Robot Calibration | 8965e7db9b548aac3338a9056a2f7545

Advances in Robot Kinematics

The calibration system proposed showed to improve the robot accuracy to well below 1mm. The system allows a large variation in robot configurations, which is essential to proper calibration. A technique was used and a straightforward convention to build kinematic models for a manipulator was developed, ensuring that no singularities are present in the error model. Mathematical tools were implemented to optimize the kinematic model parameterization, avoiding redundancies between parameters and improving the parameter identification process. A portable, ease of use, speedy and reliable vision-based measuring system using a single camera and a plane calibration board was developed and tested independently of the robot calibration process. The robot calibration system approach proposed here stood out to be a feasible alternative to the expensive and complex systems available today in the market, using a single camera and showing good accuracy and ease of use and setup. Results showed that the RAC model used (with slight modifications) is not very robust, since even for images filling the entire screen and captured at approximately the same distances from the target, the focus length was not constant and showed an average error shifted by approximately 3% from the exact one. This amount of error can produce 3-D measurement errors much larger than acceptable. Practically speaking, the solution for this problem developed here for a set of camera and lens was to use an external measurement system to calibrate the camera, at least once. The measurement accuracy obtained is comparable to the best found in academic literature for this type of system, with median values of accuracy of approximately 1.5-2.00% when compared to the distances from the target. However, this accuracy is obtained over a much larger distance range and different camera orientations than usual applications for cameras require, making the system suitable for robotic metrology. For future research it is suggested that the target plate and the calibration board have to be improved to permit the camera to be placed at larger ranges of distances from the target, allowing larger calibration volumes to be used. One path that might be followed is to construct a much larger calibration board, with localized clusters of calibration points of different sizes, instead of just one pattern of point distribution. So, if the camera is placed at a greater distance, larger dots can be used all over the area of the calibration board. If the camera is nearer to the target, smaller dots can be used at particular locations on the calibration board. Different dot sizes make easier for the vision processing software to recognize desired clusters of calibration points. Other sources of lens distortions such as decentering and thin prism can be also modeled, and so their influence on the final measurement accuracy can be understood. Another issue concerns the influence orientation measured data may have on the final accuracy. Non-geometric parameters such as link elasticity, gear elasticity and gear backlash might be modeled, and a larger number of parameters introduced in the model parameterization. This procedure may improve the accuracy substantially if the robot is used with greater payloads.

Advanced Intelligent Computing, Theories and Applications

Visual Sensing and its Applications: Integration of Laser Sensors to Industrial Robots provides comprehensive and up-to-date coverage of research and development on this robotic vision system. A laser-structured light is the main concern in discussions of visual sensing. Also addressed in this book are all components of the robotic vision system and an emphasis on how to increase the accuracy of the system using three levels of calibration. This includes calibration of the vision system (eye calibration), calibration of eye-to-hand configuration and calibration of robot kinematics (hand calibration). With the integration of the laser sensors to industrial robots numerous applications in the field of robotic welding, grinding, machining, inspection, and palletizing are illustrated based on practical engineering projects in order to demonstrate how the visual sensing is performed. The book will serve as a valuable resource for researchers and engineers in the areas of robotics and machine vision. Dr. Zhongxue Gan is a vice chairman and chief scientist of the ENN Group, China. He serves as a member of the National Energy Expert Consultation Committee of China and member of the National Coal Council of the USA. He is also a co-founder of Intersmart Robotic Systems Co. Ltd., China. He was a research fellow in flexible automation systems at ABB and a founding director of ABB Corporate Research Robot Laboratories, both in the USA and in China. Dr. Qing Tang is a co-founder and CEO of Intersmart Robotic Systems Co. Ltd., China and an adjunct professor in Physics at Sichuan University, China. He was a principle consulting engineer and project manager at the ABB Corporate Research Robot Laboratory in the USA.

Intelligent Robotics and Applications

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.
Advances in Robot Kinematics

Robot manipulators are developing more in the direction of industrial robots than of human workers. Recently, the applications of robot manipulators are spreading their focus, for example Da Vinci as a medical robot, A SIM O as a humanoid robot and so on. There are many research topics within the field of robot manipulators, e.g. motion planning, cooperation with a human, and fusion with external sensors like vision, haptic and force, etc. Moreover, these include both technical problems in the industry and theoretical problems in the academic fields. This book is a collection of papers presenting the latest research issues from around the world.

Vision Based Automatic Theodolite for Robot Calibration

Calibration is playing an increasingly important role in industrial robotics. Higher accuracy demands are being placed on flexible assembly and manufacturing systems which in turn require robot manufacturers to produce higher quality precision robots.

