Advances In Robot Kinematics Ysis And Control

The Complexity of Robot Motion Planning makes original contributions both to roboticsand to the analysis of algorithms. In this groundbreaking monograph John Canny resolveslong-standing problems concerning the complexity of motion planning and, for the central problem offinding a collision free path for a jointed robot in the presence of obstacles, obtains exponentialspeedups over existing algorithms by applying high-powered new mathematical techniques.Canny's newalgorithm for this "generalized movers' problem," the most-studied and basic robot motion planningproblem, has a single exponential running time, and is polynomial for any given robot. The algorithmhas an optimal running time exponent and is based on the notion of roadmaps - one-dimensionalsubsets of the robot's configuration space. In deriving the single exponential bound, Cannyintroduces and reveals the power of two tools that have not been previously used in geometricalgorithms: the generalized (multivariable) resultant for a system of polynomials and Whitney'snotion of stratified sets. He has also developed a novel representation of object orientation basedon unnormalized quaternions which reduces the complexity of the algorithms and enhances theirpractical applicability.After dealing with the movers' problem, the book next attacks and derivesseveral lower bounds on extensions of the problem: finding the shortest path among polyhedralobstacles, planning with velocity limits, and compliant motion planning with uncertainty. Itintroduces a clever technique, "path encoding," that allows a proof of NP-hardness for the first twoproblems and then shows that the general form of compliant motion planning, a problem that is thefocus of a great deal of recent work in robotics, is non-deterministic exponential time hard. Cannyproves this result using a highly original construction.John Canny received his doctorate from MITAnd is an assistant professor in the Computer Science Division at the University of California,Berkeley. The Complexity of Robot Motion Planning is the winner of the 1987 ACM DoctoralDissertation Award.

This book presents the most recent research advances in the theory, design, control, and application of robotic systems, which are intended for a variety of purposes such as manipulation, manufacturing, automation, surgery, locomotion, and biomechanics.

This research report brings together present trends in advanced welding robots, robotic welding, artificial intelligent and automatic welding. It includes important technical subjects on welding robots such as intelligent technologies and systems, and design and analysis. Modeling, identification and control of the welding process are presented, as well as knowledge-based systems for welding and tele-robotic welding. Other topics covered are sensing and data fusion, computer vision and virtual-reality applications of the welding process. An overview of intelligent and flexible manufacturing systems is given in addition to artificial intelligent technologies for industrial processes.

The contributions in this book were presented at the sixth international symposium on Advances in Robot Kinematics organised in June/July 1998 in Strobl/Salzburg in Austria. The preceding symposia of the series took place in Ljubljana (1988), Linz (1990), Ferrara (1992), Ljubljana (1994), and Piran (1996). Ever since its first event, ARK has attracted the most outstanding authors in the area and managed to create a perfect combination of professionalism and friendly athmosphere. We are glad to observe that, in spite of a strong competition of many international conferences and meetings, ARK is continuing to grow in terms of the number of participants and in terms of its scientific impact. In its ten years, ARK has contributed to develop a remarkable scientific community in the area of robot kinematics. The last four symposia were organised under the patronage of the International Federation for the Theory of Machines and Mechanisms -IFToMM. interest to researchers, doctoral students and teachers, The book is of engineers and mathematicians specialising in kinematics of robots and mechanisms, mathematical modelling, simulation, design, and control of robots. It is divided into sections that were found as the prevalent areas of the contemporary kinematics research. As it can easily be noticed, an important part of the book is dedicated to various aspects of the kinematics of parallel mechanisms that persist to be one of the most attractive areas of research in robot kinematics.

Government Reports Announcements & Index
Mechanics, Planning, and Control
Fundamentals Of Robotics: Linking Perception To Action
Advances in Robot Kinematics 2016
Darwin2K
Simulating Humans

The Second Conference on Mechanisms, Transmissions and Applications - MeTrApp 2013 was organised by the Mechanical Engineering Department of the University of the Basque Country (Spain) under the patronage of the IFToMM Technical Committees Linkages and Mechanical Controls and Micromachines and the Spanish Association of Mechanical Engineering. The aim of the workshop was to bring together researchers, scientists, industry experts and students to provide, in a friendly and stimulating environment, the opportunity to exchange know-how and promote collaboration in the field of Mechanism and Machine Science. The topics treated in this volume are mechanism and machine design, biomechanics, mechanical transmissions, mechatronics, computational and experimental methods, dynamics of mechanisms and micromechanisms and microactuators.

