Topical Issue: Mechanics, Dynamical Systems And Control: Theory And Applications

PREFACE

The present issue contains a collection of invited papers on the topics of mechanics, dynamical systems and geometric control theory, some of them are extended versions of the ones presented in the last international conference of Physics and Control, PHYSCON 2013.

The paper by T. Filippova about state estimation for a class of nonlinear dynamic systems through HJB technique deals with the state estimation problem for dynamical control systems with a special structure, in which the nonlinear terms in the right-hand sides of related differential equations are quadratic in state coordinates. Ellipsoidal estimates of reachable sets of the control system are constructed, assuming that initial system states are unknown but bounded. The author makes use of the comparison principle for the first-order ODEs of the Hamilton-Jacobi-Bellman type and the generalized solutions of Hamilton-Jacobi-Bellman inequalities which allows to find the set-valued estimates of reachable sets as the level sets of a related cost functional.

The paper by C. Romero-Melendez et al. tackles the so-called motion planning problem through two different techniques: differential flatness and nilpotent approximation. The authors consider two examples for carrying out the study: an under-actuated vibratory mechanical systems and a non-holonomic car-like robot towing a trailer. In the first model, on the basis of differential flatness, a parametrized trajectory by two flat outputs and the corresponding derivatives is constructed. In the second model a nilpotent system that approximate the original one in a neighborhood of a reference trajectory is constructed.

The paper by O. Peñaloza-Mejía et al. is about discontinuous control design for tracking feasible trajectories in under-actuated manipulators, in which a discontinuous controller for tracking feasible trajectories in 2 degrees-of-freedom under-actuated manipulators is proposed. The controller is designed as an extension to the under-actuated case of the computed torque control approach with a PD-type controller. Under certain conditions, the proposal ensures stability of the closed-loop system, and allows to track, simultaneously for all the system variables, feasible trajectories to reach static and non-static configurations under relatively large drifts in initial conditions.

An interesting recollection of results and open problem on stable Hurwitz polynomials, (a real polynomial for which all of its roots have negative real part), is presented in the paper by B. Aguirre-Hernández et al. The importance of the Hurwitz polynomials can be appreciated in the study of the stability of a linear system: if the characteristic polynomial is Hurwitz then the system is stable.

The paper by A. Anzaldo-Meneses et al. deals with the optimal control problem for control affine driftless systems with quadratic cost, than further satisfy the property that the Lie algebra generated by the vector fields defining the system is 3-step nilpotent. The authors make use of the Pontryagin Maximum Principle for providing necessary conditions for the extremal trajectories, that in some low dimensions allow the explicit integration for the adjoint system. The 5-dimensional case is discussed in some detail and related with the so-called Cartan algebra and the non-holonomic mechanical problem of the plate and a ball.

The problem of resonance instability of nonlinear vibrations of a string under harmonic heating is addressed in the paper by E.V. Kurmyshev et al. The existence of parametric resonance and transient phenomena in nonlinear systems under the action of an external force are important characteristics of dynamical systems. Nonlinear vibrations of a thin stretched string, with an alternating electric current passing through, in a non-uniform magnetic field are described by complicated equations of motion. The authors study the combined effect of the intrinsic (geometrical) nonlinearity and Joule heating on the elastic string oscillation in the frame of a simplified model. By using a combined analytical-numerical approach in studying the dynamics of the proposed model, the authors solve the model analytically by iterations and then numerically, both methods show a good agreement almost everywhere, except in small intervals near resonant frequencies of different modes. Numerical solutions show instabilities near resonant frequencies in contrast to that of the approximate analytical solutions by iterations, such instabilities are explained by means of the theory of Mathieu equations.

The paper by O. Sanchez-Rodriguez et al. presents a nonlinear control approach for the stabilization of a Planar Vertical Take Off and Landing air-craft model with two rotors and restricted spatial mobility. The authors utilize a methodology named Immersion and Invariance stabilization, which consists of a controller which is strengthened by immersion in a system with better performance characteristics and its invariance ensures the converge to a point of stability. The paper addresses the stabilization of the decoupling between the longitudinal and lateral dynamics, the mathematical model for the dynamics is described in detail and the stabilization methods are validated by numerical software simulation.

Finally the paper by O. Olotu and E. J. Dansu discusses the optimization of proportional control problems with equality constraints. The authors use the quadratic penalty function method for converting the constrained problems into unconstrained problems. Discretization of the objective functions and the constraints is carried out using the composite Simpsons Rule and the fourth order Adams-Moulton techniques respectively.

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