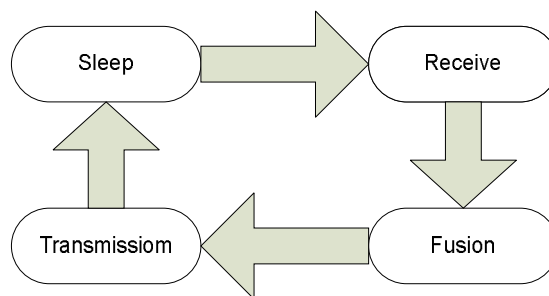


Fig 8. State Conversion Model

- Sleep state, the sensor and communication module of sensor node are both closed. sensor node have no task.
- Receive state, sensor module is closed and communication module is open, the sensor node receive data from other node.
- Fusion state, the sensor and communication module of sensor node is also closed, the sensor node fulfill the fusing process.
- Transmit state, the sensor module is closed and the communication module is open, sensor node transmit data to other nodes.

V. RESULTS

In all simulations, sensor nodes are uniformly deployed in area of $500 \times 500m^2$. There are some mobile agents distributed in the hexagon area and only one sink node is located. The sink node and all mobile agents are not energy limited, while the sensor nodes are all stationary and have the same initial energy 100 J. The running time of each round during data gathering is 200 s.

TABLE I. SIMULATION PARAMETER

Area	500 X 500 meter
Initial energy	100 Joule
Simulation end	200 Seconds
Channel Type	Wireless
MAC Protocol	802.11
Routing Protocol	BECM
Frequency	2.4 GHz

Here all the results are taken as different amount of sensor nodes on same environment Fig 9. shows Packet Delivery Ratio (PDR) vs Nodes as the number of nodes are increase in the network more number of nodes are available in the cluster so, with the help of mobile agent data collection at Base Station is more effective as compared to less number of nodes.

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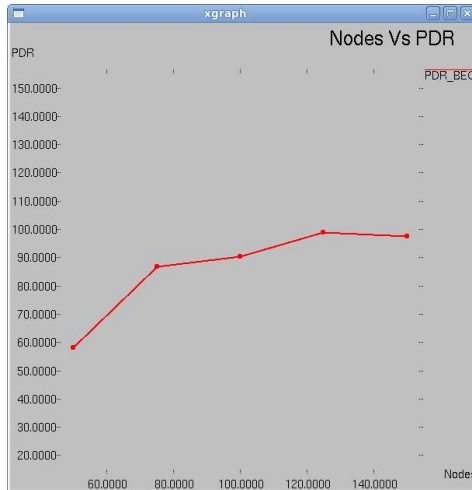


Fig 9. Packet Delivery Ratio V/S Nodes

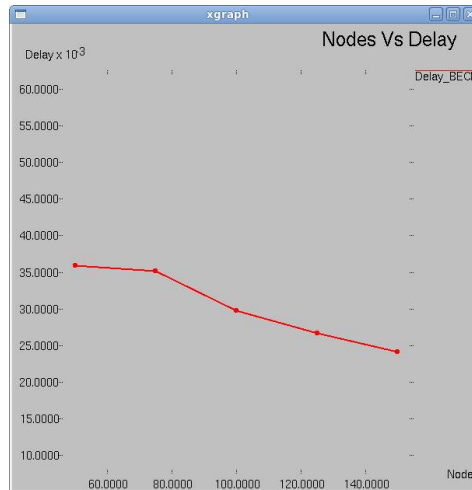


Fig 10. Delay V/S Nodes

Fig 10. shows graph of Delay vs Nodes, as more number of nodes are available in the network mobile agent can do its work more efficiently. Data available at node easily reach to cluster head with the help of mobile agent. So that delay will be reduce of the network.

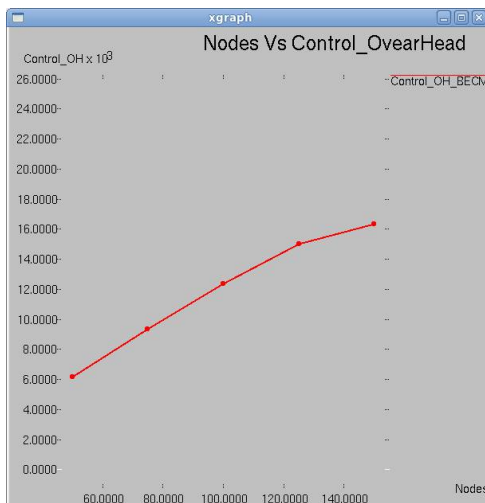


Fig 11. Control Overhead V/S Nodes

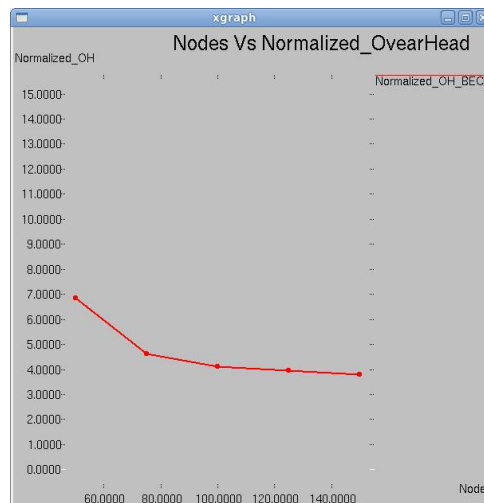


Fig 12. Normalize Overhead V/S Nodes

Control overhead is used to show the efficiency of the routing protocol. It is defined, as the ratio of the number of control messages and control packets e.g., RTS, CTS and ACK propagated by each node throughout the network and the number of the data packets received by the destinations.

