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Enhancing Embedded System Efficiency with Digital Signal Processing Cores

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Abstract : This paper presents a comprehensive analysis of the performance advantages offered by DSP (Digital Signal Processing) cores compared to traditional MCU (Microcontroller Unit) cores in the execution of various functions critical to real-time applications. The focus is on the integration of DSP functionalities, specifically in the context of motor control applications such as Field-Oriented Control (FOC), trigonometric calculations, back-EMF estimation, digital filtering, and high-resolution PWM generation. Through comparative analysis, it is demonstrated that DSP cores significantly enhance processing efficiency, achieving faster execution times for complex mathematical operations essential for precise torque and speed control. The study highlights the capabilities of DSP cores, including single-cycle Multiply-Accumulate (MAC) operations and optimized hardware for trigonometric functions, which collectively reduce latency and improve real-time performance. In contrast, MCU cores, while capable of performing similar tasks, typically exhibit longer execution times due to reliance on software-based solutions and lack of dedicated hardware acceleration. The findings underscore the critical role of DSP cores in applications requiring high-speed processing and low-latency response, making them indispensable in the automotive, industrial, and robotics sectors. This work serves as a reference for future developments in embedded systems, emphasizing the importance of architecture choice in achieving optimal performance in demanding computational tasks.

Keywords : CPU core, DSP, assembly code, motor control
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