Machine learning-based strategy for efficient node localization in wireless sensor networks

Abstract:

Node localization is a fundamental challenge in Wireless Sensor Networks (WSNs) as precise location estimation is essential for various applications. Traditional localization techniques, including bio-inspired and mathematical models, often struggle with high computational complexity and limited adaptability to diverse environments. Recent advancements in Machine Learning (ML) offer promising solutions by leveraging data-driven approaches to optimize localization accuracy. This survey explores existing localization methods in WSNs, categorizing them into range-based and range-free techniques. Furthermore, it examines the application of ML models such as Support Vector Regression (SVR), Random Forest Regression (RFR), and CatBoost Regression (CAT) in reducing Average Localization Error (ALE). Additionally, optimization strategies, including the Giant Trevally Optimizer (GTO), are evaluated for their role in enhancing prediction accuracy and reducing computational time. A comparative analysis of conventional and ML-driven localization methods is conducted to highlight their strengths, limitations, and potential improvements. Finally, this paper discusses emerging trends, challenges, and future research directions in ML-based localization for WSNs.

Keywords:

Wireless Sensor Networks, Node Localization, Machine Learning, Optimization, Average Localization Error