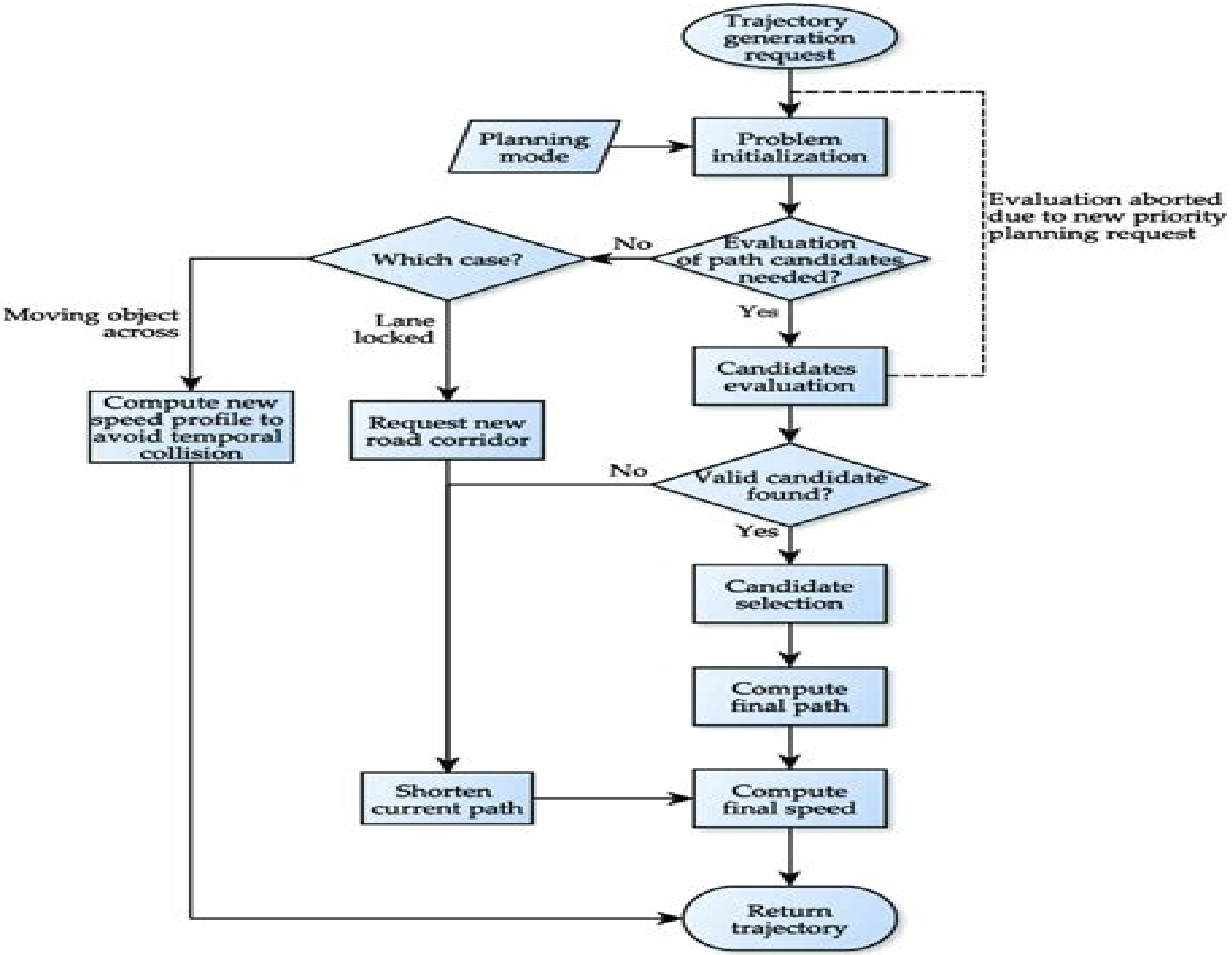
Trajectory generation request
Planning mode
Problem initialization
Evaluation aborted due to new priority planning request
Which case?
No
Evaluation of path candidates needed?
Moving object across
Lane locked
Yes
Candidates evaluation
Compute new speed profile to avoid temporal collision
Request new road corridor
No
Valid candidate found?
Yes
Candidate selection
Compute final path
Shorten current path
Compute final speed
Return trajectory

Planning Algorithms Motion Planning

AW Rasmussen

Planning Algorithms Motion Planning:

