

MATRIX METHOD FOR DETERMINING THE INERTIA CHARACTERISTICS OF COMPOSITE ASYMMETRIC MECHANICAL SYSTEMS

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In this paper, the mathematical apparatus of monomial $(1, 0, -1)^4$ matrices is applied to the development of an algorithm of inertia matrix transformation and the calculation of the center of mass of composite asymmetric vehicles as complex mechanical systems under translations and rotations of coordinate systems in space. Formulas for calculation are presented in harmonic, ordered, and compact matrix form directly adapted to computer technologies. The proposed new matrix algorithm allows one to effectively solve a wide range of problems of dynamic design of composite vehicles under substantial changes in the layout diagram both in structure and in composition. Vehicle layout diagrams are represented as complex spatial configurations in the form of individual subconstructions, which are asymmetric rigid bodies whose position and orientation in the layout diagram are varied in the course of the dynamic design of a complex mechanical system, for example, a launch vehicle. On the whole, a system of this type is considered as a composite asymmetric rigid body of complex spatial configuration. The dynamic performance of vehicles is mainly governed by their inertia characteristics, which include the total mass, the center of mass position, and the axial moment of inertia and the product of inertia calculated in a constructively convenient reference system. Vehicles of this type may be exemplified by hybrid motor vehicles, rail vehicles, flying vehicles of different purposes, etc.

The problems of motion stability, stabilization, steerability, and dynamic load are solved on the basis of a correct calculation of vehicle inertia characteristics. A correct calculation of inertia characteristics involves repeated spatial translations of the reduction centers of subconstructions and rotations of their axes. This complicated and cumbersome problem can be solved effectively by using the new mathematical apparatus of monomial $(1, 0, -1)^4$ matrices, which is conveniently implementable in computer technologies.

Keywords: *inertia characteristics, moments of inertia, center of mass, monomial matrices, quaternion matrices, Rodrigues–Hamilton parameters, vehicles.*

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