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CONTROL OF ROBOT MANIPULATORS IN JOINT SPACE

Springer Science & Business Media **Tutors can design entry-level courses in robotics with a strong orientation to the fundamental discipline of manipulator control pdf solutions manual Overheads will save a great deal of time with class preparation and will give students a low-effort basis for more detailed class notes Courses for senior undergraduates can be designed around Parts I – III; these can be augmented for masters courses using Part IV**

CONTROL OF ROBOT MANIPULATORS IN JOINT SPACE

Springer **Tutors can design entry-level courses in robotics with a strong orientation to the fundamental discipline of manipulator control pdf solutions manual Overheads will save a great deal of time with class preparation and will give students a low-effort basis for more detailed class notes Courses for senior undergraduates can be designed around Parts I – III; these can be augmented for masters courses using Part IV**

MODEL-BASED VARIABLE-STRUCTURE CONTROL OF ROBOT MANIPULATORS IN JOINT SPACE AND IN CARTESIAN SPACE

MODELLING AND CONTROL OF ROBOT MANIPULATORS

Springer Science & Business Media **Fundamental and technological topics are blended uniquely and developed clearly in nine chapters with a gradually increasing level of complexity. A wide variety of relevant problems is raised throughout, and the proper tools to find engineering-oriented solutions are introduced and explained, step by step. Fundamental coverage includes: Kinematics; Statics and dynamics of manipulators; Trajectory planning and motion control in free space. Technological aspects include: Actuators; Sensors; Hardware/software control architectures; Industrial robot-control algorithms. Furthermore, established research results involving description of end-effector orientation, closed kinematic chains, kinematic redundancy and singularities, dynamic parameter identification, robust and adaptive control and force/motion control are provided. To provide readers with a homogeneous background, three appendices are included on: Linear algebra; Rigid-body mechanics; Feedback control. To acquire practical skill, more than 50 examples and case studies are carefully worked out and interwoven through the text, with frequent resort to simulation. In addition, more than 80 end-of-chapter exercises are proposed, and the book is accompanied by a solutions manual containing the MATLAB code for computer problems; this is available from the publisher free of charge to those adopting this work as a textbook for courses.**

MODEL-BASED VARIABLE-STRUCTURE

Open Dissertation Press **This dissertation, "Model-based Variable-structure Control of Robot Manipulators in Joint Space and in Cartesian Space" by □□□, Po-lun, Law, was obtained from The University of Hong Kong (Pokfulam, Hong Kong) and is being sold pursuant to Creative Commons: Attribution 3.0 Hong Kong License. The content of this dissertation has not been altered in any way. We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation. All rights not granted by the above license are retained by the author. DOI: 10.5353/th_b3121246 Subjects: Robotics Manipulators (Mechanism) - Automatic control**

TASK-SPACE SENSORY FEEDBACK CONTROL OF ROBOT MANIPULATORS

Springer **This book presents recent advances in robot control theory on task space sensory feedback control of robot manipulators. By using sensory feedback information, the robot control systems are robust to various uncertainties in modelling and calibration errors of the sensors. Several sensory task space control methods that do not require exact knowledge of either kinematics or dynamics of robots, are presented. Some useful methods such as approximate Jacobian control, adaptive Jacobian control, region control and multiple task space regional feedback are included. These formulations and methods give robots a high degree of flexibility in dealing with unforeseen changes and uncertainties in its kinematics and dynamics, which is similar to human reaching movements and tool manipulation. It also leads to the solution of several long-standing problems and open issues in robot control, such as force control with constraint uncertainty, control of multi-fingered robot hand with uncertain contact points, singularity issue of Jacobian matrix, global task-space control, which are also presented in this book. The target audience for this book includes scientists, engineers and practitioners involved in the field of robot control theory.**

