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PREFACE

A SPECIAL SELECTION ON MECHANICAL ENGINEERING APPLIED TO BIOMEDICINE — PART I

Published 15 October 2020

Part I of this special issue collects the contributions concentrating on Mechanical Engineering Applied to Biomedicine. It aims to accounts for outstanding and novel research in mechanics used for biomedicine and relevant fields. The details of the accepted 21 papers are as follows:

Sufen Zhou *et al.* study the fetal–placental hemodynamic parameters in women with severe preeclampsia in second- and third-trimester pregnancy with a view to developing effective predictive indicators for preeclampsia and providing support for the prenatal clinical treatment of preeclampsia. The result indicates that 3D power quantitative doppler ultrasound provides a novel avenue for the study of severe preeclampsia.

Monan Wang *et al.* propose an improved MC algorithm based on the standard Marching Cubes (MC) algorithm. It is concluded that the improved MC algorithm can make up for the voids problem, the accuracy and applicability of the algorithm are demonstrated by two sets of examples. The algorithm is applied to the medical image 3D reconstruction system.

Moon-Seok Kwon *et al.* investigate gait characteristics of elderly women in overground and slope walkway conditions. Repeated measure analysis of variance (ANOVA) is evaluated to compare mean differences of different conditions and mean difference between younger and older elderly women. The findings suggest that specific-walkway condition should be considered for fall prevention and clinical interventions in elderly women.

Kap-Soo Han *et al.* work in the effects of muscle strength on the spine stabilization exercise and they analyze spine using a whole-body tilt device. Musculoskeletal modeling is performed and the results are validated through a comparison with the electromyography (EMG) analysis. It indicates that hard or extreme exercise may cause musculoskeletal injuries for rehabilitation patients and elderly people with weak muscle strength.

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Tsung-Min Lee *et al.* show in their study that the Taguchi analysis is integrated with phantom and innovative gauges to optimize the CT scan protocol for peripheral arterial occlusive disease (PAOD) syndrome. The findings suggest that muscle strength can be a major factor for maintaining postural activities according to a subject's body conditions.

Yubin Liu *et al.* design modular reconfigurable mobile robots with a cam-ball type connection mechanism. The chassis of the robot adopts a triangular wheel-track mechanism design (TWT) that combines the advantages of both wheeled and tracked type mobile robots providing high terrain adaptability and vehicle trafficability. Modular mobile reconfigurable robot system has broad application prospects in the field of medical auxiliary robots.

Samwon Yoon *et al.* aim to examine the effects of full immersion virtual reality training on balance and knee function in patients who had undergone total knee replacement. It concludes that virtual reality exercise programs are effective in early rehabilitation after total knee replacement, and have clinical value as inexpensive methods that can promote active participation.

Jun Zhong *et al.* build an ankle rehabilitation robot by employing pneumatic muscle actuators which are soft and have similar compliance with biological muscles. Compliant ankle rehabilitation robot in this research is realized by employing pneumatic muscle actuators as power source. In future, passive and active rehabilitated experiments will be executed to verify the capacities of the robot.

Yongqing Cai *et al.* intend to propose and verify the insertion of a rectangular thin-walled sleeve between an arch wire and a bracket to minimize the resistance effect on the biomechanical behavior of tooth movement by using the finite element (FE) method. Authors concluded that FE results revealed that the insertion of a thin-walled sleeve in a small round arch wire and a bracket could have a positive influence on final tooth movement.

Seung-Rok Kang *et al.* evaluate the effect of basic fitness function according to whole-body vibration (WBV) stimulus with slope during deadlift in adults. The findings indicate that WBV exercise with slope is the most efficient exercise protocol for improving muscle function of the trunk. WBV with slope could help stimulate trunk muscles more and efficiently, could result in a more positive effect on muscle function and for efficient patient rehabilitation.

Geon Kim *et al.* discuss multidirectional ankle displacement and associated stiffness when a posterior–anterior impact force is applied to the posterior knee compartment. A three-dimensional motion capture system and force plates are used to acquire angular displacement and ankle joint moment data. The study suggests that individuals with foot hyperpronation present with multidirectional hypermobility and a reduction in ankle stiffness.

Do-Young Kwon *et al.* evaluate the difference of static postural balance between scans without evidence of dopaminergic deficit (SWEDD) and Parkinson's disease (PD) patients. Center of pressure (COP) is measured for quantitative evaluation during static standing. It reflects that a few COP-based out-come variables might be useful to distinguish SWEDDs patients from PD patients. This study suggests that a static postural balance test can be used for clinic screening and identification of potential SWEDDs.

Haiquan Feng *et al.* carry out animal experiments and clinical trials to evaluate efficiency of a new stent for the treatment of iliac vein stenosis. They conclude that through the large animal *in vivo* experiment, compared with the commonly used iliac vein stents in clinic, the new iliac vein stent with NiTi alloy had good supporting performance during the 90-day follow-up.

Mi-Hyun Choi *et al.* discuss somatosensory evoked potential (SEP) patterns in the C3 somatosensory area with varying frequency and intensity of vibrotactile stimuli. Data on the SEP patterns generated in response to various frequencies and intensities of somatosensory stimuli and the development of relevant databases will elucidate the various clinical applications and applicable domains where SEP assessment can be beneficial.

Jin Seung Choi *et al.* compare the effects of vibration on the knee and ankle torque after performing leg-press exercises for four weeks. The results show that the isometric and isokinetic joint torque of the knee and ankle improv overall for both groups after four weeks. Further studies are required to investigate the method of applying vibration to each muscle and the frequency and amplitude of vibration, as well as the effects of vibration on the elderly and patients under rehabilitation.

