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A Review of Leach, Teen & EECDA Data Aggregation Protocols Along with Their Variations in WSN

Obulapu Hitesh Reddy*, Siddharth Chauhan, Pardeep Singh
CSED, NITH, Himachal Pradesh,
India

Abstract— Data aggregation process plays a key function in wireless sensor networks. The overall aim of data aggregation techniques is to assemble and combine information in an energy efficient way so that the lifetime of the network can be increased. In order to increase the energy efficiency and network lifetime, many researchers have proposed in data aggregation in wireless sensor networks since 1993.This research points to systematic study of subjects and challenges in data collection in wireless sensor networks. Data aggregation areas from six aspects: type of data aggregation techniques, secure data, privacy preserving data, cluster based data, energy efficient data and maximum lifetime of data aggregation. We accomplished a systematic literature review of data aggregation in wireless sensor networks in last two decades (1993-2015).we have identified 44 primary studies relevant to the aim of this research. After investigating this study, we found that six aggregation approach in wireless sensor networks. Data collection has various algorithms on the basis of performance criteria. Data collection techniques are promising in the area of wireless sensor networks. In this paper, we study cluster based data aggregation techniques approaches in networks and describe the various approaches in hierarchical networks protocols.

Keywords— Data Aggregation, Wireless Sensor Networks, Clustering, Sensor Nodes, Energy efficiency.

I. INTRODUCTION

In the recent past, wireless sensor networks have been introduced to utilize in many applications. Data aggregation are broadly used to decrease computation, improve scalability, and save energy in various monitoring applications of WSN moving target tracking [1], structural health monitoring [2], wildlife habitat monitoring [3], seismic monitoring [4], and toxic waste monitoring [5], [6].

Wireless sensor networks comprise of numerous tiny sensor nodes that are deployed in an application area to evaluate the given physical phenomenon [7]-[9]. Senor nodes have limited processing capabilities and limitation of low battery power [10]. Sensor nodes cooperatively transmit their information through the network to a central gateway also called as a base station [11]. This information is piled up at base station, get analysed and treated according to the demands [12]. Information gathering is set as the systematic collection of sensed information from multiple sensors to be eventually carried to the base station for handling [8]. In a manner to preserve resources and energy, data must be aggregated. A simple way of doing that is aggregating (sum, average, min, max, count) the data originating from different nodes [13]. Data aggregation techniques plays a major function in wireless sensor networks. The overall intent of data aggregation algorithms is to gather and combine information in an energy effective manner so that the lifetime of the mesh can be increased [14]. The method of reducing information redundancy by gathering the information nearby sensor nodes is called data aggregation [15].

Recent advances in wireless sensor networks (WSNs) have led to many new promising applications including environmental monitoring, facility monitoring and military surveillance [16]- [18]. This applications need to handover a large volume of current, detected information from one socket of the network to another [19]. Since sensor nodes have limited processing capabilities, battery life is most important in WSNs real- time applications [20], [21]. This requires the procedure of energy efficient data dissemination protocols for aggregation of the detected information [22].

The rest of the paper has been organized as follows. In section 2 we analyse search strategy comprises literature resources and search process. In section 3 we discuss the cluster data aggregation approaches in wireless sensor networks. In section 4 we see the result and discussions and finally in we section 5 we conclude the paper.

II. SEARCH STRATEGY

The search strategy comprises literature resources and search process, which are detailed one by one as follows.

A. Literature Resources

The literature resources we used to search for primary studies include four electronic databases (IEEE Xplore, ACM Digital library, Science Direct library and Springer library). Some other important International Journals, Books, and Thesis report from google scholar.

The search terms constructed previously were used to search for journal papers and conference papers in the four electronic databases. The search conditions were adapted to accommodate different databases, since the search engines of

different database use different syntax of search strings. We conducted searches in the database by keywords, title and abstract.

