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Title of Thesis : Energy Efficient Cluster based Secure Routing Protocol for Wireless Sensor Networks

Abstract

In last two decades, Wireless Sensor Network (WSN) has gained huge popularity because of its little or no infrastructure based network communication & applicability in variety of applications like military, health, environment etc. It has tiny size low powered device called sensors to monitor the area of interest. An important consideration for WSN is energy efficiency due to its confined power level which has attracted huge researchers. There are many unattended applications of WSN (e.g. dense forest, battle field) where it's infeasible to recharge or replace the battery based power supply of sensor nodes. Clustering organizes a deployed network into connected hierarchy and makes the network scalable & energy efficient thereby prolonging the lifetime of WSN.

To extend the stability period of homogeneous model in WSN, two protocols (LEASE & SE-LEACH) have been designed and simulated through experiment. In homogeneous model, all the nodes are presumed to have equal computational and memory capacity with energy level at par. In LEASE protocol, cluster head selection index for each node is calculated on the basis of residual energy, average reachability to neighbouring nodes, dissipation rate and number of times a node is already chosen as cluster head. In SE-LEACH, a rank is calculated for each node to determine its candidature for cluster head role. This rank is dependent upon the current battery level, node density, average distance to member nodes, distance to base station and average power required if chosen as cluster head. The non- cluster head nodes elect their cluster head on the basis of chance which is dependent upon its distance to cluster head node, residual energy of cluster head node, its density, average distance to nearby nodes. The performance metrics chosen are stability period, average energy, half node death and packet delivery to base station. It has been observed from the experimental results that LEASE & SE-LEACH give better results than LEACH, SEP & MOD-LEACH protocols.

To achieve load balancing for stability enhancement, heterogeneity model has been adapted in proposed work in which sensor nodes differ from each other in terms of energy level. By virtue of heterogeneity energy, lifetime of the network can be extended. Proposed work exploits energy heterogeneity with two levels & multi-level energy nodes. Two base stations

are positioned on either side of the target area (e.g. forest fire, landslide, earth quake etc.) at distant place unlike presumed at centre in most of the previous research work. Re-Clustering in proposed work takes place only when energy of sensor node falls below a defined threshold. Stability & Persistent period (coverage of target area) are used as performance metrics. Simulation experiments have been carried out for the proposed work. It has been observed from the experimental results that proposed work achieves load balancing with better performance in terms of stability and persistence period.

To achieve energy efficient clustering, zonal based approach has been adapted to extend Z-SEP protocol. In this proposed work, the network is divided into zones with randomly deployed sensor nodes. Clustering process takes place in each zone. Extraneous energy is supplied to some of the nodes so as to increase the stability span. It has been observed from experimental results that proposed work has elongated lifetime in terms of stable period in comparison with ZSEP, SEP, LEACH & DEEC protocol.

For the selection of best candidate for cluster head role, three protocols (FBECS, E-CAFL & E-FUCA) have been proposed by designing Fuzzy Inference System (FIS). The proposed FBECS protocol contemplates the remnant energy, farness from base station and density as input to FIS for choosing the best cluster head candidate. The experimental results validate better performance of FBECS to its counterparts BCSA and LEACH. The proposed E-CAFL protocol is an improvement over CAFL protocol. It takes residual energy, node density & distance from sink as input to FIS for calculating rank. It has been observed from the simulation results that E-CAFL has better stability period & protracted lifetime as compared to LEACH & CAFL protocol. The proposed E-FUCA protocol is an enhancement over FUCA protocol which considers residual energy, closeness to base station and average distance to neighbour nodes for calculating rank and competition radius during selection of cluster head. During cluster formation, non-cluster head nodes intelligently select their cluster head and balances the load. Our experimental results exhibit tremendous performance in comparison to LEACH & FUCA protocol.

For secure WSN, highly secure energy efficient codeword authenticated key exchange (CAKE) protocol has been proposed. It is based on one way hashing with one time password & codeword authentication. BAN logic & Random Oracle Model have been used for formal proof and AVISPA tool has been used for simulating the proposed work. CAKE has been compared with other existing mutual authentication schemes which depicts significant reduction in computational time and energy consumption. The proposed protocol preserves CIA and can counter several attacks making the protocol suitable for various WSN applications.