

NONLINEAR CONTROL SYSTEMS DESIGN

*Selected Papers from the IFAC Symposium, Capri, Italy
14–16 June 1989*

Edited by

A. ISIDORI

Università di Roma, "La Sapienza", Rome, Italy

Published for the

INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL

by

PERGAMON PRESS

Member of Maxwell Macmillan Pergamon Publishing Corporation

OXFORD · NEW YORK · BEIJING · FRANKFURT
SÃO PAULO · SYDNEY · TOKYO · TORONTO

CONTENTS

ALGEBRAIC METHODS IN NONLINEAR CONTROL THEORY

Computer-aided Design of Nonlinear Observers J. BIRK, M. ZEITZ	1
Should the Theories for Continuous-time and Discrete-time Linear and Nonlinear Systems Really Look Alike? M. FLIESS	7
Differential Algebra and Controllability A. HADDAK	13
Prime Differential Ideals in Nonlinear Rational Control Systems C.H. MOOG, J. PERRAUD, P. BENTZ, Q.T. VO	17
Controllability of Bilinear Systems - A Survey and Some New Results U. PIECHOTKA, P.M. FRANK	23
Differential Algebra and Partial Differential Control Theory J.F. POMMARET	29
Canonical Forms for Nonlinear Systems M. ZEITZ	33

GEOMETRIC METHODS IN NONLINEAR CONTROL THEORY

New Sufficient Conditions for Dynamic Feedback Linearization B. CHARLET, J. LEVINE, R. MARINO	39
On the Structure Algorithm, Degenerate Controlled Invariant Distributions and the Block Decoupling Problem J. DESCUSSE	47
Nonlinear Model Matching with an Application to Hamiltonian Systems H.J.C. HUIJBERTS	53
Virtual Decomposition and Time Scale Decoupling Control of Nonlinear Systems S. ISHIJIMA	59
Trajectory Equivalence and Weakly Invariant Distributions of Nonlinear Systems M. SAMPEI, K. FURUTA	65
On the Structure of Small-time Reachable Sets for Multi-input Nonlinear Systems in Low Dimensions H. SCHATTLER	71

Structural Properties of Realizations of External Differential Systems A.J. VAN DER SCHAFT	77
On the Use of Stable Distributions in Design Problems L.L.M. VAN DER WEGEN	83
 DISCRETE-TIME SYSTEMS	
Target-directed Control of Nonlinear Systems R.F. DRENICK	89
On the Controllability of Nonlinear Discrete-time Systems A. MOKKADEM	95
Nonlinear Decoupling in Discrete Time S. MONACO, D. NORMAND-CYROT, T. ISOLA	99
Recursive Identification Algorithms as Nonlinear Systems: Parameter Identifiability and Controllability C.A. SCHWARTZ, H. OZBAY	107
 INPUT-OUTPUT METHODS OF ANALYSIS AND DESIGN	
Nicely Nonlinear Modelling: A DF Approach with Application to "Linearized" Process Control D. ABASTANOTTI, P. COLANERI, J.C. GEROMEL, R. GHIDONI, G. GUARDABASSI	113
Nonlinear Predictive Control by Inversion S. ABU EL ATA-DOSS, M. FLIESS	119
A Volterra Method for Nonlinear Control Design S.A. AL-BAIYAT, M.K. SAIN	125
The Application of a Computer Algebra System to the Analysis of A Class of Nonlinear Systems H.A. BARKER, Y.W. KO, P. TOWNSEND	131
Input-Output Approximations of Dynamical Systems G. CASINOVÌ	137
Harmonic Balancing Using a Volterra Input Output Description S.T. GLAD, K. STAHL	143
Symbolic Calculus and Volterra Series V. HOANG NGOC MINH, G. JACOB	149
Local and Minimal Realization of Nonlinear Dynamical Systems and Lyndon Words G. JACOB, N. OUSSOUS	155
 STABILITY AND REGULATION	
An Investigation of Linear Stabilizability of Planar Bilinear Systems A. BACCIOTTI, P. BOIERI	161

Vibrational Control of Nonlinear Time Lag Systems: Vibrational Stabilization and Transient Behavior J. BENTSMAN, K.S. HONG, J. FAKHFAKH	167
Stabilizability of Nonholonomic Control Systems A.M. BLOCH	173
A Lyapunov Approach to Stabilize Feedback Linearized Nonlinear Systems with Disturbances J.-P. CALVET, Y. ARKUN	179
Local Asymptotic Stabilization of Two Dimensional Polynomial Systems D. CHENG, W.P. DAYAWANSA, C.F. MARTIN, G. KNOWLES	185
Nonlinear Stabilization of a Class of Singularly Perturbed Uncertain Systems M. CORLESS, F. GAROFALO, L. GLIELMO	189
Stability Analysis of Quadratic Systems R. GENESIO, A. TESI	195
A Generalisation of the Small-gain Theorem for Nonlinear Feedback Systems D.J. HILL	201
On a Nonlinear Multivariable Servomechanism Problem HUANG JIE, W.J. RUGH	207
Global Dynamics Achievable by Feedback Controls: Some Preliminary Results E. KAPPOS	213
On the Absolute Stability Criteria Improving and Absolute Stability Regions Construction A.A. VORONOV	219
An Approach to Nonlinear Multivariable Control Systems Design R.T. YANUSHEVSKY	225

