CHAPTER 3

LITERATURE SURVEY

3.1 INTRODUCTION

The sensor nodes in wireless sensor network have limitations such as limited battery power, unreliable communication links, and frequent topology changes. These limitations lead to a challenge in the design of routing protocols. The major energy consumption in WSN node is during the communication process. Pottie & Kaiser (2000) revealed the possibility of execution of over 3000 instructions for the same cost as the transmission of one bit over 100 m. Hence the battery energy of the node can be utilized effectively by reducing the number of transmissions. This can be achieved by

(i) Avoiding redundant transmission
(ii) Choosing shortest path data transmission
(iii) During idle state make node to sleep
(iv) Minimizing the number of retransmissions.

Many energy based routing protocols choose their next hop on the basis of either the node with highest residual energy or the node which sends the packet through the path with minimum energy from the sender node to the sink (Heinzelman et al 2000, Kim & Kim 2006 and Shah & Rabaey 2002).
3.2 SURVEY ON LINK QUALITY BASED ROUTING

Zhi-Qiang Guo et al (2013) propose a Fuzzy Logic Based Multidimensional Link Quality Estimation for Multi-Hop Wireless Sensor Networks to evaluate the quality of the link. Here data-driven modelling and statistical inference methods to model the burstiness of wireless link packet loss are discussed which reflects the reliability of packet retransmission in the data link layer. A fuzzy logic based link quality indicator (FLI) was implemented, which is a comprehensive reflection of single hop reliability of packet delivery, link volatility, and packet loss burst. In this approach only the packet delivery rate is taken as primary parameter to design a system. But efficient routing not only depends on packet delivery rate it also depends on some other factors like residual energy, signal strength between the nodes etc.

Javad Vazifehdan et al (2014) propose two novel energy-aware routing algorithms for wireless ad hoc networks, called reliable minimum energy cost routing (RMECR) and reliable minimum energy routing (RMER). They focus on three important requirements energy consumption and the remaining battery energy of nodes as well as quality of links to find energy-efficient and reliable routes that increase the operational lifetime of the network.

Wei Dong et al (2013) propose an Efficient Code Dissemination protocol leveraging 1-hop link quality information based on the TinyOS platform. It supports configurable packet sizes dynamically and, by increasing the packet size for high PHY rate radios, it significantly improves the transmission efficiency. It employs an accurate sender selection algorithm to mitigate transmission collisions and transmissions over poor links. It employs a simple impact-based back off timer design to shorten the time spent in coordinating multiple eligible senders so that the largest impact sender is most likely to transmit.
3.3 SURVEY ON TOPOLOGY MANAGEMENT

Christopher Farah et al (2008) propose a novel approach to detect any change in the topology of the network by logically setting a Boolean value for every node in the network. Changes in topology have their impact on the boundary, i.e., boundary level may change or a new boundary may occur. A new data structure called neighborhood ring is introduced for every node which is a series of Boolean values of neighbor nodes, which are at a one-hop distance from the particular node. Any topological movement of a node results in changes in the neighborhood ring of the corresponding node and its neighbors.

Liu et al (2005) propose a dynamic topology management scheme based on mobility prediction. This centralized technique is implemented by the sink. The current location, velocity and direction of the moving node are considered based on which the location of the next prediction interval is fixed. The Mathematical model for mobility prediction is proposed, but prone to prediction errors. And this is mainly suitable only for single target tracking. In case of multiple tracking system energy consumption is higher.

RogaiaMhemed et al (2012) propose a novel approach for cluster formation in WSNs that use Fuzzy Logic which enhance the network lifetime. Fuzzy Logic Cluster Formation Protocol (FLCFP) prolongs the lifetime of WSNs by using the Fuzzy Inference System (FIS). The main difference between FLCFP and LEACH lies in the cluster formation phase. In FLCFP, the non-CH nodes compute a chance value for each CH by applying the FIS. In Fuzzy logic based performance optimization (FBSDA), a tree based and cluster based selection of the best route is achieved on the basis of the path length power of node and reputation. The best and the normal nodes are selected for data aggregation and the worst nodes are neglected by cluster head. Each parameter is taken as a fuzzy input set and the final decision is
based on the output of the intersection of the corresponding fuzzy set members. The FBSDA algorithm shows the better delivery rate and less energy consumption but does not ignore the data from malicious or fault links.

