

Manual vs. robotic milling parameters for development of a new robotic system in cranial surgery

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Abstract. The milling of bone is a time-consuming and straining effort during surgery at the cranial vault. In order to determine possible advantages of a robotic system, the registration of different milling parameters during defined surgical procedures was the aim of this study. Eleven neurosurgeons were asked to mill a bovine scapula. The task consisted of geometric figures (one line and a circle) that had to be milled in a depth of 3 mm. Main focus was laid on the accuracy of the milling. In addition, the registered parameters such as forces, temperature and speed will be used as a reference for the design and validation of the robotic system. The same task was done by a robotic (hexapod) system, constructed at the Helmholtz-Institute Aachen (HIA). In comparison with the surgeon, the robotic system showed a higher accuracy at a greater velocity. The forces and temperatures showed minor differences. If further test results are consistent, it would be advantageous to use a robotic system to perform large craniectomies, especially in cosmetically relevant areas due to its advantage in accuracy and speed compared to a surgeon. © 2004 CARS and Elsevier B.V. All rights reserved.

Keywords: Bone milling; Craniotomy; Robot-assisted surgery

1. Introduction

In cases of metastatic involvement of the cranial vault or in some meningiomas the surgeon has to handle destructed or tumor-infiltrated skull during craniotomy and craniectomy, in a large number of cases located at the forehead of the patient. Due to the cosmetically relevant area a precise milling is needed, especially in case a template and a prefabricated implant has to be used. Resection of large pathologies is a time-consuming and straining surgical procedure.

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Medical Image Computing and Computer Assisted Intervention - MICCAI 2019 Dinggang Shen, Tianming Liu, Terry M. Peters, Lawrence H. Staib, Caroline Essert, Sean Zhou, Pew-Thian Yap, Ali Khan, 2019-10-10 The six volume set LNCS 11764 11765 11766 11767 11768 and 11769 constitutes the refereed proceedings of the 22nd International Conference on Medical Image Computing and Computer Assisted Intervention MICCAI 2019 held in Shenzhen China in October 2019 The 539 revised full papers presented were carefully reviewed and selected from 1730 submissions in a double blind review process The papers are organized in the following topical sections Part I optical imaging endoscopy microscopy Part II image segmentation image registration cardiovascular imaging growth development atrophy and progression Part III neuroimage reconstruction and synthesis neuroimage segmentation diffusion weighted magnetic resonance imaging functional neuroimaging fMRI miscellaneous neuroimaging Part IV shape prediction detection and localization machine learning computer aided diagnosis image reconstruction and synthesis Part V computer assisted interventions MIC meets CAI Part VI computed tomography X ray imaging Robotics in Surgery Russel A. Faust, 2007 Robotics began as a science fiction creation which has become quite real first in assembly line operations such as automobile manufacturing airplane construction etc They have now reached such areas as the ever multiplying medical field Robotic surgery is now becoming highly practised in open heart lung and other forms of surgery This book covers the developing stages of robotic surgery and its expectations in the medical field *Computer Assisted Radiology and Surgery*, 2004 **Concept and Design of a Hand-held Mobile Robot System for Craniotomy** Kane, Gavin J., 2013-10-30 This work demonstrates a highly intuitive robot for Surgical Craniotomy Procedures Utilising a wheeled hand held robot to navigate the Craniotomy Drill over a patient's skull the system does not remove the surgeons from the procedure but supports them during this critical phase of the operation CARS 2004 H. U. Lemke, Heinz U. Lemke, 2004 Almost 500 paper and poster contributions from more than 30 countries had to be evaluated for CARS 2004 In addition to the traditional CARS themes and topics emphasis has been given to developments such as IHE Surgical Workflow and PACS Operation Room of the Future and Strategic Thinking In special congress sessions partner societies such as SPIE and SCAR have joined these endeavours to assist in achieving progress in these fields While the increased reliance on multi source information is proceeding at a rapid rate it is interesting to note that the basis for the greater part of medical decision making is still medical imaging This may change as genomics and proteomics fulfil more of their potential but it is estimated that more than half of current hospital visits result in imaging studies In that respect it is true that the more things change the more they stay the same Alphonse Karr 1849 and that medical imaging is the cornerstone of the field This focus on medical imaging is evident throughout the CARS conference with sessions dedicated to Medical Imaging MI itself Image Processing and Display IPD Image Guided Radiological Therapy IGRT Image Guided Therapy IGT and separate symposia on Computer Aided Diagnosis based on imaging and both

