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Energy Conservation Protocols in Wireless Sensor Network: A Review

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***Abstract*—** Wireless sensor network tends to be field of great interest for researcher. Sensor network lifespan plays a vital role in wireless sensor network due to severe resource limitations of the sensor nodes. A usefulness of wireless sensor network depends upon proper deployment of sensor node across geographical area. However each sensor node is capable of networking data and signal processing. To conserve energy and to increase lifetime of sensor nodes many protocols were developed. In this paper a survey on various energy conserving protocols have been done. These protocols are helpful in selection of perfect cluster head for wireless sensor network, so that perfect networking and signal processing can be done. In the end section individual node evaluation matrices are shown which are helpful in detecting the role played by sensor node.

Keywords- *Wireless Sensor Network, Sensor, Cluster Head, Clustering*

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I. INTRODUCTION

Wireless Sensor Network's are composed of bitsy and slashed devices. These bitsy and slashed devices are called as sensor nodes. The radical aim of sensor node is to sense something, monitor it and then explain it. WSN have variety of enactments in following sectors: Security areas, transportation, industrial sector etc [1]. The sensor nodes plays a vital role in WSN, it may be meager in numbers or may be thousands in numbers depending upon the area it covers [30].Initially wireless sensor network was used in military enactments such as tracking by combatant etc. According to the changing needs of society, now a days the role of wireless sensor networks is accelerating very fast like in enactment areas of health, monitoring of lodging, automation etc[2]. In sensing certain phenomena for proper deployment of resources sensors are used physically. Stints of sensors can be done on the basis of figure 1.

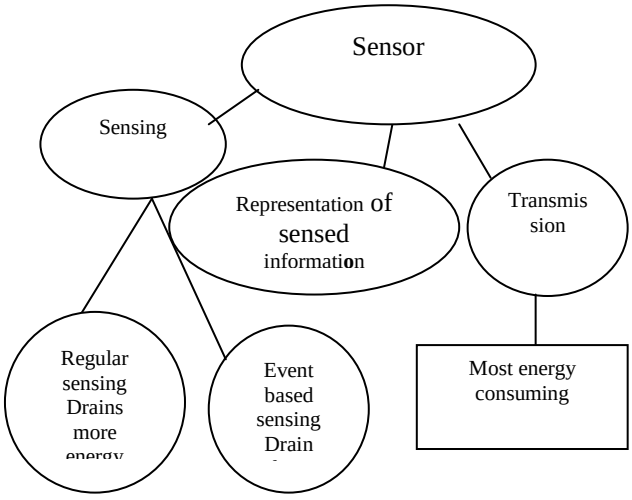

Figure 1. Life road of sensor node

Reasons for hauling energy is that in radio communication energy ruin is proportional to distance^4 and size of data according to the theory of communication [3]. Sensors can communicate via RF Signals. Methods for communication for sensors are single hop and multi hop. Base station gets information directly from sensors in single hop method while in case of multi hop method base station gets information through mediocre nodes. The basic structure of WSN is shown in figure 2.

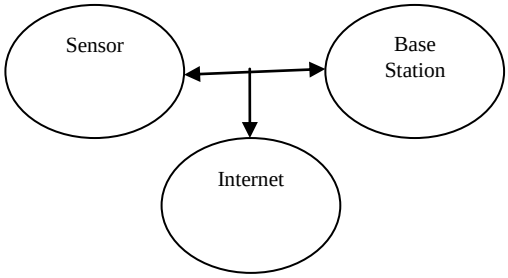

Figure 2. Basic structure of WSN

II. CLUSTERING

In clustering three things are important sensors, cluster heads (ch) and cluster members [28]. In clustering grouping of sensors can take place having one cluster head and other sensors will play the role of cluster members. Hauling energy will be saved using clusters. There is a systematic path follows in cluster for sending sensed information i.e. from cluster sensors to cluster heads. Clustering is based upon hierarchical network. Base stations will receive aggregated data from cluster heads in clustering instead of directly from sensors [4]. Clustering leads to maximize the lifetime and minimize the energy [5, 6, 7]. Also it leads to scalability. Given below is the taxonomy of clustering methods. Clustering method can be categorized as :

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A. *Clustering process*

It depends upon control manner, execution nature, convergence time, parameters for cluster head election, proactively and objectives.