Ali Barati et al (2011) has used an adaptive fuzzy inference system to detect faulty readings in WSN. Also, to reduce the effect of faulty readings, a confidence number is used applying the Debraj De Algorithm. The shortcoming of this technique is its performance of only static localization and is based on distance, hence very vulnerable to faulty links.

Nouha Baccour et al (2010) propose a fuzzy algorithm that solves two objectives. The first is the reduction of energy consumption, which results in an increase in the network operations life span and the second is to meet a defined end-to-end delay and hence increasing reliability by reducing the number of packet losses considerably. By using different fuzzy parameters and if-then rules, each node can make a decision to choose its next step for routing towards the destination (sink). This algorithm is only for static nodes and hence needs extension to mobile nodes and different energy of nodes.

Kannan & Sree Renga Raja (2013) proposes the Reliable Power aware Scheme (RPAS) for the node to transmit and receive packets. The energy consumption of different node components in different operating modes are modeled and analyzed for WSN nodes and for the entire network. In this algorithm only energy consumption is taken for extending the network lifetime and the nodes are considered to be static and hence it need to be improved for dynamic topology.

Krasimira Kapitanova et al (2012) propose fuzzy based robust event detection in wireless sensor network for increasing event detection accuracy. In this paper, to reduce the memory size, rule based approach is implemented
and it is limited to static approach. It has been observed that an efficient sensor network, preferably has a dense deployment of nodes in order to obtain a tight coverage and it is necessary to check that the nodes are capable of self-reconfiguration in case of mobility. It is to be noted that such sort of topology changes due to node mobility cannot be discretely quantified as it depends on instantaneous changes. Hence it is necessary to obtain a non-quantifiable approach for mobility control and topology management.

### 3.4 SURVEY ON EFFICIENT ENERGY MANAGEMENT ROUTING

Jeong-Hun Lee & Ilkyeong Moon (2014) proposes modelling and optimization of energy efficient routing in wireless sensor network. This paper deals with the mathematical models for a routing protocol (network design) under particular resource restrictions within a wireless sensor network. Two types of constraints are considered are the distance between the linking sensors and the energy used by the sensors. The proposed models aim to identify energy-efficient paths that minimize the energy consumption of the network from the source sensor to the base station.

Vinay Kumar et al (2011) discuss efficient clustering algorithms in wireless sensor networks for maximizing network life time. Clusters create hierarchical WSNs which incorporate efficient utilization of limited resources of sensor nodes and thus extends network lifetime.

Zhao Han et al (2014) propose General Self-Organized Tree-Based Energy-Balance routing protocol (GSTEB), that builds a routing tree using a process where, for each iteration, BS assigns a root node and broadcasts this selection to all sensor nodes. Subsequently, each node selects its parent by considering only itself and its neighbour information, thus making GSTEB a dynamic protocol.
Jianwei Niu et al. (2014) propose the Reliable Reactive Routing Enhancement (R3E) for increasing the resilience to link dynamics for WSNs/IWSNs. R3E is designed to enhance existing reactive routing protocols to provide reliable and energy-efficient packet delivery against the unreliable wireless links by utilizing the local path diversity. R3E remarkably improves the packet delivery ratio, while maintaining high energy efficiency and low delivery latency.

Roseline & Sumathi (2011) discuss the various energy efficient routing protocols and algorithms for wireless sensor networks. They discuss the characteristics of sensor nodes and designing objectives for a network. Various proactive and reactive protocols also get analysed in various aspects to extend the lifetime of the entire network.

