

Article

Structural Optimization Design of a Six-Degrees-of-Freedom Serial Robot with Integrated Topology and Dimensional Parameters

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Abstract: In the structural design of serial robots, topology and dimensional parameters design are independent, making it challenging to achieve synchronous optimization design between the two. To address this issue, a topology-and-dimension-parameter integrated optimization method (TPOM) is proposed by setting critical variables to connect topology layout and dimensional features. Firstly, the topology layout is extracted by the edge detection technique. Structural manufacturability reconstruction is conducted by measuring the dimensions of the layout through a program. Additionally, for the reconstructed structural layout, critical variables are set using three-dimensional software (SOLIDWORKS2021). The experiments primarily involve critical variables, quality, and deformation as variables. Then, the response surface methodology is selected to construct the stiffness–mass metamodel, and based on this, the structural deformation is analyzed. Lastly, the multi-objective genetic algorithm (MOGA) is employed to optimize the critical variables, and an optimized structure is established for validation. The results indicate that the proposed method (TPOM) reduces the mass of the structure by 15% while maintaining its stiffness. In addition, the deformation of the whole structure is less than 0.352 mm, which meets the requirements of industrial applications. Through quantitative analysis of the experimental results, the feasibility and superiority of the proposed method have been demonstrated.

Keywords: critical variables; integrated optimization method; stiffness–mass metamodel; MOGA

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1. Introduction

Robotics is a field that focuses on the development and study of robots, encompassing the modeling, design, and manufacturing of robotic systems [1]. Industrial robots are extensively employed in the automotive and electronics industries, as well as in other fields [2–4]. Serial robots [5–7] are essential components of robots. The complex parameter coupling and multi-objective design of serial robots have attracted the attention and research of scholars [8–11]. To address the structural requirements for serial robots in different environments, researchers evaluate and improve the performance of robots through simulations, providing accurate design and optimization solutions [12,13].

With the industry's continuous improvement and the demand for precision component machining, serial robots face higher performance requirements, especially in structural design. In the past, the design approach involved increasing the cross-sectional area of the stress concentration regions in the structure to enhance stiffness. However, this design method increases the serial robots' weight and causes more significant deformation under the influence of gravity. To address this issue, in recent years, new technologies such as topology optimization, evolutionary structural optimization (ESO), and solid isotropic material with penalization (SIMP) have been widely used in the structural design of serial

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associate degree and medical laboratory technician diploma if he she successfully completes 120 ects by taking all the compulsory courses and reaching a gpa of at least 2.00 out of 4.00 length and process

ascp technician certification mlt ascp ht pbt mla - Dec 08 2022

web the ascp medical technician certification is a notable certificate that confirms the skills and proficiency of healthcare professionals in the field of medical laboratory science this ascp technician certification provided by the american society for clinical pathology

mlt ascp medical laboratory technician vivian health - Nov 07 2022

web the medical laboratory technician mlt certification through the american society for clinical pathology ascp prepares laboratory technicians with the skills necessary to assist laboratory staff in various clinical settings

verify credentials ascp - Sep 05 2022

web ascp certification credentials are listed with the designation ascp after the category initials for us certification and ascp i after the category initials for international certification as follows medical laboratory technician mlt ascp international medical laboratory technician mlt ascp i time limited certifications

medical lab scientist mls ascp certification medical - Mar 31 2022

web earn a medical laboratory technician mlt ascp certification and complete two years of qualifying clinical laboratory experience gain five years of full time acceptable clinical laboratory experience hold a now discontinued cla ascp certification and complete four years of qualifying clinical laboratory experience

impact of time lapse on ascp board of certification medical laboratory - May 01 2022

web aug 1 2015 ascp board of certification research and development committee and others impact of time lapse on ascp board of certification medical laboratory scientist mls and medical laboratory technician mlt examination scores laboratory medicine volume 46 issue 3 1 august 2015 pages e53 e58