New Cluster Making Scenario for Next Generation System Using Graph Theory System

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Abstract **-** The wireless sensor networks (WSN) consists of several autonomous sensor nodes with sensing, processing and wireless communication capabilities. Sensor network is considered as the critical network because of limited availability of resources in terms of sensing range, memory, energy specification etc. These sensor nodes are distributed spatially to monitor physical and environmental conditions, such as temperature, pressure, humidity, vibration, sound, motion or pollutants and cooperatively send the sensed data to the end user through the network. In this work, the sensor network security issues are resolved in clustered network when a new node enters to the network. In this present work, two stage authenticated communication is defined. The first level authentication is applied between the base station and the cluster head. As a new node will enter to the system the cluster heads in range will be identified and the cluster head will send the request to base station for the acceptance of new node.

Prolonged network lifetime, scalability and load balancing are important requirements for WSN applications. Clustering the sensor nodes is an effective technique to achieve these goals. Many clustering based power management and data dissemination routing protocols have been specifically designed for WSNs where energy consumption is an essential design issue. In this thesis I have simulated communication graph theory based cluster which is updated version of graph theory protocol which is one of the clustering based energy efficient routing protocols using MATLAB.

Keywords **-** *WSN, scalability and load balancing, graph theory, cluster.*

I. INTRODUCTION

The main problem in wireless communication networks is the field nodes are battery resource constrained. Consider a situation of multi-hop wireless communication in a sensor network in which the information from a node is transferred to the base station using ad hoc multi hop network. That is, the sensed information from a field sensor node is forwarded by multiple intermediate nodes until information reaches the base station.

Wireless sensor networks are attracting great interest in a number of application do-mains concerned with monitoring and control of physical phenomena, as they enable dense and effective deployments at low cost. However, application development is still one of the main hurdles to a wide adoption of WSN technology. If one of the nodes which participate in multi-hop forwarding is switched off due to low battery power, the network is disconnected and the field information could be lost on the way. While energy efficiency of communication protocols try to ensure extended network lifetime, battery drainage problem still remains. In many applications, due to the deployment terrain condition or because of the sheer number of field nodes, it is very difficult or infeasible to replace the exhausted batteries .The means to recharge the nodes without shutting down the network is very important for uninterrupted operation of the network and also to keep the network maintenance cost at a minimum.

The major challenges faced by this type of networks are energy-efficiency (sensors are powered by on-board batteries) and self-organization. Self-organization protocols enable sensors to communicate with the sink while continuously adapting to topological changing because of the wireless link's dynamic nature and because nodes may disappear. The radio chip accounts for most of the energy consumed on a wireless sensor. Reducing the use of this chip does reduce the sensor's energy consumption, yet it makes communication between sensors more complex. As a result, there is a trade-off between energy-efficiency and ease of communication thus efficiency of the self-organization scheme.

Wireless Sensor Networks (WSNs) have been widely considered as one of the most important technologies for the recent years. A wireless sensor network is composed by hundreds or thousands of small compact devices, called sensor nodes, equipped with sensors that are densely deployed in a large geographical area. Enabled by recent advances in microelectronic mechanical systems (MEMS) and wireless communication technologies, tiny, cheap, and smart sensors deployed in a physical area and networked through wireless links and the Internet provide unprecedented opportunities for a variety of civilian and military applications, The applications may be environment control such as office building, robot control and guidance in automatic manufacturing environments, interactive toys, high security smart homes, and identification , for example, environmental monitoring, battle field surveillance, and industry process control. Wireless sensor networks (WSNs) are the products which integrate sensor techniques, embedded techniques, and distributed information processing and communication techniques. We know that previously there have been significant improvements in processor design and computing, and performance limits of wireless sensor networks. The performance limits include network capacity and network lifetime. Network capacity typically refers to the maximum amount of bit volume that can be successfully delivered to the base station by all the nodes in the network. Whereas network lifetime refers to the maximum time limit those nodes in the network remain alive until one or more nodes drain up their energy. This technology is distinguished from traditional wireless communication networks, for example, cellular systems and mobile ad hoc networks (MANET), WSNs have unique characteristics, for example, denser level of node deployment, higher unreliability of sensor nodes, and severe energy, computation, and storage constraint, which present many new challenges in the development and application of WSNs.

