

DYNAMICS AND ROBUST CONTROL OF ROBOT-ENVIRONMENT INTERACTION



Miomir Vukobratovic • Dragoljub Surdilovic
Yury Ekalo • Dusko Katic

Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics

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Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics:

Dynamics and Robust Control of Robot-environment Interaction Miomir Vukobratović, 2009 This book covers the most attractive problem in robot control dealing with the direct interaction between a robot and a dynamic environment including the human robot physical interaction It provides comprehensive theoretical and experimental coverage of interaction control problems starting from the mathematical modeling of robots interacting with complex dynamic environments and proceeding to various concepts for interaction control design and implementation algorithms at different control layers Focusing on the learning principle it also shows the application of new and advanced learning algorithms for robotic contact tasks The ultimate aim is to strike a good balance between the necessary theoretical framework and theoretical aspects of interactive robots

Advances on Theory and Practice of Robots and Manipulators Marco Ceccarelli, Victor A. Glazunov, 2014-06-02 This proceedings volume contains papers that have been selected after review for oral presentation at ROMANSY 2014 the 20th CISM IFToMM Symposium on Theory and Practice of Robots and Manipulators These papers cover advances on several aspects of the wide field of Robotics as concerning Theory and Practice of Robots and Manipulators ROMANSY 2014 is the twentieth event in a series that started in 1973 as one of the first conference activities in the world on Robotics The first event was held at CISM International Centre for Mechanical Science in Udine Italy on 5-8 September 1973 It was also the first topic conference of IFToMM International Federation for the Promotion of Mechanism and Machine Science and it was directed not only to the IFToMM community Proceedings volumes of ROMANSY have been always published to be available also after the symposium to a large public of scholars and designers with the aim to give an overview of new advances and trends in the theory design and practice of robots This proceedings volume like previous ones of the series contains contributions with achievements covering many fields of Robotics as Theory and Practice of Robots and Manipulators that can be an inspiration for future developments

Advances in Robot Design and Intelligent Control Aleksandar Rodić, Theodor Borangiu, 2016-11-26 This book presents the proceedings of the 25th International Conference on Robotics in Alpine Danube Region RAAD 2016 held in Belgrade Serbia on June 30th-July 2nd 2016 In keeping with the tradition of the event RAAD 2016 covered all the important areas of research and innovation in new robot designs and intelligent robot control with papers including Intelligent robot motion control Robot vision and sensory processing Novel design of robot manipulators and grippers Robot applications in manufacturing and services Autonomous systems humanoid and walking robots Human robot interaction and collaboration Cognitive robots and emotional intelligence Medical human assistive robots and prosthetic design Robots in construction and arts and Evolution education legal and social issues of robotics For the first time in RAAD history the themes cloud robots legal and ethical issues in robotics as well as robots in arts were included in the technical program The book is a valuable resource for researchers in fields of robotics engineers who implement robotic solutions in manufacturing services and healthcare and master's and Ph.D. students working on