Cardiovascular and Maxillofacial Imaging Still it is up to you the engineers scientists clinicians and related personnel participating in CARS to ensure that innovation in technology and procedures is not developed just for the sake of change but instead to achieve progress and thereby provide better patient care

Handbook of Robotic and Image-Guided Surgery

Mohammad Hossein Abedin Nasab,2019-09-25 Handbook of Robotic and Image Guided Surgery provides state of the art systems and methods for robotic and computer assisted surgeries In this masterpiece contributions of 169 researchers from 19 countries have been gathered to provide 38 chapters This handbook is 744 pages includes 659 figures and 61 videos It also provides basic medical knowledge for engineers and basic engineering principles for surgeons A key strength of this text is the fusion of engineering radiology and surgical principles into one book A thorough and in depth handbook on surgical robotics and image guided surgery which includes both fundamentals and advances in the field A comprehensive reference on robot assisted laparoscopic orthopedic and head and neck surgeries Chapters are contributed by worldwide experts from both engineering and surgical backgrounds

Total Knee Arthroplasty Johan Bellemans,Michael D. Ries,Jan M.K.

Victor,2005-08-01 Take away my knee pain and give me better motion This is what the arthritic patient expects from a Total Knee Arthroplasty TKA By virtue of standardization of the TKA procedure surgeons can nowadays solve the pain issue for the majority of the patients Restoration of function is a goal of a different order and forms the scope of this book The editors confronted today s leading knee surgeons with the limitations of current surgical techniques and technology They challenged them to define new thresholds of functional capacity after Total Knee Arthroplasty A Guide to Get Better Performance in TKA describes the cutting edge in surgical techniques prosthetic design and achievement of excellent function for these patients

Medical Robotics Vanja Bozovic,2008-01-01 The first generation of surgical robots are already being installed in a number of operating rooms around the world Robotics is being introduced to medicine because it allows for unprecedented control and precision of surgical instruments in minimally invasive procedures So far robots have been used to position an endoscope perform gallbladder surgery and correct gastroesophageal reflux and heartburn The ultimate goal of the robotic surgery field is to design a robot that can be used to perform closed chest beating heart surgery The use of robotics in surgery will expand over the next decades without any doubt Minimally Invasive Surgery MIS is a revolutionary approach in surgery In MIS the operation is performed with instruments and viewing equipment inserted into the body through small incisions created by the surgeon in contrast to open surgery with large incisions This minimizes surgical trauma and damage to healthy tissue resulting in shorter patient recovery time The aim of this book is to provide an overview of the state of art to present new ideas original results and practical experiences in this expanding area Nevertheless many chapters in the book concern advanced research on this growing area The book provides critical analysis of clinical trials assessment of the benefits and risks of the application of these technologies This book is certainly a small sample of the research activity on Medical Robotics going on around the globe as you read it but it surely covers a good deal of what has been done in the field

recently and as such it works as a valuable source for researchers interested in the involved subjects whether they are currently medical roboticists or not

European Robotics Forum 2024 Cristian Secchi, Lorenzo Marconi, 2024-12-31 This book collects the scientific contributions presented at the European Robotics Forum ERF 2024 that is the reference event for the EuRobotics association In the months leading up to the forum a direct call was launched to the many industrial players who are members of EuRobotics and who were asked to specify particularly important areas of development according to their roadmap The outcome of this survey and the topics of the Workshops held during the forum have been used to calibrate an industry driven scientific program where research objectives meet industrial needs The contributions collected in the book cover a wide spectrum of robotics research encompassing mechatronics algorithms Artificial Intelligence Human Robot Collaboration and many robotic applications

