ENGINEERING GEOMETRY and COMPUTER GRAPHICS

K. L. Panchuk, D. S. Korchagin, I. V. Krysova
Geometrical mass-inertia model of dynamic surface forming

The dependence of elements of inertia tensor on cross-sectional area bounded by the generatrix of the dynamic surface is determined. Also, the dependence on the area of dynamic parameters describing the flow of working substance, such as the flow rate, the average flow velocity over the cross section, the flow power in the cross section, etc., has also been determined. Studies have shown that the inertia tensor contains geometric information about the generatrix and can be used for shaping the channel surface In accordance with the dynamic parameters of the working substance. A geometric model of the formation of a dynamic surface is obtained, based on the application of the mass-inertial characteristics of its generating lines. The carried out research allow to achieve the most optimal combination of the regime (dynamic) characteristics of the working substance transported by the dynamic surface and the design characteristics of this surface.

Keywords: dynamic surface, mass-inertial characteristics, guide line, moment of inertia, ellipsoid of inertia, skeleton surface.

F. N. Pritykin, D. I. Nefedov
Investigation of exclusion zone effect on shape and position of region of allowed manipulator configurations

The results of investigations related to the development of technologies for the analytical designation of allowed configurations in the space of generalized coordinates are presented. All allowed configurations in the space of generalized coordinates are represented by a geometric object. This object is defined analytically using set of its bounding kinematic surfaces and set theory. The dependencies obtained allow us to define the region of allowed configurations being the knowledge base for the intelligent control of the motion of the mechanism in space.

Keywords: the space of generalized coordinates, area of allowed configurations, kinematic surfaces, virtual simulation of robot motions, restricted areas.

MECHANICS

P. D. Balakin, V. N. Belkov, L. O. Shtripling
Modeling of autovariator operation as adjuster of components of transformed power in adaptive drive gears of cars

The full use of the available power and the preservation of the stationary mode of operation of the power plant (engine) of the transport machine under conditions of variable external loading are urgent tasks.
The solution of the indicated problems is possible by creating mechanical drives with an autochangeable speed transfer function and non-holonomic coupling of the main links.
The additional controlled motion of the links is formed by a variable part of the transformable power flow and is realized by an integrated control circuit, functioning solely on the basis of the laws of mechanics.

Using the Gibbs function for the energy of accelerations a mathematical model for the work of a mechanical autovariator is developed, the results of the study are presented, on the basis of which it is possible to carry out design calculations for the links and connections of the autovariator including automatic control circuits.

P. D. Balakin, L. O. Shtripling
Force and power ratios in chain of steering of mechanical autovariator

On the basis of the principle of designing of mechanical systems investment of systems with property of adaptation to actual parameters and the mode of operation offers the mechanical system capable to autosteering of components of the transformed power that allows to provide stationary power setting of the car in the conditions of variable external loading.
It is reached at the expense of the steering chain which is built in a drive gear which realizes additional degree of freedom and functions on the basis of laws of mechanics, due to energy of the main power stream autochanging kinematic characteristics of a drive gear, such system is called an autovariator.
The found force and power ratios allow to execute necessary design calculations of links and communications of a mechanical autovariator of the V-belt drive scheme.

Yu. A. Burian, D. A. Babichev, M. V. Silkov, V. N. Belkov, I. N. Kvasov
Evaluating effectiveness of vibration isolation using hydro pneumatic spring with inertial motion converter

The study refers to the important area of applied mechanics – the theory of vibration isolation of vibration-active objects. Simple and reliable design is offered and questions of mathematical modeling of hydro-pneumatic mounting base with rubber-coated casing that is filled with liquid. Hydraulic inertial motion converter is mounted inside the casing. The mathematical model of the suspension, allowing you to select options to reduce the power transmission gain on the ground in a certain frequency range is obtained.

