Name of the Scholar : **M. BALA KRISHNA**

Name of the Supervisor : **PROFESSOR M. N. DOJA**

Department : **COMPUTER ENGINEERING**
FACULTY OF ENGINEERING & TECHNOLOGY

Title of the Thesis : **DESIGN OF WIRELESS SENSOR NETWORK PROTOCOLS USING HEURISTIC AND SOFT COMPUTING TECHNIQUES**

ABSTRACT

Wireless Sensor Network (WSN) is an infrastructureless network comprising of low-cost sensor nodes that are deployed in dense and remote geographical areas, to monitor the variations in surrounding physical environment. Sensor networks are grouped into clusters, and the Cluster Head (CH) within each group controls and coordinates the functioning of sensor nodes in the network. The sensor nodes are resource constrained and thus have limitations in computing, memory storage and energy level of the node. This necessitates the design of energy efficient protocols for sensor networks. Extensive research is being carried out in various layers of WSN protocol stack to optimize the network performance. The middle layers of WSN protocol stack are platform independent and are adaptable to the upper layers of WSN protocol stack. In this thesis, we propose the design of wireless sensor network protocols using heuristic and soft computing techniques. Soft Computing (SC) techniques are computational intensive and evolutionary based design models that comprises of meta-heuristics, decision-based control logic, knowledge-based learning and probabilistic-based methods. The proposed WSN protocols are: (i) Prioritized Hybrid Duty Cycle MAC (PHDC-MAC) protocol based on heuristics (ii) Clustered Ant Colony Optimization (C-ACO) routing protocol based on Swarm Intelligence (iii) Feed-Forward Trained Minimum Spanning Tree Topology Control (FFTMST-TC) protocol based on Artificial Neural Network and (iv) Fuzzy Logic Session based Symmetric Key Management (FL-SSKM) protocol based on Fuzzy Logic System. This thesis is divided into seven chapters, and the elucidation of each chapter is given as follows.

Chapter 1 explains the characteristic features of wireless sensor network. This chapter classifies the sensor network based on the mode of deployment and network application. The architecture of sensor node and sensor system is given in detail. This chapter explains the features of WSN protocol stack and elucidates the functionality of each layer and their respective applied protocols.

Chapter 2 explains the features of heuristic and soft computing techniques. Heuristic techniques as compared to the traditional complex methods, use the simple appropriation methods in the experimental analysis to achieve the desired results. Soft Computing techniques like Artificial Neural Network (ANN) and Fuzzy Logic Systems (FLS) are explained in detail. Swarm Intelligence based Ant Colony Optimization (ACO) is elucidated in detail. In this thesis, the design of WSN protocols are implemented using heuristics and soft computing techniques.

Chapter 3 explains the significance of duty cycle methods and gives the classification of MAC protocols for WSNs. This chapter presents our proposed Prioritized Hybrid Duty Cycle MAC (PHDC-MAC) protocol based on the heuristic technique. PHDC-MAC protocol prioritizes the sensor nodes based on the number of data packets and the node energy. In the High Priority Synchronous Mode, the number of data packets and the node energy is more than the threshold value, and the sensor nodes switch their transceivers to transmit or receive state. In the Low Priority Asynchronous Mode, the number of data packets and the node energy is less than the threshold value, and the sensor nodes switch their transceivers to listen or sleep state. PHDC-MAC protocol decreases the control overhead and saves the node energy of the network.

Chapter 4 explains the routing parameters and gives the classification of routing protocols for WSNs. This chapter presents our proposed Clustered Ant Colony Optimization (C-ACO) routing protocol based on the Swarm Intelligence technique. In C-ACO, the optimized route path is a function of pheromone count and minimum hop count. The pheromone count is mapped to the node distance and node energy of the network. The routing paths are formed based on the traversal path count (pheromone count), path history (pheromone update), cluster size and the network topology. ACO based local search method identifies the delays and link failures in the network, and establishes the alternate route paths in the network. C-ACO routing protocol saves the node energy and optimizes the route paths in the network.

Chapter 5 explains the significance of node connectivity based on topology control protocols. This chapter presents our proposed Feed-Forward Trained Minimum Spanning Tree Topology Control (FFTMST-TC) protocol based on the Artificial Neural Network (ANN). The feed-forward neural network is trained with the input parameters and the validation sets, to achieve the desired network connectivity. The target of the trained neural network establishes the node connectivity with energy more than the threshold value. Full connectivity (without energy threshold) and partial connectivity (with energy threshold) of the proposed FFTMST-TC protocol are compared with the existing MST-TC protocols. FFTMST-TC protocol improves the node connectivity and coverage ratio of the network.

Chapter 6 explains the phases of key management techniques used in security protocols. This chapter presents our proposed Fuzzy Logic Session based Symmetric Key Management (FL-SSKM) protocol based on the Fuzzy Logic System (FLS). FL-SSKM minimizes the number of keys by using incremental re-keying technique along the intruded paths of the network. The re-keying technique assigns new key to the compromised nodes of the network. If the number of intrusions is more than the threshold limit, then the network topology is re-constructed with a new common key assigned to all the nodes of the network. FL-SSKM protocol saves the memory space and reduces the key complexity in the network.

Chapter 7 concludes our achievements for the design of WSN protocols using heuristic and soft computing techniques. The design metrics and performance evaluations are highlighted in this chapter. In future work, the directions and enhanced perspectives of our proposed WSN protocols are elucidated in detail.