II. WIRELESS SENSOR NETWORKS

Wireless Sensor Networks (WSN) have gained world-wide attention in recent years due to the advances made in wireless communication, information technologies and electronics field. The development of low-cost, low-power, a multifunctional sensor has received increasing attention from various industries. Sensor nodes or motes in WSNs are small sized and are capable of sensing, gathering and processing data while communicating with other connected nodes in the network, via radio frequency (RF) channel. Wireless sensor network [13] are one of the category belongs to ad-hoc networks. Sensor network are also composed of nodes. Here actually the node has a specific name that is “Sensor” because these nodes are equipped with smart sensors. A sensor node is a device that converts a sensed characteristic like temperature, vibrations, pressure into a form recognize by the users. Wireless sensor networks nodes are less mobile than ad-hoc networks. So mobility in case of ad-hoc is more. In wireless sensor network data are requested depending upon certain physical quantity. So wireless sensor network is data centric. A sensor consists of a transducer, an embedded processor, small memory unit and a wireless transceiver and all these devices run on the power supplied by an attached battery.

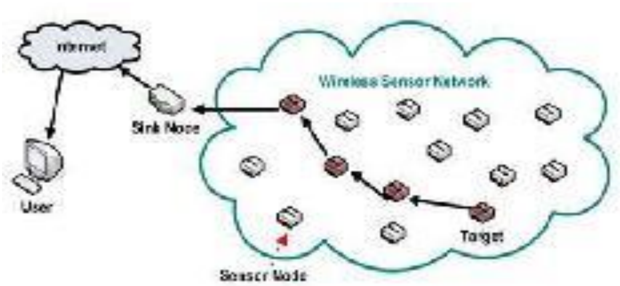

Fig.1: Wireless sensor network

The wireless sensor nodes are the central element with limited computing and processing power in a wireless sensor network (WSN). It is through a node that sensing, processing, and communication take place. It stores and executes the communication protocols and the data processing algorithms. The quality, size, and frequency of the sensed data that can be extracted from the network are influenced by the physical resources available to the node. Therefore, the design and implementation of a wireless sensor node is a critical step. It is made up four basic components: [3, 36, 37].

1. A sensing unit,
2. A processing unit,
3. A transceiver unit and
4. A power unit.

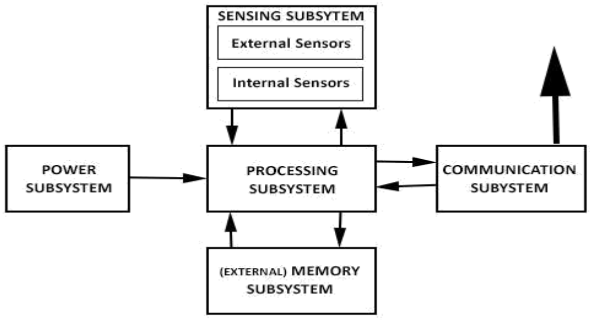

Fig.2: Architecture of a sensor node.

There can be application dependent additional components such as a location finding system, a power generator and mobilize. Figure 2 presents the architecture of a sensor node.

Most available wireless sensor devices are considerably constrained in terms of computational power, memory, efficiency and communication capabilities due to economic and technology reasons. That‘s why most of the research on WSNs has concentrated on the design of energy and computationally efficient algorithms and protocols, and the application domain has been confined to simple data-oriented monitoring and reporting applications.

III. PROBLEMS UNDER INVESTIGATION AND CONTRIBUTIONS

The key challenge in WSN is to minimize the energy consumption and enhance the network lifetime of the sensor network. Since energy is an important limited resource in wsn so we have to consider minimizing the usage of this resource. By choosing conventional routing protocols for data transmission like direct communication with BS, MTE (Minimum Energy Transmission), and energy consumption is more and lifetime of network is not hopeful. So clustering based routing protocols is one of the solutions of the above mentioned problem. LEACH is one of the clustering based protocols where sensor nodes form clusters, they send data to cluster heads (CHs). Then CHs aggregate the received data and send it to the base station (BS). If the cluster formation, cluster heads selection and randomization of CHs are formed properly then it will help to minimize the energy dissipation and prolong the network lifetime. Here we develop a appropriate new cluster making scenario based on communication graph theory which based on leach and deec protocol. While sensor networks share many similarities with other distributed systems, they are subject to a variety of unique challenges and constraints. These constraints impact the design of a WSN, leading to protocols and algorithms that differ from their counterparts in other distributed systems. This section describes the most important design constraints of a WSN [3].

