Korean Society of Biomechanics 2008
제 1 회 추계 학술대회

인사말

저희 대한생체역학회가 첫 발걸음을 뗀지 1년이 되었습니다. 산고 끝에 건강한 아이가 태어나 1년간 무럭무럭 자란 후에 맞이하는 첫 돌과 같은 학술대회를 KAIST에서 개최하게 됨을 정말 기쁘고 영광스럽게 생각하지 않을 수 없습니다. 이에 대한생체역학회 모든 회원님들과 함께 이 즐거움을 나누고자 합니다. 또한, 누구보다도 본 학회의 창립과 발전을 위하여 물심양면으로 애써 주신 전 생체역학연구회 회장님, 그리고 간사님들께 대한생체역학회 회원 모두를 대표하여 무한한 감사의 말씀을 올립니다.

사회적인 요구가 있어 새로운 제품이 태어나듯이 저희 생체역학은 바야흐로 인간의 무병장수라는 시대적인 요구사항에 의하여 수많은 사람들의 관심을 끌게 되었습니다. 이에 저희는 이러한 애정 어린 눈길에 보답하여야 한다는 시대적인 책임감도 동시에 느끼지 않으면 안 된다고 생각합니다. 그렇게 하기 위해서는 무엇보다도 관련분야의 교수님들, 연구원들, 학생들이 모두 한자리에 모여서 관심사에 대하여 토의할 수 있는 장을 마련하는 것이 저희들의 책무라는 데에 의견을 모았고, 작년 창립총회를 거쳐 오늘 본격적인 모임을 시작하게 된 것입니다. 저희 대한생체역학회는 국내뿐 아니라 해외의 관련 학회와의 긴밀한 협력관계를 유지하여 관련 연구와 교육의 세계화에 전력을 기울이고 있습니다. 수년 내에 아시아-태평양생체역학 학술대회를 한국에서 개최하기 위한 준비를 하고 있으며, 나아가 국제생체역학회 및 미국생체역학회와의 협력관계를 증진시키기 위한 노력을 아끼지 않고 있습니다.

대한생체역학회 회원 여러분, 세계에서 예를 찾기 힘들 정도로 아름다운 한국의 가을하늘 아래에서, 그리고 세계적인 연구교육기관으로서의 면모를 갖추어 가고 있는 KAIST에서 뜻 깊은 학술대회를 개최하게 되었음에 다시 한번 감사 드립니다. 특히, 연구와 교육에 매우 바쁘심에도 불구하고 본 학술대회의 준비를 위해서 애써 주신 KAIST 김정, 신현정, 박수경 교수님, 그리고 대한생체역학회 이사 여러분께 깊은 감사의 말씀을 드립니다. 아무쪼록 우리 모두에게 유익하고 풍성한 결과를 주고, 또 내년 모임을 기다리게 하는 학술대회가 될 수 있기를 기원합니다.

2008년 10월 9일

대한생체역학회장 강 곤 배상

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Program at a Glance

October 9

13:00 - 14:00	Registration
14:00 - 14:20	Opening Remark
14:20 - 15:00	Dr. Zev Rymer
15:00 - 15:40	Dr. Hyung Soon Park
15:40 - 16:20	Dr. J.K. Francis Suh
16:30 - 18:30	Session I
18:30 -	Dinner

October 10

09:00 - 10:15	Session II
10:30 - 12:00	Tutorial Sessions
12:00 - 13:30	Lunch
13:30 - 14:30	Poster Session
14:30 - 16:30	Session III
16:30 - 16:45	Closing Remark

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Schedule - (1)

October, 9 (Thursday)			
Time			
13:00~14:00	Registration		
14:00~14:20	Opening Remark		
14:20~16:20	Invited Session		
	14:20~15:00	Dr. Zev Rymer (Rehabilitation Inst. of Chicago)	
	15:00~15:40	Dr. Hyung Soon Park (Rehabilitation Inst. of Chicago)	
	15:40~16:20	Dr. J. K. Francis Suh (Tulane Univ.)	
16:30~18:30	Session I		
	16:30~16:45	CT영상을 이용한 3차원 Cubitus Valgus 수술 계획법	김유진(이상 강북삼성병원), 동용원, 박창우, 박신석 (고려대학교)
	16:45~17:00	젊은 성인과 고령자의 자세동요 비교	김지원, 김다혜, 엄광문 (이상 건국대학교), 홍정화, 박병규(고려대학교)
	17:00~17:15	고령자용 신발 평가 변인 추출을 위한 고령자와 20대 성인의 보행 특성 비교	최진승, 강동원, 문경률, 탁계래 (건국대학교)
	17:15~17:30	보행 회복을 위한 보행 궤도 훈련 장치	모하메드 캄룰 하산, 박승훈, 강 곤(경희대학교)
	17:30~17:45	고령자 자세균형 훈련 효과에 관한 분석	박용군, 오가영, 김동욱, 권대규, 김남균(전북대학교)
	17:45~18:00	한 손 쥐는 동작에 의한 편측적 영역에서의 EEG Coherence에 대한 연구	우진철, 황민철, 김종화 (상명대학교)
	18:00~18:15	기능적 전기자극시 편마비환자의 보행분석	손량희, 박선우, 김영호 (연세대학교)
	18:15~18:30	상지 거동 모방을 위한 착용형 로봇의 메커니즘 설계	이영수,홍성준,장혜연,장재호, 한창수(이상 한양대학교), 한정수(한성대학교)
18:30~	Dinner		

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Schedule - (2)