Robotic Systems for Handling and Assembly

The second edition of this handbook provides a state-of-the-art overview on the various aspects in the rapidly developing field of robotics. Reaching for the human frontier, robotics is vigorously engaged in the growing challenges of new emerging domains. Interacting, exploring, and working with humans, the new generation of robots will increasingly touch people and their lives. The credible prospect of practical robots among humans is the result of the scientific endeavor of a half a century of robotic developments that established robotics as a modern scientific discipline. The ongoing vibrant expansion and strong growth of the field during the last decade has fueled this second edition of the Springer Handbook of Robotics. The first edition of the handbook soon became a landmark in robotics publishing and won the American Association of Publishers PROSE Award for Excellence in Physical Sciences & Mathematics as well as the organization’s Award for Engineering & Technology. The second edition of the handbook, edited by two internationally renowned scientists with the support of an outstanding team of seven part editors and more than 200 authors, continues to be an authoritative reference for robotics researchers, newcomers to the field, and scholars from related disciplines. The content has been restructured to achieve four main objectives: the enlargement of foundational topics for robotics, the enlightenment of design of various types of robotic systems, the extension of the treatment on robots moving in the environment, and the enrichment of advanced robotics applications. Further to an extensive update, fifteen new chapters have been introduced on emerging topics, and a new generation of authors have joined the handbook’s team. A novel addition to the second edition is a comprehensive collection of multimedia references to more than 700 videos, which bring valuable insight into the contents. The videos can be viewed directly augmented into the text with a smartphone or tablet using a unique and specially designed app. Springer Handbook of Robotics Multimedia Extension Portal: http://handbookofrobotics.org/

Computer Vision Based Robot Calibration and Control

Advances in Service and Industrial Robotics

This book constitutes the refereed proceedings of the International Workshop on Robotics in Smart Manufacturing, WRS M 2013, held in Porto, Portugal, in June 2013. The 20 revised full papers presented were carefully reviewed and selected from numerous submissions. The papers address issues such as robotic machining, off-line robot programming, robot calibration, new robotic hardware and software architectures, advanced robot teaching methods, intelligent warehouses, robot co-workers and application of robots in the textile industry.

Optimised Robot Calibration Using a Vision-based Measurement System with a Single Camera

Although parallel robots are known to offer many advantages with respect to accuracy, dynamics, and stiffness, major breakthroughs in industrial applications have not yet taken place. This is due to a knowledge gap preventing fast and precise execution of industrial handling and assembly tasks. This book focuses on the design, modeling, and control of innovative parallel structures as well as the integration of novel machine elements. Special attention is paid to the integration of active components into lightweight links and passive joints. In addition, new control concepts are introduced to minimize structural vibrations. Although the optimization of robot systems itself allows a reduction of cycle times, these can be further decreased by improved path planning, robot programming, and automated assembly planning concepts described by 25 contributions within this book. The content of this volume is subdivided into four main parts dealing with Modeling and Design, System Implementation, Control and Programming as well as Adaptronics and Components. This book is aimed at researchers and postgraduates working in the field of parallel robots as well as practicing engineers dealing with industrial robot development and robotic applications.

Springer Handbook of Robotics

Describes the details of the calibration process step-by-step, covering systems modeling, measurement, identification, correction and performance evaluation. Calibration techniques are presented with an explanation of how they interact with each other as they are modified. Shows the reader how to determine if, in fact, a robot problem is a calibration problem and then how to analyze it.

Robotic Measurement System

The topics addressed in this book cover the whole range of kinematic analysis, synthesis and design and consider robotic systems possessing serial, parallel and cable driven mechanisms. The robotic systems range from being less than fully mobile to kinematically redundant to over constrained. The fifty-six contributions report the latest results in robot kinematics with emphasis on emerging areas such as design and control of humanoid or humanoid subsystems. The book is of interest to
researchers wanting to bring their knowledge up to date regarding modern topics in one of the basic disciplines in robotics, which relates to the essential property of robots, the motion of mechanisms.

