Intesab Aalami
ISSN: 2348-5035
Vol. 12 / No. 4 / August 2024

Edge Computing: Enhancing Real-Time Data Processing

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Abstract

Edge computing has emerged as a transformative computing paradigm that processes data closer to its source rather than relying solely on centralized cloud infrastructure. This approach reduces latency, improves bandwidth utilization, enhances privacy, and enables real-time decision-making for applications such as the Internet of Things (IoT), autonomous vehicles, smart manufacturing, healthcare, and smart cities. By integrating edge computing with artificial intelligence, 5G networks, and cloud computing, organizations can achieve faster data processing and greater operational efficiency. However, challenges including security, interoperability, resource management, and scalability remain significant. This paper examines the concepts, benefits, applications, challenges, and future prospects of edge computing in modern information systems.

Keywords

Edge Computing, Real-Time Data Processing, Internet of Things, 5G, Artificial Intelligence, Cloud Computing, Distributed Computing, Smart Cities, Edge AI, Digital Transformation.

Introduction

The rapid growth of connected devices and data-intensive applications has created increasing demand for computing models capable of processing information with minimal delay. Traditional cloud computing provides scalable resources but often experiences latency when data must travel to distant data centers. Edge computing addresses this limitation by processing data closer to where it is generated.

Edge computing distributes computing resources across edge devices, gateways, and local servers, enabling faster analysis and response. This architecture is particularly valuable for applications requiring immediate decision-making, including industrial automation, autonomous transportation, healthcare monitoring, and intelligent surveillance.

The convergence of edge computing with the Internet of Things (IoT), artificial intelligence (AI), machine learning, and fifth-generation (5G) communication networks has accelerated digital transformation. AI-powered edge devices can analyze data locally, reducing bandwidth consumption while improving reliability and user experience.

Organizations increasingly deploy edge computing in manufacturing for predictive maintenance, healthcare for remote patient monitoring, retail for personalized customer

services, agriculture for precision farming, and smart cities for traffic management and environmental monitoring.

Despite its advantages, edge computing presents challenges related to cybersecurity, data privacy, interoperability, resource constraints, device management, and integration with cloud infrastructure. Robust security mechanisms, standardized protocols, and efficient orchestration are essential for successful deployment.

The future of edge computing is expected to focus on Edge AI, federated learning, digital twins, sustainable computing, and intelligent distributed systems that support low-latency, secure, and scalable digital services.

Conclusion

Edge computing is transforming modern computing by enabling real-time data processing closer to data sources. Its integration with AI, IoT, cloud computing, and 5G technologies supports faster decision-making, improved efficiency, and enhanced user experiences across multiple industries. Continued advancements in security, interoperability, and intelligent edge management will strengthen its role in future digital ecosystems.

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