October, 10 (Friday)			
Time			
09:00~ 10:15	Session II		
	09:00~ 09:15	인간-기계 인터페이스를 위한 근전도 기반의 실시간 상지부 의도 추출 연구	권순철, 김 정(KAIST)
	09:15~ 09:30	보행속력에 따른 인체보행전략 변화에 관한 연구	강현민, 박수경(KAIST)
	09:30~ 09:45	원자힘 현미경을 통한 세포의 물성치 해석	김영진, 신현정, 김 정(KAIST)
	09:45~ 10:00	Multi-cellular compression device에 의한 기계적 자극이 세포에 미치는 영향	김순희, 윤재영, 신현정(KAIST)
10:00~ 10:30	Coffee Break		
10:30~ 12:00	Tutorial Sessions		
	10:30~ 11:00	고관절 개발 및 수술법	이중명 (국립의료원)
	11:00~ 11:30	로봇 수술	조영호 (국립암센터)
	11:30~ 12:00	장애인 운동능력 향상을 위한 보조기구	조강희 (충남대학교)
12:00~ 13:30	Lunch		
13:30~ 14:30	Poster Session		
14:30~ 16:30	Session III		
	14:30~ 14:45	인공고관절 Ball head의 설계변수 변화에 따른 생체역학적 평가	김형진,유정훈(이상 연세대학교), 윤인찬, 최귀원(이상 KIST), 박흥석
	14:45~ 15:00	컴퓨터 네비게이션 슬관절 전치환술에서 핀홀에 의한 대퇴골 골절위험성	박형균, 박원만, 김윤혁 (이상 경희대학교), 김경수(경기대학교)
	15:00~ 15:15	고령자의 다양한 높이의 앉은 자세에서 일어서기 시 동작특성 및 근길이 변화	황성재, 손종상, 김정윤, 임도형, 김영호 (연세대학교)
	15:15~ 15:30	저 강도 초음파의 골다공증 치료 효능	김효선, 고창용, 서동현, 임도형, 김한성(연세대학교)
	15:30~ 15:45	유한요소 해석을 이용한 골융합 골조직의 전자기장 분포 예측	민성기, 홍정화, 김철승 (고려대학교)
16:30~ 16:45	Closing Remark		

Invited Session

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Current R&D in Rehabilitation in the USA

Dr. William Z. Rymer

Dr. William Z. Rymer

Current position

President of the Rehabilitation Institute Research Corporation

Research Director of the Rehabilitation Institute of Chicago

Director of the Medical Biomechanics Program, Northwestern Univ. Medical School

Professor of Northwestern Univ.

Education

M.D.(1962) : Melbourne Univ. Medical School, Melbourne, Australia – Medicine

Ph.D.(1973) : Monash Univ., Australia – Neurophysiology

Honors and Awards

Chairman, Engineering Foundation Conference “Biomechanics of Movement” Henniker, 1979

Chairman, NIH Special Study Section (8 occasions)

Member, GRM Study Section: 1994-1998, Chair: 1999-2001

Honorary Life Member, American Physical Therapy Association

Editorial Board, Journal of Neurophysiology, 1984-1987

Co-Chair, NIH task force panel on ”Neurophysiological Dysfunction” in Rehabilitation Science

Member, Scientific Advisory Board, Spinal Cord Research Fdn., Paralyzed Veterans of America, 1989-1994

Member, Initial Review Group NIH "Geriatrics and Rehabilitation" 1995- present

Editor-in-Chief, IEEE Transactions in Neural Systems and Rehabilitation Engineering, 2001-2004

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Recent Publications

1. Makhsous M, Venkatasubramanian G, Chawla A, Pathak Y, Priebe M, **Rymer WZ**, Lin F. Investigation of soft-tissue stiffness alteration in denervated human tissue using an ultrasound indentation system. *J Spinal Cord Med*.; 31(1):88-96; 2008 (PubMed – in process)
2. Mirbagheri MM and **Rymer WZ**. Time-course of changes in arm impairment after stroke: variables predicting motor recovery over 12 months. *Arch Phys Med Rehabil*; 2008 June 27 [in press]
3. Chung SG, van Rey E, Bai Z, **Rymer WZ**, Roth EJ, Zhang LQ. Separate quantification of reflex and nonreflex components of spastic hypertonia in chronic hemiparesis. *Arch Phys Med Rehabil*; 89(4):700-10; 2008 April
4. Mirbagheri MM, Tsao C, **Rymer WZ**. Changes of elbow kinematics and kinetics during one year after stroke. *Muscle Nerve*. 37(3):387-95, 2008 Mar
5. Mirbagheri MM, Alibiglou L, Thajchayapong M, **Rymer WZ**. Muscle and reflex changes with joint angle in hemiparetic stroke. *J Neuroeng Rehabil*, 5(1):6; 2008 Feb 27 [Epub ahead of print]
6. Gerachshenko T, **Rymer WZ**, Stinear JW. Abnormal corticomotor excitability assessed in biceps brachii preceding pronator contraction post-stroke. *Clin Neurophysiol*; 119(3):683-92; 2008 Mar

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Neuro-Rehabilitation using Robotic Systems

Dr. Hyung Soon Park

Spasticity (reflex hyperexcitability and hypertonus) and contracture are major sources of disability in stroke patients and physical therapy has been regarded as the cornerstone of the rehabilitation process. Recently, robotic devices have shown their effectiveness in rehabilitation. We have developed a low cost and portable robotic system capable of intelligent passive stretching, voluntary movement training, and quantitative outcome measurement. The portable robotic system has the potential to allow for home-based therapy, and a technology that we developed for enabling remote assessment through internet with haptic feel will be introduced. Finally, the multi-DOF (degrees of freedom) robotic system developed for comprehensive whole arm rehabilitation will be presented.