**Modular Robots: Theory and Practice**

Grave Rudolf

Robot calibration is the process of enhancing the accuracy of a robot by modifying its control software. This book provides a comprehensive treatment of the theory and implementation of robot calibration using computer vision technology. It is the only book to cover the entire process of vision-based robot calibration, including kinematic modeling, camera calibration, pose measurement, error parameter identification, and compensation. The book starts with an overview of available techniques for robot calibration, with an emphasis on vision-based techniques. It then describes various robot-camera systems. Since cameras are used as major measuring devices, camera calibration techniques are reviewed. Camera-Aided Robot Calibration studies the properties of kinematic modeling techniques that are suitable for robot calibration. It summarizes the well-known Denavit-Hartenberg (D-H) modeling convention and indicates the drawbacks of the D-H model for robot calibration. The book develops the Complete and Parametrically Continuous (CPC) model and the modified CPC model, that overcome the D-H model singularities. The error models based on these robot kinematic modeling conventions are presented. No other book available addresses the important, practical issue of hand/eye calibration. This book summarizes current research developments and demonstrates the pros and cons of various approaches in this area. The book discusses in detail the final stage of robot calibration - accuracy compensation - using the identified kinematic error parameters. It offers accuracy compensation algorithms, including the intuitive task-point redefinition and inverse-jacobian algorithms and more advanced algorithms based on optimal control theory, which are particularly attractive for highly redundant manipulators. Camera-Aided Robot Calibration defines performance indices that are designed for off-line, optimal selection of measurement configurations. It then describes three approaches: closed-form, gradient-based, and statistical optimization. The included case study presents experimental results that were obtained by calibrating common industrial robots. Different stages of operation are detailed, illustrating the applicability of the suggested techniques for robot calibration. Appendices provide readers with preliminary materials for easier comprehension of the subject matter. Camera-Aided Robot Calibration is a must-have reference for researchers and practicing engineers-the only one with all the information!

**The Development of a Genetic Programming Method for Kinematic Robot Calibration**

**An Evaluation of Robot Calibration Techniques for World Accuracy Improvement**

**Fundamentals of Manipulator Calibration**

**Intelligent Computing Methodologies**

This book contains 26 papers presented at the NATO Advanced Research Workshop on "CAD Based Programming for Sensory Robots," held in IL CIOCCA, Italy, July 4-6, 1988. CAD based robot programming is considered to be the process where CAD (Computer Based) models are used to develop robot programs. If the program is generated, at least partially, by a programmer interacting, for example, with a computer graphics display of the robot and its workcell environment, the process is referred to as graphical off-line programming. On the other hand, if the robot program is generated automatically, for example, by a computer, then the process is referred to as automatic robot programming. The key element here is the use of CAD models both for interactive and automatic generation of robot programs. CAD based programming, therefore, brings together computer based model generation and robot program generation and as such cuts across several disciplines including geometric modeling, robot programming, kinematic and dynamic modeling, artificial intelligence, sensory monitoring and so-on.

**Visual Sensing and its Applications**

This two volume set LNAI 8917 and 8918 constitutes the refereed proceedings of the 7th International Conference on Intelligent Robotics and Applications, ICIRA 2014, held in Guangzhou, China, in December 2014. The 109 revised full papers presented were carefully reviewed and selected from 159 submissions. The papers aim at enhancing the sharing of individual experiences and expertise in intelligent robotics with particular emphasis on technical challenges associated with varied applications such as biomedical applications, industrial automations, surveillance, and sustainable mobility.

**A New Robot Calibration Methodology and Experimental Study**

**Robot Vision**

The purpose of robot vision is to enable robots to perceive the external world in order to perform a large range of tasks such as navigation, visual servoing for object tracking and manipulation, object recognition and categorization, surveillance, and higher-level decision-making. Among different perceptual modalities, vision is arguably the most important one. It is therefore an essential building block of a cognitive robot. This book presents a snapshot of the wide variety of work in robot vision...
that is currently going on in different parts of the world.

Image-Guided Interventions

This book – in conjunction with the volumes LNCS 8588 and LNBI 8590 – constitutes the refereed proceedings of the 10th International Conference on Intelligent Computing, ICIC 2014, held in Taiyuan, China, in August 2014. The 85 papers of this volume were carefully reviewed and selected from numerous submissions. The papers are organized in topical sections such as soft computing; artificial bee colony algorithms; unsupervised learning; kernel methods and supporting vector machines; machine learning; fuzzy theory and algorithms; image processing; intelligent computing in computer vision; intelligent computing in communication networks; intelligent image/document retrievals; intelligent data analysis and prediction; intelligent agent and Web applications; intelligent fault diagnosis; knowledge representation/reasoning; knowledge discovery and data mining; natural language processing and computational linguistics; next generation sequencing and metagenomics; intelligent computing in scheduling and engineering optimization; advanced modeling, control and optimization techniques for complex engineering systems; complex networks and their applications; time series forecasting and analysis using artificial neural networks; computer human interaction using multiple visual cues and intelligent computing; biometric system and security for intelligent computing.

