CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

There is a vast literature relating to energy-saving in WSNs as numerous methods have been proposed in the last few years, and there is still much ongoing research on how to optimize energy usage in battery-limited sensor networks. However, none of the proposed solutions is promising. For example, if safety applications require fast and timely responsiveness, this is not the case for other applications, such as in agriculture where the delay property is not as important. It is believed that WSN energy-saving problems should be tackled by taking into consideration application requirements in a more systematic manner.

Christine Jones et al (2001) presented a comprehensive summary of recent work addressing energy efficient and low-power design within all layers of the wireless network protocol stack. Since the network interface is a significant consumer of power, considerable research has been devoted to low-power design of the entire network protocol stack of wireless networks in an effort to enhance energy efficiency.

Mihaela Cardei et al (2002) proposed an efficient method to achieve energy savings by organizing the sensor nodes into a maximum number of disjoint dominating sets which are activated successively. Only the sensors from the active set are responsible for monitoring the target area and for disseminating the collected
data. All other nodes are into a sleep mode, characterized by low energy consumption. They defined the maximum disjoint dominating sets problem and also designed a heuristic that computes the sets. The theoretical analysis and performance evaluation results are presented to verify their approach.

Lan Wang and Yang Xiao (2005) provided a survey on energy-efficient scheduling mechanisms in sensor networks that have different design requirements than those in traditional wireless networks. They classified these mechanisms based on their design assumptions and design objectives. Different mechanisms may make different assumptions about their sensors including detection model, sensing area, transmission range, failure model, time synchronization, and the ability to obtain location and distance information. They may also have different assumptions about network structure and sensor deployment strategy. Furthermore, while all the mechanisms have a common design objective to maximize network lifetime, they may also have different objectives determined by their target applications.

Raghunathan et al (2006) surveyed several techniques that show promise in addressing and alleviating energy consumption challenge. In addition for describing recent advances in energy-aware platforms for information processing and communication protocols for sensor collaboration, they also looked at emerging, hitherto largely unexplored techniques, such as the use of environmental energy harvesting and the optimization of the energy consumed during sensing.

Anastasi et al (2009) presented a valuable taxonomy of energy-conservation schemes. They devoted special attention to a systematic and comprehensive
classification of the solutions proposed in the literature. They stressed the importance of different approaches such as data-driven and mobility-based schemes. They had drawn final observations about the different approaches to energy management. As far as “traditional” techniques to energy saving, an important aspect which has to be investigated more deeply is the integration of the different approaches into a single off-the-shelf workable solution. This involves characterizing the interactions between different protocols and exploiting cross-layer interactions. Most of the solutions proposed in the literature assume that the energy consumption of the radio is much higher than the energy consumption due to data sampling or data processing.

Shaoqing Wang & Jingnan Nie (2010) studied and compared the energy efficiency of cooperation and direct transmission schemes in WSN. The expressions of energy efficiency of the two schemes are derived, respectively. The numerical results reveal that for the small distance separation between the source and destination nodes, the direct transmission scheme is more energy efficient than cooperation and the relay location, packet size, and modulation level have important effects on energy efficiency. At last, energy efficiency maximization for the cooperative communication system is achieved by optimizing both the packet size and modulation level jointly.

Ridha Soua and Pascale Minet (2011) classified energy efficient techniques into five classes, namely data reduction, control reduction, energy efficient routing, duty cycling and topology control. Then they detailed each of them, presenting subdivisions and giving many examples. Junaid Ahmed Khan et al (2014) presented a survey on high level taxonomy of energy management in WSNs. They analyzed
different battery-driven energy consumption based schemes and energy harvesting based energy provision schemes. They also highlighted the recent breakthrough of wireless energy transference to a sensor node as an alternative to typical batteries. They recommended taking into account recent energy provisioning advancements in parallel with the traditional energy conservation approaches for a sensor network while designing energy efficient schemes.

