Robotic Exoskeleton For Rehabilitation Of The Upper Limb


Passive Upper-Limb Exoskeleton Hand Rehabilitation of Stroke PatientThe book reports on advanced topics in the areas of wearable robotics research and practice. It focuses on new technologies, including neural interfaces, soft wearable robots, sensors and actuators technologies, and discusses important regulatory challenges, as well as clinical and ethical issues. Based on the 2nd International Symposium on Wearable Robotics, WeRob2016, held October 18-21, 2016, in Segovia, Spain, the book addresses a large audience of academics and professionals working in government, industry, and medical centers, and end-users alike. It provides them with specialized information and with a source of inspiration for new ideas and collaborations. It discusses exemplary case studies highlighting practical challenges related to the implementation of wearable robots in a number of fields. One of the focus is on clinical applications, which was encouraged by the organization of WeRob2016 with the International Conference on Neurorehabilitation, INCR2016. Additional topics include space applications and assistive technologies in the industry. The book merges together the engineering, medical, ethical and political perspectives, thus offering a multidisciplinary, timely snapshot of the field of wearable technologies.

Living with Robots Rehabilitation Robotics summarizes the rationale for robot-assisted therapy and presents the technological steps in the evolution of the design and development of advanced wearable and upper extremity rehabilitation robots. After presenting the basic mechanisms of natural and artificial movement restoration, and the rationale for robot-aided movement therapy, it shows several design criteria that are relevant for the development of effective and safe rehabilitation robots.

Interfacing Humans and Robots for Gait Assistance and Rehabilitation Stroke is one of the most challenging diseases to treat because of the physical disability it causes. In New Zealand and many other countries, the rate of new cases is increasing rapidly. One of the biggest challenges is how to design and develop effective and safe robotic systems to assist and rehabilitate patients with gait disorders. This book provides a comprehensive overview of the state of the art in the field of gait and balance rehabilitation. It describes technologies and devices together with the requirements and factors to be considered during their application in clinical settings. The book covers physiological and pathophysiological basis of locomotion and posture control, describes integrated approaches for the treatment of neurological diseases and spinal cord injury, as well as important principles for designing appropriate clinical studies. It presents computer and robotic technologies currently used in rehabilitation, such as exoskeleton devices, functional electrical stimulation, virtual reality and many more, highlighting the main advantages and challenges both from the clinical and engineering perspective. Written in an easy-to-understand style, the book is intended for people with different background and expertise, including medical and engineering students, clinicians and physiotherapists, as well as technical developers of rehabilitation systems and their corresponding human-computer interfaces. It aims at fostering an increased awareness of available technologies for balance and gait rehabilitation, as well as a better communication and collaboration between the users and developers.

Advances in Mechanism and Machine Science Wearable exoskeletons are electro-mechanical systems designed to assist, augment, or enhance motion and mobility in a variety of human motion applications and scenarios. The applications, ranging from providing power supplementation to assist the wearers to situations where human motion is resisted for exercising applications, cover a wide range of domains such as medical devices for patient rehabilitation training recovering from trauma, movement aids for disabled persons, personal care robots for providing daily living assistance, and reduction of physical burden in industrial and military applications. The development of effective and affordable wearable exoskeletons poses several design, control and modelling challenges to researchers and manufacturers. Novel technologies are therefore being developed in adaptive motion controllers, human-robot interaction control, biophysical sensors and actuators, materials and structures, etc. In this book, the editors and authors report recent advances and technology breakthroughs in exoskeleton developments. It will be of interest to engineers and researchers in academia and industry as well as manufacturing companies interested in developing new markets in wearable exoskeleton robotics.

Textbook of Neural Repair and Rehabilitation Volume 2 of the Textbook of Neural Repair and Rehabilitation stands alone as a clinical handbook for neurorehabilitation.

Rehabilitation Robotics The book reports on advanced topics in the areas of wearable robotics research and practice. It focuses on new technologies, including neural interfaces, soft wearable robots, sensors and actuators technologies, and discusses important regulatory challenges, as well as clinical and ethical issues. Based on the 4th International Symposium on Wearable Robotics, WeRob2018, held October 16-20, 2018, in Pisa, Italy, the book addresses a large audience of academics and professionals working in government, industry, and medical centers, and end-users alike. It provides them with specialized information and with a source of inspiration for new ideas and collaborations. It discusses exemplary case studies highlighting practical challenges related to the implementation of wearable robots in a number of fields. One of the focus is on clinical applications, which was encouraged by the organization of WeRob2018 with the International Conference on Neurorehabilitation, INCR2018. Additional topics include space applications and assistive technologies in the industry. The book merges together the engineering, medical, ethical and political perspectives, thus offering a multidisciplinary, timely snapshot of the field of wearable technologies.

