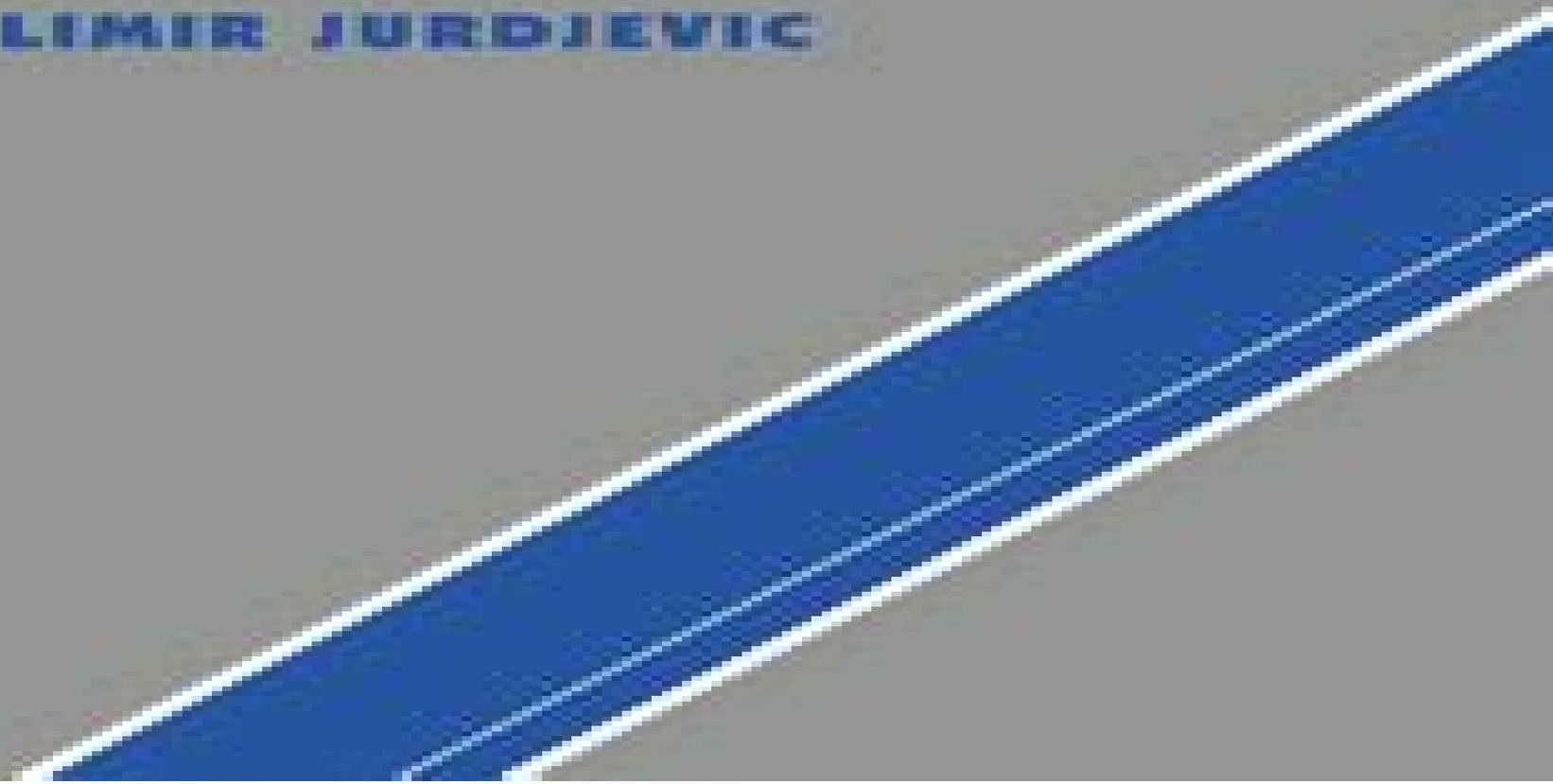


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Geometric Control Theory

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Geometric Control Theory

Andrei A. Agrachev, Yuri Sachkov



Geometric Control Theory:

