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ENHANCING USB COMMUNICATION PROTOCOLS FOR REAL TIME DATA TRANSFER IN EMBEDDED DEVICES

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ABSTRACT

The rapid advancement of embedded systems has increased the demand for efficient and high-speed data transfer solutions, with USB (Universal Serial Bus) emerging as a preferred communication interface. This research focuses on enhancing USB communication protocols to enable real-time data transfer in embedded devices, addressing the growing need for low-latency and high-reliability connections. Traditional USB implementations often face challenges related to data transmission delays, packet loss, and synchronization issues, particularly in time-sensitive applications such as medical devices, industrial automation, and IoT systems.

This study explores modifications to existing USB protocols, including the optimization of data flow control mechanisms and the integration of enhanced error-checking algorithms. Additionally, real-time scheduling techniques are evaluated to prioritize critical data transfers, reducing jitter and ensuring timely delivery. Furthermore, the research proposes leveraging USB 3.0 and USB 4.0 standards for improved throughput and energy efficiency while maintaining backward compatibility with legacy systems.

By implementing these enhancements, the study aims to provide a robust framework for real-time communication in embedded devices, improving system performance and reliability. Simulations and case studies demonstrate the effectiveness of the proposed techniques in achieving low-latency communication under various operational conditions. The findings of this research offer valuable insights for developers and manufacturers, enabling them to design more efficient USB-based embedded systems. These improvements can potentially expand the use of USB communication in critical domains, driving innovation in applications requiring seamless and real-time data exchange.

KEYWORDS: *USB Communication, Real-Time Data Transfer, Embedded Devices, Low-Latency Protocols, Data Flow Optimization, Error-Checking Algorithms, USB 3.0, USB 4.0, Energy-Efficient Communication, Real-Time Scheduling, System Performance, Seamless Data Exchange*

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