AN OPTIMUM TRAJECTORY PLANNER FOR ROBOT MANIPULATORS IN JOINT-SPACE AND UNDER PHYSICAL CONSTRAINTS

ROBOT MANIPULATORS

MODELING, PERFORMANCE ANALYSIS AND CONTROL

John Wiley & Sons **This book presents the most recent research results on modeling andcontrol of robot manipulators. Chapter 1 gives unified tools to derive direct andinverse geometric, kinematic and dynamic models of serial robotsand addresses the issue of identification of the geometric anddynamic parameters of these models. Chapter 2 describes the main features of serial robots,the different architectures and the methods used to obtain directand inverse geometric, kinematic and dynamic models, paying specialattention to singularity analysis. Chapter 3 introduces global and local tools forperformance analysis of serial robots. Chapter 4 presents an original optimization techniquefor point-to-point trajectory generation accounting for robotdynamics. Chapter 5 presents standard control techniques in thejoint space and task space for free motion (PID, computed torque,adaptive dynamic control and variable structure control) andconstrained motion (compliant force-position control). In Chapter 6, the concept of vision-based control isdeveloped and Chapter 7 is devoted to specific issue ofrobots with flexible links. Efficient recursive Newton-Euleralgorithms for both inverse and direct modeling are presented, aswell as control methods ensuring position setting and vibrationdamping.**

ADAPTIVE CONTROL OF ROBOT MANIPULATORS

A UNIFIED REGRESSOR-FREE APPROACH

World Scientific **This book introduces an unified function approximation approach to the control of uncertain robot manipulators containing general uncertainties. It works for free space tracking control as well as compliant motion control. It is applicable to the rigid robot and the flexible joint robot. Even with actuator dynamics, the unified approach is still feasible. All these features make the book stand out from other existing publications.**

THEORY OF ROBOT CONTROL

Springer Science & Business Media **A study of the latest research results in the theory of robot control, structured so as to echo the gradual development of robot control over the last fifteen years. In three major parts, the editors deal with the modelling and control of rigid and flexible robot manipulators and mobile robots. Most of the results on rigid robot manipulators in part I are now well established, while for flexible manipulators in part II, some problems still remain unresolved. Part III deals with the control of mobile robots, a challenging area for future research. The whole is rounded off with an appendix reviewing basic definitions and the mathematical background for control theory. The particular combination of topics makes this an invaluable source of information for both graduate students and researchers.**

CONTROL OF ROBOT MANIPULATORS

Macmillan Coll Division

ROBOT MANIPULATOR CONTROL

THEORY AND PRACTICE

CRC Press **Robot Manipulator Control offers a complete survey of control systems for serial-link robot arms and acknowledges how robotic device performance hinges upon a well-developed control system. Containing over 750 essential equations, this thoroughly up-to-date Second Edition, the book explicates theoretical and mathematical requisites for controls design and summarizes current techniques in computer simulation and implementation of controllers. It also addresses procedures and issues in computed-torque, robust, adaptive, neural network, and force control. New chapters relay practical information on commercial robot manipulators and devices and cutting-edge methods in neural network control.**

SPRINGER HANDBOOK OF ROBOTICS

Springer Science & Business Media **With the science of robotics undergoing a major transformation just now, Springer's new, authoritative handbook on the subject couldn't have come at a better time. Having broken free from its origins in industry, robotics has been rapidly expanding into the challenging terrain of unstructured environments. Unlike other handbooks that focus on industrial applications, the Springer Handbook of Robotics incorporates these new developments. Just like all Springer Handbooks, it is utterly comprehensive, edited by internationally renowned experts, and replete with contributions from leading researchers from around the world. The handbook is an ideal resource for robotics experts but also for people new to this expanding field.**

ROBOTICS

MODELLING, PLANNING AND CONTROL

Springer Science & Business Media **Based on the successful Modelling and Control of Robot Manipulators by Sciavicco and Siciliano (Springer, 2000), Robotics provides the basic know-how on the foundations of robotics: modelling, planning and control. It has been expanded to include coverage of mobile robots, visual control and motion planning. A variety of problems is raised throughout, and the proper tools to find engineering-oriented solutions are introduced and explained. The text includes coverage of fundamental topics like kinematics, and trajectory planning and related technological aspects including actuators and sensors. To impart practical skill, examples and case studies are carefully worked out and interwoven through the text, with frequent resort to simulation. In addition, end-of-chapter exercises are proposed, and the book is accompanied by an electronic solutions manual containing the MATLAB® code for computer problems; this is available free of charge to those adopting this volume as a textbook for courses.**