Zahra Rezaei and Shima Mobininejad (2012) surveyed the main techniques used for energy conservation in sensor networks. The main focus of this article is primarily on duty cycling schemes which represent the most compatible technique for energy saving and they also focused on the data-driven approaches that can be used to improve the energy efficiency. Finally, they made a review on some communication protocols proposed for sensor networks. Also they summarized some research results which have been presented in the literature on energy saving methods in sensor networks.

Sahoo et al (2012) outlined the design factors and challenges in sensor networks. Then, they described several MAC layer and routing layer protocols proposed for sensor networks. Also they proposed an adaptive approach to find an optimal routing path from source to sink when the sensor nodes are deployed randomly deployed in a restricted service area with single sink. Their analysis says that their approach reduces the message communication to find a optimal routing path. Hence, the network consumes less energy and increases the lifetime of the network.
Shilpa Das and Benudhar Sahu (2014) discussed about the basic issues of energy in WSN, distinct sources affecting energy, and the recent techniques to conserve energy. Sandra Sendra et al (2011) presented a survey of power saving and energy optimization techniques for wireless sensor networks, which enhances the ones in existence and introduced the reader to the most well known available methods that can be used to save energy. They are analyzed from several points of view: Device hardware, transmission, MAC and routing protocols.

Karthika Sundaram et al (2016) elaborated several techniques, which reduce the energy consumption of sensor nodes. They classified the energy efficient techniques into seven classes based on energy waste in WSN, namely duty cycling, data handling, reliable routing protocol and overhead reduction, mobility, fast communication and energy efficient forwarding scheme, topology management and energy efficiency based on QoS. They described subdivisions and examples under each category. Anandbabu et al (2016) made an attempt to study the energy efficient approaches in WSNs. They proposed the classification of energy efficient approaches in WSNs and also overviewed ongoing research approaches, and provide discussion and provision of some design issues and requirements for building energy efficient mechanisms for WSNs.

2.2 Improving Energy Efficiency Using Connected Dominating Set

This section enumerates the various schemes for improving energy efficiency using Connected Dominating Set (CDS) that exist in literatures.
Yannis Manolopoulos et al (2010) proposed Node Importance Data Dissemination protocol (NIDD) is a dynamic dominating set-based structure control method. Here the creation of the CDS is done “on-the-fly”. Initially this protocol measures the node importance of nodes in the network. Then this broadcasting protocol disseminates information over the whole network. Their simulation results shows that this scheme is efficient method and no causes with more clusters. Also this scheme exhibits immunity on the strength on the size of the CDS.

Yun Wang et al (2007) presented the Localized Distributed Topology Control algorithm (LTDC) has designed to handle the structure by r-hop confined structure information. And it eliminate long burden edges and reduce long cover of radius then utilize minimum amount energy that hold k-connectivity of dominating set.

Najla Al-Nabhan et al (2014) proposed the Distributed Algorithm for CDS (DACDS) proposed to build an optimal size CDS for dynamic CDS creation and conservation. DACDS follows 3-hop communication methods on dispersed location. And also enhanced by non-spanning tree CDS creation methods required knowledge.

Niranjan Ray et al (2017) author discussed size of nodes present in dominator set. The member of nodes segmented the transmission channel among neighbors. So, CDS that has minimum regulator message and intervention issues.

Ning Zhang et al (2010) described the virtual backbone Diameter, CDS Diameter: The span of a connected graph is lengthiest routes among a couple of nodes. Virtual backbone calculates the span through the subgraph which induced by
member nodes. The most protracted path, the packet may arrive the destination easily by the size of CDS Diameter.

Jing Zhang et al (2015) proposed protocol called Average Backbone Path Length (ABPL). Average Backbone Path Length (ABPL): the packets to travel on the backbone with an average length and reach the destiny. So that communication cost of ABPL is average. The backbone has well defined by any pair(x,y) of ABPL by hop distances of a possible pair of nodes.

Zhen Yang Xu et al (2006) discussed the Average energy spent in the network for transferring the packet to the target gets. The mean energy consumption (mec) each node is calculated by the formula $\text{MEC} = \frac{(E_0 - E_t)}{(n \times t)}$ Where n is the number of the nodes, t is period, E0 is the sum of energy at an initial stage, Et is sum remaining energy after ‘t’ time. The metric applied networks are proportional to the network’s lifespan.

