Universitatea
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din Brașov

HABILITATION THESIS

SUMMARY

Title: Dynamic modeling and analysis of parallel mechanical structures with joint clearances and flexible links

Domain: Mechanical Engineering

Author: Assoc. Prof. Dr. Eng. Nadia Ramona Crețescu

Transilvania University of Brașov

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This habilitation thesis presents the research conducted by the undersigned following the public defense of the doctoral thesis, that is, during the period 2011-2025. The research was primarily conducted in the field of parallel robots, more specifically on the Delta parallel robot. This research aimed at determining the influence of link flexibility, as well as friction and clearances in spherical joints on its kinematic and dynamic behavior, as well as identifying an optimized solution for such a Delta parallel robot that would lead to better kinematic and dynamic performance.

The research presented in the habilitation thesis is oriented in two directions:

- Identifying the effects of link flexibility, frictions, and clearances in spherical joints on the kinematic and dynamic behavior of the robot;
- Identifying an optimized solution that would lead to better performance of the robot.

The first research direction aims to verify the additive effect of the bar-type link flexibility of the Delta parallel robot, frictions, and clearances in the robot's spherical joints. Thus, the analyses were performed using the ADAMS software, respectively the ADAMS Autoflex module for analysis with elastic elements, highlighting their effect, considered both separately and cumulatively.

The second research direction addresses the problem of identifying an optimized geometric solution of a Delta parallel robot, by performing modeling and numerical simulations in the ADAMS software. The analyses were performed by changing the diameter of the bar-type elements, identifying an optimal variant of their diameter. At the same time, another analysis was to identify an admissible optimal solution of the clearances in the spherical joints; therefore, several variants were tested to analyze the kinematic and dynamic behavior of the Delta parallel robot.

All these research results are presented in detail in the chapters of the habilitation thesis.

The introduction presents the main mechanical structures of parallel robots used in various fields (industry, medicine, etc.).

The first chapter presents a current state of research conducted on Delta-type parallel robots, identifying the main problems addressed in various studies, from analytical modeling to the analysis of the effects of element elasticity, both analytically and through numerical simulations using various software.

Chapter 2 is dedicated to the analysis of the effect of link flexibility, friction and clearances in the spherical joints on the kinematic and dynamic behavior of the Delta parallel robot, highlighting their influence both separately and together.

Chapter 3 analyzes the dynamic effect of the clearance in the spherical joints of the Delta parallel robot. In this regard, several values of clearance in the upper and lower spherical joints were considered.

Chapter 4 presents an analysis of the effect of changing the diameter value of the bar-type elements of the Delta parallel robot, as well as the effect of the clearance in the spherical joints on the kinematic and dynamic behavior of the Delta parallel robot, in order to identify a geometrically optimized solution of the Delta robot.