Human-Centric Robotics The book reports on advanced topics in the areas of wearable robotics research and practice. It focuses on new technologies, including neural interfaces, soft wearable robots, sensors and actuators technologies, and discusses important regulatory challenges, as well as clinical and ethical issues. Based on the 4th International Symposium on Wearable Robotics, WeRob2018, held October 16-20, 2018, in Pisa, Italy, the book addresses a large audience of academics and professionals working in government, industry, and medical centers, and end-users alike. It provides them with specialized information and with a source of inspiration for new ideas and collaborations. It discusses exemplary case studies highlighting practical challenges related to the implementation of wearable robots in a number of fields. One of the focus is on clinical applications, which was encouraged by the organization of WeRob2018 with the International Conference on Neurorehabilitation, INCR2018. Additional topics include space applications and assistive technologies in the industry. The book merges together the engineering, medical, ethical and political perspectives, thus offering a multidisciplinary, timely snapshot of the field of wearable technologies.
the possibilities of the robot while allowing them to maintain control of the robot at all times. This book gives a general overview of the robotics exoskeletons and introduces the reader to this robotic field. Moreover, it describes the development of an upper limb exoskeleton for tremor suppression in order to illustrate the influence of a specific application in the designs decisions.

Exoskeletons in Rehabilitation Robotics The potential systems of robotic technologies to aid in the rehabilitation of populations with cerebral palsy is a burgeoning area of research. It is able to provide more repeatable and enjoyable physiotherapy regimes, in addition to lessening the burden on physiotherapists, shifting their work to a supervisory role. In this chapter, the authors present a control architecture for an elbow exoskeleton device is presented. The exoskeleton could afford the novel actuation joint, presented as the Bio-Sensor & Joint (BJS) and this is used to apply torques to the elbow joint. A torque controller based on sliding mode control (SMC) was derived from a model of the system and compared to a feedback-linearised proportional derivative (PD) controller for pure trajectory tracking. It was found that the SMC controller was more robust to distortions and modeling uncertainties. The SMC controller was then tested for efficacy in applying torques to the elbows of human participants, while they conducted Activities of Daily Living (ADLs), where it was found that constant torques could be applied regardless of the presence of variable human motion. Tests were also conducted for evaluating the SMC torque controller for reducing human input and was shown to reduce trajectory error for both healthy participants and a participant diagnosed with cerebral palsy. Finally, a high-level gravity augmentation controller was developed that uses Denavit- Hartenberg parameters to estimate the component of gravity perpendicular to the forearm. With this information, the SMC torque controller can be commanded to exert a torque on the elbow that varies in response to orientation relative to the gravity vector, thus simulating the lifting of a weight. Experiments were conducted where participants were asked to perform a range of physical and simulated weightlifting (sEMG) signals, with sEMG signals as a measure of exertion. While the controller was able to accurately vary the torque on the elbow as the orientation relative to the gravity vector changed, it was not possible to draw statistically significant conclusions regarding the effect of the augmented gravity conditions on the participants’ physical exertion.

Converging Clinical and Engineering Research on Neurorehabilitation II The concepts represented in this textbook are explored for the first time in assistive and rehabilitation robotics, which is the combination of physical, cognitive, and social human–robot interaction to empower gait rehabilitation and assist human mobility. The aim is to consolidate the methodologies, modules, and technologies implemented in lower-limb exoskeletons, smart walkers, and social robots when human gait assistance and rehabilitation are the primary targets. This book presents the combination of emergent technologies in healthcare applications and robotics science, such as soft robotics, force control, novel sensing methods, brain–computer interfaces, serious games, automatic learning, and motion planning. From the clinical perspective, case studies are presented for testing and evaluating how these robots interact with humans, analyzing acceptance, perception, biomechanics factors, and physiological mechanisms of recovery during the robotic assistance or therapy. Interfacing Humans and Robots for Gait Assistance and Rehabilitation will enable undergraduate and graduate students of biomedical engineering, rehabilitation engineering, robotics, and health sciences to understand the clinical needs, technology, and science of human–robot interaction behind robotic devices for rehabilitation, and the evidence and implications related to the implementation of those devices in actual therapy and daily life applications.

Development of Human-inspired Robotic Exoskeleton (HuREx) Designed for Lower-limb Gait Rehabilitation for Stroke Patients

The book reports on advanced topics in the areas of neurorehabilitation research and practice. It focuses on new methods for interfacing the human nervous system with electronic and mechatronic systems to restore motor function and neural function. Importantly, the book combines perspectives from basic research, clinical research, and interdisciplinary engineering ones, to promote, feed and encourage collaborations between clinicians, neuroscientists and engineers. Based on the 2016 International Conference on Neurorehabilitation (ICNR 2016) held on October 18-21, 2016, in Segovia, Spain, this book covers various aspects of neurorehabilitation research and practice, including new insights into biomechanics, brain physiology, neuropsychology, and brain damages and diseases, as well as innovative methods and technologies for studying and/or recovering brain function, from data mining to interface technologies and neuroprosthetics. In this way, it offers a concise, yet comprehensive reference guide to neurosurgeons, rehabilitation physicians, neurologists, and bioengineers. Moreover, by highlighting current challenges in understanding brain diseases as well as in the available technologies and their implementation, the book is also expected to foster new collaborations between the different groups, thus stimulating new ideas and research directions.

