

POLISH ACADEMY OF SCIENCES
INSTITUTE OF MATHEMATICS

**BANACH
CENTER**
Publications

VOLUME **32**

Geometry
in Nonlinear Control
and
Differential Inclusions

WARSZAWA 1995

GEOMETRY IN NONLINEAR CONTROL AND DIFFERENTIAL INCLUSIONS

Editors of the Volume

BRONISŁAW JAKUBCZYK
WITOLD RESPONDEK
TADEUSZ RZEŻUCHOWSKI

WARSZAWA 1995

PREFACE

The present volume is based on contributions of the speakers of two workshops which took place in the framework of the Banach Center Semester on Control Theory and Optimization in the Spring of 1993 (proceedings of two other workshops are published elsewhere).

The first workshop on Differential Inclusions was held May 17–29, 1993 and was organized by H. Frankowska, A. Fryszkowski, and T. Rzeżuchowski. During the workshop 28 lectures were presented on such subjects as behavior of reachable maps, viability, convergence to extremal points of Aumann's integrals, likelihood of solutions, applications in control, quasi-statics, population biology, etc. Four important contributions are included in this volume. They concern weak and strong convergence of selections, solutions with bounded variation staying in moving closed sets, stochastic inclusions, and singular perturbations.

The second workshop on Geometry in Nonlinear Control, May 31–June 25, was organized by B. Jakubczyk and W. Respondek. It brought together 64 participants from 16 countries. About 40 lectures or series of lectures were presented. The aim of this workshop was to present differential geometric techniques in application to nonlinear control theory. Such methods and techniques have been used since the beginning of the seventies and, recently, they have again attracted a growing interest reflected by interactions of nonlinear system theory, theory of distributions, sub-Riemannian geometry and singularity theory. The volume contains papers based on talks and expository series of lectures. The topics covered include: optimal control, theory of static and dynamic feedback, symmetries and invariants of systems, systems on Lie groups, differential algebraic approach, stabilization, nonlinear observers, non-holonomic systems, linearization of systems, sub-Riemannian geometry.

We hope that the volume is representative for recent developments of the theory in the two fields mentioned above. It can serve both experts in these fields and newcomers, graduate students, etc.

It happens that all the organizers of the two workshops were former students of Professor Czesław Olech. It is then our pleasure to dedicate this volume to him.

The Organizers

CONTENTS

D. AEYELS, Stability of nonautonomous systems by Liapunov's direct method	9–17
E. ARANDA-BRICAIRE, C. H. MOOG and J.-B. POMET, Infinitesimal Brunovský form for nonlinear systems with applications to dynamic linearization	19–33
V. AYALA BRAVO, Controllability of nilpotent systems	35–46
E. J. BALDER, Connections between recent Olech-type lemmas and Visintin's theorem	47–52
H. BENABDELLAH, C. CASTAING and M. A. GAMAL IBRAHIM, BV solutions of multi- valued differential equations on closed moving sets in Banach spaces	53–81
R. M. BIANCHINI, Variational approach to some optimization control problems	83–94
B. BONNARD and M. PELLETIER, Time minimal synthesis with target of codimension one under generic conditions	95–109
R. L. BRYANT and R. B. GARDNER, Control structures	111–121
S. ČELIKOVSKÝ, Global linearization of nonlinear systems — A survey	123–137
F. COLONIUS and W. KLIEMANN, Asymptotic null controllability of bilinear systems	139–148
G. CONTE, A. M. PERDON and C. H. MOOG, Toward a notion of canonical form for nonlinear systems	149–165
A. DAVYDOV, Singularities of the maximum function over a preimage	167–181
T. E. DUNCAN, Solvable optimal control of Brownian motion in symmetric spaces and spherical polynomials	183–197
R. EL ASSOUDI, J. P. GAUTHIER and I. A. K. KUPKA, Controllability of right invariant systems on semi-simple Lie groups	199–208
M. FLIESS, J. LÉVINE, P. MARTIN and P. ROUCHON, Differential flatness and defect: an overview	209–225
J. P. GAUTHIER and I. A. K. KUPKA, Genericity of observability and the existence of asymptotic observers	227–244
S. JANECZKO, Systems of rays in the presence of distribution of hyperplanes	245–260
V. JURDJEVIC, Casimir elements and optimal control	261–275
M. KISIELEWICZ, Strong and weak solutions to stochastic inclusions	277–286
M. KRASTANOV, Forward invariant sets, homogeneity and small-time local controlla- bility	287–300
F. PELLETIER and L. VALÈRE BOUCHE, Abnormality of trajectory in sub-Riemannian structure	301–317
J.-B. POMET, A differential geometric setting for dynamic equivalence and dynamic linearization	319–339
M. QUINCAMPOIX, Singular perturbations for systems of differential inclusions	341–348
J. RUDOLPH, Well-formed dynamics under quasi-static state feedback	349–360
G. STEFANI and P. ZEZZA, Minima in control problems with constraints	361–378
H. J. SUSSMANN, Symmetries and integrals of motion in optimal control	379–393
M. ZHITOMIRSKIĬ, Singularities and normal forms of smooth distributions	395–409