National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Optimization Techniques and Machine Learning Stratergies for Small and Dense Energy Efficient LoRa Networks
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Venue	: Seminar Room, EC Dept. (EC-303)
Date and Time	: 15 May 2024 (05.00 PM)
Abstract	: The Internet of Things (IoT) has emerged as a transformative force, connecting billions of devices to facilitate data-driven decision-making and enhance operational efficiency across various sectors. However, the proliferation of IoT devices brings forth challenges related to energy consumption, communication efficiency, and network scalability, particularly in dense deployment scenarios. This dissertation aims to address the challenges of dynamic nodes and dense deployments of nodes by proposing innovative solutions for energy-efficient IoT nodes, specifically focusing on LoRa (Long Range) technology and its communication protocol LoRaWAN. This doctoral dissertation focuses on the development of energy efficient system by optimising the transmission parameters. By harnessing both optimization techniques and machine learning strategies, the research aims to develop robust solutions that strike a balance between energy conservation and communication efficiency. The study begins with an in-depth exploration of LoRa and LoRaWAN technologies, setting the foundation for subsequent investigations. The study first introduces two node-centric algorithms, tailored for dynamic LoRa nodes, showcasing the latter as an enhanced algorithm with superior performance metrics. The theoretical descriptions are strengthened by the hardware implementation of the algorithms. This practical validation not only confirms the conceptual foundations but also showcases the algorithm&rsquos real-world feasibility and performance. However, the algorithms are developed for dynamic nodes and not generalized for a large scale deployment. The next step is to focus on generalizing the algorithm on a network management level where mathematical optimization models aimed at optimizing communication efficiency by balancing energy consumption and delivery ratios. A binary integer linear programming model was introduced to offer a structured method for network configuration. This model serves as a comprehensive framework that optimizes various network parameters, ensuring efficient and effective deployment of IoT systems. The study shifts its focus to Machine Learning, presenting a web application tailored for energy consumption prediction. An extensive evaluation of twelve machine learning regression models was conducted to pinpoint the most effective model for predicting energy consumption. Performance metrics were utilized throughout the evaluation process to assess the accuracy and reliability of each model. Finally, a detection methodology is proposed to distinguish between greedy and standard nodes in the network. By utilizing data from the network, a classification task was devised to differentiate between standard and greedy nodes based on their transmission parameters and energy consumption patterns. This classification aimed to develop a method that could effectively identify nodes consuming excessive energy or operating sub-optimally, enabling better management and optimization of the network. Through rigorous evaluations and real-world implementations, this dissertation demonstrates the potential of these proposed solutions in achieving scalable, reliable, and energy-efficient IoT deployments.