Dr. Hyung Soon Park

Current position

Research Scientist with Rehabilitation Institute of Chicago

Research Assistant Professor with the Dept. of Physical Medicine and Rehabilitation, Northwestern University

Director of Engineering with Rehabtek LLC

Education

B.S.(1994) : KAIST, South Korea – Precision Engineering & Mechatronics

M.S.(1996) : KAIST, South Korea – Mechanical Engineering

Ph.D.(2003) : KAIST, South Korea – Mechanical Engineering

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Honors and Awards

Graduated with Rank 1 (President Prize), KAIST Department of Mechanical Engineering, Daejeon, South Korea

NSF (National Science Foundation) ICRA -05 Award,

2005 IEEE International conference on Robotics and Automation, Barcelona, Spain.

NSF (National Science Foundation) STTR/SBIR Phase I, Grant Number 0539841

US Department of Education, NIDRR, SBIR Grant Number H133S070060

NSF STTR/SBIR Phase II, Grant Number 0750515

US Department of Education, NIDRR, Distinguished Fellowship

Recent Publications

1. **Hyung-Soon Park**, Nicole A. Wilson, and Li-Qun Zhang, "Gender Differences in Passive Knee Joint Properties under Tibial Rotation," Journal of Orthopedic Research. Vol. 26, Issue 7, pp. 937-44, 2008.
2. **Hyung-Soon Park**, Qiyu Peng and Li-Qun Zhang, "A Portable Tele-Assessment System for Remote Evaluation of Elbow Joints with Spasticity", IEEE Trans. on Neural Systems and Rehabilitation Engineering. Vol. 16, No. 3, pp. 245-254, 2008.
3. **Hyung-Soon Park,** and Jeong Wan Lee, "Development of a Tele-rehabilitation System for Outcome Evaluation of Physical Therapy", Journal of Biomedical Engineering Research. Vol. 29, pp. 179-186, 2008.
4. Paul Sung and **Hyung-Soon Park**, "Gender difference in ground reaction force following perturbations in subjects with low back pain", Gait and Posture, 2008 (accepted for publication).
5. Bradley J. Dunlap, Eldin E. Karaikovic, **Hyung-Soon Park**, Mark J. Sokolowski, and Li-Qun Zhang, "Load sharing properties of cervical pedicle screw-rod constructs vs. lateral mass", (Submitted to Spine, 2008).
6. David T. Fung, **Hyung-Soon Park**, Chulhyun Ahn, Shu Q. Liu, and Li-Qun Zhang, "Analysis of ACL Impingement with Characterization of 3-D Geometry of the ACL and Intercondylar Notch," (Submitted to Clinical Biomechanics, 2008).

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Age-Related Changes in Biomechanical Properties of Posterial Scleral Tissues: A Possible Cause of Glaucomatous Vision Loss

Dr. J. K. Francis Suh

Custom 3-D experimental and computational tools were developed to investigate the age-related differences in the biomechanical properties of posterior and peripapillary sclera from old (>18 years) and young (<2.1 years) rhesus monkeys following acute elevation of intraocular pressure (IOP) from 5 to 45 mm Hg.

The posterior scleral shells from both eyes of eight rhesus monkeys (four young and four old) were individually mounted on a custom-built pressurization apparatus. IOP was incrementally increased from 5 to 45 mm Hg, and the 3-D displacements of each shell were measured using electronic speckle pattern interferometry. The geometry of each scleral shell was reconstructed from data generated by a 3-D digitizer (topography) and a 20 MHz ultrasound transducer (thickness). A fiber-reinforced constitutive model that includes stretch-induced stiffening and a directionality distribution of the collagen fibers was applied to each scleral shell, and a unique set of biomechanical properties was obtained using an inverse finite element (FE) method. Local displacements, thickness, stress and strain, tangent modulus, structural stiffness, and preferred collagen fiber orientation were mapped for each posterior scleral shell.

The predictions of the model matched the 3-D experimental displacements well. The posterior sclera exhibited inhomogeneous, anisotropic, nonlinear mechanical behavior in all eyes. The sclera was significantly thinner ($p = 0.038$; multiple linear regression), and tangent modulus and structural stiffness were significantly higher ($p < 0.0001$: generalized estimating equation) in the old monkey group. On average, scleral collagen fibers were circumferentially oriented around the optic nerve head (ONH). Moreover, we found no difference in the preferred fiber orientation and fiber concentration factor between young and old monkey eyes for both scleral regions.

Posterior and peripapillary sclera in old monkeys is significantly stiffer than that from young monkeys and is therefore subject to higher stresses but lower strains at all levels of IOP. Age-related stiffening of the sclera should have a large effect on ONH biomechanics, and could therefore play a role in age-related susceptibility to glaucomatous vision loss.