Clustering Process	Role Played
Control manner	Centralized, Distributed, Hybrid
Execution nature	Probalistic, Interactive
Convergence time	Variable, Constant
Parameters for cluster head election	Deterministic, Adaptive, Random
Proactively	Proactive, Reactive, Random
Objectives	Fault tolerance, Load balancing, Data aggregation fusion, Guarantee of connectivity, Lifetime extension, Quality of service etc.

Figure 3. Life road of clustering process

B. *Clustering Characteristics*

It depends upon variability of cluster whether it is fixed or variable, uniformity of cluster sizes whether it is even or uneven, inter and intra clustering routing whether it is single hope or multi hope.

C. *Cluster Head Characteristics*

It depends upon existence based upon cluster head or non cluster head, difference of characteristic whether it is homogeneous or non homogeneous, mobility whether it is mobile or stationary and its role as relay or aggregation/fusion or sink/base station.

D. *Algorithm processing*

It depends upon cluster construction and data transmission.

III. DESIGNING ISSUES IN ROUTING PROTOCOL

A node can be evaluated on its individual perimeters [33]. On the basis of these characteristics, a node can be assigned different roles e.g. Leaf node, Cluster head node, Associate node etc. Basic components [34] of the node are Power source, microcontroller, ADC, transreciever and external memory.

The perimeters of a node can be given as follows:

Perimeter	Remarks
Flexibility	For adapting wide range of applications, node architecture must be adaptive and flexible.
Robustness	For supporting lifetime requirement of node, it must be robust enough so that individual failure must be tolerated.
Security	A node must be capable of handling security operations like encryption, authentication etc.
Communication	Communication range of node must be high enough to enhance performance.
Computation	For increasing communication between nodes system must be able to fast decode and compute the arrived data.
Size and Cost	Physical size and deployment cost of node matters a lot in WSN. Overall deployment of node depends upon physical size.

Figure 4. Individual node evaluation matrices

In WSN protocols used for network [8] seems to be very important. Major hurdles in WSN routing protocols includes:

- Designing in routing protocols in wireless sensor network depends upon node behavior, coverage area, energy management [12, 13, 14], scalability and application orientedness.

- Sensor range and its accuracy matters a lot in WSN. Most energy consuming task is data transmission [17]. So the design of routing protocol is such that it balances both an accuracy and optimization of energy.

- Fault detection [9]

- Proper deployment of nodes can take place due to variable nature of nodes. Nodes nature depends upon the field in which it is used. Nodes may be less or huge in a network [15, 17].

- Distribution and data gathering [11].

- Timing issues [10, 36].

- Security issues [29].

- Nodes in WSN have homogeneous or heterogeneous behavior. Both have different capabilities according to their behavior like life of batteries in homogeneous nodes etc [15].

- Coverage area is another big designing issue in WSN [16, 17].

IV. REVIEW ON VARIOUS ENERGY CONSERVATION PROTOCOLS

A. *CACC[35]*

CACC is Clustering Algorithm based on Cell Combination. For considering geographic location information

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of nodes hexagonal cells are used for monitoring region. Circular shapes for cells are preferred so the channel resuse and energy efficiency can improve.

B. VAP-E [40]

VAP-E is Virtual Area Partition Energy Efficient Clustering. It works for heterogeneous network. Cluster load are easily balanced with VAP-E.

C. FoVs [37]

FoVs is Overlapped Field of View. This algorithm finds the intersection polygon for which multimedia sensor network works. It also computes overlapped areas for establishing clusters and find cluster membership.

D. PDCH [38]

PDCH is Pegasis Algorithm Improving Based on Double Cluster Head. For improving load balancing this algorithm uses super and bottom level cluster heads. For large network it is very helpful. It is totally based upon chain topology which is hirerical in nature.

E. HAS [39]

HAS is Harmony Search Algorithms. It is based upon metaheuristic optimization. It is analogus to music improvisation process where musician continuously put efforts in obtaining better harmony.

F. HEED [20]

HEED is Hybrid Energy Efficient Distributed Clustering. It comes under the category of distributed protocol. HEED performs his work on the basis of hybrid, which acts as a bridge between intra cluster elucidation cost and residual energy of node.

G. LEACH [17]

LEACH is Low Energy Adaptive Clustering Hierarchy. Cluster head in LEACH is based upon probability and random selection. LEACH-C [17] is centralized one. In LEACH-C every node is actively involves in sending information to base station on the basis of node current location. Also it keep track of energy level.