robotics projects New Trends in Medical and Service Robots Philippe Wenger,Christine Chevallereau,Doina Pisla,Hannes Bleuler,Aleksandar Rodić,2016-04-20 Medical and service robotics integrates several disciplines and technologies such as mechanisms mechatronics biomechanics humanoid robotics exoskeletons and anthropomorphic hands This book presents the most recent advances in medical and service robotics with a stress on human aspects It collects the selected peer reviewed papers of the Fourth International Workshop on Medical and Service Robots held in Nantes France in 2015 covering topics on exoskeletons anthropomorphic hands therapeutic robots and rehabilitation cognitive robots humanoid and service robots assistive robots and elderly assistance surgical robots human robot interfaces BMI and BCI haptic devices and design for medical and assistive robotics This book offers a valuable addition to existing literature **Cable-Driven Parallel Robots** Andreas Pott,Tobias Bruckmann,2014-08-14 This volume presents the outcome of the second forum to cable driven parallel robots bringing the cable robot community together It shows the new ideas of the active researchers developing cable driven robots The book presents the state of the art including both summarizing contributions as well as latest research and future options The book cover all topics which are essential for cable driven robots Classification Kinematics Workspace and Singularity Analysis Statics and Dynamics Cable Modeling Control and Calibration Design Methodology Hardware Development Experimental Evaluation Prototypes Application Reports and new Application concepts *New Trends in Medical and Service Robots* Aleksandar Rodić,Doina Pisla,Hannes Bleuler,2014-04-08 This volume describes new frontiers in medical and service robotics in the light of recent developments in technology to advance robot design and implementation In particular the work looks at advances in design development and implementation of contemporary surgical rehabilitation and biorobots Surgical robots allow surgeons greater access to areas under operation using more precise and less invasive methods Rehabilitation robots facilitate and support the lives of the infirm elderly people or those with dysfunction of body parts affecting movement These robots are also used for rehabilitation and related procedures such as training and therapy Biorobots are designed to imitate the cognition of humans and animals The need to substitute humans working on delicate tiresome and monotonous tasks or working with potentially health damaging toxic materials requires intelligent high performance service robots with the ability to cooperate advanced communication and sophisticated perception and cognitive capabilities Progress in this field is fast and results need to be disseminated to stimulate both practical applications and further research Thus these papers are a valuable addition to existing literature **Bioinspired Design and Control of Robots with Intrinsic Compliance** Yongping Pan,Zhao Guo,Dongbing Gu,2020-12-04 This eBook is a collection of articles from a Frontiers Research Topic Frontiers Research Topics are very popular trademarks of the Frontiers Journals Series they are collections of at least ten articles all centered on a particular subject With their unique mix of varied contributions from Original Research to Review Articles Frontiers Research Topics unify the most influential researchers the latest key findings and historical advances in a hot research area Find out more on how to host your own Frontiers Research Topic or contribute

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manipulators In each chapter the mathematical concepts are illustrated with experimental results obtained with a two manipulator system They are presented in enough detail to allow readers to implement the concepts in their own systems or in Control Environment for Robots a MATLAB based simulation program freely available from the authors The target audience for Robust Control of Robots includes researchers practicing engineers and graduate students interested in implementing robust and fault tolerant control methodologies to robotic manipulators

Robust Robotic Manipulation for Effective Multi-contact and Safe Physical Interactions Mikael Daniel Gabriel Jorda, 2020 Robots are complex systems at the intersection of numerous engineering domains The goal of many researchers is to build a fully capable and safe robot that can work and assist humans in their daily lives To reach these goals the complex robotic systems must be separated in different subsystem components such as perception world understanding navigation manipulation interfaces and interaction These subsystems need to be safe and robust in order to synergistically work together In particular a reliable and general robot manipulation framework for free space and contact tasks is required for robots to become useful in new environments In this thesis we aim at developing a theoretical and practical foundation for safe and robust robotic manipulation involving multiple simultaneous physical interactions with complex and unknown environments We start with the well known operational space control framework a task oriented control methodology that enables task dynamic decoupling and hierarchical control structures After reviewing the operational space control theory for controlling a robot task and posture we present a series of practical considerations for its robust implementation on real hardware platforms The integration in this framework of constraints such as joint limits and obstacles is then discussed and a method to react safely to unexpected contacts on the robot structure during operations is proposed These constraints are handled as control objectives in the control hierarchy using artificial potential fields to generate repulsive forces and dynamically consistent projections to ensure an independent control of the constraints and task objectives This systematic treatment of constraints at the control level enables a robust autonomous execution of complex tasks in changing environments This framework was extended over the years to consider underactuated robots in arbitrary contact situations This resulted in a comprehensive formulation to the problem of controlling a high dimensional robotic system involving complex tasks subject to various constraints obstacles balance and multiple contacts Contacts are essential for robot manipulation On the one hand parts of the robot tasks involve physical interactions that need to be controlled precisely On the other hand further contacts are required on underactuated systems in order to enable the robot motion and guarantee its balance In addition contacts between the robot and the environment are subject to geometric and friction constraints that need to be addressed by the control framework Therefore in this thesis the operational space whole body control framework is completed to enable a systematic treatment of multi contact scenarios A virtual linkage model separates the contact forces into three sets The resultant forces allow the robot to compensate for its underactuation The task contact forces are controlled to their desired