A New Objective Function for Robot Calibration

Robot Calibration: Modeling Measurement and Applications

An Experimental Comparison of Robot Kinematic Calibration Methods

This book introduces the latest advances in modular robotics, and presents a unified geometric framework for modeling, analysis, and design of modular robots, including kinematics, dynamics, calibration, and configuration optimization. Supplementing the main content with a wealth of illustrations, the book offers a valuable guide for researchers, engineers and graduate students in the fields of mechatronics, robotics, and automation who wish to learn about the theory and practice of modular robots.

Robot Calibration

This book presents the proceedings of the 31st International Conference on Robotics in Alpe-Adria-Danube Region (RAAD), held in Klagenfurt, Austria, June 8-10, 2022. It gathers contributions by researchers from several countries on all major areas of robotic research, development and innovation, as well as new applications and current trends. The topics covered include: novel designs and applications of robotic systems, intelligent cooperating and service robots, advanced robot control, human-robot interfaces, robot vision systems, mobile robots, humanoid and walking robots, bio-inspired and swarm robotic systems, aerial, underwater and spatial robots, robots for ambient assisted living, medical robots and bionic prostheses, cognitive robots, cloud robotics, ethical and social issues in robotics, etc. Given its scope, the book offers a source of information and inspiration for researchers seeking to improve their work and gather new ideas for future developments.

Camera-Aided Robot Calibration

Robot Calibration Using Artificial Neural Networks

Robot calibration is the process of identifying the real geometrical parameters in the kinematic structure of an industrial robot. This book compares different robot calibration methods used in the industry with different measurement systems (laser trackers, stereo cameras, touch probes, ). This work introduces easier and more affordable robot calibration methods, such as calibrating robots with a telescoping ballbar. The robot calibration methods described in this book are the same methods used in RoboDK , a software tool for offline programming, robot calibration and robot performance tests, including the ISO 9283 tests.

Modelling, Simulation and Robot Calibration

Modelling, Simulation and Robot Calibration

This book is the proceedings of the 9th International Symposium of Robotics Research, one of the oldest and most prestigious conferences in robotics. The goal of the symposium was to bring together active, leading robotics researchers from academia, government and industry, to define the state of the art of robotics and its future direction. The broad spectrum of robotics research is covered, with an eye on what will be important in robotics in the next millennium.

Intelligent Robotics and Applications

Intelligent Robotics and Applications

Responding to the growing demand for minimally invasive procedures, this book provides a comprehensive overview of the current technological advances in image-guided surgery. It blends the expertise of both engineers and physicians, offering the latest findings and applications. Detailed color images guide readers through the latest techniques, including cranial, orthopedic, prostate, and endovascular interventions.
Affordable Robot Calibration for Industrial Robots

CAD Based Programming for Sensory Robots

Robot Calibration and Performance Measurement

This journal sub-line is a forum both for stimulating and disseminating cutting-edge material on the full spectrum of edutainment genres including game-based learning and VR-based education. It covers technical aspects from graphics and AI to systems design.

Robotics in Smart Manufacturing

The International Conference on Intelligent Computing (ICIC) was formed to provide an annual forum dedicated to the emerging and challenging topics in artificial intelligence, machine learning, pattern recognition, image processing, bioinformatics, and computational biology. It aims to bring together researchers and practitioners from both academia and industry to share ideas, problems, and solutions related to the multifaceted aspects of intelligent computing. ICIC 2010, held in Changsha, China, August 18-21, 2010, constituted the 6th International Conference on Intelligent Computing. It built upon the success of ICIC 2009, ICIC 2008, ICIC 2007, ICIC 2006, and ICIC 2005, that were held in Ulsan, Korea, Shanghai, Qingdao, Kunming and Hefei, China, respectively. This year, the conference concentrated mainly on the theories and methodologies as well as the emerging applications of intelligent computing. Its aim was to unify the picture of contemporary intelligent computing techniques as an integral concept that highlights the trends in advanced computational intelligence and bridges theoretical research with applications. Therefore, the theme for this conference was "Advanced Intelligent Computing Technology and Applications." Papers focusing on this theme were solicited, addressing theories, methodologies, and applications in science and technology.

Robot Calibration and Performance Specification Determination
Progress in Robotics and Intelligent Systems

This is the second text of a series that focuses on developments in robotics and intelligent systems, and provides insight, guidance, and specific techniques for those concerned with the design and implementation of robotics and intelligent system applications.

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