Exploiting Direct Optimal Control for Motion Planning in Unstructured Environments Kristoffer Bergman,2021-03-16 During the last decades motion planning for autonomous systems has become an important area of research The high interest is not the least due to the development of systems such as self driving cars unmanned aerial vehicles and robotic manipulators The objective in optimal motion planning problems is to find feasible motion plans that also optimize a performance measure From a control perspective the problem is an instance of an optimal control problem This thesis addresses optimal motion planning problems for complex dynamical systems that operate in unstructured environments where no prior reference such as road lane information is available Some example scenarios are autonomous docking of vessels in harbors and autonomous parking of self driving tractor trailer vehicles at loading sites The focus is to develop optimal motion planning algorithms that can reliably be applied to these types of problems This is achieved by combining recent ideas from automatic control numerical optimization and robotics The first contribution is a systematic approach for computing local solutions to motion planning problems in challenging unstructured environments The solutions are computed by combining homotopy methods and direct optimal control techniques The general principle is to define a homotopy that transforms or preferably relaxes the original problem to an easily solved problem The approach is demonstrated in motion planning problems in 2D and 3D environments where the presented method outperforms a state of the art asymptotically optimal motion planner based on random sampling The second contribution is an optimization based framework for automatic generation of motion primitives for lattice based motion planners Given a family of systems the user only needs to specify which principle types of motions that are relevant for the considered system family Based on the selected principle motions and a selected system instance the framework computes a library of motion primitives by simultaneously optimizing the motions and the terminal states The final contribution of this thesis is a motion planning framework that combines the strengths of sampling based planners with direct optimal control in a novel way The sampling based planner is applied to the problem in a first step using a discretized search space where the system dynamics and objective function are chosen to coincide with those used in a second step based on optimal control This combination ensures that the sampling based motion planner provides a feasible motion plan which is highly suitable as warm start to the optimal control step Furthermore the second step is modified such that it also can be applied in a receding horizon fashion where the proposed combination of methods is used to provide theoretical guarantees in terms of recursive feasibility worst case objective function value and convergence to the terminal state The proposed motion planning framework is successfully applied to several problems in challenging unstructured environments for tractor trailer vehicles The framework is also applied and tailored for maritime navigation for vessels in archipelagos and harbors where it is able to compute energy efficient trajectories which complies with the international regulations for preventing collisions at sea **Planning Algorithms** Steven M. LaValle,2006-05-29

Planning algorithms are impacting technical disciplines and industries around the world including robotics computer aided design manufacturing computer graphics aerospace applications drug design and protein folding This coherent and comprehensive book unifies material from several sources including robotics control theory artificial intelligence and algorithms The treatment is centered on robot motion planning but integrates material on planning in discrete spaces A major part of the book is devoted to planning under uncertainty including decision theory Markov decision processes and information spaces which are the configuration spaces of all sensor based planning problems The last part of the book delves into planning under differential constraints that arise when automating the motions of virtually any mechanical system This text and reference is intended for students engineers and researchers in robotics artificial intelligence and control theory as well as computer graphics algorithms and computational biology Motion Planning in Medicine: Optimization and Simulation Algorithms for Image-Guided Procedures Ron Alterovitz,Ken Goldberg,2008-07-23 Written by Ron Alterovitz and Ken Goldberg this monograph combines ideas from robotics physically based modeling and operations research to develop new motion planning and optimization algorithms for image guided medical procedures Optimized-Motion Planning Cherif Ahrikencheikh,Ali A. Seireg,1994-10-14 The first handbook to the practical specifics of motion planning Optimized Motion Planning offers design engineers methods and insights for solving real motion planning problems in a 3 dimensional space Complete with a disk of software programs this unique guide allows users to design test and implement possible solutions useful in a host of contexts especially tool path planning Beginning with a brief overview of the general class of problems examined within the book as well as available solution techniques Part 1 familiarizes the reader with the conceptual threads that underlie each approach This early discussion also considers the specific applications of each technique as well as its computational efficiency Part 2 illustrates basic problem solving methodology by considering the case of a point moving between stationary polygons in a plane This section features algorithms for data organization and storage the concepts of passage networks and feasibility charts as well as the path optimization algorithm Elaborating on the problematic model described in Part 2 Part 3 develops an algorithm for optimizing the motion of a point between stationary polyhedra in a 3 dimensional space This algorithm is first applied to the case of nonpoint objects moving between obstacles that can be stationary or moving with known patterns It s then used in connection with the extensively investigated problem of motion planning for multilink manipulators **Motion Planning in Dynamic Environments** Kikuo Fujimura,2012-12-06 Computer Science Workbench is a monograph series which will provide you with an in depth working knowledge of current developments in computer technology Every volume in this series will deal with a topic of importance in computer science and elaborate on how you yourself can build systems related to the main theme You will be able to develop a variety of systems including computer software tools computer graphics computer animation database management systems and computer aided design and manufacturing systems Computer Science Workbench represents an important new contribution