We limited the search to the period of from 1 June 1996 to 1 June 2015, because the applications of data aggregation in wireless sensor networks were set out in the former 1990s [23].

B. Search and Selection Process

Data aggregation involves a complete search of all relevant authors. For this cause, we defined the search process, and divided into the following three phases

Search phase 1: Search the four electronic databases, books, thesis and other journals individually and then collect the returned papers together to from a set of candidate papers.

Selection phase 1: We extract the relevant document to our subject by applying selection criteria, parameter measures and keywords.

Search phase 2: Scan the reference list of the relevant papers to find the mostly related topics in our paper and then add them into the set.

The detailed search process and the number of papers identified at each phase are shown in Fig.1.

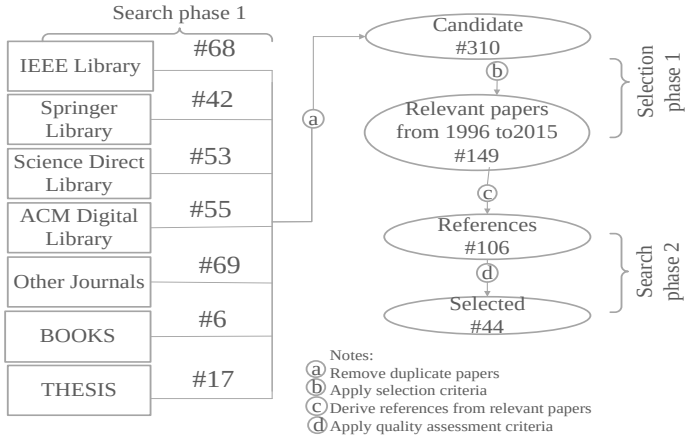

Fig. 1 Search and selection process

III. DATA AGGREGATION APPROACHES IN WIRELESS SENSOR NETWORKS

Data aggregation is a major concept in wireless sensor networks due to the strong redundancy and relationship among sensors data. Data aggregation can be known as a set of programmed approaches of merging the information that reach from various sensor nodes into a lot of meaningful data [24]. Data aggregation solutions usually consist of three key components: aggregation path, aggregation function, and data storage [25].

Data aggregation methods are significantly blown up by network architecture as revealed in the Fig. 2. Data aggregation based in networks are categorized into two. They are Flat networks and Hierarchical networks [26]. The flat networks are further divided by depending on event-driven and query-driven, such as push diffusion, directed diffusion and pull diffusion [27]. The hierarchical network are further classified into six parts hybrid, chain, tree, cluster, multi-path, and grid based approaches. In this paper we discuss about various cluster data aggregation protocols [28].

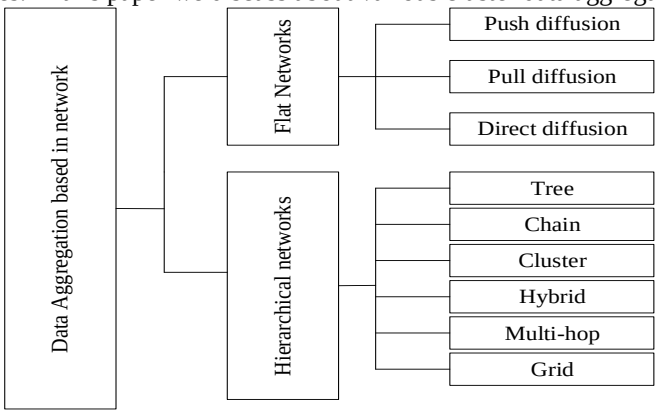

Fig. 2 Classification of Data Aggregation in network

A. Cluster based data aggregation protocols

A group sensor nodes from clusters on basis of similarity. A cluster head is formed in each cluster to collect data locally and send the aggregation result to base station [29]. By using long rage radio transmission cluster head can directly communicate with sink. Cluster head generally forms a tree structure to send the collected information by multi-hopping over other Cluster heads which outcomes in major energy saving [30]. Fig. 3 shows an various protocols are proposed in cluster data aggregation in Wireless sensor network.