MODERN ROBOTICS

Cambridge University Press **A modern and unified treatment of the mechanics, planning, and control of robots, suitable for a first course in robotics.**

DYNAMICS AND CONTROL OF AUTONOMOUS SPACE VEHICLES AND ROBOTICS

Cambridge University Press **Presents the established principles underpinning space robotics with a thorough and modern approach. This text is perfect for professionals in the field looking to gain an understanding of real-life applications of manipulators on satellites, and of the dynamics of satellites carrying robotic manipulators and of planetary rovers.**

ADAPTIVE NEURAL NETWORK CONTROL OF ROBOTIC MANIPULATORS

ADAPTIVE FORCE CONTROL OF ROBOTIC MANIPULATORS

This thesis presents a scheme in modeling, analysis and control of robotic manipulators. The objective is to control both the end effector position and contact force, against a well pre-defined surface, despite of robot dynamic parameter uncertainty. A Lyapunov based adaptive force controller is introduced for this purpose that controls the robot in the joint space. The controller is presented in three steps. In the first step the force error was shown to be proportional to the residual force. In the Second step a composite adaptive controller is used with the focus on the convergence of the residual force. In the third step, a parameter recovery scheme was developed. This scheme is based on the generated control signal and the feedback obtained by the position, velocity, and force sensors. It allows control of the robot in the world coordinate space instead of joint space by using the recovered parameters in the inverse kinematics equations to generate the desired task trajectory in joint space.--The results demonstrated the efficiency of using adaptive force control, as robot parameters in practical applications are not exactly known, or may change with tasks.

A MATHEMATICAL INTRODUCTION TO ROBOTIC MANIPULATION

CRC Press **A Mathematical Introduction to Robotic Manipulation presents a mathematical formulation of the kinematics, dynamics, and control of robot manipulators. It uses an elegant set of mathematical tools that emphasizes the geometry of robot motion and allows a large class of robotic manipulation problems to be analyzed within a unified framework. The foundation of the book is a derivation of robot kinematics using the product of the exponentials formula. The authors explore the kinematics of open-chain manipulators and multifingered robot hands, present an analysis of the dynamics and control of robot systems, discuss the specification and control of internal forces and internal motions, and address the implications of the nonholonomic nature of rolling contact are addressed, as well. The wealth of information, numerous examples, and exercises make A Mathematical Introduction to Robotic Manipulation valuable as both a reference for robotics researchers and a text for students in advanced robotics courses.**

ROBOT FORCE CONTROL

Springer Science & Business Media **One of the fundamental requirements for the success of a robot task is the capability to handle interaction between manipulator and environment. The quantity that describes the state of interaction more effectively is the contact force at the manipulator's end effector. High values of contact force are generally undesirable since they may stress both the manipulator and the manipulated object; hence the need to seek for effective force control strategies. The book provides a theoretical and experimental treatment of robot interaction control. In the framework of model-based operational space control, stiffness control and impedance control are presented as the basic strategies for indirect force control; a key feature is the coverage of six-degree-of-freedom interaction tasks and manipulator kinematic redundancy. Then, direct force control strategies are presented which are obtained from motion control schemes suitably modified by the closure of an outer force regulation feedback loop. Finally, advanced force and position control strategies are presented which include passivity-based, adaptive and output feedback control schemes. Remarkably, all control schemes are experimentally tested on a setup consisting of a seven-joint industrial robot with open control architecture and force/torque sensor. The topic of robot force control is not treated in depth in robotics textbooks, in spite of its crucial importance for practical manipulation tasks. In the few books addressing this topic, the material is often limited to single-degree-of-freedom tasks. On the other hand, several results are available in the robotics literature but no dedicated monograph exists. The book is thus aimed at filling this gap by providing a theoretical and experimental treatment of robot force control.**

ADAPTIVE ROBOT CONTACT PLANNING AND CONTROL

This thesis relies on modeling, control and dynamic analysis of robotic manipulators. The objective is to introduce a way to control an unknown robot manipulator utilizing an adaptive, Lyapunov based controller. Relying on this controller, we are able to respecify the desired task in the joint space despite of parameters uncertainties.--Robot manipulators can be reprogrammed to perform multi-task performance, where parameters can change according to the given task. Generating the desired trajectories in the joint space of the manipulator that are essential to any kind of controller is unachievable in these very realistic settings.