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Dr. J. K. Francis Suh

Current position

Visiting Scientist in KIST(Korea Institute of Science & Technology), Korea,

President & Principal Investigator in Moksan BioEng, LLC, MA, USA

Adjunct Professor of Biomedical Engineering in the Dept. of Biomedical Eng., Tulane Univ., LA, USA

Education

B.S.(1978) : Seoul National Univ., South Korea – Engineering Education/Mechanical Engineering

M.S.(1980) : Seoul National Univ., South Korea – Mechanical Design & Production Engineering

Ph.D.(1989) : Rensselaer Polytechnic Inst., NY, USA – Mechanical Engineering

Honors and Awards

Researcher of the Month (October), Pittsburgh Tissue Engineering Initiative, 1997

Young Investigator Award (USA-China-Japan Conference on Biomechanics), 1991, 1994

Volvo Award on Lowback Pain Research, International Society for the Study of the Lumber Spine, 1999

Teacher of the Year, AEMB (Biomedical Engineering Honor Society, Tulane University), 2006

Recent Publications

1. M. Girard, J.C. Downs, C.F. Burgoyne, and **J-K.F. Suh**, (2008) Experimental surface strain mapping of porcine peripapillary sclera due to elevations of intraocular pressure, *Journal of Biomechanical Engineering*, **130**(4): 041017.
2. M. Girard, J.C. Downs, C.F. Burgoyne, and **J-K.F. Suh**, (2008) Scleral mechanics: Part I – Development of an anisotropic hyperelastic constitutive model, (*Submitted and currently in review*).
3. M. Girard, J.C. Downs, M. Bottlang, C.F. Burgoyne, and **J-K.F. Suh**, (2008) Scleral mechanics: Part II – Inverse finite element characterization, (*Submitted and currently in review*).

SESSION I

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CT영상을 이용한 3차원 Cubitus Valgus 수술 계획법

김유진[1], 동용원[2], 박장우[2], 박신석[2]

3D Cubitus Valgus surgical planning using CT images

Eugene Kim, Yongwon Dong, Jangwoo Park and Shinsuk Park

[1] **정형외과, 강북삼성병원**

[2] **기계공학과, 고려대학교**

Key words: Cubitus Valgus, Surgical Planning, CT images

Abstract

Conventionally, surgeons have measured the carrying angle using 2D X-ray images for Cubitus valgus surgery. However, the carrying angle is difficult to measure precisely using 2D images, and the measured data is not credible because the real surgical operation is performed in 3D space.

In this study we built a 3D bone model of the arm based on 2D CT images and the carrying angle of cubitus valgus deformity was estimated by using the 3D model. The carrying angle was estimated from the cross sectional centerline of the 3D bone model, and the surgery was planned by overlapping the mirrored image of the normal arm and the image of the abnormal arm.

The results of this study show that the measurement of the carrying angle based on the 3D model is more precise and reliable compared to the conventional 2D measurement.

The proposed method is applicable to general osteotomy operations. The surgeon can perform osteotomy with much higher precision with 3-dimensional surgical planning. The proposed method can be extended to image-guided surgical procedures.

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젊은 성인과 고령자의 자세동요 비교

김지원[1], 김다혜[1] 엄광문[1#], 홍정화[2], 박병규[2]

Comparison of Postural Sway in the Elderly and the Youngs

Ji-Won Kim, Da-Hye Kim, Gwang-Moon Eom
, Jeong-Hwa Hong, Byung-Kyu Park

[1#] 교신저자, 건국대학교 의학공학부

[1] 건국대학교 의학공학부

[2] 고려대학교

Key words: postural sway, COP, fall-risk, squat-and-stand

Abstract

In this paper, COP (center of pressure) during quiet standing and squat-and-stand movement was analyzed to compare the postural control of young and elderly subjects with special interest in the elderly females who were reported to have higher fall rate than the elderly males. Subjects include the young subjects (10 males: 21.8±2.6yrs, 10 females: 20.4±0.3yrs) and the elderly subjects (8 males: 75.5±4yrs, 8 females: 72.3±3.5yrs). Analysis parameters were the mean of the distance between the instantaneous COP and the average COP (COP distance) and the mean of the COP movement velocity (COP velocity) in both AP (anterio-posterior) and ML (medio-lateral) directions. During quiet standing, the COP distance in ML direction of elderly females was significantly greater than that of elderly males and the COP velocity of elderly females in both ML and AP direction were significantly greater than those of all the other groups. During squat-and-stand movement, the COP distance of elderly females was not significantly different with that of the elderly males. However, the COP velocity of elderly females was significantly greater than that of all the other groups. The large lateral weight shift (COP distance) of elderly females during quiet standing may explain their greater fall rate. However, this does not apply to squat-and-stand movement. In contrast, COP velocity results show that the elderly females' COP is rapidly trembling compared to that of elderly males during both quiet standing and squat-and-stand movement. This results suggest that rapid trembling or postural sway may reflect the reduced postural control ability and the risk of falling.

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제 1 회 추계 학술대회

고령자용 신발 평가 변인 추출을 위한 고령자와 20대 성인의 보행 특성 비교

최진승, 강동원, 문경률, 탁계레#

Comparison of gait characteristics of elderly and young people for evaluating elderly shoe

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Key words: 보행 특성, 고령자용 신발

Abstract

60세 이상의 고령자의 경우, 노화로 인해 20대 성인과 신경근골격의 차이가 나타나게 된다. 이로 인해, 고령자와 20대 성인의 보행 패턴에 차이가 발생한다. 신발은 보행에 있어, 가장 기본적인 보호 및 보조 장구로 보행 패턴에 영향을 줄 수 있다. 최근에는 신발의 형태나 구조를 이용해 다양한 운동효과나 기능적인 측면에 도움을 주고자 하고 있다. 따라서 본 연구의 목적은 고령자용 신발 개발을 위해 60대 이상 고령자와 20대 성인의 보행 특성 비교하고, 특성에 따른 평가 변인을 도출하고자 한다. 이를 위해 남성 고령자 16명(평균 69years, 63.5kg, 164.5cm)과 20대 성인 남성 10명(평균 26.3years, 75.3kg, 173.4cm)을 대상으로 보행 패턴을 분석하였다. 실험은 적외선 카메라 6대로 구성된 3차원 동작분석기(Motion analysis Corp., USA)와 2대의 지면반력기(AMTI Corp., USA)를 이용해 동작 및 지면반발력 데이터를 수집하였다. 데이터는 OrthoTrak software 6.5.1(Motion analysis Corp., USA)과 Matlab 6.5(Mathwork Inc., USA)를 이용한 inverse dynamic를 통해 운동학적, 운동역학적 변인을 추출하여 분석하였다. 그 결과, 보행 속도 변인, 엉덩관절과 발목관절의 가동 범위, 질량중심과 압력중심의 기울기 경사각 등의 변인에서 차이를 확인하였고, 이러한 변인의 비교를 통해 고령자의 안정성을 유지하면서 근육 운동에 효과가 있는 신발 선정을 위한 평가 변인의 적용이 가능할 것이다. 본 연구의 결과는 추후 고령자 신발을 평가하는데 중요한 참고자료가 될 수 있을 것으로 사료된다.