A. Energy

The constraint most often associated with sensor network design is that sensor nodes operate with limited energy budgets. Typically, they are powered through batteries, which must be either replaced or recharged (e.g., using solar power) when depleted. For some nodes, neither option is appropriate, that is, they will simply be discarded once their energy source is depleted. Whether the battery can be recharged or not significantly affects the strategy applied to energy consumption. For non rechargeable batteries, a sensor node should be able to operate until either its mission time has passed or the battery can be replaced. The length of the mission time depends on the type of application, for example, scientists monitoring glacial movements may need sensors that can operate for several years while a sensor in a battle field scenario may only be needed for a few hours or days. As a consequence, the first and often most important design challenge for a WSN is energy efficiency.

B. Scalability

While high-density deployment of sensor nodes in a WSN provides redundancy and improves the fault tolerance of the network, this also creates scalability challenges. The number of sensor nodes deployed for sensing a physical phenomenon may be on the order of hundreds or thousands. Therefore, the networking protocols developed for these networks should be able to handle these large numbers of nodes efficiently. The density can range from a few to hundreds of sensor nodes in a region, which can be less than 10m in diameter. The node density depends on the application for which the sensor nodes are deployed.

C. Production Costs

Since the sensor networks consist of a large number of sensor nodes, the cost of a single node is very important to justify the overall cost of the networks. If the cost of the network is more expensive than deploying traditional single sensor devices, then the sensor network will not be cost justified. As a result, the cost of each sensor node has to be kept low. The cost for Bluetooth is usually less than $10. The cost of a sensor node should be less than $1 in order for sensor networks to be practically feasible. Current prices for sensor devices are much higher than even for Bluetooth. Furthermore, a sensor node may also have some additional units, e.g., for sensing and processing. Also it may be equipped with a location finding system, mobilize, or power generator depending on the applications of the sensor networks. These units all add to the cost of the sensor devices. As a result, the cost of a sensor node is a very challenging issue given the number of functionalities.

D. WSN Topology

The large numbers of inaccessible and unattended sensor nodes which are prone to frequent failures make topology maintenance a challenging task. The major challenge is the deployment of these sensor nodes in the field so that the phenomenon of interest can be monitored efficiently. This constitutes the pre deployment and deployment phase. Topology maintenance is also important after the initial deployment, i.e., the post-deployment phase, where the protocol parameters and operations can be adopted according to the network topology. Finally, the re-deployment phase may be necessary if several nodes fail or deplete their energy to prolong the network lifetime. Overall, densely deploying a high number of nodes requires careful handling of topology maintenance. We describe next issues related to topology maintenance and change in these three phases.

E. Challenges Associated with WSN Routing Protocol

New application scenarios lead to new challenges:

- **Energy-aware algorithms:** sensor nodes are powered by external batteries and it can be difficult to replace them when consumed, so it is critical to design algorithms and protocols that utilize minimal energy. To do that, implementers must reduce communication between sensor nodes, simplify computations and apply lightweight security solutions.

- **Location discovery:** many applications that can track an object require knowing the exact or approximate physical location of a sensor node, in order to link sensed data with the object under analysis. So many geographical routing protocols need the location of sensor nodes to forward data among the networks. Location discovery protocols must be designed in such a way that minimum information is needed to be exchanged among nodes to discover their location. Solutions like GPS are not recommended because of the energy consumption and the price of the components.

- **Cost:** this is another factor that influences design. Manufacturers try to keep the cost at minimum levels since most sensor nodes are usually needed for many applications. New technologies are always costly. If the cost is high, the adoption and spread of sensor technology will be prohibitive.