Wearable Robotics: Challenges and Trends

This book contains the proceedings of the 1st Latin American Congress on Automation and Robotics held at Panama City, Panama in February 2017. It gathers research work from researchers, scientists, and engineers from academia and private industry, and presents current and exciting research applications and future challenges in Latin American. The scope of this book covers a wide range of themes associated with advances in automation and robotics research encountered in engineering and scientific research and practice. These topics are related to control algorithms, systems automation, perception, robotics, computer vision, educational robotics, robotics modeling and simulation, and robotics and mechanism design. LACAR 2017 has been sponsored by SENACYT (Secretaría Nacional de Ciencia, Tecnología e Innovación of Panama).

Wearable Robotics: Challenges and Trends This revised, updated second edition provides an accessible, practical overview of major areas of technical development and clinical application in the field of neurorehabilitation movement therapy. The initial section provides a rationale for technology application in movement therapy by summarizing recent developments in neuroplasticity and motor learning. It then explains the state of the art in human–machine interaction requirements for clinical rehabilitation practice. Subsequent sections describe the ongoing revolution in robotic therapy for upper extremity movement and for walking, and then describe other emerging technologies including electrical stimulation, virtual reality, wearable sensors, and brain–computer interfaces. The promises and limitations of these technologies in neurorehabilitation are discussed. Throughout the book the chapters provide detailed practical information on state-of-the-art clinical applications of these technologies, spinal cord injury, and other neurological disorders. The text is illustrated, spinal cord with photographs and schematic diagrams which serve to clarify the information for the reader. Neurorehabilitation Technology, Second Edition is a valuable resource for neurologists, biomedical engineers, roboticists, rehabilitation specialists, physiotherapists, occupational therapists and those training in these fields.

Essentials of Physical Medicine and Rehabilitation Present Your Research to the World!

The World Congress 2009 on Medical Physics and Biomedical Engineering – the triennial scientific meeting of the IUPPSM - is the world’s leading forum for presenting the results of current scientific work in health-related physics and technologies to an international audience. With more than 2,800 presentations it will be the biggest conference in the field of Medical Physics and Biomedical Engineering in 2009! Medical physics, biomedical engineering and bioengineering have been driving forces of innovation and progress in medicine and healthcare over the past two decades. As new key technologies arise with significant potential to open new options in diagnostics and therapeutics, it is a multidisciplinary task to evaluate their benefit for medicine and healthcare with respect to the quality of performance and therapeutic output. Covering key aspects such as information and communication technologies, micro- and nanosystems, optics and biotechnology, the congress will serve as an inter- and multidisciplinary platform that brings together people from basic research, R&D, industry and medical application to discuss these issues. As a major event for science, medicine and technology the congress provides a comprehensive overview and in-depth, first-hand information on new developments, advanced technologies and current and future applications. With this Final Program we would like to give you an overview of the dimension of the congress and invite you to join us in Munich! Olaf Dössel Congress President Wolfgang C.

Mechatronic Systems in Engineering Every year there are about 800,000 new stroke patients in the US, and many of them suffer from upper limb neuromuscular disabilities including but not limited to: weakness, spasticity and abnormal synergy. Patients usually have the potential to rehabilitate (to some extent) based on neuroplasticity, and physical therapy intervention helps accelerate the recovery. However, many of these patients could not afford the novel actuation joint, presented as the Bio-Sensor & Joint (BJS) and this is used to apply torques to the elbow joint. A torque controller based on sliding mode control (SMC) was derived from a model of the system and compared to a feedback-linearised proportional derivative (PD) controller for pure trajectory tracking. It was found that the SMC controller was more robust to distortions and modeling uncertainties. The SMC controller was then tested for efficacy in applying torques to the elbows of human participants, while they conducted Activities of Daily Living (ADLS), where it was found that constant torques could be applied regardless of the presence of variable human motion. Tests were also conducted for evaluating the SMC torque controller for reducing human input and was shown to reduce trajectory error for both healthy participants and a participant diagnosed with cerebral palsy. Finally, a high-level gravity augmentation controller was developed that uses Denavit- Hartenberg parameters to estimate the component of gravity perpendicular to the forearm. With this information, the SMC torque controller can be commanded to exert a torque on the elbow that varies in response to orientation relative to the gravity vector, thus simulating the lifting of a weight. Experiments were conducted where participants were asked to perform a range of physical and simulated weightlifting (sEMG) signals, with sEMG signals as a measure of exertion. While the controller was able to accurately vary the torque on the elbow as the orientation relative to the gravity vector changed, it was not possible to draw statistically significant conclusions regarding the effect of the augmented gravity conditions on the participants’ physical exertion.
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signals are used. It brings convenience to practical use, as well as technical challenges. (3) To provide better AAN control, which is still not well understood in the academia, I worked out a redundant version of modified dynamic manipulability ellipsoid (DME) model to propose an Arm Postural Stability Index (APSFI) to quantify the difficulty heterogeneity of the 3D Cartesian workspace. The theoretical framework could be used to teach the exoskeleton where and when to provide assistance, and to guide the virtual reality where to add new minimal challenges to stroke patients. To the best of my knowledge, it is also for the first time that human arm redundancy resolution was investigated when arm gravity is considered. (4) For the first time, my colleagues and I have done a pilot study on asymmetric dual-arm training using the exoskeleton system on one (1) post-stroke patient. The exoskeleton on the healthy side could trigger assistance for that on the affected side, and validates that the current mechanism/control is eligible for asymmetric dual-arm training. (5) Other works of mine include: activities of daily living (ADLs) data visualization for VR game difficulty design; human arm synergy modeling; dual-arm manipulation taxonomy classification (on-going work).