Parallel structures are more effective than serial ones for industrial automation applications that require high precision and stiffness, or a high load capacity relative to robot weight. Although many industrial applications have adopted parallel structures for their design, few textbooks introduce the analysis of such robots in terms of dynamics and control. Filling this gap, Parallel Robots: Mechanics and Control presents a systematic approach to analyze the kinematics, dynamics, and control of parallel robots.

It brings together analysis and design tools for engineers and researchers who want to design and implement parallel structures in industry. Covers Kinematics, Dynamics, and Control in One Volume The book begins with the representation of motion of robots and the kinematic analysis of parallel manipulators. Moving beyond static positioning, it then examines a systematic approach to performing Jacobian analysis. A special feature of the book is its detailed coverage of the dynamics and control of parallel manipulators. The text examines dynamic analysis using the Newton-Euler method, the principle of virtual work, and the Lagrange formulations. Finally, the book elaborates on the control of parallel robots, considering both motion and force control. It introduces various model-free and model-based controllers and develops robust and adaptive control schemes. It also addresses redundancy resolution schemes in detail. Analysis and Design Tools to Help You Create Parallel Robots In each chapter, the author revisits the same case studies to show how the techniques may be applied. The case studies include a planar cable-driven parallel robot, part of a promising new generation of parallel structures that will allow for larger workspaces. The MATLAB® code used for analysis and simulation is available online. Combining the analysis of kinematics and dynamics with methods of designing controllers, this text offers a holistic introduction for anyone interested in designing and implementing parallel robots.

Robots and Screw Theory describes the mathematical foundations, especially geometric, underlying the motions and force-transfers in robots. The principles developed in the book are used in the control of robots and in the design of their major moving parts. The illustrative examples and the exercises in the book are taken principally from robotic machinery used for manufacturing and construction, but the principles apply equally well to miniature robotic devices and to those used in other industries. The comprehensive coverage of the screw and its geometry lead to reciprocal screw systems for statics and instantaneous kinematics. These screw systems are brought together in a unique way to show many cross-relationships between the force-systems that support a body equivalently to a kinematic serial connection of joints and links. No prior knowledge of screw theory is assumed. The reader is introduced to the screw with a simple planar example yet most of the book applies to robots that move three-dimensionally. Consequently, the book is suitable both as a text at the graduate-course level and as a reference book for the professional. Worked examples on every major topic and over 300 exercises clarify and reinforce the principles covered in the text. A chapter-length list of references gives the reader source-material and opportunities to pursue more fully topics contained in the text.

This introduction to robotics offers a distinct and unified perspective of the mechanics, planning and control of robots. Ideal for self-learning, or for courses, as it assumes only freshman-level physics, ordinary differential equations, linear algebra and a little bit of computing background. Modern Robotics presents the state-of-the-art, screw-theoretic techniques capturing the most salient physical features of a robot in an intuitive geometrical way. With numerous exercises at the end of each chapter, accompanying software written to reinforce the concepts in the book and video lectures aimed at changing the classroom experience, this is the go-to textbook for learning about this

fascinating subject.

Transactions of the North American Manufacturing Research Institution of SME.

Mechanical Engineering

Computer Graphics, Animation, and Control

Robot Manipulators

Mechanisms and Robots Analysis with MATLAB®

Applications of kinematics and statics to robotics

THE REAL THING by Isaac Asimov Back in 1939, when I was still a teenager, I began to write (and publish) a series of stories about robots which, for the first time in science fiction, were pictured as having been deliberately engineered to do their job safely. They were not intended to be creaky Gothic menaces, nor outlets for mawkish sentiment. They were simply well-designed machines. Beginning in 1942, I crystallized this notion in what I called 'The Three Laws of Robotics' and, in 1950, nine of my robot stories were collected into a book, I, Robot. I did not at that time seriously believe that I would live to see robots in action and robotics becoming a booming industry .... Yet here we are, better yet, I am alive to see it. But then, why shouldn't they be with us? Robots fulfil an important role in industry. They do simple and repetitive jobs more steadily, more reliably, and more uncomplainingly than a human being could - or should. Does a robot displace a human being? Certainly, but he does so at a job that, simply because a robot can do it, is beneath the dignity of a human being; a job that is no more than mindless drudgery. Better and more human jobs can be found for human beings - and should.

