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Wireless FPGA-Based Motion Controller Design by Implementing 3-Axis Linear Trajectory

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Abstract : Designing a high accuracy and high precision motion controller is one of the important issues in today's industry. There are effective solutions available in the industry but the real-time performance, smoothness and accuracy of the movement can be further improved. This paper discusses a complete solution to carry out the movement of three stepper motors in three dimensions. The objective is to provide a method to design a fully integrated System-on-Chip (SOC)-based motion controller to reduce the cost and complexity of production by incorporating Field Programmable Gate Array (FPGA) into the design. In the proposed method the FPGA receives its commands from a host computer via wireless internet communication and calculates the motion trajectory for three axes. A profile generator module is designed to realize the interpolation algorithm by translating the position data to the real-time pulses. This paper discusses an approach to implement the linear interpolation algorithm, since it is one of the fundamentals of robots' movements and it is highly applicable in motion control industries. Along with full profile trajectory, the triangular drive is implemented to eliminate the existence of error at small distances. To integrate the parallelism and real-time performance of FPGA with the power of Central Processing Unit (CPU) in executing complex and sequential algorithms, the NIOS II soft-core processor was added into the design. This paper presents different operating modes such as absolute, relative positioning, reset and velocity modes to fulfill the user requirements. The proposed approach was evaluated by designing a custom-made FPGA board along with a mechanical structure. As a result, a precise and smooth movement of stepper motors was observed which proved the effectiveness of this approach.

Keywords : 3-axis linear interpolation, FPGA, motion controller, micro-stepping
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