ABSTRACT

Today wireless sensor networks are employed in diversified application fields ranging from battlefield to hospitals. These sensor networks are provided with sensor nodes to sense, collect and forward the data to one or multiple sinks. These sensor nodes exhibit many pragmatic challenges due to their self-organizing mode of operations.

Most of these wireless sensor networks are deployed in environments where human access is limited or prohibited. Lifetime of a sensor network is defined in terms of lifetime of sensor nodes in that network. Lifetime of a sensor node is determined based on the energy it holds in it. Since sensor nodes are provided with limited energy resources, efficient utilization and preservation of energy becomes a crucial and inevitable issue in prolonging the lifetime of sensor networks.

Clustering the sensor network is a technique that is widely adopted in these solutions which includes its advantages and limitations. Clustering mechanism in sensor networks attains its efficiency in terms of energy preservation and robustness but experiences hot-spot issues in practical scenarios.

This research work proposes four energy-aware clustering approaches to improve the lifetime of wireless sensor networks. Juxtaposing and assimilating the merits of existing solutions, the proposed clustering approaches attempt to improve the energy characteristics and lifetime of a wireless sensor network.

The first proposed approach of this research work presents a clustering algorithm for wireless sensor networks, namely, Energy Aware Fuzzy Clustering Algorithm (EAFCA). This approach employs fuzzy logic to elect cluster heads for clusters in a wireless sensor network. The cluster heads are elected based on three parameters: residual energy, mean distance to 1-hop neighbors and 2-hop coverage of the competing sensor nodes. This approach also adopts a probabilistic path selection for multi-hop relay between cluster heads and sink which avoids the depletion of energy at nodes on identified set of paths followed in conventional clustering approaches.

The second proposed clustering approach, namely, Zonal Clustering Algorithm (ZCA), focuses to improve the lifetime of a sensor network by eliminating the impact of hot-spot issues in clustering. Cluster heads functioning nearer to the sink tend to deplete their energy in a rapid manner and experience hot-spot issue in the conventional clustering process. To avoid this, the proposed work, provides multiple cluster heads for every cluster depending upon their hop-distance from the sink and effectively balances the energy consumption across the sensor network. This approach aims at reducing the energy consumption arising due to the frequent re-clustering process in sensor networks.

The third proposed clustering approach, namely, Centralized data Aggregation Supported Transmission Scheme Selection (CAS-TSS) focuses on selecting an efficient transmission scheme between Multiple Input Multiple Output (MIMO) and Single Input Single Output (SISO). This work also combines the idea of centralized data aggregation scheme along with this. Under constant bit rate, MIMO achieves higher transmission rate than SISO but imposes on significant increase in the overhead. From the energy perspective, the suitable transmission scheme is selected for the wireless

sensor network. This work also adopts the Centralized data-Aggregation Scheme (CAS) for saving the energy during transmission. The proposed clustering approach which integrates the merits of transmission scheme selection and centralized data aggregation reduces the energy consumption and hence the lifetime of the sensor network is enhanced.

The fourth proposed approach of the research work concentrates on providing efficient energy harvesting resources to wireless sensor networks since the techniques employed on tiny, limited and non-rechargeable energy resources are always constrained in their lifetime guarantees. The proposed Efficient Energy Harvesting assisted Clustering (EEHC) algorithm harvests the consumed energy within a stipulated time period. The proposed algorithm contributes by avoiding the presence of residual nodes while clusters are formed. Also, this clustering algorithm circumvents overlapping in the neighborhood clusters. Owing to these contributions, the boundaries of clusters are set in a deterministic manner and the need for energy harvesting is reduced significantly. Data transmission has been controlled with respect to the energy harvested.

The performance of the proposed energy-aware clustering approaches has been compared against the conventional and modern clustering approaches using the simulation done in MATLAB. Simulation results exhibit that the proposed clustering approaches achieve energy efficiency in comparison with the existing clustering approaches. Hence the lifetime of wireless sensor network has been improved in all these proposed approaches against the benchmarked and contemporary clustering approaches.