120 leading experts from twelve countries have participated in creating this Second Edition of the Handbook of Industrial Robotics. Of its 66 chapters, 33 are new, covering important new topics in the theory, design, control, and applications of robotics. Other key features include a larger glossary of robotics terminology with over 800 terms and a CD-ROM that vividly conveys the colorful motions and intelligence of robotics. With contributions from the most prominent names in robotics worldwide, the Handbook remains the essential resource on all aspects of this complex subject.

Furthering the aim of reducing human exposure to hazardous environments, this monograph presents a detailed study of the modeling and control of vehicle-manipulator systems. The text shows how complex interactions can be performed at remote locations using systems that combine the manipulability of robotic manipulators with the ability of mobile robots to locomote over large areas. The first part studies the kinematics and dynamics of rigid bodies and standard robotic manipulators and can be used as an introduction to robotics focussing on

robust mathematical modeling. The monograph then moves on to study vehicle-manipulator systems in great detail with emphasis on combining two different configuration spaces in a mathematically sound way. Robustness of these systems is extremely important and Modeling and Control of Vehicle-manipulator Systems effectively represents the dynamic equations using a mathematically robust framework. Several tools from Lie theory and differential geometry are used to obtain globally valid representations of the dynamic equations of vehicle-manipulator systems. The specific characteristics of several different types of vehicle-manipulator systems are included and the various application areas of these systems are discussed in detail. For underwater robots buoyancy and gravity, drag forces, added mass properties, and ocean currents are considered. For space robotics the effects of free fall environments and the strong dynamic coupling between the spacecraft and the manipulator are discussed. For wheeled robots wheel kinematics and non-holonomic motion is treated, and finally the inertial forces are included for robots mounted on a forced moving base. Modeling and Control of Vehicle-manipulator Systems will be of interest to researchers and engineers studying and working on many applications of robotics: underwater, space, personal assistance, and mobile manipulation in general, all of which have similarities in the equations required for modeling and control.

Mechanical engineering, an engineering discipline borne of the needs of the industrial revolution, is once again asked to do its substantial share in the call for industrial renewal. The general call is urgent as we face profound is sues of productivity and competitiveness that require engineering solutions, among others. The Mechanical Engineering Series features graduate texts and research monographs intended to address the need for information in contemporary areas of mechanical engineering. The series is conceived as a comprehensive one that covers a broad range of concentrations important to mechanical engineering graduate education and research. We are fortunate to have a distinguished rost er of consulting editors on the advisory board, each an expert in one the areas of concentra tion. The names of the consulting editors are listed on the next page of this volume. The areas of concentration are: applied mechanics; biome chan ics; computational mechanics; dynamic systems and control; energetics; mechanics of materials; processing; thermal science; and tribology.

Mechanics and Control

New Developments

Advances in Robot Kinematics: Analysis and Control
The Journal of the American Society of Mechanical Engineers
Theory, Methods, and Algorithms
A Geometric Approach to Modeling and Analysis

A novel algorithmic approach to mechanism design based on a geometric representation of kinematic function called configuration space partitions. This book presents the configuration space method for computer-aided design of mechanisms with changing part contacts. Configuration space is a complete and compact geometric representation of part motions and part interactions that supports the core mechanism design tasks of analysis, synthesis, and tolerancing. It is the first general algorithmic treatment of the kinematics of higher pairs with changing contacts. It will help designers detect and correct design flaws and unexpected kinematic behaviors, as demonstrated in the book's four case studies taken from industry. After presenting the configuration space framework and algorithms for mechanism kinematics, the authors describe algorithms for kinematic analysis, tolerancing, and synthesis based on configuration spaces. The case studies follow, illustrating the application of the configuration space method to the analysis and design of automotive, micro-mechanical, and optical mechanisms. Appendixes offer a catalog of higher-pair mechanisms and a description of HIPAIR, an open source C++ mechanical design system that implements some of the configuration space methods described in the book, including configuration space visualization and kinematic simulation. HIPAIR comes with an interactive graphical user interface and many sample mechanism input files. The Configuration Space Method for Kinematic Design of Mechanisms will be a valuable resource for students, researchers, and engineers in mechanical engineering, computer science, and robotics.