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제 1 회 추계 학술대회

보행 회복을 위한 보행 궤도 훈련 장치

모하메드 캄룰 하산, 박승훈, 강곤

Gait Trajectory Guiding Device for Gait Rehabilitation

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Key words: gait pattern simulation, gait training

Abstract

Practice, Effort and Specificity have been proved as the major principles for gait rehabilitation. The best way to improve performance of a motor task is to execute that specific motor task again and again. To assure the consistency of a task specific repetitive gait rehabilitation training with accuracy, from both the patient and therapist ends for a long training session, automated gait trainer can be a solution for providing a patient having paretic or artificial leg, with a natural gait-like movement. This paper describes the design and implementation of a gait trajectory guiding device based on two automated foot-boards which move following a computer simulated patient-specific walking trajectory. Replication of a true walking pattern, robust and compact mechanical design and acting in harmony with the patient's successive improvement were the main concerns in developing this device. An elaborate gait-database collected from various sources has been used to determine patient specific gait trajectory. Along with the guided foot panels, a body weight suspension system has been implemented for supporting the partial weight of the patient depending on feedbacks of the load sensors mounted on each foot-board. The main consideration of the software interface was to make sure a good graphical representation of continuous feedback-data from the device and patient history of consecutive training sessions.

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제 1 회 추계 학술대회

고령자 자세균형 훈련 효과에 관한 분석

박용군 [1,4], 오가영 [1,4], 김동욱 [2], 권대규 [2,3], 김남균 [2]

Analysis on Training Effects of Postural Control for Elderly Adults

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Key words: Rehabilitation training, Postural control

Abstract

In this study, we describe the effects of a training system based on an unstable platform and a visual interactive system in improving the postural control ability. In order to verify the training effects, fifteen elderly volunteers took part in a series of balance training using this system. An additional fifteen elderly volunteers which were employed as the control group, were also tested for comparison with the training group. To evaluate the effects of the training, we measured the relevant parameters, such as the sway path and the sway area of center of pressure in the different visual conditions and standing positions, the concentric isokinetic strength of ankle and knee joints prior to and after the training. The results indicated that the training system could be used to assess successfully the gradual improvement of the postural control capability of the volunteers in the system, and showed promise in terms of improving the balance capabilities of the volunteers. Moreover, the observed significant improvement in the postural capability of the elderly subjects indicated that elderly subjects may benefit more from training using the system described herein for the improvement of postural control ability.

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제 **1** 회 추계 학술대회

한 손 쥐는 동작에 의한 편측적 영역에서의 EEG Coherence 에 대한 연구

우진철 [1], 황민철 [2], 김종화 [1]

Research on EEG coherence at lateral area by one-hand grip movement

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Key words: BCI, EEG Coherence

Abstract

EEG Coherence 는 EEG 가 발현되는 두 영역 간의 상관성을 구하는 기술로 인간의 두뇌활동을 평가하는데 사용되고 있다. 본 연구에서는 편측적 영역의 C3 를 포함한 4 개의 측정영역간 EEG Coherence 를 사용하여 손 동작을 예측하는 시스템을 구축하였다. 5 명의 대학생의 250 회 동작과 휴식 반복시의 coherence 데이터를 훈련하여 분석된 편측 coherence 알고리듬에 의해 동작유무 예측을 가능하게 하였다. 이는 동작이 자유롭지 못한 의수 착용환자가 의수에 동작의도를 전달하는데 유용하게 활용될 수 있다.

Korean Society of Biomechanics 2008
제 1 회 추계 학술대회

기능적 전기자극시 편마비환자의 보행분석

손량희[1], 박선우[1], 김영호[12]

Gait Analysis of Hemiplegic patients with Functional Electrical Stimulation

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Key words: FES, Hemiplegic walking, Gait Analysis

Abstract

Functional electrical stimulation (FES) is widely used to correct foot drop and toe drag during hemiplegic walking. We have focused on the portable detection of gait phases of patients with hemiplegia. In this study, sensor signals during hemiplegic walking with and without FES were investigated.

Three hemiplegic patients were participated for this study. The patients' gait with and without FES was analyzed using the three-dimensional motion analysis system synchronized with a portable sensor system. The sensor system consisted of a foot switch and a tilt sensor. The foot switch was used for electrical stimulation in this study.

Anskle joint angle were more dorsiflextion(14°) then hemiplegic patient's walking without electrical stimulation. Portable sensor system could detect the gait event for stimulation successfully.

The results have shown advantages of the gait event system using sensor system. It is expected that this study gives information about portable FES assistive walking system.