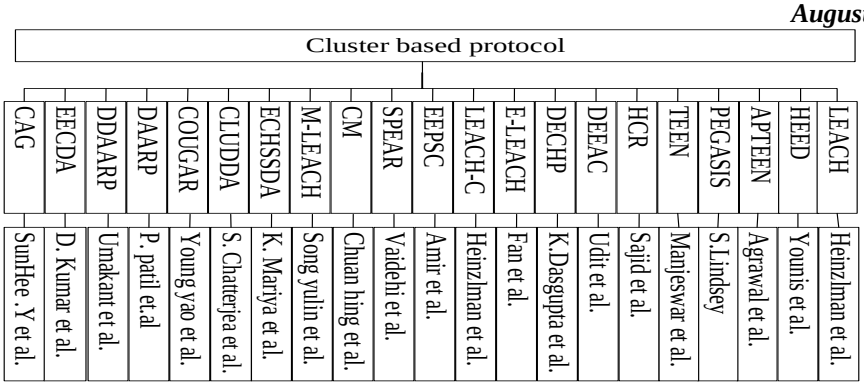

Fig. 3 Cluster based protocols

1) LEACH (Low- Energy Adaptive Clustering Hierarchy)

In 2000 Heinzelman et al [31], [32], proposed the LEACH protocol. Its major idea is to decrease the number of nodes at one hop distance from BS. LEACH protocol is primarily used for perpetual monitoring and periodic data reporting applications. Cluster head is selected randomly to transmit to the base station [32], [16]. The cluster head obtains information from all other sensors in the group, performs data collection, and transfers the aggregated information to the BS [17] LEACH implements the full-fusion converge cast routing to prolong wireless sensor network lifetime [33]. LEACH protocol performs by two phases cluster setup phase and steady phase [34]. Cluster setup phase performs cluster head election. Head nodes would quickly use up their partial energy. LEACH slot in randomized cycle of the high-energy cluster head place among the sensors. The aggregation of gathering information and further communication with the base station is accomplished in steady state phase [31].

2) LEACH-C (LEACH-Centralized)

In 2000 Heinzelman et al [32], proposed the LEACH-C protocol. A modified version of LEACH, where the central base station performs the clustering to increase energy efficiency [16]. It employs a centralized clustering algorithm to elect CH. It has same steady–state phase as LEACH but different setup phase. In the set-up stage of LEACH-C, every system transfers data about the present position by using GPS and residual energy level to BS [31], [35]. To decisive good cluster, the BS needs to corroborate that the energy load is equally spread between all the guests. For this, BS calculates the average node energy, and defines which nodes have energy below this fair, and clients have energy less than the threshold energy cannot be CHs for the present round. Once the CH and its cluster members are found, the BS announces a message to achieve the CH ID for each guest [36]. If a CH ID is same as its own ID, the client is a CH; or else the client decides its TDMA period for data communication and goes to sleep until it's time to communicate data. LEACH uses distributed clustering algorithm and provides no warranty about the arrangement and number of CHs LEACH-C protocol can get more serious performance by dispersing the CHs throughout the network [37].

3) E-LEACH (Energy LEACH)

In 2007 Liu et al, has proposed E-LEACH [38] protocol to improve the CH selection procedure. It considers the residual energy of nodes to select which node will be CH or will not be after the first round. As like LEACH, E-LEACH is also divided into rounds and each round contain cluster formation phase and cluster steady phase. Every node has the same probability to turn into CH in first round and nodes are selected as CHs randomly. In next rounds, residual energy of nodes consider to select the CHs, because residual energy of nodes is different after each round. The nodes have high energy will become CHs rather than nodes with low energy [39]. Simulation results show network death time for Energy-LEACH protocol longer than LEACH protocol. The results show that Energy-LEACH protocols prolong the network lifetime as compared with the commonly used LEACH protocol.