Control and Dynamic Manipulability of a Dual-Arm/Hand Robotic Exoskeleton System (EXO-ULB) for Rehabilitation Training in Virtual Reality Spinal cord injury (SCI) is one of the main pathologies causing significant loss of neurological function. Therefore, a variety of pharmacological and non-pharmacological therapies are the aims of several different approaches to SCI. The standard care for patients with SCI can include supportive care, such as physical therapy, occupational therapy, and speech therapy, as well as rehabilitation techniques such as biofeedback, cognitive-behavioral therapy, and neuroplasticity. This book contains eight chapters that are divided into three sections: Introduction, Pharmacological Therapies, and Non-Pharmacological Therapies. The authors of the chapters deal with the pathophysiology of SCI, the effect of antioxidant and immunosuppressive agents, stem cell-based therapies, the use of cultured cells for transplantation or regeneration, and the application of non-invasive modalities (transcutaneous electrical spinal cord stimulation, etc.) for SCI rehabilitation.

Rehabilitation Robotic Hand Exoskeletons A wearable robot is a mechatronic system that is designed around the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with. Teleoperation and power amplification were the first applications, but after recent technological advances the range of application fields has widened. Increasing recognition from the scientific community means that this technology is now employed in telemanipulation, man-amplification, neurorobot control research and rehabilitation, and to assist with impaired human motor control. Logical in structure and original in its global orientation, this volume gives a full overview of wearable robotics, providing the reader with a complete understanding of the key applications and technologies suitable for its development. The main topics are demonstrated through two detailed case studies: one on a lower limb active orthosis for a human leg, and one on a wearable robot that suppresses upper limb tremor. These examples highlight the difficulties and potentialities in this area of technology, illustrating how design decisions should be made based on these. As well as discussing the cognitive interaction between human and robot, this comprehensive text also covers: the mechanics of the wearable robot and its biomechanical interaction with the user, including state-of-the-art technologies that enable sensory and motor interaction between human (biological) and wearable artificial (mechatronic) systems; the basis for bionspiration and biomimetics, general rules for the development of biologically-inspired designs, and how these could serve recursively as biological models to explain biological systems; the study on the development of networks for wearable robotics. Wearable Robotics: Biomechatronic Exoskeletons will appeal to lecturers, senior undergraduate students, postgraduates and other researchers of mechanical, electronic, electrical, and bioengineering who are interested in the area of assistive robotics. Active system developers in this sector of the engineering industry will also find it an informative and welcome resource.

Human-Centric Robotics This 2nd edition remains the only comprehensive evidence-based text on the Occupational Therapy management of the stroke patient. The book presents the most up-to-date research and clinical content in a holistic fashion, combining aspects of background medical information, samples of functionally based evaluations, and treatment techniques and interventions. There are chapters on specific functional aspects of living after stroke, such as driving, sexuality, mobility and gait, and self-care. Instructor resources are available; please contact your Elsevier sales representative for details. Case studies are featured in every chapter to help the reader understand how concepts apply to the real world. 2 chapters that feature the true stories of stroke victims, presenting occupational therapy situations from the point of view of the patient. Key terms, chapter objectives, and review questions help students better understand and remember important information. 7 new chapters make this text more comprehensive than ever! Psychological Aspects of Stroke Rehabilitation Improving Participation and Quality of Life Through Occupation The Task-Oriented Approach to Stroke Rehabilitation Approaches to Motor Control Dysfunction: An Evidence-Based Review Vestibular Rehabilitation and Stroke How Therapists Think: Exploring Clinician's Reasoning When Working With Clients Who Have Cognitive and Perceptual Problems Following Stroke Stroke Rehabilitation: A Multidisciplinary Approach


