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A microservice-based architecture for unmanned aerial vehicle control systems

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Abstract

This paper presents a microservice-based operating system architecture for unmanned aerial vehicle (UAV) control, designed to improve modularity, scalability, and fault isolation compared to traditional monolithic and ROS-based systems. The proposed architecture is organized into four layers, i.e., hardware, driver microservices, application orchestrator, and frontend, enabling clear separation between hardware interaction, control logic, and user interface components.The architecture introduces a hybrid communication model that combines synchronous request–response interactions for user commands with asynchronous event-driven coordination for autonomous behaviors and safety-critical responses. Core UAV functionalities, including positioning, motor control, battery monitoring, communication, and perception, are decomposed into independent services that interact through standardized interfaces.In addition, the paper provides a structured qualitative analysis of architectural trade-offs by comparing microservice-based, monolithic, and ROS-based approaches across key system-level criteria, including modularity, scalability, fault isolation, and real-time support. The contribution is positioned at the level of system architecture design and qualitative analysis, providing a structured foundation for integrating microservices into UAV control systems under real-time constraints. The presented architecture establishes a foundation for future implementation, quantitative validation, and deployment in distributed UAV control environments.

Keywords: *autonomous drones; microservices architecture; service orchestration*

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