Modern technical advancements in areas such as robotics, multi-body systems, spacecraft, control, and design of complex mechanical devices and mechanisms in industry require the knowledge to solve advanced concepts in dynamics. " Mechanisms and Robots Analysis with MATLAB" provides a thorough, rigorous presentation of kinematics and dynamics. The book uses MATLAB as a tool to solve problems from the field of mechanisms and robots. The book discusses the tools for formulating the mathematical equations, and also the methods of solving them using a modern computing tool like MATLAB. An emphasis is placed on basic concepts, derivations, and interpretations of the general principles. The book is of great benefit to senior undergraduate and graduate students interested in the classical principles of mechanisms and robotics systems. Each chapter introduction is followed by a careful step-by-step presentation, and sample problems are provided at the end of every chapter.

This book constitutes the refereed proceedings of the 4th International Conference on Simulation, Modeling, and Programming for Autonomous Robots, SIMPAR 2014, held in Bergamo, Italy, in October 2014. The 49 revised full papers presented were carefully reviewed and selected from 62 submissions. The papers are organized in topical sections on simulation, modeling, programming, architectures, methods and tools, and systems and applications.

The essential introduction to the principles and applications of feedback systems—now fully revised and expanded This textbook covers the mathematics needed to model, analyze, and design feedback systems. Now more user-friendly than ever, this revised and expanded edition of Feedback Systems is a one-volume resource for students and researchers in mathematics and engineering. It has applications across a range of disciplines that utilize feedback in physical, biological, information, and economic systems. Karl Åström and Richard Murray use techniques from physics, computer science, and operations research to introduce control-oriented modeling. They begin with state space tools for analysis and design, including stability of solutions, Lyapunov functions, reachability,

state feedback observability, and estimators. The matrix exponential plays a central role in the analysis of linear control systems, allowing a concise development of many of the key concepts for this class of models. Åström and Murray then develop and explain tools in the frequency domain, including transfer functions, Nyquist analysis, PID control, frequency domain design, and robustness. Features a new chapter on design principles and tools, illustrating the types of problems that can be solved using feedback Includes a new chapter on fundamental limits and new material on the Routh-Hurwitz criterion and root locus plots Provides exercises at the end of every chapter Comes with an electronic solutions manual An ideal textbook for undergraduate and graduate students Indispensable for researchers seeking a self-contained resource on control theory

Management and applications of industrial robots

Robotic Fabrication in Architecture, Art and Design

Robots and Screw Theory

IEEE/ASME International Conference on Advanced Intelligent Mechatronics Proceedings

4th International Conference, SIMPAR 2014, Bergamo, Italy, October 20-23, 2014. Proceedings

Advanced Mechanics in Robotic Systems

The area of simulated human figures is an active research area in computer graphics, and Norman Badler's group at the University of Pennsylvania is one of the leaders in the field. This book summarizes the state of the art in simulating human figures, discusses many of the interesting application areas, and makes some assumptions and predictions about where the field is going.

The book presents the state of the art and recent advances in the area of kinematics of robots and mechanisms. It consists of about fifty outstanding contributions dedicated to various aspects of kinematic modelling and control, emphasising in particular the kinematic performances of robots and mechanisms, workspace and trajectory analysis, numerical and symbolic computational methods and algorithms, analysis, simulation and optimisation. The book is of interest to researchers, graduate students, and engineers specialising in the kinematics of robots and mechanisms. It should also be of interest to those engaged in work relating to kinematic chains, mechatronics, mechanism design, biomechanics and intelligent systems.

Darwin2K: An Evolutionary Approach to Automated Design for Robotics is an essential reference tool for researchers, professionals, and students involved in robot design or in evolutionary synthesis, design, and optimization. It is also necessary for users of Darwin2K. Researchers and hobbyists interested in genetic algorithms and artificial life techniques will find the book interesting. The primary purpose of this book is to describe a methodology for using computers to automatically design robots to meet the specific needs of an application. Details of many novel aspects of the methodology are presented, including an evolutionary algorithm for synthesizing and optimizing multiple objective functions, an algorithm for dynamic simulation of arbitrary robots, an extensible software architecture, and a new representation for robots that is appropriate for robot design. The methodology as a whole is significant in terms of its impact on robot design practices, and as a case study in building evolutionary design systems. Individual parts of the systems are also relevant to other areas. For example, the evolutionary algorithm can be used for design and optimization problems other than robotics, and the dynamic simulation algorithm can be used for analysis and simulation of existing robots or as a part of a manual design tool. The book also gives an overview of previous work in automated design of robots, and of evolutionary design in other engineering disciplines.

