



A Survey of Edge Computing Technologies and Their Applications in Real-Time Processing

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Description

Edge computing has emerged as a transformative approach in computing architecture, enabling data processing closer to data sources rather than relying on centralized cloud systems. By processing data at or near its source, edge computing reduces latency, improves response times and lowers bandwidth usage, making it particularly effective for real-time applications. As a growing technology, edge computing is being widely adopted across industries, such as healthcare, manufacturing, autonomous vehicles and smart cities. This paper discusses edge computing technologies, their infrastructure and architecture and diverse applications that influence real-time data processing capabilities. Manufacturing facilities are increasingly deploying edge computing to support industrial automation and predictive maintenance. Edge computing systems monitor equipment health and performance by processing data from sensors in real time.

By identifying potential issues before they lead to equipment failure, edge computing reduces downtime and maintenance costs. In addition, manufacturing robots equipped with edge AI can respond to environmental changes quickly, improving efficiency and accuracy on production lines. Smart cities utilize edge computing to manage and analyze data from traffic systems, utilities, surveillance cameras and environmental sensors. For example, traffic monitoring systems

process data locally at intersections to detect congestion patterns and adjust signal timings in real time, minimizing traffic bottlenecks. Similarly, environmental sensors can monitor air quality and noise pollution, generating real-time alerts and allowing authorities to address public safety issues proactively. Edge computing in retail enhances customer experiences through real-time personalization and efficient inventory management. Edge devices analyze shopper behavior and preferences, allowing retailers to offer tailored promotions and product recommendations immediately. Additionally, edge computing supports cashier-less stores, where cameras and sensors process customer activities in real time, enabling seamless checkout experiences. Edge computing has improved security and surveillance systems by enabling real-time video analysis and anomaly detection. Surveillance cameras equipped with edge AI can process video feeds locally, identifying suspicious behaviors or unauthorized access.

With immediate alerts and real-time analytics, security personnel can respond faster to potential threats, ensuring more proactive security management. The future of edge computing lies in enhanced AI capabilities, increased deployment of 5G and deeper integration with cloud systems. As AI algorithms become more optimized, edge devices will be able to handle even more complex processing tasks locally. The rollout of 5G networks will further accelerate edge computing by providing faster, more reliable connections, particularly important for applications such as Augmented Reality (AR), Virtual Reality (VR) and autonomous driving. Additionally, hybrid architectures that combine the strengths of edge and cloud computing will likely become more common. In these setups, edge computing handles time-sensitive tasks, while the cloud provides advanced analytics and storage. This integrated model will enable real-time processing while ensuring that longer-term analytics are available for large-scale insights.

Edge computing represents a major advancement in computational architecture, providing real-time data processing capabilities essential for a variety of applications. From autonomous vehicles to smart cities, the technology is enhancing efficiency, safety and user experience across diverse industries. Despite challenges, such as managing distributed resources and ensuring data security, edge computing's benefits make it a compelling solution for applications requiring low latency and immediate response times. As edge computing continues to evolve, supported by advancements in AI and 5G, its adoption will likely expand further, enabling even more sophisticated real-time processing across a growing array of applications.

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