KINEMATICS AND CONTROL OF ROBOT MANIPULATORS

SERIAL AND PARALLEL ROBOT MANIPULATORS

KINEMATICS, DYNAMICS, CONTROL AND OPTIMIZATION

BoD – Books on Demand **The robotics is an important part of modern engineering and is related to a group of branches such as electric**

ROBOT MANIPULATORS

TRENDS AND DEVELOPMENT

BoD – Books on Demand **This book presents the most recent research advances in robot manipulators. It offers a complete survey to the kinematic and dynamic modelling, simulation, computer vision, software engineering, optimization and design of control algorithms applied for robotic systems. It is devoted for a large scale of applications, such as manufacturing, manipulation, medicine and automation. Several control methods are included such as optimal, adaptive, robust, force, fuzzy and neural network control strategies. The trajectory planning is discussed in details for point-to-point and path motions control. The results in obtained in this book are expected to be of great interest for researchers, engineers, scientists and students, in engineering studies and industrial sectors related to robot modelling, design, control, and application. The book also details theoretical, mathematical and practical requirements for mathematicians and control engineers. It surveys recent techniques in modelling, computer simulation and implementation of advanced and intelligent controllers.**

REDUNDANCY IN ROBOT MANIPULATORS AND MULTI-ROBOT SYSTEMS

Springer Science & Business Media **The trend in the evolution of robotic systems is that the number of degrees of freedom increases. This is visible both in robot manipulator design and in the shift of focus from single to multi-robot systems. Following the principles of evolution in nature, one may infer that adding degrees of freedom to robot systems design is beneficial. However, since nature did not select snake-like bodies for all creatures, it is reasonable to expect the presence of a certain selection pressure on the number of degrees of freedom. Thus, understanding costs and benefits of multiple degrees of freedom, especially those that create redundancy, is a fundamental problem in the field of robotics. This volume is mostly based on the works presented at the workshop on Redundancy in Robot Manipulators and Multi-Robot Systems at the IEEE/RSJ International Conference on Intelligent Robots and Systems - IROS 2011. The workshop was envisioned as a dialog between researchers from two separate, but obviously related fields of robotics: one that deals with systems having multiple degrees of freedom, including redundant robot manipulators, and the other that deals with multirobot systems. The volume consists of twelve chapters, each representing one of the two fields.**

MODELING, IDENTIFICATION AND CONTROL OF ROBOTS

Butterworth-Heinemann **Written by two of Europe's leading robotics experts, this book provides the tools for a unified approach to the modelling of robotic manipulators, whatever their mechanical structure. No other publication covers the three fundamental issues of robotics: modelling, identification and control. It covers the development of various mathematical models required for the control and simulation of robots. · World class authority · Unique range of coverage not available in any other book · Provides a complete course on robotic control at an undergraduate and graduate level**

VISUAL SERVOING

REAL-TIME CONTROL OF ROBOT MANIPULATORS BASED ON VISUAL SENSORY FEEDBACK

ROBOT DYNAMICS AND CONTROL

John Wiley & Sons **This self-contained introduction to practical robot kinematics and dynamics includes a comprehensive treatment of robot control. It provides background material on terminology and linear transformations, followed by coverage of kinematics and inverse kinematics, dynamics, manipulator control, robust control, force control, use of feedback in nonlinear systems, and adaptive control. Each topic is supported by examples of specific applications. Derivations and proofs are included in many cases. The book includes many worked examples, examples illustrating all aspects of the theory, and problems.**

