Nonholonomic motion of rigid mechanical systems from a DAE viewpoint

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Abstrak

This book contains a unique description of the nonholonomic motion of systems of rigid bodies by differential algebraic systems. Nonholonomic Motion of Rigid Mechanical Systems from a DAE Viewpoint focuses on rigid body systems subjected to kinematic constraints (constraints that depend on the velocities of the bodies, e.g., as they arise for nonholonomic motions) and discusses in detail how the equations of motion are developed. The authors show that such motions can be modeled in terms of differential algebraic equations (DAEs), provided only that the correct variables are introduced.
Several issues are investigated in depth to provide a sound and complete justification of the DAE model. These issues include the development of a generalized Gauss principle of least constraint, a study of the effect of the failure of an important full-rank condition, and a precise characterization of the state spaces. In particular, when the mentioned full-rank condition is not satisfied, this book shows how a new set of equivalent constraints can be constructed in a completely intrinsic way, where, in general, these new constraints comply with the full-rank requirement.
Several equivalent DAE formulations are discussed and analyzed thoroughly. The value of these DAE models rests upon the premise that they are more accessible than others to an effective numerical treatment. To substantiate this, a numerical algorithm is presented and numerical results for several standard problems are included to demonstrate the efficiency of this approach.