

Wireless Rechargeable Sensor Networks: A Comprehensive Review of Static Sensor Charging Techniques

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Abstract:

Wireless rechargeable sensor networks (WRSNs) have emerged as a pivotal technology supporting diverse applications, including smart urban infrastructure, industrial automation, the Internet of Things (IoT), and environmental surveillance. By integrating wireless power transfer (WPT), these networks address the persistent energy limitations inherent in traditional sensor systems. Nonetheless, an ongoing challenge lies in maintaining regular and efficient sensor charging to reduce node failures while optimizing overall energy expenditure. This study presents an in-depth review of existing charging mechanisms, which are broadly classified into full and partial charging approaches, along with scheduling schemes such as on-demand and periodic charging. It also provides a critical analysis of recent advancements, highlighting how emerging technologies contribute to enhanced energy efficiency and system sustainability. The paper also identifies open research challenges in scalability, economic viability, and the incorporation of renewable energy solutions. Finally, it outlines prospective research avenues centered on AI-assisted hybrid models, reinforcement learning techniques, and distributed energy management frameworks, aiming to advance the next generation of WRSNs.

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