- **Security:** it is not possible to introduce a new technology without considering security aspects. However, as it happens with other technologies, security is not the top priority when designing something new. Security solutions are constrained when applying them to sensor networks

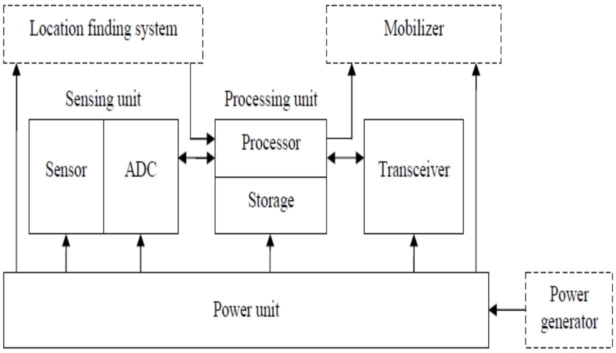

Fig.3: The basic components of a sensor node

F. Factors Affecting Design of Routing Protocol

The main design challenge in WSNs is to prolong network lifetime while keeping communication integrity. This is complicated by the fact that nodes in a WSN are constrained in energy supply, processing capability and available bandwidth. There are many factors related to the inherent characteristics of WSNs that have to be considered in order to design an efficient WSN routing protocol. These factors include:

- node deployment
- data reporting method
- node and link heterogeneity
- reliability
- energy consumption
- scalability
- network dynamics
- transmission media
- connectivity, coverage
- data aggregation and
- Quality of service.

IV. CLUSTERING BASED ROUTING PROTOCOLS

Routing of data from source to destination is an important challenge in wireless sensor network. To route data from source to destination various models are proposed as follows.

A. One Hop Model

It is the simplest model where data is sending from source (sensors) towards destination (BS) directly [38]. No intermediate node participates to send the data to BS here. The figure 5 represents one hop model where all sensor nodes send data to base station directly. Based on one hop model direct communication protocol works.

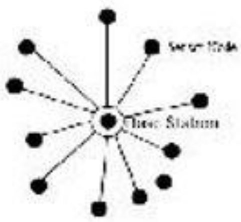

Fig.4: One hop model

B. Direct Communication Protocol

Direct communication protocol [1] is one of the simplest routing protocols in WSN. It is based on One Hop Model. In Direct communication routing protocol, each sensor nodes sends its data to BS directly. So if the BS is far away from the sensor nodes direct communication requires more transmit energy for each node. This will drain the energy level quickly of each node which reduces the system lifetime greatly. So it is only acceptable when the BS is closed to the sensor nodes or the transmit energy level of nodes is very large. It may be an acceptable and possibly optimal method of communication in WSN. The amount of energy used in figure 6 can be modeled using direct communication protocol is: (3d1+ d2).^2.

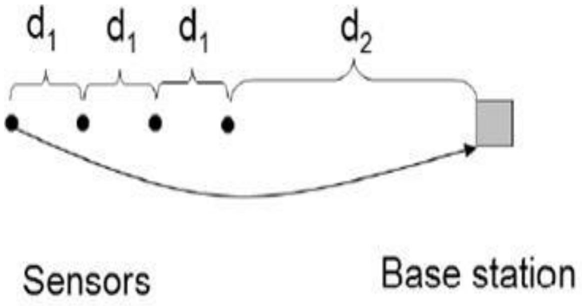

Fig.5: Simple linear network (direct communication)

1. Limitation

While considering the network large in size, if direct routing is selected as a routing protocol to send the data from source (sensors) to destination (BS) then all nodes send data to BS directly. So the node which is at maximum distance from the BS will have to lost more energy than the nodes closed to BS. So after sending very small amount of data the far away nodes will die which leads to reduce network lifetime. That's why adopting direct routing protocol in large network is not feasible in WSN.

C. Multichip Model

In multichip model nodes choose their neighbors to forward data towards the BS. "This model is an energy efficient model of routing. [38]." Figure 7 presents the multi hop model. Minimum Transmission Energy (MTE) protocol works based on this multichip model.

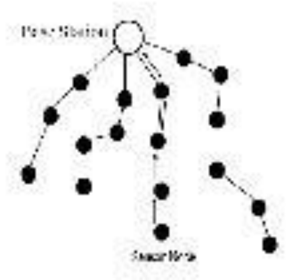

Fig.6: Multi-hop model

1. Minimum Transmission Energy Protocol (MTE)

In a wireless communication distance between transmitting node and receiving node may be very long. Thus the choosing of multi-hop routing to minimize the energy dissipation of long distance data transmission is very sensible. In multichip routing one or more intermediate nodes acts as routers if the total energy dissipation can be reduced.

