

Chapter 2

Integrating Edge Computing and AI for Energy-Efficient Data Processing in Wireless Sensor Network

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ABSTRACT

Wireless sensor networks are critical for applications like industrial automation, smart cities, healthcare, and environmental monitoring. However, challenges arise with energy consumption, latency, and bandwidth due to the large data generated. Integrating Edge Computing and AI offers a solution by enabling efficient data analysis with lower energy consumption. Edge computing brings processing closer to data sources, allowing real-time data analysis without relying on cloud servers, reducing energy usage and extending network lifespan. AI techniques, such as

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machine learning and deep learning, enhance data filtering, anomaly detection, and predictive maintenance at the edge. This approach boosts WSN scalability and responsiveness by managing large data efficiently. This study examines WSN architectures with edge computing and AI, focusing on key frameworks, technologies, and energy-saving methods. Through case studies, it demonstrates how this integration enhances performance, data efficiency, and supports intelligent decision-making in various WSN deployments.

1. INTRODUCTION

Cloud computing has undergone significant transformations in recent years, experiencing a surge in demand for efficient and scalable solutions. Load balancing, a critical aspect of cloud-based systems, plays a pivotal role in ensuring performance and reliability. It involves distributing incoming network traffic or computing workload across multiple servers to optimize resource utilization and prevent any single server from becoming a bottleneck. As technology evolves, the future of load balancing is poised for innovative advancements to address the growing complexities of modern computing environments (Afzal & Kavitha, 2019). In this era of digital transformation, where cloud computing is central, researchers and industry experts are actively exploring novel approaches to enhance load balancing mechanisms. This paper delves into future trends and innovations in load balancing, particularly focusing on their application in cloud computing environments (Armbrust et al., 2010). The discussion encompasses emerging technologies, methodologies, and strategies promising to revolutionize the way resources are managed and distributed across cloud infrastructure (Beloglazov et al., 2012). As cloud architectures diversify and expand, the integration of edge computing introduces new challenges and opportunities for load balancing. Real-time processing at the edge, coupled with the proliferation of Internet of Things (IoT) devices, necessitates load balancing solutions capable of dynamically adapting to varying workloads and network conditions. Moreover, incorporating machine learning algorithms into load balancing mechanisms holds potential to enable intelligent decision-making, optimizing resource allocation based on historical data and real-time analysis (Dey et al., 2024). Additionally, the future of load balancing is likely to witness the rise of intelligent automation, where self-learning algorithms and automated decision-making processes play a crucial role in managing workloads efficiently (Dikaiakos et al., 2009). This shift towards autonomous load balancing systems aims to reduce human intervention, enhance system responsiveness, and improve overall performance in dynamic cloud environments. Load Balancing is essential to maximizing the scalability, performance, and availability of data center networks.

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