“Stability analysis of complex mechanical systems”
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In chapter 1 problems of stability of rigid bodies coupled via the Cardan-Hooke joints are studied. These problems have an important impact on mechanical engineering, since the mentioned systems may serve as suitable models for various gyroscopes or centrifuges and other aerospace devices, which may rotate on the string-type links. Contrary to the problems of symmetric linked bodies, in the cases studied by the authors, completely different and challenging problems related to stability occur. The rotated chains of rigid bodies become unstable exhibiting both typical instability zones as well the so called zones with odd order instability that cause serious difficulties in their analysis.

After derivation of the governing equations yielded by the 2nd order Lagrange equations, the authors study only linear models. Then, by introducing suitably chosen (for stability analysis) general coordinates, they study stability of non-symmetric mechanical systems applying the Lagrange-Dirichlet theorem. Detecting special properties of the studied matrices, the authors analyze various bifurcational configurations together with their stability using many original ideas. In particular, stability of an arbitrary rotating rigid body around a vertical axis is analyzed in some detail (mainly analytically).

The stability of a dynamically non-symmetric centrifuge suspended by a system of coupled identical cylinders via the Cardan-Hooke joints is studied and many interesting systems dynamics are either reported or explained.

I very much enjoyed personally regarding the section devoted to a study of the influence of the so called internal and external friction on vertical configuration stability of an inverted rigid body dynamics.

The last section of Chapter 1 refers to stability problems of vertical axis rotation of a statically non-balanced chain of coupled axially symmetric rigid bodies. It should be emphasized that a serious mathematical difficulty arises when one begins to study three or more linked rigid bodies. The authors show how to overcome the raised problems and they demonstrate useful results devoted to stability estimation of the considered problems.

Chapter 2 is devoted to the analysis of stability of a rigid body with a string suspension. It has an important impact on many engineering problems like investigation of a rigid body dynamics coupled with a parachute or a helicopter movement, as well as analysis of the transport of various objects suspended on a string.

Although long time ago various interesting dynamical phenomena of a rigid body suspended on a string have been experimentally observed, there were not any theoretical explanations of the observed phenomena. The

authors present very interesting results of the bifurcational behavior of the system together with its detailed stability estimation.

In Chapter 3 the authors study the dynamics of a high velocity centrifuge suspended via a system of electromagnetic and mechanical devices. It has been shown that the latter ones influence a string suspension in the way analogous to that of a rigid body discussed earlier. It has been experimentally observed that the mentioned centrifuge exhibited dynamical stability loss and bifurcational phenomena, which have been explained via the theoretical approach applied by the authors.

Chapter 4 deals with the analysis of free vibrations of some gyroscopic systems. They play an important role in various applications, for example they are used to control movements of airplanes, rockets, ships, etc., as well as to measure rotational and translatory velocities of many mechanical objects.

In general, a change in the orientation of gyroscope rotor axes in relation to unmovable stars occurs very slowly. In order to study dynamics of the rotors of the mentioned gyroscopes, the so called precession theory of gyroscopes is typically used. However, in other cases, i.e. when transitional processes take place, like those generated by impacts and/or sudden changes of the acting forces, the so called nutation theory of gyroscopes must be applied. In the latter case serious mathematical problems occur, and the authors solve successfully and originally many tasks devoted to such types of problems.

The last chapter addresses an important problem of stability investigation of a system of inertial navigation aimed on position determination of an object moving in arbitrary manner around the Earth. Many original and mathematically advanced approaches are used to solve the problem satisfactorily. The stereographic projection in kinematic problems of material navigation is applied and the Lyapunov functions are used in monitoring the perturbed equations. Four integrals are derived allowing the construction of a general solution to the mentioned equations. The Rodrigues-Hamilton parameters are applied to estimate the coordinates of an object, and then a few methods of vibrations damping exhibited by inertial object coupled with a horizontally stabilized platform are proposed. In addition, the so called autonomous determination of the object coordinates taking into account the Earth non-spherical properties is carried out.

To conclude, this is a very theoretically advanced monograph, and it is recommended for mathematicians, physicists and engineers working in the field of mechanics and mechatronics. The book includes mainly results published by the authors, and the list of references mainly contains Russian papers and books. However, a rather advanced knowledge of the theory of differential equations and dynamical systems is required in order to get through the book successfully. The occurred typos in equations (sometimes) forces a reader to derive them himself, but it takes a long time and certainly makes an impression of the results presented by the authors.