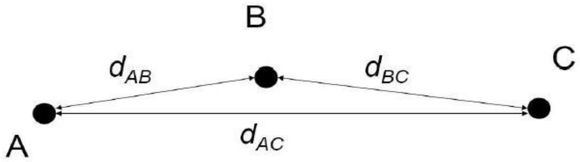

Fig.7: Minimum transmission energy (MTE) protocol

The Minimum Transmission Energy [1],[38],[39] protocol is an energy- aware multihop routing approach in wireless networks. In MTE intermediate nodes are chosen to relay data packets from source to a given destination so as to minimize the total transmission energy. Assuming a d^ 2 (d is the distance between transmitting node and receiving node) power loss implemented to estimate the energy dissipation during transmission for the configuration shown bellow node A will choose node B as the intermediate node to relay data packets to the destination node C if and only if

$$d_{AB}^2 + d_{BC}^2 < d_{AC}^2$$

This multi-hop routing can be implemented in wireless sensor networks where all the nodes must send their data to the BS. Each node must start up routine to determine next hop neighbour using a particular protocol. Data is passed to each node's next hop neighbor until the data reaches to the BS. If the intermediate nodes die, the route must be recomputed to ensure the connectivity with the BS. Since the distance between nodes and the BS may be very long the significant energy reduction for data transmission can be achieved by using the MTE protocol.

The amount of energy used can be modeled for figure 9 using MTE protocol is: example (3d1^2 + d2^2).

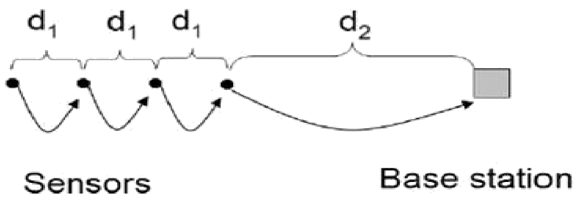

Fig.8: Multi-hop communication

2. Limitation

In multihop routing the nodes closer to the base station will get maximum load of the network because they have to send their own data as well as data from other nodes. If this scenario is considered in large network size, then huge number of data packets will be routed through these nodes, closer to the sink. This will drain the energy levels of the nodes near to the sink very quickly. So multihop routing in large network size is also a challenge.

D. Cluster Based Model

Clustering is an efficient approach that has been implemented in many communication protocols in wireless environment. In Cluster Based Model [38] network is grouped into different clusters .Each cluster is composed of one cluster head (CH) and cluster member nodes. "The respective CH gets the sensed data from cluster member nodes, aggregates the sensed information and then sends it to the Base Station.(BS).[38]." Cluster members do not communicate directly with the sink node. Thus minimizes the energy consumption and number of messages communicated to base station. "Ultimate result of clustering the sensor nodes is prolonged network lifetime.[38]". Figure 10 presents the cluster based model.

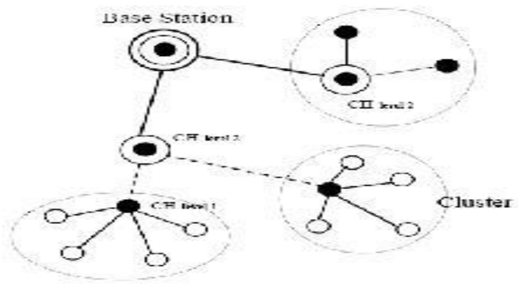

Fig.9: Cluster based model

1. Limitation

In cluster based model, formation of clusters, selection of CH of each node and formation of schedule is an overhead. Besides this the CHs receive the data, aggregate the data and transmit the data, so required energy is much more of each CH.