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제 1 회 추계 학술대회

상지 거동 모방을 위한 착용형 로봇의 메커니즘 설계

이영수[1], 홍성준[1], 장혜연[1], 장재호[1], 한창수[1], 한정수[2]

Design of Wearable Robot Mechanism of Shoulder and Elbow Joint

Young-Su Lee, Sung-Jun Hong, Hye-Yeon Jang, Jae-Ho Jang, Chang-Su Han, Jung-Su Han

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Key words: Weaeable Robot, Exoskeleton, Meal Assistance

Abstract

Recently, many researchers have tried to develop wearable robot that have various fields such as for medical, military purposes. We have been studying robotic exoskeletons to assist the motion of persons who have problems with muscle function in daily activities and rehabilitation. The upper-limb motions (shoulder, elbow and wrist motion) are especially important for persons to perform daily activities. In this paper, we proposed the mechanism design of the exoskeleton which consists of 4-DOF for shoulder and 1-DOF for elbow robotic exoskeleton to assist upper-limb motion, is to say that the shoulder flexion/extension, abduction/adduction, internal/external rotation, and elbow extension/flexion in daily activity and rehabilitation. And we compared the new mechanism design and prototype mechanism design. Herein we also kinematically analyze the proposed system to find out force transmission ratio and singular point. This research will induce that the proposed wearable robot system make human's motion more powerfully and more variety.

※ **위 사업은 'SEOUL R&BD PROGRAM'의 지원을 받아 수행되었음.**

SESSION II

Korean Society of Biomechanics 2008
제 1 회 추계 학술대회

인간-기계 인터페이스를 위한 근전도 기반의 실시간 상지부 의도 추출 연구

권순철[1], 김정[1]

Study of an Real-time Intention Sensing of Upper Limb using Surface Electromyogram for Human-Machine Interface

Suncheol Kwon[1] and Jung Kim[1]

[1] **기계공학과**, KAIST

Key words: **근전도**, **의도 추출**, **온라인**

Abstract

This paper presents the results of an real-time intention sensing using surface electromyogram(sEMG) signals for Human-Machine Interface(HMI). “Intention sensing” is defined as a capacity of the machine to detect one’s intention of motion and to predict his motion. Intention sensing can become a solution of physical HMI in the unstructured tasks by recognizing human’s changeable motion. The target of the intention sensing is about the upper limbs, which includes shoulder and elbow joints in the vertical plane (parallel to the sagittal plane), because they are frequently moved during handling an object. An artificial neural network (ANN) was used to match the relationship between sEMG and upper limb motion in the vertical plane. The sEMG signals from the four sites were fed into the ANN and captured motion data were used as references. The prediction method was tested on one subject through drawing experiments. The performance was evaluated by a root mean squared error (RMSE) and the result was comparable to previous studies (RMSE < 0.02 rad). These results imply that the method is useful for the natural interaction between a human and a machine interface.

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제 1 회 추계 학술대회

보행속력에 따른 인체보행전략 변화에 관한 연구

강현민[1], 박수경[1]

Gait strategy change as function of human walking speed

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Key words: push-off impulse, gait strategy change

Abstract

Human walking can be explained by McGeer's passive walker. The passive walker can walk down hill using only gravity energy and can generate human-like locomotion without any control. There is heel-strike impulse every step which loses mechanical energy. For that reason, human uses push-off impulse to compensate the energy loss. The balance of heel-strike and push-off impulses let human walk steadily. However, there is a limitation of push-off impulse which cannot increase according to walking speed. So that, human have to use other energy source to compensate energy loss through gait strategy change from ankle to hip joint.

To verify this hypothesis, we measured ground reaction force and kinematic data during human walking. The ground reaction force gives information of which push-off impulse cannot increase like as heel-strike impulse. The mechanical energy calculated from kinematic data informs that the energy increase during swing phase, and it shows there is another energy input. The results of push-off limitation and of mechanical energy increment tell us that human changes gait strategy in fast walking.

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제 1 회 추계 학술대회

원자힘 현미경을 통한 세포의 물성치 해석

김영진[1], 신현정[1], 김정[1]

Nanomechanical analysis of AFM probing on living cells.

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Key words: Atomic Force Microscope, Finite Element Method

Abstract

Mechanical responses against the induced stimuli in living cells are crucial for understanding cellular behavior, identifying cellular structures, and even distinguishing special types of diseases. Controlled mechanical stimuli are applied to the cell's surface and underlying structures, and the responses are recorded for the measurements of the responses. Since the different experimental techniques with the various types, magnitudes and rates of stimuli lead to different mechanical responses even in the same cell, the selection of the technique is one of the challenging issues. In this study, Atomic force microscopy (AFM) was used to record the mechanical responses of cells due to its high spatial resolution and high sensitivity. AFM probing experiments on liver cancer cells and normal liver cells were performed with spherical-particle-attached and conical tip. The experiment results were analyzed by simple linear contact model, named Hertz-Sneddon model. Hertz-Sneddon model showed limitations summarized as; 1) Elastic modulus differences due to geometric effects resulting from large deformations and 2) Nonlinearity resulting from the cell's internal structures. We developed novel finite element (FE) models that include topological information. The FE model can estimate accurate mechanical properties of cells with property coherences regardless of geometric effects as well as identify cytoskeletal effects on cellular behavior. Our FE analysis results can be used for understanding mechanism how a disease process affects mechanical properties as well as distinguishing special types of diseases from mechanical property changes.