in the field of practical computer technology TOSIYASU L KUNII To my parents Kenjiro and Nori Fujimura Preface Motion planning is an area in robotics that has received much attention recently Much of the past research focuses on static environments various methods have been developed and their characteristics have been well investigated Although it is essential for autonomous intelligent robots to be able to navigate within dynamic worlds the problem of motion planning in dynamic domains is relatively little understood compared with static problems *Robot Motion Planning* Jean-Claude Latombe,2012-12-06 One of the ultimate goals in Robotics is to create autonomous robots Such robots will accept high level descriptions of tasks and will execute them without further human intervention The input descriptions will specify what the user wants done rather than how to do it The robots will be any kind of versatile mechanical device equipped with actuators and sensors under the control of a computing system Making progress toward autonomous robots is of major practical inter est in a wide variety of application domains including manufacturing construction waste management space exploration undersea work as sistance for the disabled and medical surgery It is also of great technical interest especially for Computer Science because it raises challenging and rich computational issues from which new concepts of broad useful ness are likely to emerge Developing the technologies necessary for autonomous robots is a formidable undertaking with deep interweaved ramifications in auto mated reasoning perception and control It raises many important prob lems One of them motion planning is the central theme of this book It can be loosely stated as follows How can a robot decide what motions to perform in order to achieve goal arrangements of physical objects This capability is eminently necessary since by definition a robot accomplishes tasks by moving in the real world The minimum one would expect from an autonomous robot is the ability to plan its x Preface own motions *Component-based Synthesis of Motion Planning Algorithms* Tristan Schäfer,2021 **The Complexity of Robot Motion Planning** John Canny,1988 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 **Motion Planning** Edgar A. Martínez García,2022-01-26 Motion planning is a fundamental function in robotics and numerous intelligent machines The global concept of planning involves multiple capabilities such as path generation dynamic planning optimization tracking and control This book has organized different planning topics into three general perspectives that are classified by the type of robotic applications The chapters are a selection of recent developments in a planning and tracking methods for unmanned aerial vehicles b heuristically based methods for navigation planning and routes optimization and c control techniques developed for path planning of autonomous wheeled platforms **Vision-Based Mobile Robot Control and Path Planning Algorithms in Obstacle Environments Using Type-2 Fuzzy Logic** Mahmut Dirik,Oscar Castillo,Fatih Kocamaz,2021-03-01 The book includes topics such as path planning avoiding obstacles following the path go to goal control localization and visual based motion control The theoretical concepts are illustrated with a developed control architecture with soft computing and artificial intelligence methods The proposed vision based motion control strategy involves three stages The first stage consists of the overhead camera calibration and the configuration of the working environment The second stage consists of a path planning strategy using several traditional path planning algorithms and proposed planning algorithm The third stage consists of the path tracking process using previously developed Gauss and Decision Tree control approaches and the proposed Type 1 and Type 2 controllers Two kinematic structures are utilized to acquire the input values of controllers These are Triangle Shape Based Controller Design which was previously developed and Distance Based Triangle Structure that is used for the first time in conducted experiments Four different control algorithms Type 1 fuzzy logic Type 2 Fuzzy Logic Decision Tree Control and Gaussian Control have been used in overall system design The developed system includes several modules that simplify characterizing the motion control of the robot and ensure that it maintains a safe distance without colliding with any obstacles on the way to the target The topics of the book are extremely relevant in many areas of research as well as in education in courses in computer science electrical and mechanical engineering and in mathematics at the graduate and undergraduate levels **Key Elements for Motion Planning Algorithms** Antonio Benitez,2010 Key Elements for Motion Planning Algorithms *Motion Planning* Xj Jing,2008-06-01 In this book new results or developments from different research backgrounds and application fields are put together to provide a wide and useful viewpoint on these headed research problems mentioned above focused on the motion planning problem of mobile ro bots

