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Thermal Resilience and Structural Integrity Analysis of a 3D Printed Robotic Arm

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Abstract: *This research presents the Thermal Resilience and Structural Integrity analysis of a 3D-printed robotic arm fabricated using Polylactic Acid (PLA). The system integrates servo-driven actuation to achieve multi-degree-of-freedom motion, with a focus on evaluating its thermal behaviour under operational conditions. Finite element analysis (FEA) is conducted to assess heat distribution, thermal expansion, and stress concentrations at critical joints, ensuring mechanical reliability.*
Additionally, structural analysis under anticipated loading conditions determines the arm's durability and deformation resistance. The study prioritizes affordability and scalability by leveraging additive manufacturing for lightweight yet functionally robust robotic structures. Experimental validation demonstrates the system's capability to maintain stable performance despite thermal variations, highlighting its potential for small-scale automation applications. This work contributes to the advancement of 3D-printed robotic systems by addressing thermal constraints and structural optimization in cost-effective robotic designs.

Keywords: 3D Printing, PLA, Thermal Analysis, Structural Integrity, Finite Element Analysis, Gesture Control, Robotic Arm

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