Spinal Cord Injury Therapy

Clinician's Guide to Assistive Technology Practical and authoritative, this new edition delivers easy access to the latest advances in the diagnosis and management of musculoskeletal disorders and other common conditions requiring rehabilitation. Each topic is presented in a concise, focused, and well-illustrated two-color format featuring a description of the condition, discussion of symptoms, examination findings, functional limitations, and diagnostic testing. The treatment section is extensive and covers initial therapies, rehabilitation interventions, procedures, and surgery. From sore shoulders in cancer patients to spinal cord injuries, Essentials of Physical Medicine and Rehabilitation, 2nd Edition provides you with the knowledge you need to face every challenge you confront. Offers practical, clinically relevant material for the diagnosis and treatment of musculoskeletal disorders. Discusses physical agents and therapeutic exercise in the prevention, diagnosis, treatment and rehabilitation of disorders that produce pain, impairment, and disability. Presents a consistent chapter organization that delivers all the content you need in a logical, practical manner. Presents a new co-editor, Thomas D. Rizzo, Jr., MD, and a pool of talented contributors who bring you fresh approaches to physical medicine and rehabilitation. Offers current evidence and expert guidance to help you make more accurate diagnoses and chose the best treatment option for each patient. Features an entirely new section on pain management so you can help your patients reach their full recovery potential. Incorporates redrawn artwork that makes every concept and technique easier to grasp. Includes updated ICD-9 codes giving you complete information for each disorder.

Rehabilitation Robotics Wearable Systems: Technologies and Applications provides a comprehensive overview of the entire field of wearable robotics, including active orthotics (exoskeleton) and active prosthetics for the upper and lower limb and full body. In its two major sections, wearable robotics systems are described from both engineering perspectives and their application in medicine and industry. Systems and applications at various levels of the development cycle are presented, including those that are still under active research and development, systems that are under preliminary or full clinical trials, and those in commercialized products. This book is a great resource for anyone working in engineering, including researchers, industry professionals and those who want to use it as a teaching mechanism. Provides a comprehensive overview of the entire field, with both engineering and medical perspectives Helps readers quickly and efficiently design and develop wearable robotics for healthcare applications.

Guccione's Geriatric Physical Therapy E-Book Restoring human motor and cognitive function has been a fascinating research area during the last century. Interfacing the human body with the electrical/mechanical devices and robots has been the primary focus of the last 50 years. The future of robotics in rehabilitation is a new frontier for therapists, clinicians and researchers to rehabilitate, diagnose and generate knowledge. The 2012 International Conference on Neurorehabilitation (ICNR2012) brings together researchers and students from the fields of Clinical Rehabilitation, Applied Neurophysiology and Biomedical Engineering, covering a wide range of research topics: - Clinical Impact of Technology - Brain-Computer Interface in Rehabilitation - Neuromotor & Neurosensory modeling and processing - Biomechanics in Rehabilitation - Neuro-Prostheses in Rehabilitation - Neuro-Robotics in Rehabilitation - Neurorehabilitation This Proceedings book includes general contributions (2-page extended abstracts) from oral and poster sessions, as well as from special sessions. A section is also dedicated to pre-post conference workshops, including invited contributions from internationally recognized researchers. A selection of most relevant papers have been considered for publication in international journals (e.g. JNER, JACCES, ...), therefore they will appear soon in their extended versions in Special Issues. These Proceedings also contain brief descriptions of keynote lectures from invited world-class professors, and a number of thematic round tables covering technological and institutional issues.

Wearable Exoskeleton Systems Living with Robots recounts a foundational shift in robotics, from artificial intelligence to artificial empathy, and foreshadows an inflection point in human evolution. As robots engage with people in social meaningful ways, soft robotics probes the nature of the human emotions that social robots are designed to emulate.

Advances in Automation and Robotics Research in Latin America This book can serve as a reference resource for those very same design and control engineers who help connect their everyday experience in design with the control field of mechatronics. This book also consists of basic and main mechatronic system's laboratory applications for use in research and development departments in academia, government, and industry, and it can be used as a reference source in university libraries. It can also be used as a resource for scholars interested in understanding and anticipating the engineering design and control process and for engineering students studying within the traditional structure of most engineering departments and colleges. It is evident that there is an expansion of mechatronics laboratories and classes
in the university environment worldwide.

New Advances in Neurorehabilitation

Exoskeletons in Rehabilitation Robotics Current physical rehabilitation services for stroke utilize a manual hands-on approach with little to no application of modern technology. As a result, physiotherapy treatment is lacking in availability, is highly subjective and can only employ very basic exercises. Increasing efforts are being made towards the development of rehabilitation robots to address these issues. This study explores the use of an exoskeleton robot for physiotherapy rehabilitation of the human upper limb. Analysis of past exoskeleton designs has revealed major limitations in these exoskeletons’ shoulder mechanism which limit the range of motion and the movements that can be performed on the shoulder. To overcome the shortcomings of past mechanism designs, a novel 4R mechanism is proposed. However, there are a range of kinematic designs of the 4R mechanism that can meet the performance requirements of a shoulder exoskeleton. To address this, a set of performance criteria are formulated and the NSGA II optimization algorithm is applied to identify an optimal design. The resulting 4R mechanism is capable of providing a wide shoulder workspace without significant mechanical interference. Performance comparisons with other shoulder mechanism designs confirm the optimized 4R mechanism has superior performance. The optimized 4R mechanism is then used to develop a 5 DOF active exoskeleton system for the shoulder and elbow joints. To maneuver the exoskeleton, an algorithm is developed to generate smooth point-to-point trajectories that are similar to the trajectories in normal human motion. This algorithm is further expanded into a trajectory planner which combines a sequence of point-to-point movements into a continuous trajectory. To control the exoskeleton, two types of admittance control algorithms are developed in this work. The admittance control allows the user’s limb to move the exoskeleton by applying forces at the designated interfaces, during which the exoskeleton can assist or resist user movement. Impedance control involves actuation of the exoskeleton to move the user’s limb through a specified trajectory with an artificial compliance. Experimental results on a healthy human subject demonstrate the diverse capabilities of the exoskeleton. The tools developed in this research open up new possibilities in the field of physical rehabilitation.

