



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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Intermediate Problem Solving and Data Structures Paul Helman, Robert Veroff, 1986 Catalog of Copyright Entries. Third Series Library of Congress. Copyright Office, 1974 **Government-supported Research International Affairs; Research Completed and in Progress July 1969-June 1970** Allan E. Suchinsky, United States State Government, 1971 The document describes current research projects those initiated in progress and completed during fiscal year 1970 in the social and behavioral sciences dealing with international affairs foreign areas and United States foreign policy for the use primarily of research officers throughout the Government The research descriptions are arranged by subject matter with cross references as appropriate at the end of each section Author **Educational Alternatives for Students with Learning Disabilities** Susan A. Vogel, 2012-12-06 Educational Alternatives for Students with Learning Disabilities responds to the pressing need to provide teachers of learning disabled students with practical knowledge regarding state of the art intervention strategies This book provides examples of validated alternative educational practices which avoid the pitfalls and stigmatizing effects on students of older models of intervention The new practices aim to maximize teaching effectiveness and to assist the learning disabled in achieving their potential The intervention strategies described in this book have the power to enhance the efforts of all concerned *Essentials of Dyslexia Assessment and Intervention* Nancy Mather, Barbara J. Wendling, 2024-02-06 Expert guidance on the features of dyslexia and the most effective treatment options *Essentials of Dyslexia Assessment and Intervention* allows psychologists graduate students reading specialists and others to quickly acquire the knowledge and skills needed to treat individuals struggling with dyslexia This book provides step by step guidance on accurately identifying assessing and using evidence based interventions with individuals with dyslexia Addressing the components that need to be considered in the assessment of dyslexia both cognitive and academic this book includes descriptions of the various tests used in a comprehensive dyslexia assessment along with detailed evidence based interventions that professionals and parents can use to help individuals struggling with dyslexia A part of the trusted *Essentials of Psychological Assessment* series this book features concise chapters designed to facilitate retention of key concepts with callout boxes bullet points and extensive illustrations Additionally the chapters contain questions to test your knowledge and reinforce what you have learned This updated second edition covers essential topics for

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Bulletin of the University of Minnesota [Announcements]. University of Minnesota, 1925 **An Introduction to PPBS** Joseph H. McGivney, Robert E. Hedges, 1972 *Storied Inquiries in International Landscapes* Tonya Huber, 2010-06-01

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web aug 5 2021 prayer pointers 5 august 2021 praise god for blessing singapore where east is located with peace prosperity and progress in the past 56 years of nation building national day is celebrated on 9 august pray for our obedience to god s command to love him by serving the needy and loving our neighbours

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web pray the opening prayer listen to the readings prepare your soul at the offertory participate in the eucharistic prayer receive communion and even respond to the dismissal

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web prayer for eagle scout court of honor dear lord from your judgment seat on high look down on a scoutmaster such as i search me through and find me whole then help me lord to reach my goal help me lord to work for

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web here is an example of an eagle scout benediction prayer that can be used in court of honor ceremonies dear lord as we gather here today to celebrate the achievements of this young man who has earned the rank of eagle scout we give thanks for the opportunities and challenges that have brought him to this moment

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web let us begin our ceremony by lighting candles symbolic of the three parts of the scout oath duty to g d and country pause for a scout to light candle duty to others pause for a scout to light candle duty to self pause for a scout to light candle mc in scouting as in most activities of life there are rules

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web eagle scout he joins the company of men who have by word deed and action upheld a way of life and an approach to living that reflects the best in our nation may serve as a role model for his troop mates and may his life reflect the values of the scout law the scout oath and traditions of his faith amen

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web jan 12 2016 worshipweb benediction for an eagle scout ceremony dear god spirit of life and love an eagle scout court of honor marks the end of one journey a journey of participating in scouting now a new journey begins with a commitment to better scouting where all may participate bless all of n s future endeavors

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web worshipweb invocation for an eagle scout ceremony dear god spirit of life and love creator of the mountains and the forests it is good to be gathered here on the occasion of n receiving his her their eagle scout award we are thankful for the service he she they has have given to his her their troop crew ship community and council

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web please stand for the invocation let us pray lord god we stand before you tonight in awe of your glory and in gratitude for all your blessings we thank you for bringing us together as a family of scouts gathered to celebrate the accomplishments of richard in attaining the rank of eagle scout

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web patrick hamilton writer rope patrick hamilton was born on 17 march 1904 in hassocks sussex england uk he was a writer known for rope 1948 gaslight 1944 and gaslight 1940 he was previously married to lois m martin and lady ursula chetwynd talbot he died on 23 september 1962 in sheringham norfolk england uk

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web rope retitled rope s end for its american release is a 1929 english play by patrick hamilton it was said to be inspired by the real life murder of 14 year old bobby franks in 1924 by university of chicago students nathan leopold and richard loeb

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