ADAPTIVE CONTROL OF NONLINEAR SYSTEMS

Nonsingular and Stable Adaptive Control of Discrete-Time Bilinear Systems C. WEN, D.J. HILL	229
Direct Adaptive Control of Nonlinear Systems P.A. COOK	235
Discrete Time Adaptive Control for a Class of Nonlinear Continuous Systems A.-M. GUILLAUME, G. BASTIN, G. CAMPION	239
Robustness of Adaptive Nonlinear Control Under an Extended Matching Condition I. KANELAKOPOULOS, P.V. KOKOTOVIC, R. MARINO	245
Switching Stabilization Control for a Set of Nonlinear Time-varying Systems LIU YONG, GAO WEIBING	251
Nonlinear Dynamics of Adaptive Linear Systems: An Elementary Example L. PRALY	257

VARIABLE STRUCTURE SYSTEMS

Asymptotic Linearization of Uncertain Systems by Means of Approximate Sliding Modes G. BARTOLINI, T. ZOLEZZI	263
On the Behavior of Variable Structure Control Systems Near the Sliding Manifold G. BARTOLINI, T. ZOLEZZI	269
On Discrete-Time Sliding Modes S.V. DRAKUNOV, V.I. UTKIN	273
A New Method for Suppressing Chattering in Variable Structure Feedback Control Systems LUO NING-SU, FENG CHUN-BO	279
Sliding Observer Design for Nonlinear State Estimation E.A. MISAWA, J.K. HEDRICK, J.-J.E. SLOTINE, G.C. VERGHESE	285

DIFFERENTIAL INCLUSIONS

Two Characterizations of Optimal Trajectories for Meyer Problem P. CANNARSA, H. FRANKOWSKA	291
On the Solution of Optimization Problems with Inclusion Constraints J.V. OUTRATA	297

OPTIMAL CONTROL

Optimal Control by Polynomial Approximation: The Discrete Time Case J.A. O'SULLIVAN, M.K. SAIN	303
Relaxation and Optimal Control of Nonlinear Distributed Parameter Systems N.S. PAPAGEORGIOU	309
The Discrete Maximum Principle: Two Methods of Proof R. PYTLAK	313
Necessary Conditions for Optimality Via Volterra Approximations G. STEFANI, P. ZEZZA	321
A Novel Computer Approach to Optimal Feedback Control of Bilinear Systems B. TIBKEN, E.P. HOFER	327

NONLINEAR CONTROL OF CHEMICAL SYSTEMS

Robust Nonlinear Control and Observer Schemes for a Chemical Reactor J. ALVAREZ, R. CASTRO	333
Control of a Continuous Bioprocess by Simple Algorithms of "P" and "L/A" Type M. LAKRORI	339

Model Predictive Control of Nonlinear Processes in the Presence of Constraints A.A. PATWARDHAN, J.B. RAWLINGS, T.F. EDGAR	345
Qualitative and Control Behavior of a Class of Chemical and Biological Systems N. SAMARDZIJA	351
Nonlinear Process Control: An Adaptive Approach which uses Physical Models J.-J.E. SLOTINE, B.E. YDSTIE	357

NONLINEAR CONTROL OF ELECTRICAL SYSTEMS

The Design of Linearizing Outputs for Induction Motors A. DE LUCA, G. ULIVI	363
The Radio-Frequency Magnetic Field Design in Biomedicine: Nuclear Magnetic Resonance Imaging J. SAU, J.J. MALLET, A. BONMARTIN	369

NONLINEAR CONTROL OF MECHANICAL SYSTEMS

Modelling and Control of a Two-axis Robot with Flexible Links J.P. BARBOT, B. MASCHKE, G. SERVETTAZ	373
Sliding Observers for Robot Manipulators C. CANUDAS DE WIT, J.-J.E. SLOTINE	379
Nonlinear Controller Design for Flight Control Systems J. HAUSER, S. SASTRY, G. MEYER	385
Lyapunov Design for Adaptive Control of Robots R. JOHANSSON	391
Nonlinear Identification and Observer Based Compensation of Friction in Mechanical Systems J.C. MARON	397
Design of Nonlinear Observers for Elastic Joint Robots P. TOMEI	403
Author Index	409
Keyword Index	411