These results cover a large range of the problems that are frequently encountered in the motion planning of mobile robots both in theoretical methods and practical applications including obstacle avoidance methods navigation and localization techniques environmental modelling or map building methods and vision signal processing etc Different methods such as potential fields reactive behaviours neural fuzzy based methods motion control methods and so on are studied Through this book and its references the reader will definitely be able to get a thorough overview on the current research results for this specific topic in robotics The book is intended for the readers who are interested and active in the field of robotics and especially for those who want to study and develop their own methods in motion path planning or control for an intelligent robotic system **Practical Motion Planning in Robotics** Kamal Gupta,Angel P. del Pobil,1998-10-15 Practical Motion Planning in Robotics Current Approaches and Future Directions Edited by Kamal Gupta Simon Fraser University Burnaby Canada Angel P del Pobil Jaume l University Castellon Spain Designed to bridge the gap between research and industry Practical Motion Planning in Robotics brings theoretical advances to bear on real world applications Capitalizing on recent progress this comprehensive study emphasizes the practical aspects of techniques for collision detection obstacle avoidance path planning and manipulation planning The broad approach spans both model and sensor based motion planning collision detection and geometric complexity and future directions Features include Review of state of the art techniques and coverage of the main issues to be considered in the development of motion planners for use in real applications Focus on gross motion planning for articulated arms enabling robots to perform non contact tasks with relatively high tolerances plus brief consideration of mobile robots The use of efficient algorithms to tackle incremental changes in the environment Illlustration of robot motion planning applications in virtual prototyping and the shipbuilding industry Demonstration of efficient path planners combining both local and global planning approaches in conjunction with efficient techniques for collision detection and distance computations International contributions from academia and industry Combining theory and practice this timely book will appeal to academic researchers and practising engineers in the fields of robotic systems mechatronics and computer science **Gross Motion Planning** Y. K. Hwang,Narendra Ahuja,1992 Advanced UAV Aerodynamics, Flight Stability and Control Pascual Marqués,Andrea Da Ronch,2017-07-11 Comprehensively covers emerging aerospace technologies Advanced UAV aerodynamics flight stability and control Novel concepts theory and applications presents emerging aerospace technologies in the rapidly growing field of unmanned aircraft engineering Leading scientists researchers and inventors describe the findings and innovations accomplished in current research programs and industry applications throughout the world Topics included cover a wide range of new aerodynamics concepts and their applications for real world fixed wing airplanes rotary wing helicopter and quad rotor aircraft The book begins with two introductory chapters that address fundamental principles of aerodynamics and flight stability and form a knowledge base for the student of Aerospace Engineering The book then covers aerodynamics of fixed wing rotary wing and hybrid unmanned aircraft before

introducing aspects of aircraft flight stability and control Key features Sound technical level and inclusion of high quality experimental and numerical data Direct application of the aerodynamic technologies and flight stability and control principles described in the book in the development of real world novel unmanned aircraft concepts Written by world class academics engineers researchers and inventors from prestigious institutions and industry The book provides up to date information in the field of Aerospace Engineering for university students and lecturers aerodynamics researchers aerospace engineers aircraft designers and manufacturers *Proceedings of 2021 International Conference on Autonomous Unmanned Systems (ICAUS 2021)* Meiping Wu,Yifeng Niu,Mancang Gu,Jin Cheng,2022-03-18 This book includes original peer reviewed research papers from the ICAUS 2021 which offers a unique and interesting platform for scientists engineers and practitioners throughout the world to present and share their most recent research and innovative ideas The aim of the ICAUS 2021 is to stimulate researchers active in the areas pertinent to intelligent unmanned systems The topics covered include but are not limited to Unmanned Aerial Ground Surface Underwater Systems Robotic Autonomous Control Navigation and Positioning Architecture Energy and Task Planning and Effectiveness Evaluation Technologies Artificial Intelligence Algorithm Bionic Technology and Its Application in Unmanned Systems The papers showcased here share the latest findings on Unmanned Systems Robotics Automation Intelligent Systems Control Systems Integrated Networks Modeling and Simulation It makes the book a valuable asset for researchers engineers and university students alike *AI and Big Data's Potential for Disruptive Innovation* Strydom, Moses,Buckley, Sheryl,2019-09-27 Big data and artificial intelligence AI are at the forefront of technological advances that represent a potential transformational mega trend a new multipolar and innovative disruption These technologies and their associated management paradigm are already rapidly impacting many industries and occupations but in some sectors the change is just beginning Innovating ahead of emerging technologies is the new imperative for any organization that aspires to succeed in the next decade Faced with the power of this AI movement it is imperative to understand the dynamics and new codes required by the disruption and to adapt accordingly AI and Big Data s Potential for Disruptive Innovation provides emerging research exploring the theoretical and practical aspects of successfully implementing new and innovative technologies in a variety of sectors including business transportation and healthcare Featuring coverage on a broad range of topics such as semantic mapping ethics in AI and big data governance this book is ideally designed for IT specialists industry professionals managers executives researchers scientists and engineers seeking current research on the production of new and innovative mechanization and its disruptions