Wearable Robotics Gait disorder is a commonly lasting side-effect for stroke and spinal cord injury survivors. Conventional gait rehabilitation trainings provided by therapists are largely dependent on their experience. Such trainings are often challenging for the therapists due to their physically intensive nature. Hence, consistent optimal results cannot always be achieved. Robotic technologies were thus introduced to automate the gait rehabilitation trainings, in order to emancipate therapists from physically intensive work as well as making rehabilitation training more accessible to patients. Research have shown that task specific repetitive training and patients’ active participation can lead to more effective gait rehabilitation. However, conventional trajectory tracking controlled robotic gait rehabilitation could change the dynamics of the walking task, reduce inputs from patients’ motor systems, lower their physical effort and thus result less effective outcomes. Therefore, it is important to ensure that the robotic gait rehabilitation training is more analogous to actual human walking and maximize the training subject’s active participation. The goal of this thesis is the development of a new robotic Gait Rehabilitation EXOskeleton (GAREX) that is compliant with the current neurorehabilitation theories in order to achieve optimised robotic gait rehabilitation. Such goal is tackled systemically in terms of both robotic design and control algorithm research. GAREX was designed to provide safe, task specific gait rehabilitation to stroke patients. Pneumatic muscles (PM) actuators were used to drive GAREX, due to their high power/force to weight ratio and intrinsic compliance. The Intrinsic compliance provides a wide range of dynamic environment for control strategy development. However, the negative correlation between PM’s force output and contracting length means a trade-off between torque and range of motion for the actuation system. The design of GAREX comprehensively addressed torque and joint range of motion requirements imposed by task-specific gait rehabilitation training. Control strategies are the key to implement the training theories into robotic operations. In order to encourage patients’ active participation, the robot should be controlled to supply just enough guidance/assistance a patient needs to complete treadmill based gait training. To implement assist-as-needed (AAN) concept, the robot should also be able to assess the extent of active participation and change the assistance provided accordingly. The intrinsic compliance of GAREX’s PM actuation system could be utilized to change the level of guidance. A multi-input-multi-output (MIMO) sliding model (SM) controller was developed to adjust assistance while guiding training subjects to walk in predefined gait trajectories. Technical experimental validation indicated that controller was able to track reference gait trajectories and the desired joint space average antagonistic PM pressures. A study with 12 healthy subjects revealed strong statistical evidence that the proposed MIMO SM controller is capable of guiding the compliance of exoskeleton To online assess the training subject’s active participation, a fuzzy logic compliance adaptation (FLCA) controller is proposed. The FLCA algorithm utilizes the robotic kinematics and human- exoskeleton interaction torque of the knee joint, to estimate the extent of the patient’s active participation. Based on the estimation, the desired compliance level can be automatically adjusted with higher compliance for more active participation and vice versa. Nevertheless, the FLCA algorithm does not requires models of the exoskeleton and biomechanics of the training subject, which means less preparation work and easier implementation. Performance of the FLCA control system was validated with three healthy subjects who simulated different extents of participation. The FLCA control system could successfully adapt the joint actuation compliance accordingly in all the scenarios.

Soft Robotics in Rehabilitation This book contains the selected papers of the Sixth International Workshop on Medical and Service Robots (MESROB 2018), held in Cassino, Italy, in 2018. The main topics of the workshop include: design of medical devices, kinematics and dynamics for medical robots, exoskeletons and prostheses, anthropomorphic hands, therapeutic robots and rehabilitation, cognitive robots, humanoid and service robots, assistive robots and elderly assistance, surgical robots, human-robot interfaces, haptic devices, and medical treatments.

