Abstract

Nowadays, the Internet of Things (IoT) plays a significant role in the development of various real-life applications such as smart cities, e-healthcare, precision agriculture, and industrial automation. Wireless Sensor Networks (WSNs) are a major ingredient of any IoT-based applications. In IoT applications, sensor nodes are used to collect real-time information such as temperature, humidity, and vibration from physical objects. Sensor nodes transmit a huge amount of data to the Base station (BS)/sink node through multi-hop communications as per end-user requirements. IoT-based applications need high-performance WSNs to process this huge amount of data in a timely manner. Traditional WSNs are unable to process huge amounts of data in a timely and energy-efficient way. In this thesis, high-performance WSNs are referred to as IoT-enabled WSNs. Several issues like uneven energy consumption, obstacle avoidance, fault detection, and fault tolerance are present in IoT-enabled WSNs, which need to be addressed to fulfil the requirements of IoT applications.

In IoT-enabled WSNs, Mobile Sinks (MSs) are a superior means of addressing uneven energy consumption in WSNs. Therefore, this thesis proposes a multi-objective grey wolf optimization-based data routing scheme for homogeneous WSNs that prevents premature death of the network. The proposed scheme selects an optimal number of rendezvous Points (RPs) in the network, and MS visits each RP to collect data from sensor nodes. Furthermore, an RP rotation scheme is also developed to balance the energy consumption of sensor nodes. Advanced IoT applications use heterogeneous sensor nodes that generate large volumes of diverse data. Efficient data-gathering is very essential for managing this data. This thesis proposes a Deep Policy Dynamic Programming (DPDP)-based routing scheme and a novel Energy Efficient Rendezvous Points Selection (EERPS) algorithm for optimal RP selection in heterogeneous WSNs. The DPDP algorithm designs an optimal path for MS-based data collection.

Real monitoring environments have obstacles that hinder sink mobility and communication, increase delays and decrease network performance. To address this, the thesis proposes an obstacle-aware energy-efficient routing scheme using Manta-ray Foraging Optimization (MRFO) algorithm. MRFO algorithm selects optimal RPs. Additionally, the EBS-A* algorithm designs a smooth, obstacle-avoiding route for MS-based data collection. IoT-enabled WSNs suffer from network cut issues due to sensor node failure. To address this issue, this thesis presents a Mobile Data Collector (MDC) based network cut detection and recovery scheme for IoT-enabled WSNs. The proposed network cut detection scheme identifies the formation of network cuts in WSNs. Furthermore, network recovery algorithm enables the data collection from isolated segments. A Reinforcement learning Brain Storm Optimization (RLBSO) algorithm is applied for optimal RPs selection and optimal MDC path design. This thesis proposes an Intelligent indoor emergency evacuation system using IoT-enabled WSNs for smart buildings. This approach proposes a Dynamic emergency Evacuation system for Shortest-Safe path Navigation (DESSN). The proposed work computes the shortest evacuation path for an individual by considering the future spread of the fire over time. It enables quick evacuation of evacuees during an emergency. It also helps to avoid detours.

We have performed extensive simulations and testbed experiments of our proposed works and compared the results with existing state-of-the-art algorithms. The simulation and testbed results show that the proposed approach outperforms existing state-of-the-art approaches in terms of network lifetime data collection delay, energy consumption, and so on.