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Design and Implementation of FPGA-Based Robotic Arm Manipulator

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Robotic arm manipulators have a wide variety of applications. It is the core of manufacturing process in all factories nowadays. In this paper, the design, implementation and control of modified design of a six degrees of freedom (DOF) LYNX-6 robotic arm FPGA-based controller is introduced. In LYNX-6 arm, the lengths of the arms are modified and we used FR4 material to achieve the lightweight requirements of the arm structure. LYNX-6 arm has 5 DOF plus a grip movement (5+1). It is also similar to human arm from the number of joints point of view. Servomotors are controlled by pulse-width modulated (PWM) signals that control the position of the servo actuator. To position the robotic arm in 3D space, the angle of each joint must be set. A MATLAB GUI is designed to pick the desired (X, Y, Z) coordinates from the user, check the robot domain , perform the inverse kinematics algorithm and send the angles data serially through wireless module to FPGA controller to generate the necessary pulse-width modulated signals for the motors. The controller architecture is implemented on a Xilinx spartan3 FPGA evaluation board using VHDL. FPGA with its large number of I/O pins and parallel processing capabilities is suitable for interfacing and controlling the six motors at the same time. The proposed FPGA-based controller offered flexible, standalone, and compact design with high system reliability [1, 2].