Fig 12. Normalized Routing Overhead is defined as the total number of routing packet transmitted per data packet. so more number of data packets are transmitted as number of nodes increase.

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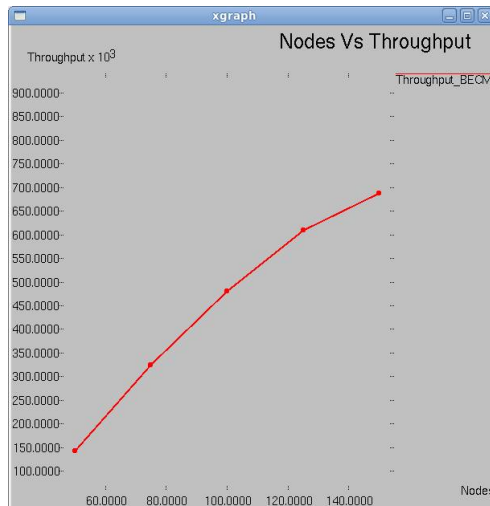


Fig 15. Throughput vs Nodes

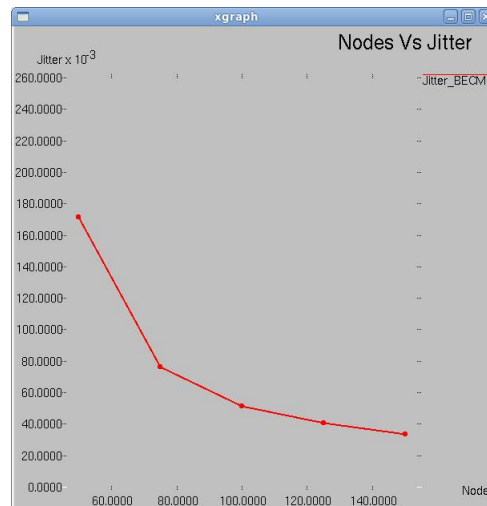


Fig 16. Jitter vs Nodes

Throughput is the number of successfully received packets in a unit time. As the number of nodes are increase communication between nodes also increase so that data received at destination is increase. jitter describe it represent variance of delay number of nodes increase jitter will decrease.

The algorithm was tested with different number of nodes. For each one, showing that the higher the number of nodes the lower the energy consumption.

V. CONCLUSION

One major drawback of clustering approach is draining cluster head energy. High energy consumption of cluster head degrade the performance of the network, and cluster head is died, whole network will be fail. Here cluster head plays its role with mobile agent and both can work simultaneously to gather data from nodes. Aided mobile agent approach with cluster head and both can work separately the performance is evaluated in term of Packet Delivery Ratio (PDR), Delay, Control Overhead, Normalized Overhead, Throughput. Result of all this are compared with different environment of nodes.

REFERENCES

- [1] Kai Lin, Min Chen, Sherali Zeadally, Joel J.P.C. Rodrigues, "Balancing energy consumption with mobile agents in wireless sensor networks" Future Generation Computer Systems, Volume 28, Pages 446–456, February 2012.
- [2] Sidhik Koyamparambil Mammu, Ashwani Sharma, Unai Hernandez-Jayo, and Nekane Sainz "A Novel Cluster-based Energy Efficient Routing in Wireless Sensor Networks" Advanced Information Networking and Applications (AINA), IEEE 27th International Conference, Pages 41–47, March 2013.
- [3] Rais Amine, Bouragba Khalid, Ziyati Elhoussaine, Ouzzif Mohammed, "Energy Consumption Balancing in Wireless Sensors Networks" Multimedia Computing and Systems (ICMCS), 2014 International Conference, Page937-933 , April 2014.
- [4] Sabet Maryam, Naji Hamid Reza, "A decentralized energy efficient hierarchical cluster-based routing algorithm for wireless sensor networks " AEU - International Journal of Electronics and Communications, Volume 69, Pages 790–799, May 2015
- [5] Say Sotheara, Kento Aso, Naoto Aomi, and Shigeru Shimamoto, "Effective Data Gathering and Energy Efficient Communication Protocol in Wireless Sensor Networks employing UAV" Wireless Communications and Networking Conference (WCNC), 2014 IEEE, Pages-2342 2347, April 2014.
- [6] Mahdi Lotfinezhad and Ben Liang "Energy Efficient Clustering in Sensor Networks with Mobile Agents" Wireless Communications and Networking Conference, 2005 IEEE, Pages-1872 1877, March 2005.
- [7] Yuzhong Chen, and Yiping Chen, "An Energy Efficient Clustering Algorithm Based on Residual Energy and Concentration Degree in Wireless Sensor Networks" International Computer Science and Computational Technology (ICSCCT '09), International Conference, Pages 309-306, Dec. 2009
- [8] Min Chen, Taekyoung Kwon, Yong Yuan, and Victor C.M. Leung, "Mobile Agent Based Wireless Sensor Networks" JOURNAL OF COMPUTERS, Volume 1, Pages 14-21, April 2006.