Mohammad Ilyas et al (2005) discussed It is an energy based metric. How long the networks will provide the service still the last node life on the networks.

Najla Al-Nabhan et al (2013) author discussed about the message complexity on CDS. calculate the sum of interchange packets among CDS creation — an algorithm which has designed like that low message complexity and minimum adjacent details to create the CDS.
Yuanyuan Zeng et al (2006) presented a novel energy efficient distributed connected dominating set algorithm grounded by coordinated rebuilding method. The procedure has time complexity and message complexity is $O(n)$.

Zhuo Liu et al (2010) presented a taxonomy and general classification of CDS construction algorithms. In addition, they measured diverse CDS construction procedures for WSNs.

Trac Nguyen and Huynh (2009) studied the problem of assigning minimum total power to a set of nodes in the plane yielding a graph containing a connected $d$-hop dominating set of bounded size. The author proved that this problem is NP-complete. They discussed numerous heuristics tricky.

Julia Albath et al (2010) introduced the energy constrained minimum dominating set (ECDS) to classical the difficult of optimally picking cluster heads by energy restrictions. author strategic to spread process for the controlled dominating set that goes in $O(\log n \log \Delta)$ cycle with great probability.

### 2.3 Improving Energy Efficiency Through Energy Efficient Routing

This section enumerates the various mechanisms for increase the energy efficiency through scheme in literatures.

Jia Xu et al (2012) proposed the protocol called E-LEACH (Energy-LEACH) is a revised cluster routing algorithm to improve the hierarchical routing protocol
LEACH. Now the E-LEACH procedure, the new way of the selecting of the cluster heads by random, and the round time for the choice is stable. Subsequently, remaining energy of node as the key metric elects whether the nodes chance into CH or not after ward the first round.

Nuray et al (2015) presented Energy Efficient Clustering-based Protocol (EECP) is clustering based protocol for single-hop, heterogeneous networks. It practices channel state information (CSI) in the key factor to identify the Cluster Heads (CHs). At this juncture nodes with diverse energy, points have measured affecting heterogeneity in the network — besides, a single-hop communication tactic has implemented for intra-cluster and inter-cluster communication. Also, an improved routing structure has planned where the focus is to improve cluster head choice process. CHs nominated in every cluster based on residual node energy and the most significant channel.

Sohini Roy (2015) proposed the Energy Aware Cluster Based Routing Scheme (EACBRS) intentions to preserving energy with the support of hierarchical routing through shrewd the most exceptional amount of cluster heads for the network, picking the energy-efficient route to the sink by influence congestion control. The base station shows the part of choosing the necessary quantity of cluster heads for respective level and reflect in the right spreading of the head nodes done the network area. Cluster creation has not frequent, and it is constant simply once new nodes arrive the network area.
Stefanos Nikolidakis et al (2013) proposed Equalized Cluster Head Election Routing Protocol (ECHERP), representations of network as a linear system by using the Gaussian elimination procedure, computes the mixtures of nodes for electing.


Ehsan Amiri et al (2014) proposed an optimal routing protocol for WSN motivated through the scavenging deeds of ants. The ants attempt to discover present paths among the source to destination. Ants behavior models is designed with fuzzy logic for took correct conclusion. The simulation outcomes express optimization of energy consumption, reduces request packets.

2.4 Improving Energy Efficiency Through Energy Efficient Clustering

This section describes the different research works carried out to provide energy efficiency through energy efficient clustering mechanisms for WSNs.

Georgios Koltsidas et al (2011) presented Clustered Routing for Selfish Sensors (CROSS) used game theory for modeling, for energy conservation a node behave selfishly give up the serving as the CH to other nodes. The payoffs value is zero because all node to refuses become CH. That leads each sensed information by node unable to transmit to the base station.
Shelly Salim et al (2013) presented the Cost and Reward-based Clustering (CORE) algorithm is a game theory based clustering algorithm, which integrates a virtual reward. When nodes become low cost as CH with high residual power, and nodes with low residual power experience a high cost for being CH. CORE is only suitable for ideal assumptions and its communication radius very large.