World Congress on Medical Physics and Biomedical Engineering September 7 - 12, 2009 Munich, Germany This useful resource is designed to offer healthcare professionals specific information about the diverse area of assistive technology. It covers the variety of technology available and explains the adaptations of the technology, as well as how different devices work together. The first section provides the fundamentals of assistive technology, discussing issues such as life span considerations in each context, and factors that influence the choice for patients category, such as need for access and alternative communication. Sections on manipulation, ambulation, and locomotion technologies are discussed next, concentrating on devices that assist with upper and lower body function. This text ends with a discussion of technologies for environments in the real world. Diversity of technology areas - covers all major areas and facets of assistive technology, including how the varied technologies can be used in conjunction to improve the ease of activities of daily living for the user. Organization of text - by grouping assistive technology into four major areas, the book is able to easily lead the reader to both the general area and the specific information they are looking for. Level of presentation - makes the text useful for both allied health professionals, their support personnel, and even the consumer looking for guidance in the area of assistive technology. Outstanding group of authors, section editors and contributors representing the country’s major programs and each area of assistive technology - provides accurate, up-to-date information for the reader.

New Trends in Medical and Service Robotics This book presents the synthesis of a Hand Exoskeleton (HE) for the rehabilitation of post-stroke patients. Through the analysis of the state-of-the-art, a topological classification was proposed. Based on the proposed classification principles, the rehabilitation HEs were systematically analyzed and classified accordingly, that is effective to both perceive the demand for proposing application-specific solutions and provide some useful guidelines for the design of a new HE. Further, a novel rehabilitation HE was designed to support patients in cylindrical shape grasping tasks with the aim of recovering the basic functions of manipulation. Numerous multi-objective optimizations followed by building a final prototype. The experimental results of the preliminary tests are promising and the potential for clinical applications of the proposed device in robot-assisted training of the human hand for grasping functions.

Robust Torque Control And Gravity Augmentation For A Wearable Robotic Exoskeleton Used In Rehabilitation Of Cerebral Palsy This book addresses cutting-edge topics in robotics and related technologies for rehabilitation, covering basic concepts and providing the reader with the information they need to solve various practical problems. Intended as a reference guide to the application of robotics in rehabilitation, it covers e.g. musculoskeletal modelling, control and analysis, biomechanics, robotics modelling and simulation, sensors, wearable devices, and the Internet of Medical Things.

Medical Robotics This book gathers the proceedings of the 15th IFTOMM World Congress, which was held in Krakow, Poland, from June 30 to July 4, 2019. Having been organized every four years since 1965, the Congress represents the world’s largest scientific event on mechanism and machine science (MMS). The contributions cover an extremely diverse range of topics, including biomechanical engineering, computational kinematics, design methodologies, dynamics of machinery, multibody dynamics, gear transmissions, history of MMS, linkage and mechanical controls, robotics and mechatronics, micro-mechanisms, reliability of machines and mechanisms, robot dynamics, standardization of terminology, sustainable energy systems, transportation machinery, tribology and vibration. Selecting from an international peer-review process, they highlight numerous exciting advances and areas that will spur novel research directions and foster new multidisciplinary collaborations.

Exoskeleton Robot for Upper Limb Rehabilitation In the last decade, diverse research areas have developed novel approaches to overcome dysfunctions after a spinal cord injury (SCI). Even though motor restoration attracts the most clinical attention, sensory, autonomic, and mental health are also aspects fundamental to improving the quality of life of SCI patients. Over four sections of therapeutic, rehabilitation, and technological approaches, this book examines preclinical and clinical studies.
using mesenchymal stem cells and pharmacological or electrical stimulation strategies. Chapters also address the impact of paraplegia and associated loss of autonomic functions, including bowel and sexual dysfunction, as well as the convergence of new technologies aimed at providing postural support and enhancing mobility.

Exoskeleton Robots for Rehabilitation and Healthcare Devices

Advanced Technologies for the Rehabilitation of Gait and Balance Disorders This book provides state-of-the-art scientific and engineering research findings and developments in the area of service robotics and associated support technologies around the theme of human-centric robotics. The book contains peer reviewed articles presented at the CLAWAR 2017 conference. The book contains a strong stream of papers on robotic locomotion strategies and wearable robotics for assistance and rehabilitation. There is also a strong collection of papers on non-destructive inspection, underwater and UAV robotics to meet the growing emerging needs in various sectors of the society. Robot designs based on biological inspirations are also strongly featured.

Stroke Rehabilitation This book provides state-of-the-art scientific and engineering research findings and developments in the area of service robotics and associated support technologies around the theme of human-centric robotics. The book contains peer reviewed articles presented at the CLAWAR 2017 conference. The book contains a strong stream of papers on robotic locomotion strategies and wearable robotics for assistance and rehabilitation. There is also a strong collection of papers on non-destructive inspection, underwater and UAV robotics to meet the growing emerging needs in various sectors of the society. Robot designs based on biological inspirations are also strongly featured.