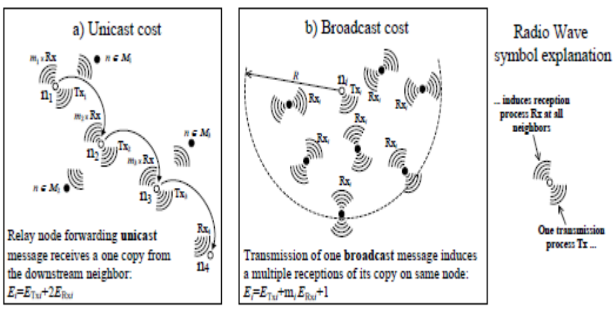

Fig.10: Cluster head to cluster child secure communication layout

V. RESULT & CONCLUSION

The data routing in wireless sensor network is realized on the links comparison base. The considered links between a sender and a receiver can be compared in terms of the length, link quality or residual energy of the node pairs. Nevertheless, the path with the smallest investigated value is selected as the route for the data delivery. For the discovering of the optima route between two nodes in the graph data structure, a Matlab implementation of Dijkstra's algorithm can be used. The Dijkstra's algorithm is implemented within a grShortPath function that is included in grTheory Matlab toolb. The grShortPath function takes an E matrix of neighbors, source i and destination j node as an input arguments. It returns a dSP matrix with the shortest path between all node pairs in the network. Furthermore, it returns a sp vectors with the nodes constituting the shortest path between nodes i; j. The E matrix must have an exact form

Algorithm: E=createNbrTable

```
row=1;
for all node pairs
   x=abs(x_i-x_j);
   y=abs(y_i-y_j);
   dist=sqrt(x^2 + y^2);
   if dist_{i,j}<R;
      plot([x_i,x_j],[y_i,y_j]; % draw edge
      E(row,1)=ID_i;
      E(row,2)=ID_j;
       E(row,3)=dist_i,j;
       row++;
```

$\Downarrow$ E matrix

ID_i	ID_j	$dist_{i,j}$
1	2	15.65
1	3	9.21
1	8	21.54
2	1	15.65
2	8	11.12
⋮	⋮	⋮

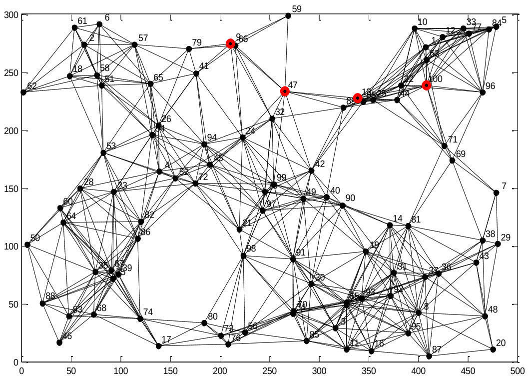

Fig. 11 Network layout with the highlighted shortest path estimated by the grShortPath function and making of cluster

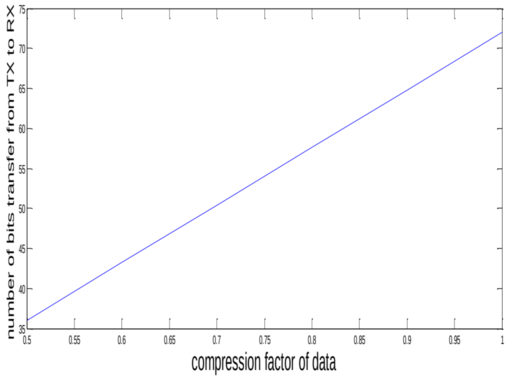

Fig.12: Number of bits transfer vs compression factor transmission fraom cluster head to destination

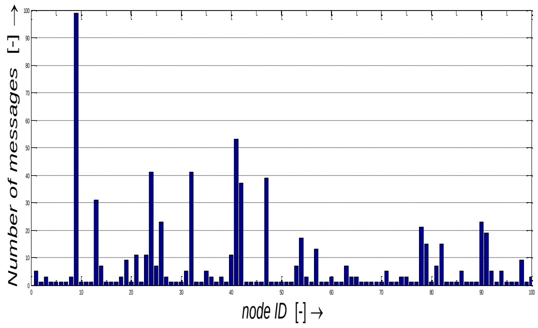

Fig.14: Number of bits transfer vs all node in different cluster making

Following point conclude this paper as

- In this work, we evaluate the performance of Clustering algorithms on the basis of stability period, network life time and throughput for heterogeneous WSNs.
- Cluster perform well under three level heterogeneous WSNs containing high energy level difference between normal, advanced and super nodes in terms of stability period with compression factor.

