Preface

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Biographical notes: Wenhui Wang received his BS from Beijing Institute of Technology in 1998 and MS from the same institute in 2001; and PhD in Mechanical Engineering from the National University of Singapore in 2005. He held a Research Associate position at the University of Toronto before joining the faculty of the University of Canterbury, where he is a Lecturer of Mechanical Engineering Department. His research areas include micro/nano biomanipulation, bio-device and instrumentations, and computer vision. He has won the Best Paper Award in IEEE CASE 2007, and the Best Student Paper Award in IEEE/ASME MESA 2008.

S. Q. Xie received his MSc, and PhD in Mechatornics from Huazhong University of Science and Technology (HUST), China, in 1995, and 1998, respectively. He received his PhD in Manufacturing Automation from the University of Canterbury, in 2001. He was a Research Associate and Postdoctoral Fellow at the University of Canterbury. He joined the University of Auckland, in 2003, and is currently a Senior Lecturer in the area of mechatronics. He has published one book, eight book chapters and over 120 international journal and conference papers. He is an Associate Editor for the *International Journal of Advanced Mechatronic Systems* and the *International Journal of Mechatronics and Intelligent Manufacturing*. He sits on the editorial board of a number of international journals such as the *International Journal of Mechatronics and Manufacturing Systems* and has served as a reviewer/referee for over 20 international journals and is a member of international program committee for many international conferences.

Recent decades have witnessed the significant development in biomedical robotics from fundamental research to commercialisation development, evaluation and feasibility studies. Robotics, initially brought in as computer-integrated systems for surgical interventions, has been emerging into a wider range of areas including image-guided therapy and rehabilitation robotics in the macro world. More recently, as biology digs into molecular level studies, robotics has also entered a new era in the micro and nano world. Capable of manipulating from metre-sized humans to micrometre-sized cells, robotics plays a unique role in biomedicine, along with the advances in computer science, transducers, materials, imaging, and MEMS, etc.

This special issue brings together a variety of exciting research papers, which report new developments in robotics for a broad range of biomedical applications. These papers cover research in endoluminal surgical robotic systems; haptic monitoring for human-robot interface; models for muscle forces, parallel robots, and nanorobots; joint motion sensors based on ionic polymer metallic composites (IPMC); controls for robotic leg gaits, and for correction of clubfoot deformity; and computer vision for robotic orthopaedic surgery

Nagy et al. present the concept of modular robotics for endoluminal surgical robotics to address the inherent limitation of single capsule units, which have a limited number of components and degrees of freedom. In the proposed procedure, the modules are ingested and assembled in the stomach cavity. Key technologies of such a system are reported including self-assembly, actuation, power, and localisation.

Zhang reports on a biomechanical simulation model to estimate upper-limb muscle forces. Dynamics for the body segments is established and the directional dependent characteristic of joint muscle forces is simulated. Experimental data collected from human subjects who

performed planar arm reaching task in different directions were used to verify the model. The results are useful for rehabilitation.

Neagoe and Diaconescu generalise methods and algorithms for accurate modelling of parallel robots. The model considers the independent kinematic parameters and the geometric parameters as error sources, leading to a region of maximum precision and optimal placement of the task.

Adtani et al. present work investigating the hybrid biomechanical mechanism for nanorobotic propulsion. The thrust force has been obtained from the unzipping of a dsDNA and utilising the force hysteresis pattern obtained during unzipping and rezipping of a dsDNA. The feasible DNA-based hybrid biomechanical actuator model is considered for locomotion of nanorobots in a liquid medium.

Chew et al. characterise IPMC as a smart material that has been proposed for measuring robotic joint motion. Particularly, a model of the sensor's response to rotary joint motion is proposed based on experiment. The results show that the model is reasonably accurate, with the angle falling within 3% of the actual value over most of the tested range of motions.

Rai present a hybrid control strategy for robotic leg prosthesis. It utilises radial basis neural network along with classical PD controller to control the motion of prosthetic leg for the level walking. It has three independent neural network and PD controllers to control the movements of three joints separately in order to achieve the level walking as in case of the other (normal) leg. The simulation results showed that the gait of the prosthetic leg can be controlled to a near normal one for level walking.

Jain et al. propose a novel mechanism for an ankle-foot orthosis based on a passive four-bar linkage for non-surgical treatment of clubfoot disorder. When fitted to the ankle, the foot orthosis controls the motion of the abnormal foot during correction. The magnitude of the force can be controlled by giving controlling number of rotation of the fly nut. The initial wearable prototype has been proposed.

Gamage et al. applied computer vision in estimating 3D pose for femur fracture segments in image-guided robotic orthopaedic surgery. The registration is performed solely utilising bony anatomical features extracted from biplanar fluoroscopic images (frontal and lateral) without invasive external fiducial markers. The novelty of the proposed methodology is involved in the anatomical features utilised, which are unproblematic and robust to extract and facilitate near real-time pose estimation.

Fok et al. proposed a framework for an intelligent virtual cognitive rehabilitation environment and presented the development of a virtual kitchen together with an intelligent assistant to guide patients to relearn meal preparation skills. The intelligent assistant used fuzzy logic to regulate the visual and audio cues based on the patient's behaviours being monitored. A preliminary clinical trial indicated that the intelligent electronic exercises could complement existing conventional rehabilitation activities in hospitals and enable therapists to better concentrate on the patient's performances and assessment.

The robotic research reported by these papers reflects the multidisciplinary nature of biomedical robotics. We hope this special issue is to be found interesting by a big audience across robotics, controls, sensors and actuators, nanotechnology, and orthopaedics.