Advances on Mechanics, Design Engineering and Manufacturing IV Salvatore Gerbino, Antonio Lanzotti, Massimo Martorelli, Ramón Mirálbes Buil, Caterina Rizzi, Lionel Roucoules, 2022-09-24 This book gathers contributions presented at the International Joint Conference on Mechanics Design Engineering and Advanced Manufacturing JCM 2022 held on June 1 3 2022 in Ischia Italy It reports on cutting edge topics in product design and manufacturing such as industrial methods for integrated product and process design innovative design and computer aided design Further topics covered include virtual simulation and reverse engineering additive manufacturing product manufacturing engineering methods in medicine and education representation techniques and collaborative and soft robotics The book is organized into five main parts reflecting the focus and primary themes of the conference The contributions presented here not only provide researchers engineers and experts in a range of industrial engineering subfields with extensive information to support their daily work they are also intended to stimulate new research directions advanced applications of the methods discussed and future interdisciplinary collaborations

Rob|Arch 2012 Sigrid Brell-Cokcan, Johannes Braumann, 2013-12-16 This volume collects about 20 contributions on the topic of robotic construction methods It is a proceedings volume of the robarch2012 symposium and workshop which will take place in December 2012 in Vienna Contributions will explore the current status quo in industry science and practitioners The symposium will be held as a biennial event This book is to be the first of the series comprising the current status of robotics in architecture art and design

Total Hip Arthroplasty Emre Tokgoz, 2022-10-19 Total Hip Arthroplasty Medical and Biomedical Engineering and Science Concepts provides an extensive overview of the most recent advancements in total hip arthroplasty THA through a thorough review of the literature in medicine engineering mathematics computing and related technologies Coverage includes the most recent engineering and computing techniques such as robotics biomechanics artificial intelligence and optimization as well as the medical and surgical aspects of pre existing conditions surgical procedure types postoperative complications and patient care This book will be a valuable introductory reference for academics students and researchers to THA concepts and advances

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 Alpe Adria 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 Intelligent Robotics and Applications Honghai Liu,Naoyuki Kubota,Xiangyang Zhu,Rüdiger Dillmann,Dalin

Zhou,2015-08-19 This three volume set LNAI 9244 9245 and 9246 constitutes the refereed proceedings of the 8th International Conference on Intelligent Robotics and Applications ICIRA 2015 held in Portsmouth UK in August 2015 The 61 papers included in the second volume are organized in topical sections on man machine interaction robot design development and control navigation and planning robot motion analysis and planning medical robot prototyping and manufacturing **Recent Developments in the Field of Non-Destructive Testing, Safety and Materials Science**

Elena Lysenko,Alexander Rogachev,Oldřich Starý,2022-06-14 This book presents the latest advances and emerging trends in research and industrial applications in non destructive testing manufacturing and process safety and diagnostics and materials science With technological advances the modern world is on the verge of a new industrial revolution being in the stage of digital transformation when innovations from different industries interpenetrate and complement each other The School of Non Destructive Testing Tomsk Polytechnic University Russia promotes scientific research and industrial application of non destructive testing and materials science technologies and related tests as well as methods to ensure safe manufacturing processes Today research and technology advancement is driven by innovations and there is a need for publications to stimulate the formation and continuous training of specialists in non destructive testing materials science and safety This book can be used as a complementary technical document to upgrade the skills of specialists in non destructive testing materials science and safety and as a primary resource for training managers and decision makers in various industries Innovations in the fields of non destructive testing production and process safety diagnostics and materials science and books that highlight the best and instructive are central to our technological world I am pleased to see this comprehensive book taking shape and advancing this field to the next generation of scientists seeking for new research opportunities **Coding Architecture** Pierpaolo Ruttico,2023-12-29 This book provides a clear picture of how

computational processes are gradually permeating and innovating the Architecture Engineering and Construction sector contributing to sustainability and aesthetic evolution It achieves that by gathering a collection of accounts shared by pioneering professionals involved in this innovation drawing from recent academic studies ongoing experimental processes conducted in cutting edge architectural and engineering offices as well as innovative industrial applications The covered subjects span a wide range including artificial intelligence and robotic manufacturing the metaverse and 3D printing strategies to counter CO2 consumption through plug ins as well as emerging materials and construction techniques The chapters feature authors who are pioneers and embrace roles like software developers architects process engineers academics and forward thinking entrepreneurs They represent authoritative references within a broader interconnected cultural and technological system an eclectic system that finds in computational processes the key to addressing the new challenges of contemporary architecture