Neurorehabilitation Technology Rehabilitation Robotics gives an introduction and overview of all areas of rehabilitation robotics, perfect for anyone new to the field. It also summarizes available robot technologies and their application to different pathologies for skilled researchers and clinicians. The editors have been involved in the development and application of robotic devices for neurorehabilitation for more than 15 years. This experience using several commercial devices for robotic rehabilitation has enabled them to develop the know-how and expertise necessary to guide those seeking comprehensive understanding of this topic. Each chapter is written by an expert in the respective field, pulling in perspectives from both engineers and clinicians to present a multi-disciplinary view. The book targets the implementation of efficient robotic strategies to facilitate the re-acquisition of motor skills. This technology incorporates the outcomes of behavioral studies on motor learning and its neural correlates into the design, implementation and validation of robot agents that behave as ‘optimal’ trainers, efficiently exploiting the structure and plasticity of the human sensorimotor systems. In this context, human-robot interaction plays a paramount role, at both the physical and cognitive level, toward achieving a symbiotic interaction where the human body and the robot can benefit from each other’s dynamics. Provides a comprehensive review of recent developments in the area of rehabilitation robotics Includes information on both therapeutic and assistive robots Focuses on the state-of-the-art and representative advancements in the design, control, analysis, implementation and validation of rehabilitation robotic systems

Wearable Robots Soft Robotics in Rehabilitation explores the specific branch of robotics dealing with developing robots from compliant and flexible materials. Unlike robots built from rigid materials, soft robots behave the way in which living organs move and adapt to their surroundings and allow for increased flexibility and adaptability for the user. This book is a comprehensive reference discussing the application of soft robotics for rehabilitation of upper and lower extremities separated by various limbs. The book examines various techniques applied in soft robotics, including the development of soft actuators, rigid actuators with soft behavior, intrinsically soft actuators, and soft sensors. This book is perfect for graduate students, researchers, and professional engineers in robotics, control, mechanical, and electrical engineering who are interested in soft robotics, artificial intelligence, rehabilitation therapy, and medical and rehabilitation device design and manufacturing. Outlines the application of soft robotic techniques to design platforms that provide rehabilitation therapy for disabled persons to help improve their motor functions Discusses the application of soft robotics for rehabilitation of upper and lower extremities separated by various limbs Offers readers the ability to find soft robotics devices, methods, and results for any limb, and then compare the results with other options provided in the book

Paraplegia Offering a comprehensive look at physical therapy science and practice, Guccione’s Geriatric Physical Therapy, 4th Edition is a perfect resource for both students and practitioners alike. Year after year, this text is recommended as the primary preparatory resource for the Geriatric Physical Therapy Specialization exam. And this new fourth edition only gets better. Content is thoroughly revised to keep you up to date on the latest geriatric physical therapy protocols and conditions. Five new chapters are added to this edition to help you learn how to better manage common orthopedic, cardiopulmonary, and neurologic conditions; become familiar with functional outcomes and assessments; and better understand the psychosocial aspects of aging. In all, you can rely on Guccione’s Geriatric Physical Therapy to help you effectively care for today’s aging patient population. Comprehensive coverage of geriatric physical therapy prepares students and clinicians to provide thoughtful, evidence-based care for aging patients. Combination of foundational knowledge and clinically relevant information provides a meaningful background in how to effectively manage geriatric disorders Updated information reflects the most recent and relevant information on the Geriatric Clinical Specialty Exam. Standard APTA terminology prepares students for terms they will hear in practice. Expert authorship ensures all information is authoritative, current, and clinically accurate. NEW! Thoroughly revised and updated content across all chapters keeps students up to date with the latest geriatric physical therapy protocols and conditions. NEW! References located at the end of each chapter point students toward credible external sources for further information. NEW! Treatment chapters guide students in managing common conditions in orthopedics, cardiopulmonary, and neurology. NEW! Chapter on functional outcomes and assessment lists relevant scores for the most frequently used tests. NEW! Chapter on psychosocial aspects of aging provides a well-rounded view of the social and mental conditions commonly affecting geriatric patients. NEW! Chapter on frailty covers a wide variety of interventions to optimize treatment. NEW! Enhanced eBook version is included with print purchase, allowing students to access all of the text, figures, and references from the book on a variety of devices.

Converging Clinical and Engineering Research on Neurorehabilitation The new technological advances opened widely the application field of robots. Robots are moving from the classical application scenario with structured industrial environments and tedious repetitive tasks to new application environments that require more interaction with the humans. It is in this context that the concept of Wearable Robots (WRS) has emerged. One of the most exciting and challenging aspects in the design of biomechatronics wearable robots is that the human takes a place in the design, this fact imposes several restrictions and requirements in the design of this sort of devices. The key distinctive aspect in wearable robots is their intrinsic dual cognitive and physical interaction with humans. The key role of a robot in a physical human–robot interaction (pHRI) is the generation of supplementary forces to empower and overcome human physical limits. The crucial role of a cognitive human–robot interaction (cHRI) is to make the human aware of the possibilities of the robot while allowing them to maintain control of the robot at all times. This book gives a general overview of the robotics exoskeletons and introduces the reader to this robotic field. Moreover, it describes the development of an upper limb exoskeleton for tremor suppression in order to illustrate the influence of a specific application in the design decisions. Copyright code: 655e07844c90ee69c0fa465250ed0c78