The 5th Joint International Conference on AI, Big Data and Blockchain (ABB 2024) Muhammad Younas,Irfan Awan,Natalia Kryvinska,Jamal Bentahar,Perin Ünal,2024-11-08 This book is the 5th Joint International Conference on AI Big Data and Blockchain ABB 2024 19 21 Aug 2024 Vienna Austria This book constitutes refereed articles which present research work on timely research themes such as novel AI methods and models deep learning techniques data analytics and

hidden patterns security privacy and trust blockchain data management and fraud detection and prevention among others The intended readership of the book includes researchers developers and practitioners in the areas of AI big data blockchain techniques technologies and their applications *Introduction to Robotics Dynamics* Pasquale De Marco, In the ever evolving realm of robotics robot dynamics stands as a cornerstone discipline unraveling the intricate interplay of forces torques and motion that govern the behavior of these fascinating machines This comprehensive book meticulously crafted for readers seeking a profound understanding of robot dynamics unveils the secrets of robot movement empowering you to design control and optimize robots with remarkable precision Written in an engaging and accessible style this book caters to a diverse audience from engineering students seeking a solid foundation in the subject to seasoned professionals seeking to expand their knowledge and expertise Within these pages you will embark on an enlightening journey delving into the depths of robot kinematics dynamics control motion planning and simulation Unravel the Mysteries of Robot Kinematics Grasp the fundamental concepts of robot kinematics the study of robot motion without regard to the forces that cause it Explore various types of robot joints and their impact on robot movement Master the art of forward and inverse kinematics the processes of determining the position and orientation of a robot s end effector based on joint angles and vice versa Delve into the Complexities of Robot Dynamics Uncover the intricacies of robot dynamics delving into the forces and torques that influence robot motion Investigate the fundamental principles of Newton Euler and Lagrangian formulations two powerful techniques for analyzing robot dynamics Gain insights into the concept of robot inertia and its significance in robot control Harness the Power of Robot Control Discover the intricacies of robot control the art of commanding and guiding robots with precision Explore various control architectures ranging from simple feedback control to advanced model based control Delve into the world of PID control a widely used control technique for robots and uncover its strengths and limitations Navigate the Labyrinth of Robot Motion Planning Embark on a journey into robot motion planning the process of determining a collision free path for a robot to follow Investigate different motion planning algorithms each with its own strengths and weaknesses Learn about obstacle avoidance techniques enabling robots to navigate complex environments safely and efficiently Unleash the Potential of Robot Simulation Discover the power of robot simulation a valuable tool for testing and validating robot designs and control algorithms Explore various robot simulation platforms and their capabilities Gain insights into the process of modeling robot dynamics for simulation purposes With its wealth of illustrative examples captivating case studies and thought provoking exercises this book provides a truly immersive learning experience transforming complex concepts into tangible insights Embrace the journey into robot dynamics and unlock the secrets of these mesmerizing machines that are shaping the future of technology If you like this book write a review *Intelligent Robotics and Applications* Jangmyung Lee,Min Cheol Lee,Honghai Liu,Jee-Hwan Ryu,2013-08-23 This two volume set LNAI 8102 and LNAI 8103 constitutes the refereed proceedings of the 6th International Conference on Intelligent Robotics and Applications ICIRA 2013 held in Busan

South Korea in September 2013 The 147 revised full papers presented were carefully reviewed and selected from 184 submissions The papers discuss various topics from intelligent robotics automation and mechatronics with particular emphasis on technical challenges associated with varied applications such as biomedical application industrial automation surveillance and sustainable mobility

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