Chapter 1

Introduction

Advancements in Micro-Electro-Mechanical Systems(MEMS), low-power electronic devices integrated with wireless communication capabilities and sensors are stimulating the growth of wireless sensor networks (WSN) across diverse applications [2]. A wireless sensor network is a collection of large number of inexpensive, tiny, autonomous wireless devices called as sensor nodes. These nodes, commonly known as motes, which are substantially smaller in size than hand-held devices such as mobile phones, or personal digital assistants (PDAs).

The WSNs are randomly deployed in large physical space to monitor physical and environmental conditions, often in real time, such as temperature, pressure, light, humidity, chemical level and fire detection [3]. The sensor nodes have the ability to operate certain devices that can control those conditions, provide efficient, reliable communications through a wireless network.

Recent years, WSNs have gained tremendous attention of young researchers. Since they provide cost effective solutions to monitor the physical environment. The sensor nodes can be deployed manually or randomly. In most of the applications the sensor nodes can be deployed randomly in remote, hostile or difficult to access environments by artillery shell or dropping from planes/boats. The WSNs benefits the society through the integration of sensor nodes into

industry, different environments and structures. The WSNs can be used in critical applications [2] such as earth-quake, tsunami, battle-field, flood and also in enemy intrusion detection, target-tracking, forest-fire detection, environmental and biological monitoring [4].

1.1 Motivation

The WSNs typically equipped with a limited wireless range radio transceiver, low computation power microcontroller and a limited energy source, usually a battery. The WSNs are quickly gaining the popularity, since they provide low cost solution to variety of applications. The WSNs introduce severe resource constraints such as low computational power, limited transmission range and limited energy. The demand for ubiquitous operations raises new and challenging algorithmic paradigms, because the standard algorithms are inadequate, since they do not address the specific requirements imposed by WSNs [5]. The classical approaches are essentially inappropriate in WSNs, since these are very different from traditional networks, like computer networks (i.e. Internet), ad-hoc or mobile ad-hoc networks (MANETS). Amongst resource constraints, energy scarceness is probably the primary factor, and it comes as an essential guideline in the analysis, modeling, study and development of centralized/distributed algorithms for WSNs.

The sensor nodes are responsible for detecting events, systematic gathering of data and transferring the gathered data to the main collecting center. A sensor network normally constitutes a wireless ad-hoc network, meaning that each sensor supports a multi-hop routing algorithm where nodes function as forwarders, relaying data packets to a base station. Owing to the dense deployment and unattended nature of WSNs, it is rare or impossible to recharge or replace node batteries. Therefore, energy conservation is a major design goal in the development of routing protocols for WSNs.

The energy efficient routing protocols are needed to extend the network lifetime, since the energy is the critical factor to extend the network lifetime. The hierarchical or cluster based routing is a standard approach [6] used for enhancing the network lifetime. In this type of routing, the network is organized into small groups called *clusters*. Each cluster has a co-ordinating node called *Cluster Head*(CH). The CH collects the data from the member nodes, aggregates the data and transmits it to the base station either directly or using multi-hop communication via next level CHs. This approach results in significant reduction of energy consumption of member nodes of the cluster by limiting the number of transmissions. Clustering also achieves efficient as well as scalable control by minimizing radio communication distances.

1.2 Research Objectives

The ultimate objective of this research work is to develop an energy efficient routing protocols to extend the lifetime of the network by reducing the inter and intra cluster communications. The cluster based routing protocols significantly perform better compared to other kind of routings. The main aim is to create and maintain even number of CHs till the end of the network lifetime. The protocols must also address hot spot problem by distributing energy load evenly among the CHs. The protocols should also consider cluster size, transmission power and energy levels of nodes to form a cluster. The protocols are also aimed to incur low overhead in terms of processing and fairly uniform distribution of CHs across the sensor network. The main objectives of the proposed research include:

- Clustering the wireless sensor network based on the metrics such as degree, hop counts, transmission range, residual energy etc.
- Selection of minimum number of cluster heads.

- To reduce communication overhead there by increasing the battery lifetime.
- To reduces channel contention and packet collisions, resulting in better network throughput under high load.
- Finding the shortest path to reach the base station using multi-hop routing.

1.3 Thesis Outline

The rest of the thesis is organized as follows:

Chapter 2: In this chapter the background information relating to WSN such as node architecture, energy constraints, key design challenges and applications of WSNs are discussed.

Chapter 3: This chapter presents extensive literature survey on routing algorithms for WSNs. It mainly discusses energy efficient cluster based routing algorithms related to WSNs.

The contributions to this thesis are discussed in *Chapter* 4, 5 and 6.

Chapter 4: In this chapter the Energy Balanced Fixed Clustering protocol to maximize the network lifetime is presented.

Chapter 5: This chapter describes in detail the architectural framework and structures of the proposed Sector Based Multi-hop Clustering algorithm.

Chapter 6: The Unequal Cluster Based Routing algorithm to address hot spot problem is described in this chapter.

Chapter 7: Finally, this chapter summarizes the conclusions drawn in the thesis.