values The internal forces provide a way to satisfy geometric and friction constraints A method using barrier functions is proposed to specify a set of internal forces that ensure the robot's balance and contact stability Even when the desired contact forces are correctly specified their control remains a challenge Indeed the fast and discontinuous closed loop dynamics of stiff physical interactions leads to instabilities in robot force control Therefore we adapt a time domain passivity approach to guarantee the stability of explicit force controllers This results in an increased robustness and safety for robotic systems in multiple contact scenarios To develop effective interfaces for human robot collaboration we also study haptic robot teleoperation Haptic devices provide an intuitive interface to remotely control robots and combine the high level cognitive autonomy of humans with the autonomous manipulation capabilities of robots The goal of haptic robot control is to maximize the transparency between the human operator and the robot environment It means that the robot environment should be felt by the human as if they were directly interacting with it and the human commands should be executed precisely by the robot Transparency is very challenging to achieve when communication delays are present in the system which occurs systematically when there is a significant physical distance between the controlled robot and its human operator To address this challenge we propose a new paradigm for performing haptic robot control Instead of relying on a global feedback loop the new method establishes two autonomous controllers acting on the robot and the haptic device interfaced via a dual proxy model The dual proxy is a bridge between the local controllers It generates appropriate motion and force inputs that are consistent with the task physical interactions The model relies on the exchange of position contact and environment geometry information avoiding the limitations caused by a direct force feedback between robot and haptic device in conventional teleoperation To estimate the environment contact geometry in real time we also design a new perception algorithm that enables a fully autonomous implementation of the dual proxy model The performance of all the control methods presented in this thesis are evaluated via simulations and hardware experimental validation Combining these methods together results in a robust safe and generic manipulation control framework for complex robots in interaction with uncertain environments Such framework is one of the key components for a complete and fully capable robotic system

Biologically Inspired Control of Humanoid Robot Arms Adam Spiers, Said Ghani Khan, Guido Herrmann, 2016-05-27

This book investigates a biologically inspired method of robot arm control developed with the objective of synthesising human like motion dynamically using nonlinear robust and adaptive control techniques in practical robot systems The control method caters to a rising interest in humanoid robots and the need for appropriate control schemes to match these systems Unlike the classic kinematic schemes used in industrial manipulators the dynamic approaches proposed here promote human like motion with better exploitation of the robot's physical structure This also benefits human robot interaction The control schemes proposed in this book are inspired by a wealth of human motion literature that indicates the drivers of motion to be dynamic model based and optimal Such considerations lend themselves nicely to achievement via

nonlinear control techniques without the necessity for extensive and complex biological models The operational space method of robot control forms the basis of many of the techniques investigated in this book The method includes attractive features such as the decoupling of motion into task and posture components Various developments are made in each of these elements Simple cost functions inspired by biomechanical effort and discomfort generate realistic posture motion Sliding mode techniques overcome robustness shortcomings for practical implementation Arm compliance is achieved via a method of model free adaptive control that also deals with actuator saturation via anti windup compensation A neural network centered learning by observation scheme generates new task motions based on motion capture data recorded from human volunteers In other parts of the book motion capture is used to test theories of human movement All developed controllers are applied to the reaching motion of a humanoid robot arm and are demonstrated to be practically realisable This book is designed to be of interest to those wishing to achieve dynamics based human like robot arm motion in academic research advanced study or certain industrial environments The book provides motivations extensive reviews research results and detailed explanations It is not only suited to practising control engineers but also applicable for general roboticists who wish to develop control systems expertise in this area

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Table of Contents Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics

1. Understanding the eBook Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - The Rise of Digital Reading Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Advantages of eBooks Over Traditional Books
2. Identifying Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - User-Friendly Interface
4. Exploring eBook Recommendations from Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics

- Personalized Recommendations
 - Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics User Reviews and Ratings
 - Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics and Bestseller Lists
5. Accessing Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics Free and Paid eBooks
- Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics Public Domain eBooks
 - Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics eBook Subscription Services
 - Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics Budget-Friendly Options
6. Navigating Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics eBook Formats
- ePub, PDF, MOBI, and More
 - Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics Compatibility with Devices
 - Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics Enhanced eBook Features
7. Enhancing Your Reading Experience
- Adjustable Fonts and Text Sizes of Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Highlighting and Note-Taking Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Interactive Elements Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
8. Staying Engaged with Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
- Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
9. Balancing eBooks and Physical Books Dynamics And Robust Control Of Robot Environment Interaction New Frontiers

In Robotics

- Benefits of a Digital Library
 - Creating a Diverse Reading Collection Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Setting Reading Goals Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Fact-Checking eBook Content of Dynamics And Robust Control Of Robot Environment Interaction New Frontiers In Robotics
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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