4) M-LEACH (Multi-hop Low- Energy Adaptive Clustering Hierarchy)

In 2007 Xiang et al, has proposed M-LEACH [38], [40]protocol picks the best route among the CH and the BS through other CHs and use these CHs as a relay station to convey information over through them. Frist, multi-hop communication is agreed among CHs. Then, according to the selected optimal path, these CHs convey information to the corresponding CH which is nearest to BS. Finally, this CH sends data to BS [41]. M-LEACH protocol is almost the same as LEACH protocol, only difference is that it makes communication mode from a single hop to multi-hop between CHs and BS.

5) EECDA (Energy Efficient Clustering and Data Aggregation)

In 2011 Kumar et al, has proposed EECDA mixture of energy efficient cluster based routing and data aggregation for refining the presentation in terms of lifetime and stability [9]. It is for the heterogeneous WSN. EECDA stabilize the energy depletion and extends the network lifetime by a factor of 51%, when compared with LEACH. Advantage of EECDA it increases the network performance by using some heterogeneous node in the network. Disadvantage of EECDA is the election process of CHs makes the network unstable.

6) M-EECAD (Multi hop Energy Efficient Clustering & Data Aggregation Protocol for Heterogeneous WSN)

In 2014 Surrender et al, has proposed M-EECDA [35] to support the energy depletion of the network efficiently. It is a mixture of clustering and multi-hop communication to increase energy consumption, stable region and network lifetime overall the network. To save energy in the network EECDA presents a three level architecture and sleep state for some cluster heads. M-EECDA consists of three types of sensor nodes: normal, advance and super. To turn a cluster head in a

round normal node use residual energy based scheme. Advance and super nodes further act as a relay node to reduce the transmission load of a normal node cluster head when they are not clustered heads in a round.

7) TEEN (Threshold sensitive Energy Efficient sensor Network protocol)

In 2001 Manjeshwar et al, has proposed TEEN [42], [5], [43]an improved version of LEACH, to be ready to react to unexpected changes in the sensor versions. TEEN uses a hierarchical approach along with the use of a data-centric mechanism [17]. The closer senor nodes from cluster and process goes on the second level until BS is reached after the cluster are formed, the CH broadcasts two thresholds to all nodes in the cluster. TEEN is a reactive protocol for time serious applications where cluster head announces two values known as hard and soft threshold [35], [43]. A hard threshold allows the nodes to transmit sensor analyses only when the sensed attributes flow above the stated threshold. A soft threshold is a minor modification in the significance of a parameter which can activate a system to communicate information once more. Thus the hard threshold and the soft threshold, decreases the overall communication and provide energy efficient network [5]. The limitations of this protocol is that if the threshold are not received, the client is unable to transfer and the user won't receive any kind of data from the network.

8) APTEEN (Adaptive Periodic TEEN)

In 2002 Manjeshwar et al, has proposed APTEEN [44] an extension to TEEN. APTEEN reports both periodic data collection and quick broadcasting of time critical events. In APTEEN the threshold value is modified according to user needs and it is same for both proactive and reactive policies. APTEEN send data periodically to BS. Thresholds: consists of the Hard threshold (HT) and Soft threshold (ST) schedule: a TDMA schedule, assigning a slot to each node Count Time (CT): the maximum time period between two successive reports sent by a node. The drawback of the APTEEN to form overhead and sustaining clusters at two levels, as considerably as the difficulty connected with performing threshold based functions and in a way to handle with attributes based naming queries [35].

IV. RESULTS AND DISCUSSIONS

In this section we discuss the overview of the selected studies and discuss the some related works also provided to support the findings.

