

METHODOLOGY FOR PHOTOGRAMMETRIC MEASUREMENT OF BACKLASHES AND ELASTIC COMPLIANCES IN HINGE JOINTS OF TRANSPORT MANIPULATORS AND SPACECRAFT BOOMS

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The experimental study on multi-link structures and their components is of extreme relevance and importance to modern science and technology. These structures are widely used in various fields, including the aerospace and the automotive industry, robotics, and construction. The presence of numerous interconnected components makes their behavior complex and nonlinear. The accuracy and reliability of such systems depend on their dynamic characteristics, which are difficult to predict theoretically due to numerous factors, such as the material compliance, hinge backlashes, and intercomponent interaction.

This study presents the authors' verified methodology for experimentally determining backlashes and elastic compliances in hinges of transport manipulators and spacecraft booms, which is based on the photogrammetric method. The versatility of the method as applied to different types of mechanical experiments was analyzed. The obtained measurement accuracy and applicability to various structures under heterogeneous conditions make the methodology substantially universal.

The methodology was tried out using a two-link fragment of a transport manipulator designed by the authors. A computational scheme was constructed to determine the effect of a hinge backlash. The scheme was used to obtain rotation trajectories of the manipulator section for different backlash values. It was found that photogrammetry can be used to determine the trajectories of each control marker on the hinge throughout its operational time. This allows one to refine computational schemes with calculated backlash values.

The proposed methodology can easily be adapted to studying the elastic compliance of multi-link structure components in local stiffness reduction zones, such as flange connections and auxiliaries-to-link attachment points.

The measurement methodology may be used in studying the dynamics of multi-link and ultralong structures by synchronizing several digital cameras. This enables remote monitoring of moving structures in space.

Keywords: *experimental modeling, hinge backlash, manipulator, visual tracking methods, photogrammetry.*

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