Intelligent Robotics and Applications Haibin Yu, Jinguo Liu, Lianqing Liu, Zhaojie Ju, Yuwang Liu, Dalin Zhou, 2019-08-05 The volume set LNAI 11740 until LNAI 11745 constitutes the proceedings of the 12th International Conference on Intelligent Robotics and Applications ICIRA 2019 held in Shenyang China in August 2019 The total of 378 full and 25 short papers presented in these proceedings was carefully reviewed and selected from 522 submissions The papers are organized in topical sections as follows Part I collective and social robots human biomechanics and human centered robotics robotics for cell manipulation and characterization field robots compliant mechanisms robotic grasping and manipulation with incomplete information and strong disturbance human centered robotics development of high performance joint drive for robots modular robots and other mechatronic systems compliant manipulation learning and control for lightweight robot Part II power assisted system and control bio inspired wall climbing robot underwater acoustic and optical signal processing for environmental cognition piezoelectric actuators and micro nano manipulations robot vision and scene understanding visual and motional learning in robotics signal processing and underwater bionic robots soft locomotion robot teleoperation robot autonomous control of unmanned aircraft systems Part III marine bio inspired robotics and soft robotics materials mechanisms modelling and control robot intelligence technologies and system integration continuum mechanisms and robots unmanned underwater vehicles intelligent robots for environment detection or fine manipulation parallel robotics human robot collaboration swarm intelligence and multi robot cooperation adaptive and learning control system wearable and assistive devices and robots for healthcare nonlinear systems and control Part IV swarm intelligence unmanned system computational intelligence inspired robot navigation and SLAM fuzzy modelling for automation control and robotics development of ultra thin film flexible sensors and tactile sensation robotic technology for deep space exploration wearable sensing based limb motor function rehabilitation pattern recognition and machine learning navigation localization Part V robot legged locomotion advanced measurement and machine vision system man machine interactions fault detection testing and diagnosis estimation and identification mobile robots and intelligent autonomous

systems robotic vision recognition and reconstruction robot mechanism and design Part VI robot motion analysis and planning robot design development and control medical robot robot intelligence learning and linguistics motion control computer integrated manufacturing robot cooperation virtual and augmented reality education in mechatronics engineering robotic drilling and sampling technology automotive systems mechatronics in energy systems human robot interaction

Robotic Fabrication in Architecture, Art and Design 2016 Dagmar Reinhardt, Rob Saunders, Jane Burry, 2016-02-03 The book presents the proceedings of Rob Arch 2016 the third international conference on robotic fabrication in architecture art and design The work contains a wide range of contemporary topics from methodologies for incorporating dynamic material feedback into existing fabrication processes to novel interfaces for robotic programming to new processes for large scale automated construction The latent argument behind this research is that the term file to factory must not be a reductive celebration of expediency but instead a perpetual challenge to increase the quality of feedback between design matter and making

CAD/CAM Robotics and Factories of the Future S. Narayanan, K. Gokul Kumar, K. Janardhan Reddy, P. Kuppan, 2006 Presents state of the art research and case studies from over 150 Design Product Design Rapid Prototyping and Tooling Manufacturing Processes Micromachining and Miniaturisation Mechanism and Robotics Artificial Intelligence and Material Handling Systems

Intelligent Robotics and Applications Sabina Jeschke, Honghai Liu, Daniel Schilberg, 2011-12-03 The two volume set LNAI 7101 and 7102 constitute the refereed proceedings of the 4th International Conference on Intelligent Robotics and Applications ICIRA 2011 held in Aachen Germany in November 2011 The 122 revised full papers presented were thoroughly reviewed and selected from numerous submissions They are organized in topical sections on progress in indoor UAV robotics intelligence industrial robots rehabilitation robotics mechanisms and their applications multi robot systems robot mechanism and design parallel kinematics parallel kinematics machines and parallel robotics handling and manipulation tangibility in human machine interaction navigation and localization of mobile robot a body for the brain embodied intelligence in bio inspired robotics intelligent visual systems self optimising production systems computational intelligence robot control systems human robot interaction manipulators and applications stability dynamics and interpolation evolutionary robotics bio inspired robotics and image processing applications

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