Xiao Chen et al. (2013) propose a framework protocol called reverse path (RP) to deal with asymmetric links and then present two efficient routing algorithms LayHet and EgyHet built on RP for satisfying performance requirements. LayHet is a performance guaranteed layer-based routing protocol that embeds the shortest path information and saves energy by minimizing the number of broadcasts and the probability of forwarding. EgyHet is its energy-upgraded version that considers nodes' remaining energy.

Degan Zhang et al. (2014) propose an energy-balanced routing method based on forward-aware factor (FAF-EBRM). Here a next-hop node is elected based on awareness of link weight and forward energy density. Furthermore, a spontaneous reconstruction mechanism for local topology is designed additionally.

Ruitao Xie & Xiaohua Jia (2014) propose an efficient clustering method for wireless sensor networks using compressive sensing. It reduces
the number of transmissions and balances the traffic load throughput of the network. Clustering is a method that uses hybrid compressive sensing for sensor networks. The sensor nodes are organized into clusters. Within a cluster, nodes transmit data to cluster heads (CH) without using compressive sensing (CS). CHs use CS to transmit data to sink.

Xiao Chen et al (2013) propose ProHet: a distributed probabilistic routing protocol that utilizes asymmetric links to reach an assured delivery rate with low overhead. For every link ProHet protocol produces a bidirectional routing by finding a reverse path. Then, based on historical statistics, forwarding nodes are chosen.

Zhanyang Xu et al (2012) propose a Density-based Energy-efficient Game-theoretic Routing Algorithm (DEGRA) that uses the game theory and utility function is framed based on density of nodes, residual energy and average energy consumption of its neighbouring nodes. Selection of cluster head is taken iteratively.

Marwa Sharawi et al (2013) discuss the soft computing paradigms based routing in wireless sensor networks. In order to prolong the network life time the scarcity in energy resources have to overcome and preserve the processing of the sensor nodes as long as possible. This paper introduces and surveys some of the Soft Computing proposed routing models for WSNs that optimally prolongs its life time.

Abderrahim Maizate & Najib El kamoun (2012) propose an enhanced passive clustering based on the distance and the residual energy for wireless sensor network which evenly distributes the energy dissipation among the sensor nodes to maximize the network lifetime. This is achieved by using the residual energy and the distance between nodes in the selection of nodes cluster heads and election of cluster head backup.
The proposal for various decision making techniques for efficient management of power in sensor network has been observed. Each node in the network has to self configured in case of mobility. It is noted that such kind of topology changes with respect to movement of nodes and it is not quantified because of its instantaneous changes. Hence it is necessary to consider the decision making process as efficient to reduce the instability of the entire network.

Many routing protocols have been proposed in the field of wireless sensor network largely on minimum energy usage, security, scalability. LEACH, HEED, PEGASIS are some kind of routing protocols which are designed especially for wireless sensor networks. In these kinds of protocols the decision making authority is given to the cluster head in case of cluster architecture and for root node in case of tree-based architecture. Based on some decision making process like game theory, fuzzy logic etc some routing protocols are designed. But, few routing protocols have been proposed solely based on some Meta heuristics.

Syed Ali Fathima & Sindhanaiselvan (2013) propose the ant colony optimization based routing in wireless sensor networks, where the routing is done based on the bio-inspired mechanism, which avoids network congestion and fast consumption of energy in the individual node. This is based on the food searching behaviour of real ants, which are divided into two types: FANT (Forward ANTs) and BANT (Backward ANTs). The main subdivision of these agents is to allow the BANTs to utilize the useful information gathered by FANTs on their trip time from source to destination. A few steps have been followed to show how these agents pass on the information to others and the FANTs contain various fields which they use during the search time. This algorithm follows three phases Route discovery phase, Route maintenance phase and route failure handling.
Selcuk Okdem & Dervis Karaboga (2009) propose routing in wireless sensor networks using an Ant Colony Optimization (ACO) Router Chip. In this paper the authors use the ACO approach on wireless sensor networks which consists of stable nodes. In this approach each ant tries to find a path with a minimum cost. It has been done based on a probabilistic decision rule, an equation which is designed based on the pheromone value, the value of heuristic related to energy and the list of identities of received data packages previously. Pheromone is a chemical substance which the ants exists when the move around which was followed by another ants.