PID CONTROL WITH INTELLIGENT COMPENSATION FOR EXOSKELETON ROBOTS

Academic Press **PID Control with Intelligent Compensation for Exoskeleton Robots explains how to use neural PD and PID controls to reduce integration gain, and provides explicit conditions on how to select linear PID gains using proof of semi-global asymptotic stability and local asymptotic stability with a velocity observer. These conditions are applied in both task and joint spaces, with PID controllers compensated by neural networks. This is a great resource on how to combine traditional PD/PID control techniques with intelligent control. Dr. Wen Yu presents several leading-edge methods for designing neural and fuzzy compensators with high-gain velocity observers for PD control using Lyapunov stability. Proportional-integral-derivative (PID) control is widely used in biomedical and industrial robot manipulators. An integrator in a PID controller reduces the bandwidth of the closed-loop system, leads to less-effective transient performance and may even destroy stability. Many robotic manipulators use proportional-derivative (PD) control with gravity and friction compensations, but improved gravity and friction models are needed. The introduction of intelligent control in these systems has dramatically changed the face of biomedical and industrial control engineering. Discusses novel PD and PID controllers for biomedical and industrial robotic applications, demonstrating how PD and PID with intelligent compensation is more effective than other model-based compensations Presents a stability analysis of the book for industrial linear PID Includes practical applications of robotic PD/PID control, such as serial sliding mode, explicit conditions for linear PID and high gain observers for neural PD control Includes applied exoskeleton applications and MATLAB code for simulations and applications**

SPACE ROBOTICS: DYNAMICS AND CONTROL

Springer Science & Business Media **Robotic technology offers two potential benefits for future space exploration. One benefit is minimizing the risk that astronauts face. The other benefit is increasing their productivity. Realizing the benefits of robotic technology in space will require solving several problems which are unique and now becoming active research topics. One of the most important research areas is dynamics, control, motion and planning for space robots by considering the dynamic interaction between the robot and the base (space station, space shuttle, or satellite). Any inefficiency in the planning and control can considerably risk by success of the space mission. Space Robotics: Dynamics and Control presents a collection of papers concerning fundamental problems in dynamics and control of space robots, focussing on issues relevant to dynamic base/robot interaction. The authors are all pioneers in theoretical analysis and experimental systems development of space robot technology. The chapters are organized within three problem areas: dynamics problems, nonholonomic nature problems, and control problems. This collection provides a solid reference for researchers in robotics, mechanics, control, and astronautical science.**

FOUNDATIONS OF ROBOTICS

ANALYSIS AND CONTROL

MIT Press **Foundations of Robotics presents the fundamental concepts and methodologies for the analysis, design, and control of robot manipulators. It explains the physical meaning of the concepts and equations used, and it provides, in an intuitively clear way, the necessary background in kinetics, linear algebra, and control theory. Illustrative examples appear throughout. The author begins by discussing typical robot manipulator mechanisms and their controllers. He then devotes three chapters to the analysis of robot manipulator mechanisms. He covers the kinematics of robot manipulators, describing the motion of manipulator links and objects related to manipulation. A chapter on dynamics includes the derivation of the dynamic equations of motion, their use for control and simulation and the identification of inertial parameters. The final chapter develops the concept of manipulability. The second half focuses on the control of robot manipulators. Various position-control algorithms that guide the manipulator's end effector along a desired trajectory are described Two typical methods used to control the contact force between the end effector and its environments are detailed For manipulators with redundant degrees of freedom, a technique to develop control algorithms for active utilization of the redundancy is described. Appendixes give compact reviews of the function atan2, pseudo inverses, singular-value decomposition, and Lyapunov stability theory. Tsuneo Yoshikawa teaches in the Division of Applied Systems Science in Kyoto University's Faculty of Engineering.**