A. Overview of selected studies

We recognized 44 studies in the area of data aggregation technique in wireless sensor networks. We had collected 310 papers related to data aggregation in wireless sensor networks. From those papers we had collected 149 papers related to hierarchical network in the data aggregation. Later we found 66 clustering data aggregation references. From these we had 44 primary studies to work on this paper. These papers are published during time period 1996-2015. Among them, 22% papers from IEEE library, 17% papers from Science direct, 18% papers from ACM library, 22% papers from other Journal, 14% papers from Springer library, 2% papers from books and 5% papers from reports. The percentage of study of all papers has shown in Fig. 4.

B. Types of data aggregation techniques

From the selected studies, we identified six type of data aggregation methods that had been applied to estimate wireless sensor networks. They are classified as follows.

1.Tree, 2. Cluster, 3. Chain, 4. Hybrid, 5. Multi, 6. Grid

Among the above listed DA methods tree, and Cluster are the two most frequently used. In this paper, we had discussed various clustering protocol are used for data aggregation in wireless sensor networks. Presents only the amount of research attention that each type of Cluster data aggregation technique has received during the past two decades; Fig. 5 is plotted to further present the distribution of research attention in each publication year.

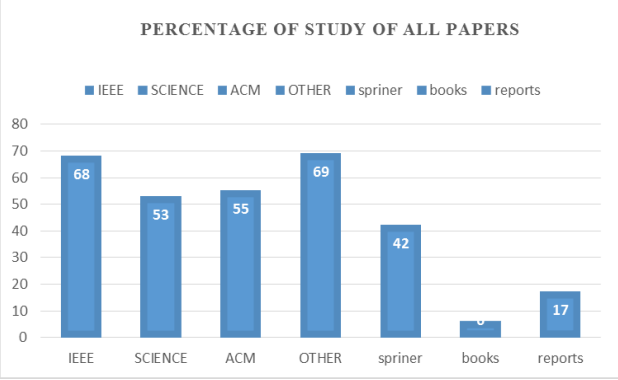

Fig. 4 Percentage of study of all papers

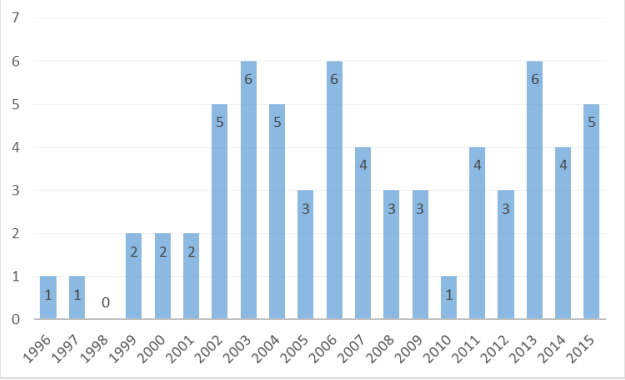

Fig. 5 Cluster year wise paper collection

V. CONCLUSIONS

In this paper we discussed various cluster data aggregation techniques are used to achieve performance measures such as lifetime of the network, energy consumption, hop count, throughput, communication overhead and data accuracy. We accomplished a systematic literature review of data aggregation in wireless sensor networks in last two decades (1996-

2015).we have identified 44 primary studies relevant to the aim of this research. In this paper we had studied the Classification of Data Aggregation in network. We have studied, the key features, the benefits and drawbacks of cluster data aggregation protocols.

REFERENCES

[1] F. Q, Z. F and G. L, "Lightweight sensing and communication protocols for target enumeration and aggregation," Mobile Hoc Networks, 2003.

[2] X. N, R. S, C. K. K, G. D, B. A, G. R and E. D, " A wireless sensor network for structural monitoring," in ACM Conference on Embedded Networked Sensor Systems (SenSys), 2004.

[3] S. R, M. A, P. J and C. D, "An analysis of a large scale habitat monitoring application.," in ACM Conference on Embedded Networked Sensor Systems (SenSys), 2004.