Marwa Sharawi et al (2012) propose a Bat Swarm algorithm for wireless Sensor Networks Lifetime Optimization. It is a population based Meta heuristic bat swarm algorithm is inspired from the social behaviour of bats. It optimizes the network as nonlinear problem to select the optimum cluster head nodes across the number of generations.

Hussein Abbass (2001) proposed a MBO: Marriage in Honey Bees Optimization, A Haplometrosis Polygynous Swarming Approach and is inspired by the phylogenetic of sociality in Hymenoptera, such as bees, ants and wasps, and the mating process in honey-bees. Eusocial insects are characterized by three main features: cooperation among adults in brood care and nest construction, overlapping of at least two generations, and reproductive division of labour. The behaviour of honey-bees is the product of their genetic potentiality, ecological and physiological environments, the social conditions of the colony, and various prior and ongoing interactions among these three. The marriage process represents one type of action that was difficult to study because the queens mate during their mating-flight far from the nest. Colony structure of the honey bees plays a major role in this.

Marwa Sharawi et al (2014) proposed a Flower Pollination Optimization Algorithm for wireless sensor network lifetime global
optimization and are based on the natural inspiration of pollination process which mimics the process of flowering plants reproduction via pollination. Pollinators are responsible for transferring pollens among the flowers and the process fall into two categories: biotic and abiotic pollens transferring mechanism. Biotic pollination is based on some insects or animals which transfer the pollens from one flower to another, whereas in abiotic pollination the flower does not depend on some pollinators. The power utilization of each sensor node is balanced and it increases the lifetime of the network.

SeyadaliMirjalili et al (2014) proposed a Grey Wolf Optimizer is a new Meta heuristic inspired by grey wolves; it explains the leadership hierarchy and the hunting mechanism of the grey wolves. The leadership hierarchy is proposed based on four types of wolves’ like alpha, beta, delta and omega in a pack consists of 5-12 wolves in an average, in which the alpha wolf tops the leadership hierarchy (i.e.) it is the leader of the whole pack. Every other wolf follows the alpha wolf, which has the responsibility of making decision and leading the pack in hunting or in any similar kind of activities. Then, the beta wolf is in the second level of the hierarchy next to the alpha wolf. The function of the beta wolf is to give advice to the leader and maintain discipline among all other wolves in that pack. Omega wolf is at the bottom level of the hierarchy whose function is to just hunt the prey and produce in front of the leader. Then the leader wolf will distribute the food to all the wolves. The wolves, which do not come under all these three categories, will be called as delta wolves and are at the third level of the hierarchy, below the beta wolves and above the omega wolves. The responsibility of the delta wolves is to watch the boundaries of the territory and warn the pack in case of danger. It also protects and guarantees the safety of the pack and also it takes care of the weak, ill and wounded wolves. Hunting is another interesting social behaviour of grey wolves. The main phases of which are (i) tracking, chasing and approaching the prey
(ii) pursuing, encircling, and harassing the prey until it stops moving and
(iii) attack towards the prey.

3.5 MOTIVATION FOR THE RESEARCH

It is extracted from the above literature survey that efficient
techniques based on fuzzy logic could serve as better energy management
approaches, contrasting binary decision making. The motivation of this
research was to develop and analyze fuzzy based, game theoretic and
optimization algorithms to achieve high efficiency in energy management.
This work proposes a Fuzzy Link Quality Assessment algorithm (F-LQA) that
determines the link quality thereby improving routing. The game theoretic
approach aims at imparting additional semantic knowledge to the system and
the Grey Wolf Optimization approach ascertains the optimization efficiency
of energy management of the aggregation system.