Geometric Control Theory Velimir Jurdjevic, 1997 Geometric control theory is concerned with the evolution of systems subject to physical laws but having some degree of freedom through which motion is to be controlled This book describes the mathematical theory inspired by the irreversible nature of time evolving events The first part of the book deals with the issue of being able to steer the system from any point of departure to any desired destination The second part deals with optimal control the question of finding the best possible course An overlap with mathematical physics is demonstrated by the Maximum principle a fundamental principle of optimality arising from geometric control which is applied to time evolving systems governed by physics as well as to man made systems governed by controls Applications are drawn from geometry mechanics and control of dynamical systems The geometric language in which the results are expressed allows clear visual interpretations and makes the book accessible to physicists and engineers as well as to mathematicians **Differential**

Geometric Control Theory Roger W. Brockett, 1983

Contemporary Trends In Nonlinear Geometric Control

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Perez, 2002-01-30 Mathematical control theory has evolved from the study of practical problems in engineering and sciences to the elaboration of deep important concepts in mathematics and applied sciences This volume concerns contemporary trends in nonlinear geometric control theory and its applications It is a fine collection of papers presenting new results relevant open problems and important applications regarding academic and real world problems The book is dedicated to Velimir Jurdjevic whose scientific activity has been influential in the research of many of the authors It contains a number of articles specially written by colleagues and friends of Vel Jurdjevic all of them leading applied mathematicians and control theorists There is also place for surveys on topics of current research which present the state of the art of modern geometric control theory Finally the volume contains several new mathematical ideas generated by geometric control theory techniques which may initiate new directions of research beyond control theory **Introduction to Geometric Control** Yuri

Sachkov, 2022-07-02 This text is an enhanced English version of the Russian edition published in early 2021 and is appropriate for an introductory course in geometric control theory The concise presentation provides an accessible treatment of the subject for advanced undergraduate and graduate students in theoretical and applied mathematics as well as to experts in classic control theory for whom geometric methods may be introduced Theory is accompanied by characteristic examples such as stopping a train motion of mobile robot Euler elasticae Dido s problem and rolling of the sphere on the plane Quick foundations to some recent topics of interest like control on Lie groups and sub Riemannian geometry are included Prerequisites include only a basic knowledge of calculus linear algebra and ODEs preliminary knowledge of control theory is not assumed The applications problems oriented approach discusses core subjects and encourages the reader to solve related challenges independently Highly motivated readers can acquire working knowledge of geometric control

techniques and progress to studying control problems and more comprehensive books on their own Selected sections provide exercises to assist in deeper understanding of the material Controllability and optimal control problems are considered for nonlinear nonholonomic systems on smooth manifolds in particular on Lie groups For the controllability problem the following questions are considered controllability of linear systems local controllability of nonlinear systems Nagano Sussmann Orbit theorem Rashevskii Chow theorem Krener s theorem For the optimal control problem Filippov s theorem is stated invariant formulation of Pontryagin maximum principle on manifolds is given second order optimality conditions are discussed and the sub Riemannian problem is studied in detail Pontryagin maximum principle is proved for sub Riemannian problems solution to the sub Riemannian problems on the Heisenberggroup the group of motions of the plane and the Engel group is described

Geometric Control Theory and Sub-Riemannian Geometry Gianna Stefani,Ugo Boscain,Jean-Paul Gauthier,Andrey Sarychev,Mario Sigalotti,2014-06-05 Honoring Andrei Agrachev s 60th birthday this volume presents recent advances in the interaction between Geometric Control Theory and sub Riemannian geometry On the one hand Geometric Control Theory used the differential geometric and Lie algebraic language for studying controllability motion planning stabilizability and optimality for control systems The geometric approach turned out to be fruitful in applications to robotics vision modeling mathematical physics etc On the other hand Riemannian geometry and its generalizations such as sub Riemannian Finslerian geometry etc have been actively adopting methods developed in the scope of geometric control Application of these methods has led to important results regarding geometry of sub Riemannian spaces regularity of sub Riemannian distances properties of the group of diffeomorphisms of sub Riemannian manifolds local geometry and equivalence of distributions and sub Riemannian structures regularity of the Hausdorff volume etc