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제 1 회 추계 학술대회

Multi-cellular compression device에 의한 기계적 자극이 세포에 미치는 영향

김순희[1], 윤재영[1], 신현정[1]

Effects of mechanical stimulus on cells via multi-cellular compression device

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Key words: Mechanical stimulation, keratinocyte

Abstract

To investigate the effects of mechanical stimuli on cells, many researchers have developed either single cell indentation devices to locally stimulate cells or compression chambers to apply global compressive pressure on cells. However, none of these previously developed devices are suitable to study the cell-cell communications amongst cells upon mechanical stimulation. To accomplish this experimental need, we developed multi-cellular indentation device using soft-lithography techniques. This device is fabricated with transparent Poly-carbonate to allow us observing cellular responses directly during micro scale PDMS poles give direct compressive stimulation to the each cell. Using this noble device, we investigated pain-receptor, sodium channel responses in keratinocytes, one of the mechano-sensitive cells and cell to cell communication. Preliminary results have shown the versatility of this compression device in studying cellular responses, thus demonstrating the feasibility of this tool as to be utilized in evolving cell mechanics research.

Tutorial Session

Korean Society of Biomechanics 2008
제 **1** 회 추계 학술대회

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Recent Publications

1. Cementless Total Hip Arthroplasty with Use of the COREN Hip System, J Korean Hip Soc, 19: 457-462, 2007.
2. Results of Revision Hip Arthroplasty using Cemented Femoral Stem., J Korean Hip Soc, 19: 472-478, 2007.
3. Treatment of Infected Total Hip Arthroplasty., J Korean Hip Soc, 20: 27-34, 2008.

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제 **1** 회 추계 학술대회

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제 **1** 회 추계 학술대회

장애인 운동능력 향상을 위한 보조기구

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SESSION III

Korean Society of Biomechanics 2008
제 **1** 회 추계 학술대회

인공고관절 Ball head의 설계변수 변화에 따른 생체역학적 평가

김형진[1,2],유정훈[1],박흥석,윤인찬[2],최귀원[2]

The Analysis of Biomechanics to Hip Implant Ball head of Design Variables Change

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Key words: 유한요소분석, 생체역학

Abstract

Femoral hip joint는 Ball head와 티타늄 합금과 Cup으로 구성되어 있으며 인공고관절 전치환술(TKR)에서 수 년 동안 성공적으로 되어 왔다. 하지만 사람마다 신체구조가 다르기 때문에 일괄적인 인공고관절의 크기를 만들 수는 없다. 따라서 Stem head의 형상선정을 위하여 Ball head의 구조적인 안정성을 확보하는 것이 중요한 문제가 되며, 이 때의 Ball head의 직경이나 Offset길이를 맞추기 위한 Neck에 얼만큼 들어가는 지에 대한 것을 주요 변수라고 생각할 수 있다.

분석에는 기본적으로 2차원 모델링과 유한요소법을 통한 구조해석 방법을 이용하였다. 먼저 SolidWorks를 이용하여 ISO 7206-5의 규격에 제시되어 있는 Ball, Neck, Cone의 세가지 부분으로 2차원 모델을 생성하였으며, 이것의 형상을 기반으로 요소망 자동생성 프로그램인 Hypermesh를 이용하여 하중 및 물성조건과 접촉면 특성을 고려한 요소망 모델을 완성하였다. 완성된 요소망 모델은 ABAQUS를 solver와 Post-processor로 이용하여 해석하고, 참고자료를 통한 기존의 결과의 특정 관심 영역에서의 응력 집중 정도를 비교하여 검증하였다.

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제 1 회 추계 학술대회

컴퓨터 네비게이션 슬관절 전치환술에서 핀홀에 의한 대퇴골 골절위험성

박형균 [1], 박원만 [1], 김윤혁 [1], 김경수 [2]

Fracture Risk caused by Pin-hole in Femur after Computer-navigated Total Knee Arthroplasty

H. K. Park, W. M. Park, Y. H. Kim, and K. Kim

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Key words: total knee arthroplasty, computer-assisted navigation, pin-hole, femoral stress failure, finite element analysis

Abstract

Total knee arthroplasty (TKA) using computer-assisted navigation has been increasingly popular. Recently, a few clinical studies have reported on a femoral stress fracture after TKA using computer-assisted navigation. The purpose of this study is to investigate the risk of stress fracture around the femoral pin-hole by finite element analysis. A three-dimensional finite element model of a male femur was reconstructed from 1mm thick computed tomography (CT) images. 1500 N of axial compressive force and 12 Nm of axial torsion were applied at the femoral head and the bone was rigidly fixed to a 20 mm above the distal end. For all cases, transcortical pin penetration mode showed the highest stress fracture risk and unicortical pin penetration mode showed the lowest stress fracture risk. Pin diameter increased the stresses, but pin number did not increase the stress fracture risk dramatically.

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제 1 회 추계 학술대회

고령자의 다양한 높이의 앉은 자세에서 일어서기 시 동작특성 및 근길이 변화

황성재[1], 손종상[1], 김정윤[1], 임도형[1,2], 김영호[1,2]

Joint movements and changes of the muscle length during sit-to-stand of the elderly subjects at various sitting height

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Key words: sit-to-stand, elderly, joint movements, muscle length

Abstract

Sit to stand (STS) movement is one of the most common activity in daily life. In addition, The Korean traditionally stand up from various sitting heights in one's daily life compared to other foreigners. In this study, we analyzed the elderly's joint movements and changes in muscle length during STS at various sitting heights (table seat, bath seat, bottom) through the motion analysis and the musculoskeletal modeling.

Five elderly (69.4±6.3years, 161.6±6.1cm, 60.9±4.7kg) and five young (24.4±1.3years, 173.3±3.3cm, 65.5±5.9kg) were participated in this experiment. Three heights of sitting posture which could represent typical sitting in Korean daily life were chosen as table seat (42cm), bath seat (21cm) and bottom (0cm).