Few suggestions for the future work:

- Cryptography concept introduce
- Life cycle
- And bandwidth utilization

VI. REFERENCES

[1] Stojmenovic, I. ; Xu Lin, *"Power-aware localized routing in wireless networks"*, IEEE Transactions on Parallel and Distributed Systems, Vol: 12 , Issue: 11, Pag: 1122 – 1133, 2001.

[2] W.Heinzelman, A.Chandrakasanand and H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks," in *Proceedings of the 33rd Annual Hawaii International Conference on System Sciences*, Maui, HI, 2000, pp. 3005- 3014.

[3] AKKAYA, K. AND YOUNIS, M. 2005. A survey of routing protocols in wireless sensor networks. *Elsevier Ad Hoc Netw. 3*, 3, 325–349.

[4] Akyildiz I. F., *Su W, Sankarasubramaniam Y, Cayirci E*, 2002"Wireless sensor network: a survey" Computer *Networks*, 393-422.

[5] Muruganathan S.D., Ma D.C.F., Bhasin R.I, and *Fpojuwo A.O.*, 2005"A centralized energy-efficient routing protocol for wireless sensor networks," *Communication magazine, IEEE*, Pp. 8-13.

[6] Nauman Israr and Irfan Awan, July 2006"Multihop routing Algorithm for Inter Cluster Head Communication","*22nd UK Performance Engineering Workshop Bournemouth UK*", Pp.24-31.

[7] K. Kalpakis, K. Dasgupta, and P. Namjoshi, "Maximum Lifetime Data Gathering and Aggregation in Wireless Sensor Networks". IEEE Networks Conference Proceedings,2002.

[8] N.M. Elshakankiri, N. M. Moustafa and Y. H. Dakroury,"Energy Efficient Routing Protocol for Wireless Sensor Network" *IEEE InternationalConference on pp. 393–398,December 2008.*

[9] Abbasi, A.A.; Younis, M. A survey on clustering algorithms for wireless sensor networks. *Comput. Commun.* 2007, *30*, 2826–2841.

[10] S. Bandyopadhyay, E. J. Coyle, "*An Energy Efficient Clustering Algorithm for Wireless Sensor Networks*", in proceeding of 586 INFOCOM 2003, April 2003.

[11] Lindsey S. and Raghavendra C., "PEGASIS: Power-Efficient Gathering in Sensor Information Systems, *in Proceedings of IEEE Aerospace Conference*, vol. 3, pp. 1125- 1130, 2002.

[12] Kulkarni, G. ; Schurgers, C. ; Srivastava, M., *"Dynamic link labels for energy efficient MAC headers in wireless sensor networks"*, Proceedings of IEEE Sensors, 2002. Vol: 2, Pag: 1520 – 1525, 2002.

[13] Di Tian ; Georganas, Nicolas D., *"Energy efficient routing with guaranteed delivery in wireless sensor networks"*, IEEE Wireless Communications and Networking, Vol: 3, Pag: 1923 – 1929, 2003.

[14] Papadopoulos, A.A. ; McCann, J.A., *"Towards the design of an energy-efficient, location-aware routing protocol for mobile, ad-hoc sensor networks"*, International Workshop Database and Expert Systems Applications,, Pag: 705 – 709, 2004.

[15] Akkaya, K. ; Younis, M., *"Energy-aware routing to a mobile gateway in wireless sensor networks"*, IEEE Global Telecommunications Conference Workshops, Pag: 16 – 21, 2004.

[16] Wentao Zhang ; Xiaohua Jia ; Chuanhe Huang ; Yan Yang, "*Energy-aware location-aided multicast routing in sensor networks"*, International Conference on Wireless Communications, Networking and Mobile Computing, Vol: 2, Pag: 901 – 904, 2005.

[17] Kimura, T. ; Sasase, Iwao, *"Energy-Efficient Routing Protocol Adapted to Mobile Sensors for Multiple Sinks in Wireless Sensor Networks"*, International Symposium on Personal, Indoor and Mobile Radio Communications, Pag: 1 – 5, 2007.

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