Some Optimization Problems in Geometric Control Theory John Brouard Baillieul,1975

The 1976 Ames Research Center (NASA) Conference on Geometric Control Theory Róbert Hermann,Clyde Martin,1977

Differential Geometric Control Theory Roger W. Brockett,Richard S. Millman,Hector J. Sussmann,1983

Introduction to Geometric Control Yuri Sachkov,2022-06-28 This text is an enhanced English version of the Russian edition published in early 2021 and is appropriate for an introductory course in geometric control theory The concise presentation provides an accessible treatment of the subject for advanced undergraduate and graduate students in theoretical and applied mathematics as well as to experts in classic control theory for whom geometric methods may be introduced Theory is accompanied by characteristic examples such as stopping a train motion of mobile robot Euler elasticae Dido s problem and rolling of the sphere on the plane Quick foundations to some recent topics of interest like control on Lie groups and sub Riemannian geometry are included Prerequisites include only a basic knowledge of calculus linear algebra and ODEs preliminary knowledge of control theory is not assumed The applications problems oriented approach discusses core subjects and encourages the reader to solve related challenges independently Highly motivated readers can acquire working knowledge of geometric control

techniques and progress to studying control problems and more comprehensive books on their own Selected sections provide exercises to assist in deeper understanding of the material Controllability and optimal control problems are considered for nonlinear nonholonomic systems on smooth manifolds in particular on Lie groups For the controllability problem the following questions are considered controllability of linear systems local controllability of nonlinear systems Nagano Sussmann Orbit theorem Rashevskii Chow theorem Krener s theorem For the optimal control problem Filippov s theorem is stated invariant formulation of Pontryagin maximum principle on manifolds is given second order optimality conditions are discussed and the sub Riemannian problem is studied in detail Pontryagin maximum principle is proved for sub Riemannian problems solution to the sub Riemannian problems on the Heisenberg group the group of motions of the plane and the Engel group is described

Control Theory from the Geometric Viewpoint Andrei A. Agrachev, Yuri Sachkov, 2004-04-15 This book presents some facts and methods of Mathematical Control Theory treated from the geometric viewpoint It is devoted to finite dimensional deterministic control systems governed by smooth ordinary differential equations The problems of controllability state and feedback equivalence and optimal control are studied Some of the topics treated by the authors are covered in monographic or textbook literature for the first time while others are presented in a more general and flexible setting than elsewhere Although being fundamentally written for mathematicians the authors make an attempt to reach both the practitioner and the theoretician by blending the theory with applications They maintain a good balance between the mathematical integrity of the text and the conceptual simplicity that might be required by engineers It can be used as a text for graduate courses and will become most valuable as a reference work for graduate students and researchers

Geometric Control Theory Geoffrey A. Zohfeld, 2016 We survey the basic theory results and applications of geometric control theory A control system is a dynamical system with parameters called controls or inputs A control trajectory is a trajectory of the control system for a particular choice of the inputs A control system is called controllable if every two points of the underlying space can be connected by a control trajectory Two fundamental problems of control theory include 1 Is the control system controllable 2 If it is controllable how can we construct an input to obtain a particular control trajectory We shall investigate the first problem exclusively for affine drift free systems A control system is affine if it is of the form $\dot{X} = X_0 + \sum_{k=1}^k u_k X_k$ where X_0 is the drift vector field X_1, \dots, X_k are the control vector fields and u_1, \dots, u_k are the inputs An affine system is called drift free if $X_0 = 0$ The fundamental theorem of control theory known as Chow Rashevsky theorem states that an affine drift free control system is controllable if the control vector fields together with their iterated Lie brackets span the entire tangent bundle of the underlying space We prove this result in the simplest case when the space is 3 dimensional and $k = 2$