H. MEDC [18]

MEDC is Mutual Exclusive Distributive Clustering. It works on the basis of mutual exclusion. In it cluster heads are selected on the support of mutual exclusion principle.

I. MEHEED [21]

MEHEED is Mutual Exclusive Hybrid Energy Efficient Distributed Clustering. It works on the basis of communication range and residual energy. MEDC work is extended in MEHEED.

J. CBDR [31]

CBDR is Cluster Based Dynamic Routing. This algorithm works in three phases pattern of cluster, cluster head picking and rearrangement of dynamic cluster. Representation of clusters and total time plays vital role in dynamical clustering.

K. UCPIT [32]

UCPIT is a novel Unequal Clustering Protocol for the Intelligent Traffic information collection (UCPIT) in ITSs which aims to equities the energy consumption of the network.

L. TEEN [22]

TEEN is abbreviated as Threshold Sensitive Energy Efficient Sensor Network. The main focus of TEEN protocol is on reactive networks. In reactive network the work of sensor node is keep sensing until they get any change in threshold value. .

M. PEACH [27]

PEACH is Power Efficient and Adaptive Clustering Hierarchy protocol. Multi-level clustering is the key point in PEACH.

N. DCHS [23]

DCHS is Distributed Cluster Head Scheduling. This scheduling is applied on two tier wireless sensor network i.e. primary and secondary tiers and helps in electing nodes of gateway and cluster head for both the primary and secondary tier.

O. EEUC [24]

EEUC is abbreviated as Energy Efficient Unequal Clustering Protocol. The main aim of EEUC is division of sensor nodes. This division results in unequal sensor clusters.

P. ECHERP [19]

ECHERP is Equalized Cluster Head Election Routing Protocol. This protocol uses Gaussian Elimination algorithm for choosing cluster head so that network life time will increase. Also balanced clustering is used for energy conservation.

Q. DHAC [25]

DHAC is Distributive Hierarchical Agglomerative Clustering. In DHAC only one hope neighbor knowledge is the primary key for building cluster.

R. SHORT [26]

SHORT is Shortest HOP Routing Tree Protocol. It is based upon the principle of chain based. Also it is centralized clustering algorithm. Performance of SHORT is better in comparison to other existing chain based protocols

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V. COMPARISION OF ENERGY CONSERVATION CLUSTERING POROTOLS

The main area of concern in all of the above mentioned clustering algorithms is that all of them can be any of the following: hierarchical scheme, miscellaneous scheme, grid scheme, location awareness, multi hope inter cluster communication, multilevel clustering, centralized clustering and distributive clustering. From the figure 6. it is clear that algorithms (CACC, HAS) comes under the category of Miscellaneous scheme, algorithm (PDCH) comes under the category of Grid Scheme, algorithm (FoVs) comes under the category of Hierarchical scheme, algorithms (EEUC, DHAC, PEACH, HEED, TEEN, LEACH) comes under the category of distributive clustering, algorithms (LEACH-C and SHORT) comes under the category of centralized clustering, algorithms (HEED and EEUC) comes under multi hope inter cluster communication, algorithms (HEED and DHAC) comes under multi level clustering and algorithm (PEACH) comes under location awareness clustering. Also it is clear that HEED supports distributive, multi hope inter cluster communication and multi level clustering.

	Protocol
Centralized	LEACH-C[17], SHORT[26]
Distributive	MEDC [18], ECHERP[19], CBDR[31], HEED[20], MEHEED[21], LEACH[17], TEEN[22], PEACH[27], DHAC[25], EEUC [24]
Multi hope Inter cluster communication	HEED[20], MEHEED[21]
Location Awareness	PEACH[27]
Multi level clustering	HEED[20], MEHEED[21], DHAC[25]
Mutual exclusion	MEDC [18], MEHEED[21]
Miscellaneous Scheme	CACC (Cell Combination For Network), HAS (Music based, Metaherustic Optimization Algorithm)
Grid Scheme	PDCH (Double Cluster Head)
Hierarchical Scheme	FoVs (Overlapped Field Of View)

Figure 5. Comparison of Clustering Protocols

VI. CONCLUSION

In this paper a survey on various energy conserving algorithms has been done. Along with this some designing issues were also discussed which are helpful in determine hurdles in energy conserving protocols. A comparison table are shown which indicates the area of concerns of various clustering algorithms. With the help of these algorithms one can build his own energy conserving algorithms and serve the society at large.

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