Seok-Woo Jang *et al.* introduce a method to distinguish between healthy people and Parkinson's disease patients using sole pressure sensor data, neural networks with weighted fuzzy membership functions (NEWFM), and preprocessing techniques. They conclude that an accuracy of 75.90% is acquired from the eight dimensions with the highest performance using their BSWFMs as the characteristics.

Monan Wang *et al.* develop a mathematical model of skeletal muscle excitation-contraction pathway based on the energy metabolism that link excitation to contraction to explore the effects of different metabolic energy systems of calcium ion changes and the force during skeletal muscle contraction. Skeletal muscle energy metabolism plays a very important role in controlling movement of the whole body and has important theoretical guidance for making exercise training plans and losing weight.

Tian Wang *et al.* apply the high-order nonlinear differential terms to explain the strain–stress curves of shape memory alloy (SMA) materials, A new kind of Ti–Ni SMA hysteretic model is introduced, and the nonlinear dynamic characteristics of

the SMA tracheal stent in cough process are discussed. The results provide a way to choose the SMA material in tracheal stent field.

MinJoo Kim *et al.* analyze the biomechanical muscle characteristics when performing transfer motion by using an indoor lift chair developed for daily life mobility aids to help the older adults living independently in an indoor space. The results show the characteristics of everyday motion of the elderly for the development of lift chair and can help improve design, function, etc. in later development of lift chair.

Ya-Hui Lin *et al.* study a semi-quantitative analysis of carotid stenosis using the inverse problem algorithm (IPA) with five risk factors is performed for 272 patients with ischemic stroke symptoms. As a kernel function of the machine learning technique, the IPA provides a substantiated prediction of the expected outcomes by solving an inverse matrix of variable coefficients. The reduction of the number of variables in computation deteriorated the prediction accuracy, exhibiting the algorithm's high sensitivity to the number of variables.

Do-Young Kwon *et al.* describe spatio-temporal gait variables in SWEDD (dopaminergic deficit) patients and normal individuals based on the idea that it is still unclear if the gait assessment can distinguish patients with scans without evidence of SWEDD patients from normal individuals. The results indicate that quantitative gait assessment could be useful for more accurate diagnosis of SWEDD patients. In addition, understanding clinical features of SWEDD patients might contribute to efficient interventions.

Generally, this special selection pursues to discussing the ongoing and active research on Mechanical Engineering Applied to Biomedicine, providing valuable insights and groundbreaking discoveries on updated Human Mechanics[1,2,8,12,13,17,18] including rehabilitation engineering, finite element analysis and biofluid mechanics etc. as well as Biomedical Imaging.[3–7,9–11,14–16,19] Hope that the selected papers will provide the readers with useful examples of state-of-art research on the most outstanding frameworks in mechanical engineering used for biomedicine and their application to challenging biomedical problems.

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Esteban Peña Pitarch holds a doctorate in the UPC. He has carried out his teaching work at the Technical College of Manresa (EPSEM), since 1988 and belongs to the department of mechanical engineering. He collaborates with the Institute of Industrial and Control Engineering (IOC), UPC, since 2008, in the robotics division. His research is focused on rehabilitation and simulation of stroke survivors, the creation of medical devices and the application of kinematics and dynamics to the human body by way of mathematical tools used in robotics. He manages a group with doctors specialized in physical medicine, rehabilitation and engineers from a number of different fields. This group has published articles in magazines and congresses and owns two patents relating to medical apparatus. Esteban Peña Pitarch belongs to the Service and Industrial Robotics (SIR) research team and is currently working on two competitive projects as the main researcher of one and collaborating in the other. He is a professor and ex-dean of college Escola Politècnica Superior d'Enginyeria de Manresa (EPSEM) at the Universitat Politècnica de Catalunya (UPC). His teaching expertise are in Kinematics and Dynamics, and Machinery Design for Undergraduate and Graduate degree for more than 30 years. He has two patents and more than 80 papers on international journals and conferences. Research interests are in Virtual Human Modeling, Rehabilitation, and Human Exoskeleton Construction.

Agnès Drochon is born in 1965, in Châteauneuf-sur-Charente, France. She obtained her diploma of Engineer in mechanics and fluid mechanics at ENSEEIHT (Toulouse, France) (1987), and a PhD in biomedical engineering at University of Technology of Compiègne (France), in 1991. She is CNRS research fellow since this time, in the Laboratory BMBI ("Bio-mechanics and Bio-engineering") of UTC. Her topics of research are cardio-vascular biomechanics, cells biomechanics, magnetohydrodynamic flow of blood, and related applications. She teaches mathematics and fluid mechanics.

Ng obtained Ph.D. at Cambridge University and elected as a Fellow of The American Society of Mechanical Engineers; The Institution of Engineering and Technology [UK], and International Engineering & Technology Institute [HK]. He researches in numerical simulation in the biomedical engineering, thermal-fluids and health-related diagnosis fields. He is Editor-in-Chief for two ISI-journals which were captured by the JCR within two-years of their inauguration. He has been recognized internationally for academic excellence. He received numerous best papers, service awards and has graduated 23 PhD and 26 Master students. He was awarded the SPRING-Singapore Merit Award for his work in thermal imagers to screen SARS fever and contributions to the Singapore Standardization Program. Twenty-one of his papers have been adopted as references in Singapore Standard (SS-582, Parts 1&2: 2020) and ISO/IEC 80601-2-59: 2017. He serves as a panel member for Singapore Biomedical and Health Standards Committee since 2011. Being a co-inventor of 3 US patents on software classifiers to identify the different stages of breast cancer development in iTBra-system, he was accoladed with equity in a listed company. His ongoing work on non-contact screening for carotid artery stenosis and superficial vein-finder has resulted in 3 TDs. He has notable citations in the field of infrared physics & technology.

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