[4] H. A, KOHLER, M and D. P, "Seismic amplitude variations due to site and basin edge effects in the Los Angeles Basin," Transcation American Geophysical Union, 2003.

[5] S. Yoon and C. Shahabi, "The Clustered AGgregation (CAG) Technique Leveraging Spatial and Temporal Correlations in Wireless Sensor Networks," ACM Transactions on Sensor Networks (TOSN), vol. 3, no. 3, March 2007.

[6] M. Demirbas and H. Ferhatosmanoglu, "Peer-to-peer spatial queries in sensor networks," in Proceedings. Third International Conference on P2P, 2003.

[7] H. Alzaid, E. Foo and J. G. Nieto, "Secure Data Aggregation in Wireless Sensor Network: a survey," Proc. 6th Australasian Information Security Conference , 2008.

[8] Rajagopalan, Ramesh, Varshney and P. k, "Data aggregation techniques in sensor networks: A survey," IEEE communication survey & tutorial, 2006.

[9] D. Kumar, T. Aseri and R. Patel, "EECDA: Energy Efficient Clustering and Data Aggregation Protocol for Heterogeneous Wireless Sensor Networks," International Journal of Computers, Communications & Control, vol. 6, no. 1, pp. 113-124, March 2011.

[10] D. Agrawal and Q.-A. Zeng, Introduction to wireless and mobile systems, Brooks/Cole, 2005.

[11] P. Bhuvaneswari, V. V and S. S, "SPEAR: sensor protocol for energy aware routing in wireless senor network," in IEEE third International Conference on Wireless communication and sensor network WCSN, Allahabad, 2007.

[12] A. Hac, Wireless sensor network designs, Manoa, Honolullu: Jhon Wiley and Sons, ltd, 2003, pp. 101-138.

[13] H. O. Tan and I. Korpeoglu, "Power Efficient Data Gathering and Aggregation in Wireless Sensor Networks," SIGMOD Record, vol. 32, no. 4, pp. 66-71, December 2003.

[14] S. Chatterjea and P. Havinga, "A Dynamic Data Aggregation Scheme For Wireless Sensor Networks," Proccedings Program for Research on Integrated Systems and Circuits, November 2003.

[15] J. Zheng and A. Jamalipour, Wireless sensor networks : a networking perspective, 2009, pp. 215-250.

[16] S. Lindsey, C. Raghavendra and K. M. Sivalingam, "Data Gathering Algorithms in Sensor Networks Using Energy Metrics," IEEE Transcation Parallel and Distributed Systems, vol. 13, no. 9, pp. 924-35, september 2002.

[17] N. Tabassum, Q. E. K. M. Mamun and Y. Urano, "COSEN: A chain oriented sensor network for efficient data collection," in Proc. ITNG, 2006.

[18] K.-H. Chen, J.-M. Huang and C.-. C. Hsiao, "CHIRON: An Energy-Efficient Chain-Based Hierarchical Routing Protocol in Wireless Sensor Networks," IEEE, 2000.

[19] W. Dargie and C. Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice, Jhon Wiley & Sons, Ltd, 2010, pp. 265-280.

[20] K. Dasgupta, "Maximum lifetime data gathering and aggregation in Wireless sensor network," in IEEE Networks'02 conference, 2002.

[21] K. Vaidhyanathan and e. al, "Data Aggregation Techniques in Sensor Networks," 2004.

[22] A. Tripathi, S. Gupta and B. Chourasiya, "Survey on data aggregation techniques for wireless sensor networks," IJARCCE, vol. 3, no. 7, July 2014.

[23] J. Wen, S. Li, Z. Lin, Y. Hu and C. Huang, "Systematic literature review of machine learning based software development effort estimation models," ELSEVIER, pp. 41-59, 2012.

[24] S. Banerjee and S. Khuller, "A clustering scheme for hierarchical control in multi-hop wireless sensor networks," in IEEE INFOCOM, Anchorage, Alaska, USA, 2001.

