Chapter 17
Fog Computing-Based Framework and Solutions for Intelligent Systems:
Enabling Autonomy in Vehicles

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ABSTRACT

The automotive industry is increasingly focusing on autonomous vehicles, leading to a need for intelligent systems that enable safe and efficient self-driving. Fog computing is a promising paradigm for real-time data processing and communication in autonomous vehicles. This chapter presents a comprehensive framework and solutions for integrating fog computing into intelligent vehicle systems, enabling autonomous features, low-latency data processing, reliable communication, and enhanced decision-making capabilities. By offloading computational tasks to nearby fog nodes, this framework optimizes resource utilization, reduces network congestion, and enhances vehicle autonomy. The chapter discusses various use cases, architectures, communication protocols, and security considerations within fog computing, ultimately contributing to the evolution of intelligent and autonomous vehicles.

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INTRODUCTION

The automotive industry is experiencing a transformation due to advancements in autonomous vehicle technologies, transforming transportation, safety, and mobility. This transformation improves road safety, reduces traffic congestion, and enhances travel efficiency. The integration of artificial intelligence, sensor systems, machine learning, and connectivity drives vehicles towards higher levels of autonomy, bringing self-driving cars closer to a tangible reality. The concept of autonomous vehicles traces its roots back to the early 20th century, with visionary ideas and prototypes that laid the foundation for today's breakthroughs (Ahangar et al., 2021; Kato et al., 2018). However, it is the recent convergence of computational power, data availability, and algorithmic innovation that has catapulted autonomous vehicles into the forefront of technological advancement. From advanced driver assistance systems (ADAS) to fully autonomous cars capable of navigating complex urban environments, the journey towards vehicular autonomy has been marked by incremental achievements, profound challenges, and a wealth of interdisciplinary research (Butt et al., 2022; Hakak et al., 2022).

This comprehensive research exploration delves into the multifaceted landscape of autonomous vehicles. It aims to provide a holistic understanding of the underlying technologies, research trends, challenges, and societal implications associated with the pursuit of vehicular autonomy. By examining the progression from basic driver assistance features to highly autonomous systems, this exploration seeks to shed light on the intricate interplay between hardware and software, regulation and ethics, human-machine interaction, and the transformative potential for various industries (Fernandes & Nunes, 2012; Hakak et al., 2022). Autonomous vehicles rely on an array of sensors, including cameras, lidar, radar, and ultrasonic sensors, to perceive their surroundings. The fusion of data from these sensors and the subsequent interpretation of the environment form the cornerstone of autonomous navigation and decision-making. Cutting-edge machine learning techniques, such as deep learning, reinforcement learning, and probabilistic modeling, empower vehicles to learn from data and adapt to diverse driving scenarios. These algorithms enable the recognition of objects, prediction of behavior, and optimization of driving trajectories (Cui et al., 2018; Hoermann et al., 2017). Autonomous vehicles must not only perceive their environment but also make real-time decisions to navigate safely and efficiently. Control and planning algorithms determine how the vehicle should move and interact with its surroundings, considering factors like traffic, pedestrians, and road conditions.

Ensuring the safety of autonomous vehicles is paramount. Rigorous testing, simulation, and validation processes are essential to building trust in these systems and minimizing the risk of accidents in complex real-world environments. The introduction of autonomous vehicles raises ethical dilemmas, such as how vehicles should prioritize the safety of occupants versus pedestrians in potential collision scenarios (Barik et al., 2018; Wu et al., 2017). Additionally, legal frameworks and regulations must evolve to accommodate the unique challenges posed by autonomous driving. The success of autonomous vehicles hinges on how well humans can interact with and trust these systems. Understanding user perceptions, preferences, and behaviors is crucial for designing user-friendly interfaces and fostering public acceptance. The advent of autonomous vehicles will have far-reaching impacts on various industries, including transportation, logistics, urban planning, and more. Exploring these effects is essential for anticipating economic shifts and making informed policy decisions (Aljumah et al., 2021; Barik et al., 2018).

The collaborative nature of autonomous vehicle advancement requires a critical examination of the state of the art, addressing challenges, and envisioning a future where autonomous vehicles coexist harmoniously with society. Engineers, researchers, policymakers, ethicists, and the general public all play

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