A MATHEMATICAL INTRODUCTION TO ROBOTIC MANIPULATION

CRC Press **A Mathematical Introduction to Robotic Manipulation presents a mathematical formulation of the kinematics, dynamics, and control of robot manipulators. It uses an elegant set of mathematical tools that emphasizes the geometry of robot motion and allows a large class of robotic manipulation problems to be analyzed within a unified framework. The foundation of the book is a derivation of robot kinematics using the product of the exponentials formula. The authors explore the kinematics of open-chain manipulators and multifingered robot hands, present an analysis of the dynamics and control of robot systems, discuss the specification and control of internal forces and internal motions, and address the implications of the nonholonomic nature of rolling contact are addressed, as well. The wealth of information, numerous examples, and exercises make A Mathematical Introduction to Robotic Manipulation valuable as both a reference for robotics researchers and a text for students in advanced robotics courses.**

MODELING AND ROBUST CONTROL OF TWO COLLABORATIVE ROBOT MANIPULATORS HANDLING A FLEXIBILE OBJECT

Robots are often used in industry to handle flexible objects, such as frames, beams, thin plates, rubber tubes, leather goods and composite materials. Moving long flexible objects in a desired path and also precise positioning and orienting the objects need a collaborative action between two robot arms. Most of the earlier studies have dealt with manipulation of rigid objects and only a few have focused on the collaborative manipulators handling flexible objects. Such studies on handling of flexible objects generally used finite element method or assumed mode method for deriving the dynamic model of the flexible objects. These approximation methods require more number of sensors to feedback the vibration measurements or require an observer. Unlike in the earlier studies, this thesis concerns with development of a dynamic model of the flexible object in partial differential equation (PDE) form and design of a robust control strategy for collaborative manipulation of the flexible objects by two rigid robot arms. Two planar rigid manipulators each with three links and revolute joints handling a flexible object is considered during the model development. Kinematic and dynamic equations of the flexible object are derived without using any approximation techniques. The resulting dynamic equation of the flexible object together with the manipulator dynamic equations form the combined dynamic model of the system. The developed complete system of dynamic equations is described by the PDE's having rigid as well as flexible parameters coupled together. Such a coupled system must be controlled without using any form of approximation techniques and this is accomplished using the singular perturbation approach. By utilizing this technique, slow and fast subsystems are identified in two different time scales and controller is designed for each subsystem. The key issue in developing a control algorithm is that, it should be robust against uncertain parameters of the manipulators and the flexible object and it should also achieve the exponential convergence. Hence, for the slow subsystem, sliding mode control algorithm is developed and for the fast subsystem, a simple feedback control algorithm is designed. In general, usage of singular perturbation technique necessitates exponential stability of the slow and fast subsystems, which is evaluated by satisfying the Tikhnov's theorem. Hence, the exponential stability analysis for both the subsystems is performed. Simulation results are presented to validate the composite control scheme. As a further consideration in the improvement of control law for the slow subsystem, two modified control algorithms are suggested. The first one focused on the avoidance of velocity signal measurement which is useful to eliminate the need of velocity sensors and the second controller aims at avoiding the complex regressor in the control law. The capability of those controllers is illustrated through simulation studies. The extension of earlier analysis has been carried out by developing the complete system of dynamic equations in joint space.

ROBUST TRACKING CONTROL OF ROBOT MANIPULATORS

REAL-TIME CONTROL OF ROBOT MANIPULATORS IN THE PRESENCE OF OBSTACLES

PATH FOLLOWING FOR ROBOT MANIPULATORS USING GYROSCOPIC FORCES

This thesis deals with the path following problem the objective of which is to make the end effector of a robot manipulator trace a desired path while maintaining a desired orientation. The fact that the pose of the end effector is described in the task space while the control inputs are in the joint space presents difficulties to the movement coordination. Typically, one needs to perform inverse kinematics in path planning and inverse dynamics in movement execution. However, the former can be ill-posed in the presence of redundancy and singularities, and the latter relies on accurate models of the manipulator system which are often difficult to obtain. This thesis presents an alternative control scheme that is directly formulated in the task space and is free of inverse transformations. As a result, it is especially suitable for operations in a dynamic environment that may require online adjustment of the task objective. The proposed strategy uses the transpose Jacobian control (or potential energy shaping) as the base controller to ensure the

convergence of the end effector pose, and adds a gyroscopic force to steer the motion. Gyroscopic forces are a special type of force that does not change the mechanical energy of the system, so its addition to the base controller does not affect the stability of the controlled mechanical system. In this thesis, we emphasize the fact that the gyroscopic force can be effectively used to control the pose of the end effector during motion. We start with the case where only the position of the end effector is of interest, and extend the technique to the control over both position and orientation. Simulation and experimental results using planar manipulators as well as anthropomorphic arms are presented to verify the effectiveness of the proposed controller.