Parallel manipulators are characterized as having closed-loop kinematic chains. Compared to serial manipulators, which have open-ended structure, parallel manipulators have many advantages in terms of accuracy, rigidity and ability to manipulate heavy loads. Therefore, they have been getting many attentions in astronomy to flight simulators and especially in machine-tool industries.The aim of this book is to provide an overview of the state-of-art, to present new ideas, original results and practical experiences in parallel manipulators. This book mainly introduces advanced kinematic and dynamic analysis methods and cutting edge control technologies for parallel manipulators. Even though this book

only contains several samples of research activities on parallel manipulators, I believe this book can give an idea to the reader about what has been done in the field recently, and what kind of open problems are in this area.

Theory and Applications

Proceedings of the AHFE 2021 Virtual Conferences on Human Factors and Simulation, and Digital Human Modeling and Applied Optimization, July 25-29, 2021, USA

The Configuration Space Method for Kinematic Design of Mechanisms

An Evolutionary Approach to Automated Design for Robotics

Parallel Robots

Modeling for Simulation, Analysis, and Control

Humans have always been fascinated with the concept of artificial life and the construction of machines that look and behave like people. As the field of robotics evolves, it demands continuous development of successful systems with high-performance characteristics for practical applications. Advanced Mechanics in Robotic Systems illustrates original and ambitious mechanical designs and techniques for developing new robot prototypes with successful mechanical operational skills. Case studies are focused on projects in mechatronics that have high growth expectations: humanoid robots, robotics hands, mobile robots, parallel manipulators, and human-centred robots. A good control strategy requires good mechanical design, so a chapter has also been devoted to the description of suitable methods for control architecture design. Readers of Advanced Mechanics in Robotic Systems will discover novel designs for relevant applications in robotic fields, that will be of particular interest to academic and industry-based researchers.

This book brings together 46 peer-reviewed papers that are of interest to researchers wanting to know more about the latest topics and methods in the fields of the kinematics, control and design of robotic systems. These papers cover the full range of robotic systems, including serial, parallel and cable-driven manipulators, both planar and spatial. The systems range from being less than fully mobile, to kinematically redundant, to over-constrained. In addition to these more familiar areas, the book also highlights recent advances in some emerging areas: such as the design and control of humanoids and humanoid subsystems; the analysis, modeling and simulation of human-body motions; mobility analyses of protein molecules; and the development of machines that incorporate man.

Homogeneous transformations; Kinematic equations; Solving kinematic equations; Differential relationships; Motion trajectories; Dynamics; Control; Static forces; Compliance; Programming. This volume collects about 20 contributions on the topic of robotic construction methods. It is a proceedings volume of the robarch2012 symposium and workshop, which will take place in December 2012 in Vienna. Contributions will explore the current status quo in industry, science and practitioners. The symposium will be held as a biennial event. This book is to be the first of the series, comprising the current status of robotics in architecture, art and design.

Vehicle-Manipulator Systems

Proceedings of the Japan-U.S.A. Symposium on Flexible Automation

Parallel Manipulators

Modern Robotics

Global Formulations of Lagrangian and Hamiltonian Dynamics on Manifolds

Robotic Welding, Intelligence and Automation

Parallel robots are closed-loop mechanisms presenting very good performances in terms of accuracy, velocity, rigidity and ability to manipulate large loads. They have been used in a large number of applications ranging from astronomy to flight simulators and are becoming

increasingly popular in the field of machine-tool industry. This book presents a complete synthesis of the latest results on the possible mechanical architectures, analysis and synthesis of this type of mechanism. It is intended to be used by students (with over 150 exercises and numerous internet addresses), researchers (with over 650 references and anonymous ftp access to the code of some algorithms presented in this book) and engineers (for which practical results, mistakes to avoid, and applications are presented). Since the publication of the first edition (2000) there has been an impressive increase in terms of study and use of this kind of structure that are reported in this book. This second edition has been completely overhauled. The initial chapter on kinematics has been split into Inverse Kinematics and Direct Kinematics. A new chapter on calibration was added. The other chapters have also been rewritten to a large extent. The reference section has been updated to include around 45% new works that appeared after the first edition.

