

Preface

The goal of this book is to present several concepts useful for the analysis of dynamical systems, and to illustrate, in the last two chapters, how they can be actually applied to improve the state of the art for two classical topics in nonlinear systems theory: the linearization of a nonlinear system by state immersion and the study of stability of equilibrium points.

The main reasoning that led us to writing this book is that some concepts that are already well developed in the literature become more important if presented together. Three of such concepts are homogeneity, symmetries (and orbital symmetries for continuous-time systems) and Lie algebras, which, in our opinion, can be better understood if symmetries are seen as a generalization of homogeneity, and Lie algebras (seen as generators of Lie groups) as a generalization of symmetries. Another very well known concept is that of first integral, that is particularly helpful for researchers working on Hamiltonian systems, or on stability of switched systems. In our opinion, similar attention should be paid to the generalization of first integrals represented by semi-invariants, which, in turn, have a special relation, that will be explored in the book, with orbital symmetries.

Nonlinear systems theory was traditionally developed for continuous-time systems, i.e., systems of ordinary differential equations. Only most recently, with the growth of the “digital world”, the attention of many researchers is concentrated on discrete-time systems, i.e., systems of difference equations. For linear systems the similarity between continuous-time and discrete-time systems is nowadays well understood and, with some important exceptions, the study of both kinds of systems can be actually performed in parallel, obtaining very similar results. Since this is not so true for nonlinear systems, in this book we have made a special effort to extend some of the concepts that are standard and well known for continuous-time systems to discrete-time ones; in some cases, we report some results, already existing for discrete-time systems, but not so well known in the control literature, that turn out to be the analogous of well known results in continuous-time.

We have tried to be self-contained as much as possible, and sometimes we have reported not only the statements, but also the proofs of some very standard results, for two reasons: first because we would like the book to reach a wider audience,

secondly because such derivations are often very similar to those that are needed to develop the less standard topics. Most of the material in the first six chapters of the book is not new, but, together with some new results, we sometimes propose an alternative derivation of some known result that we consider more useful to better understand the topic or its relationship with other results presented earlier.

Finally, we would like to apologize for the inevitable errors and omissions, especially in giving credit for the results presented in the book.

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