CONTROL DYNAMICS OF ROBOTIC MANIPULATORS

Elsevier **Control Dynamics of Robotic Manipulators deals with both theory and mechanics of control and systems dynamics used in robotic movements. The book discusses mechanical models of robot manipulators in relation to modular RP-unit manipulators, multiple mechanical system (Cartesian Model), or generalized coordinates (Lagrangian Model). The text also describes equations used to determine the force characteristics, energy, and power required in manipulators. For example, damping forces dissipate energy caused by dry friction or viscous damping at mechanical joints due to slips and sheer effects on surfaces. Other examples are oil, water, and air resistance in the environment of the manipulator, as well as damping in links caused by microscopic interface effects. Demands for high-speed and high-accuracy in manipulators require sturdiness in control against variations in the system parameter. The book cites a situation where the manipulator works in a "hot cell" and must be controlled remotely. The text also tackles the avoidance of obstacles by nonvisual means by referring to the works of Lozano, Perez and Wesley, and of Reibert and Horn. The text is useful for students of civil, structural, and mechanical engineering. It will also profit technicians of automatic, telecontrol, and designers of industrial machinery.**

SPACE BASED ROBOT MANIPULATORS

DYNAMICS AND ADAPTIVE CONTROL

ANALYSIS AND CONTROL OF ROBOT MANIPULATORS WITH KINEMATIC REDUNDANCY

A closed-form solution formula for the kinematic control of manipulators with redundancy is derived, using the Lagrangian multiplier method. Differential relationship equivalent to the Resolved Motion Method has been also derived. The proposed method is proved to provide with the exact equilibrium state for the Resolved Motion Method. This exactness in the proposed method fixes the repeatability problem in the Resolved Motion Method, and establishes a fixed transformation from workspace to the joint space. Also the method, owing to the exactness, is demonstrated to give more accurate trajectories than the Resolved Motion Method. In addition, a new performance measure for redundancy control has been developed. This measure, if used with kinematic control methods, helps achieve dexterous movements including singularity avoidance. Compared to other measures such as the manipulability measure and the condition number, this measure tends to give superior performances in terms of preserving the repeatability property and providing with smoother joint velocity trajectories. Using the fixed transformation property, Taylor's Bounded Deviation Paths Algorithm has been extended to the redundant manipulators. (KR).

CONTROL AND DYNAMIC SYSTEMS V39: ADVANCES IN ROBOTIC SYSTEMS PART 1 OF 2

ADVANCES IN THEORY AND APPLICATIONS

Elsevier **Advances in Robotic Systems, Part 1 shows how the activity in robotic systems has increased significantly over the past decade. Major centers of research and development in robotic systems were established on the international scene, and these became focal points for the brilliant research efforts of many academicians and industrial professionals. The systems aspects of robotics, in general, and of robot control, in particular, are manifested through a number of technical facts. This book comprises 10 chapters, with the first focusing on applications of neural networks to robotics. The following chapters then discuss a unified approach to kinematic modeling, identification and compensation for robot calibration; nonlinear control algorithms in robotic systems; and kinematic and dynamic task space motion planning for robot control. Other chapters cover discrete kinematic modeling techniques in Cartesian space for robotic system; force distribution algorithms for multifingered grippers; frequency analysis for a discrete-time robot system; minimum cost trajectory planning for industrial robots; tactile sensing techniques in robotic systems; and sensor data fusion in robotic systems. This book will be of interest to practitioners in the fields of computer science, systems science, and mathematics.**