[25] F. Hu and X. Cao, Wireless sensor networks principles and practice, 1 ed., vol. 1, Auerbach, 2010, pp. 249-252.

[26] G. S. Chhabra and D. Sharma, "Cluster-Tree based Data Gathering in Wireless Sensor Network," International Journal of Soft Computing and Engineering (IJSCE), vol. 1, no. 1, March 2011.

[27] E. Fasoloy, M. Rossiy, J. Widmer and M. Zorzi, "In-network Aggregation Techniques for Wireless Sensor Networks: A Survey," IEEE Wireless communication, 2007.

[28] P. patil and U. Kulkarni, "Analysis of data aggregation techniques in wireless sensor networks," IJCEM, vol. 16, no. 1, January 2013.

[29] U. Sajjanhar and P. Mitra, "A clustering scheme for hierarchical control in multi-hop wireless sensor networks," in International Conference on Mobile Data Managment MDM07, 2007.

[30] H. Cam, S. Ozdemir, P.Nair and D. Muthuavinashiappan, "ESPDA: Energy-Efficient and Secure Pattern Based Data Aggregation for Wireless Sensor Networks," Proceedings IEEE Sensors, vol. 2, pp. 732-736, October 2003.

[31] W. R. Heinzelman, "Application-Specific Protocol Architectures for Wireless Networks," , 2000.
[32] W. R. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-Efficient communication protocol for wireless micro sensor networks," in Proceedings the 33rd Annivesery Hawaii International Conference, 2000.
[33] J. Shin and C. Suh, "CREEC: Chain Routing with Even Energy Consumption," IEEE Communications and Networks, pp. 17-25, 2011.
[34] K.Maraiya, K. Kant and N. Gupta, "Efficient Custer Head Selection Scheme for Data Aggregation in Wireless Sensor Network," Internatinal Juornal of Computer Applications, vol. 23, no. 9, 2011.
[35] S. Kumar, M. Prateek, N. Ahuja and B. Bhushan, "MEECDA: Multihop Energy Efficient Clustering and Data Aggregation Protocol for HWSN," International Journal of Computer Applications, vol. 88, no. 9, February 2014.
[36] K. Maraiya, K. Kant and N. Gupta, "Wireless Sensor Network: A Review on Data Aggregation," International Journal of Scientific & Engineering Research, vol. 2, no. 4, 2011.
[37] Z. Can and M. Demirbas, "A survey on in-network querying and tracking services for wireless sensor networks," Ad Hoc Networks, p. 596–610, 2012.
[38] F. Xiang and S. Yulin, "Improvement on LEACH protocol of wireless sensor network," in International conference on sensor technologies and applications, 2007.
[39] S. Hussain and A. W. Matin, "Hierarchical Cluster-based Routing in Wireless Sensor Network," in 5th International Conference on Information Processing in Sensor Network IPSN06, USA, 2006.
[40] H. Zhou, "Study and design on cluster routing protocols of wireless sensor networks," 2006.
[41] A. S. Zahmati, B. Abolhassani, A. A. B. Shirazi and A. S. Bakhtaran, "An Energy efficient protocol with static clustering for wireless sensor networks," intenational journal on electronics, circuits and system, vol. 1, no. 2, pp. 135-138, 2008.
[42] S. YOON and C.SHAHABI, "Exploiting spatial correlation towards an energy efficient Clustered AGgregation technique (CAG)," in IEEE International Conference on Communications, 2005.
[43] A. MANJESHWAR and D. AGRAWAL, "TEEN: A Routing protocol for enhanced efficiency in wireless sensor networks," International Workshop on Parallel and Distributed Computing, vol. 1, pp. 2009-2015, April 2001.
[44] A. MANJESHWAR and D. AGRAWAL, "APTEEN: A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks," International Workshop on Parallel and Distributed Computing, 2002.