Geometric Control Theory C. Martin, R. Hermann, National Aeronautics and Space Administration. Ames Research Center, 1977

Optimal Control and Geometry: Integrable Systems Velimir Jurdjevic, 2016-07-04 The synthesis of symplectic geometry the calculus of variations and control theory offered in this book

provides a crucial foundation for the understanding of many problems in applied mathematics Focusing on the theory of integrable systems this book introduces a class of optimal control problems on Lie groups whose Hamiltonians obtained through the Maximum Principle of optimality shed new light on the theory of integrable systems These Hamiltonians provide an original and unified account of the existing theory of integrable systems The book particularly explains much of the mystery surrounding the Kepler problem the Jacobi problem and the Kovalevskaya Top It also reveals the ubiquitous presence of elastic curves in integrable systems up to the soliton solutions of the non linear Schroedinger s equation Containing a useful blend of theory and applications this is an indispensable guide for graduates and researchers in many fields from mathematical physics to space control

Geometric Control of Mechanical Systems Francesco Bullo,Andrew D. Lewis,2004-11-04 The area of analysis and control of mechanical systems using differential geometry is flourishing This book collects many results over the last decade and provides a comprehensive introduction to the area [Some Applications of Geometric Control Theory to the Estimation and the Control of Nonlinear Dynamical Systems](#) Alfons Alexander Akutowicz,1993

Descriptor Systems and Geometric Control Theory Douglas Jeffrey Bender,1985

Geometric Optimal Control Heinz Schättler,Urszula Ledzewicz,2012-06-26 This book gives a comprehensive treatment of the fundamental necessary and sufficient conditions for optimality for finite dimensional deterministic optimal control problems The emphasis is on the geometric aspects of the theory and on illustrating how these methods can be used to solve optimal control problems It provides tools and techniques that go well beyond standard procedures and can be used to obtain a full understanding of the global structure of solutions for the underlying problem The text includes a large number and variety of fully worked out examples that range from the classical problem of minimum surfaces of revolution to cancer treatment for novel therapy approaches All these examples in one way or the other illustrate the power of geometric techniques and methods The versatile text contains material on different levels ranging from the introductory and elementary to the advanced Parts of the text can be viewed as a comprehensive textbook for both advanced undergraduate and all level graduate courses on optimal control in both mathematics and engineering departments The text moves smoothly from the more introductory topics to those parts that are in a monograph style were advanced topics are presented While the presentation is mathematically rigorous it is carried out in a tutorial style that makes the text accessible to a wide audience of researchers and students from various fields including the mathematical sciences and engineering Heinz Sch ttler is an Associate Professor at Washington University in St Louis in the Department of Electrical and Systems Engineering Urszula Ledzewicz is a Distinguished Research Professor at Southern Illinois University Edwardsville in the Department of Mathematics and Statistics

Geometric Control and Non-holonomic Mechanics Velimir Jurdjevic,Richard W. Sharpe,1998 Nine papers from the June 1996 conference focus on research directions having origins in mechanics and differential geometry but driven by modern control theory Among the topics lie determined systems and optimal problems with

symmetries Dubins problem in the hyperbolic plane using the open disc model and geometry and structure in the control of linear time invariant systems Annotation copyrighted by Book News Inc Portland OR *Differential Geometric Control Theory* BROCKETT, Millman, Jod, Hector J. Sussmann, 1982-12-01 **Geometric Control of Patterned Linear Systems** Sarah C. Hamilton, Mireille E. Broucke, 2012-04-05 This monograph is aiming at researchers of systems control especially those interested in multiagent systems distributed and decentralized control and structured systems The book assumes no prior background in geometric control theory however a first year graduate course in linear control systems is desirable Since not all control researchers today are exposed to geometric control theory the book also adopts a tutorial style by way of examples that illustrate the geometric and abstract algebra concepts used in linear geometric control In addition the matrix calculations required for the studied control synthesis problems of linear multivariable control are illustrated via a set of running design examples As such some of the design examples are of higher dimension than one may typically see in a text this is so that all the geometric features of the design problem are illuminated

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