Yu. A. Burian, D. V. Sitnikov, B. A. Kalashnikov, E. A. Voronov, S. A. Makeyev
Two-stage active vibration isolation system with electrodynamic compensator of vibro active forces

The principle of constructing the two-stage active vibration isolation system is considered. In this system the electrodynamic compensator of the vibro active forces is installed on the intermediate frame. The movable mass motion control of compensator is carried out according to information from the absolute displacement sensor of the intermediate frame. The principle of dynamical inertial compensation of force consists in the fact that in the reciprocating motion of the mass of the movable assembly of the compensator the additional inertial force compensating for given frequency the vibro active force will be created. The principal scheme for the electrodynamic compensator control is given, the stability is evaluated. It is shown that the application of the electrodynamic compensator reduce the force transfer to the base by 20–30 dB and shifts the range of vibration isolation effective to the low frequency range (0,5–10 Hz).

Keywords: two-stage vibration isolation system, electrodynamic compensator, force transfer factor, frequency characteristic, stability, displacement sensor.

S. A. Korneyev, V. S. Korneyev, E. A. Voronov, D. I. Cherniavsky, D. A. Romanyuk
Calculation-experimental method for determining load characteristics of highly elastic couplings of different designs for non-axial shafts

The paper presents a phenomenological method for design of rubber-cord elastic element elastomeric coupling of any rotationally symmetric design. In the nonlinear approximation of the first order, the effect of the induced deformation anisotropy with allowance for the influence of temperature is described. The basic tests necessary for determining the material parameters of the proposed mathematical model are indicated.

Keywords: highly elastic coupling, load characteristics, shaft misalignment, deformation anisotropy, constitutive relations.

V. N. Sorokin, N. V. Zakharenkov
Increasing efficiency of vibration protection system by using pneumatic rubber cord devices

The article is devoted to investigation of the vibration protection system based on pneumatic rubber-cord devices. The device and principle of operation of the combined vibration protection system with the use of rubber-cord shells as power elements are presented. The analysis of the developed mathematical model is carried out. New methods of construction and algorithms for controlling the active vibration protection system are investigated on the created experimental complex. The results obtained at the experimental complex are presented and analyzed. The study of the developed mathematical model of combined vibration protection system with throttle control of gas pressure in power cells has shown its efficiency in the low-frequency range. The evaluation of the quality of the combined vibration protection system using integral criteria has shown its effectiveness up to 40 % in comparison with the passive vibration protection system with harmonic excitation. The obtained test results have a discrepancy in the low-frequency region of the operating range with mathematical modeling data at the level of 10 %.

Keywords: vibration control, rubber-cord shell, mathematical model, active suspension, control system, performance evaluation.

AVIATION AND ROCKET-SPACE ENGINEERING

I. S. Vavilov, A. I. Lukyanchik, P. S. Yachmenev, R. N. Litau, A. V. Lysakov
Application of heat of solid-state microwave element in dilatometric evaporator valve of micro thruster of a small spacecraft

The article is devoted to experimental processing and theoretical investigation of the method of cooling the crystal of the microwave transistor of correcting micro truster for small spacecraft. A distinctive feature of the proposed method is the use of heat removed from the microwave transistor in the dilatometric evaporator valve.
In general, this work is a continuation of the work on the creation of methodological bases for the design of the micro thruster correction microcircuit with microwave heating of the working fluid. In this article we are talking about cooling the microwave transistor in vacuum conditions with the use of the extracted energy in the dilatometric valve and for preheating the working fluid before entering the microwave chamber.

E. V. Shendaleva
Comparative tests of bench equipment for test of gas-turbine engines

In the article questions of comparative tests of gas-turbine engines are considered. The problem consists in appreciable difference in a gas-turbine engine testing results on different testing benches. The method of interlaboratory (interstand) comparative research has been suggested to use for collation of measurers and control tools precision. At the same time this method is capable of defining relative characteristics of gas turbine engines and their degree of similarity to working conditions. Having applied this method it can provide the support of measuring results traceability at testing benches of different enterprises, improvement of quality and safety of the aircraft equipment is result of this approach.