A world list of books in the English language.

Tomorrow's robots, which includes the humanoid robot, can perform task like tutoring children, working as tour guides, driving humans to and from work, do the family shopping etc. Tomorrow's robots will enhance lives in ways we never dreamed possible. No time to attend the decisive meeting on Asian strategy? Let your robot go for you and make the decisions. Not feeling well enough to go to the clinic? Let Dr Robot come to you, make a diagnosis, and get you the necessary medicine for treatment. No time to coach the soccer team this week? Let the robot do it for you.Tomorrow's robots will be the most exciting and revolutionary things to happen to the world since the invention of the automobile. It will change the way we work, play, think, and live. Because of this, nowadays robotics is one of the most dynamic fields of scientific research. These days, robotics is offered in almost every university in the world. Most mechanical engineering departments offer a similar course at both the undergraduate and graduate levels. And increasingly, many computer and electrical engineering departments are also offering it.This book will guide you, the curious beginner, from yesterday to tomorrow. The book will cover practical knowledge in understanding, developing, and using robots as versatile equipment to automate a variety of industrial processes or tasks. But, the book will also discuss the possibilities we can look forward to when we are capable of creating a vision-guided, learning machine.

This book is of interest to researchers inquiring about modern topics and methods in the kinematics, control and design of robotic manipulators. It considers the full range of robotic systems, including serial, parallel and cable driven manipulators, both planar and spatial. The systems range from being less than fully mobile to kinematically redundant to overconstrained. In addition to recognized areas, this book also presents recent advances in emerging areas such as the design and control of humanoids and humanoid subsystems, and the analysis, modeling and simulation of human body motions, as well as the mobility analysis of protein molecules and the development of machines which incorporate man.

Mathematics, Programming, and Control : the Computer Control of Robot Manipulators

Latest Advances in Robot Kinematics

Robotics in Practice

Mathematical Reviews

Fundamentals of Robotic Mechanical Systems

Feedback Systems

Gathering presentations to the First International Conference on Cable-Driven Parallel Robots, this book covers classification and definition, kinematics, workspace analysis, cable modeling,

hardware/prototype development, control and calibration and more.

This book provides an accessible introduction to the variational formulation of Lagrangian and Hamiltonian mechanics, with a novel emphasis on global descriptions of the dynamics, which is a significant conceptual departure from more traditional approaches based on the use of local coordinates on the configuration manifold. In particular, we introduce a general methodology for obtaining globally valid equations of motion on configuration manifolds that are Lie groups, homogeneous spaces, and embedded manifolds, thereby avoiding the difficulties associated with coordinate singularities. The material is presented in an approachable fashion by considering concrete configuration manifolds of increasing complexity, which then motivates and naturally leads to the more general formulation that follows. Understanding of the material is enhanced by numerous in-depth examples throughout the book, culminating in non-trivial applications involving multi-body systems. This book is written for a general audience of mathematicians, engineers, and physicists with a basic knowledge of mechanics. Some basic background in differential geometry is helpful, but not essential, as the relevant concepts are introduced in the book, thereby making the material accessible to a broad audience, and suitable for either self-study or as the basis for a graduate course in applied mathematics, engineering, or physics.

This book provides readers with a timely snapshot of modeling and simulation tools, including virtual and mixed-reality environment, for human factors research. It covers applications in healthcare and physical ergonomics, military and transportation systems, industrial monitoring, as well as economics and social sciences. Based on the AHFE 2021 International Conference on Human Factors and Simulation and the AHFE 2021 International Conference on Digital Human Modeling and Applied Optimization, held virtually on 25– 29 July, 2021, from USA, the book offers a unique resource for modelling and simulation researchers seeking insights into human factors research and to human factors experts seeking reliable computational tools.

Classic, comprehensive treatment covers Euclidean displacements; instantaneous kinematics; two-position, three-position, four-and-more position theory; special motions; multiparameter motions; kinematics in other geometries; and special mathematical methods.

Theoretical Kinematics

Applied Mechanics Reviews

Proceedings of the Second Conference MeTrApp 2013

Advances in Robot Kinematics

The Complexity of Robot Motion Planning

Rob|Arch 2012