Dongfeng Xie et al (2013) proposed the Localized Game-theoretical Clustering Algorithm (LGCA) need the total information such as some nodes involved clustering each round. The selfish sensor nodes play essential roles. This global information has required for the clustered routing for selfish sensors algorithm. By equilibrium, probability node wishes to join the CH. The algorithm got the optimal payoff by playing selfishly node. So only one offered as CH in their district.

Ademola Abidoye et al (2011) proposed a novel clustering algorithm for energy efficiency in wireless sensor networks (ANCAEE). Author use the transmission method single hop and multiple hop with respect of node to cluster and cluster to base station.

Baranidharan and Santhi (2015) proposed a new clustering algorithm named Genetic Algorithm based Energy efficient Clustering Hierarchy (GAECH) to increase First Node Die (FND), Half Node Die (HND), and Last Node Die (LND) with a new fitness utility. The experimental outcomes also evidently show well about the GAECH better than other algorithms.
2.5 Improving Energy Efficiency Through Energy Efficient Data Aggregation

This section presents a detailed review of energy efficient data aggregation protocol design oriented literatures.

In Chul Song et al (2006) proposed Query-Based Routing Tree (QBRT) is constructed for each continuous query with the goal of increasing the amount of in-network processing. First, the MD-tree is defined for a given continuous query, using a measure called the minimum distance. The minimum distance of a node indicates how far the node is from some other node that generates a message. Next, the construction of MD-trees is described for sensor networks. MD-trees has constructed by the messages generated from sensor nodes.

Md. Sajidul Islam et al (2014) presented the Energy-Efficient Data Aggregation Tree (EEDAT) reduces the cost of data transmission by data aggregation with intermediate nodes. The intermediate nodes have merged the data packet and reduce the hop distance of traveling data packet on the network which helps to reduce the transmission cost. For data forwarding, each node has selected the node in the upper-level tree by the aggregation ratio. The intermediate nodes have selected based on its remaining energy level.

Hu Yanhua et al (2016) presented the AggreTree minimizes the energy consumption by maximal weighted independent set. The data aggregation tree has formed by link collision matrix, and that communication has been establishing through the link set. From the collision matrix, an approximate maximal weighted
independent set has constructed through each interval of the communication link. The communication links are carefully selected for a low weighted delay and increase the lifetime of the network.

Seung-Jong Park et al (2008) proposed “minimum dominating set” (MDS) with the shortest path tree (SPT) in direction to collective connected data. To decrease the duplicate between associated nodes and shorten the organization transmission and perform two function of local and global aggregation.

Ameya Bhatlavande and Amol Phatak (2015) investigating the performances of “Data Routing for In-Network Aggregation” (DRINA) approach by extending for routing efficiency. The authors presented the evaluation of this proposed DRINA against the SPT in standings of avg throughput, E2E delay, delivery ratio, and average energy consumption for scalable and varying network scenarios. For routing efficiency the authors proposed new algorithm as addition in DRINA named as Improved DRINA (IDRINA).

Anbuchelian and Chandra Sekar (2016) proposed a cluster based routing protocol Load Balanced Cuckoo Search algorithm with effective cluster head selection. Furthermore the load balancing function has been proposed to distribute the traffic over the multiple paths, which has been selected by energy level on the path. The proposed load balanced cuckoo search retains 56% of node for total of 500 rounds while the existing protocol LEACH retains only 24% of nodes.

Kamlesh Waghmare et al (2017) presented a fuzzy rule inference method for cluster head selection and data aggregation on sink node as well as shortest path is
found by using Euclidean distance method to improve the lifetime of WSN working. Their proposed algorithm has lower computational overhead and high accuracy for communication. Also their proposed system gives the data aggregation methodology allowing to the cluster head to eliminate the redundant data simulations execute under special conditions. This methodology also gives design view about the system development in detail and helps them to optimize the result indices prior to deployment.