As the results, the elderly showed both smaller knee/hip flexion and larger trunk flexion relatively in comparison to the young during table seat STS. The elderly also showed larger dorsiflexion and smaller ROM of knee, hip, trunk compared to the young during bath seat STS. Additionally, the elderly showed larger plantarflexion, hip flexion, smaller knee flexion and trunk flexion during the first half of bottom STS and larger knee flexion, hip flexion and trunk flexion during the second half of bottom STS.

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제 1 회 추계 학술대회

저 강도 초음파의 골다공증 치료 효능

김효선, 고창용, 서동현, 임도형, #김한성

In-vivo Effects of Low Intensity Ultrasound Stimulation for Treatment of Osteoporotic Bone

H.S. Kim, C.Y. Ko, D.H. Seo, D.H. Lim, #H.S. Kim

의공학과 & 의료공학연구원, 연세대학교

Key words: **초음파, 골다공증**

Abstract

The current study is performed to identify quantitatively if the low intensity ultrasound (LIUS) stimulation is effective on treatment of osteoporosis. Eight virgin ICR mice (14-week-old, approximate weight 25g) were used and ovariectomized (OVX) to induce osteoporosis. Right tibia (RT) for each mouse was then stimulated with the LIUS (1.0 kHz frequency, 30mW/cm^2 intensity, 200μs pulse width, and stimulation for 20 minutes/day and 5 days/week over a 6-week period), but left tibia (LT) was not stimulated. To investigate alterations of morphological characteristics, structural parameters were calculated from in-vivo micro-CT images at 0 day and 14 days. The relative variations of BV/TV and Tb.N in RT were significantly bigger than those in LT, while the relative variation of Tb.Pf in RT was significantly smaller than that in LT ($p<0.05$). The relative variations of BV/TV at region directly stimulated LIUS in RT was significantly bigger than that in LT ($p<0.05$). These results showed that LIUS might beneficially affect the osteoporotic bones.

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제 1 회 추계 학술대회

유한요소 해석을 이용한 골융합 골조직의 전자기장 분포 예측

민성기[1], 홍정화[1], 김철승[1]

Estimation of Electro Magnetic Field in Osseointegrated Bone Structure by using Finite Element Analysis

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Key words: osseointegration, electro magnetic, strain generated potential, pore pressure, implant stability

Abstract

Osseointegration could be described as the modality for stable fixation of titanium implant to bone structure. There exist several ways to assess implant stability related to osseointegration, but unfortunately, there have been severe problems in these stability testing methods. Besides patients feel pain while testing, it is possible to exert bad influence to ongoing osseointegration since these methods are in mechanical contact loading conditions. In this paper new stability assessing method having no contact requirement was proposed. But in order to apply new assessing method the infinitesimal amounts of magnetic field should be measured. The aim of this paper is to predict the distribution and magnitude of magnetic field in implanting bone in order to verify that new method is feasible. This study was performed using a completely osseointegrated rabbit tibia-titanium implant composite. The generation of magnetic field in bone structure is related to strain generated potential(SGP) caused by the generation of porepressure. The distribution of porepressure in bone structure caused by external load obtained from finite element analysis using ABAQUS. The magnitudes of pore pressure were found to be significantly increased when the position was approached for the interface of implant-bone. The relationship between porepressure and SGP obtained from the uniaxial strain loading experiment about the given specimen. From this relationship, distribution of SGP in entire specimen was estimated. As boundary conditions on nodes with SGP the final distribution of magnetic field could be obtained by using ANSYS capable of multi-physics analysis. As a consequence, we showed the estimated magnetic field is on measurable range.

Poster Session

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제 1 회 추계 학술대회

P - 1

근전도 기반의 손가락 힘 예측 알고리즘 개발

최창목[1], 권순철[1], 박원일[1], 신미혜[1], 김정[1]

Development of an Algorithm for the Finger Force Prediction Based on Electromyogram (EMG)

Changmok Choi[1], Suncheol Kwon[1], Wonil Park[1], Mihye Shin[1], and Jung Kim[1]

[1] **기계공학과**, KAIST

Key words: **근전도, 손가락 힘**

Abstract

This paper describes a real-time isometric pinch force prediction algorithm from surface electromyogram (sEMG) using artificial neural network (ANN) for human robot interactive applications. The activities of seven muscles which are observable from surface electrodes and also related to the movements of the thumb and index finger joints were recorded during pinch force experiments. For the successful implementation of the real-time prediction algorithm, an off-line analysis was performed using the recorded activities. Four muscles were selected for the force prediction by using the Fisher linear discriminant analysis among seven muscles, and the four muscle activities provided effective information for mapping sEMG to the pinch force. The ANN structure was designed to make training efficient and to avoid both under- and over-fitting problems. The pinch force prediction algorithm was tested on five volunteers and the results were evaluated using two criteria: normalized root mean squared error (NRMSE) and correlation (CORR). The training time for the subjects was only 2 min 29 sec, but the prediction results were successful with NRMSE = 0.099 ±0.011 and CORR = 0.940 ±0.007. These results imply that the proposed algorithm is useful to measure the produced pinch force without force sensors in real-time. The possible applications include controlling bionic finger robot systems to overcome finger paralysis or amputation.

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제 1 회 추계 학술대회

P - 2

생체조직의 기계적 물성 획득을 위한 마이크로모터 기반의 최소침습형 인덴터 개발

안범모[1], 김 정[1]

Development of Motorized Minimally Invasive Indenter for Measurement and Modeling of Soft Tissue Behavior

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[1] **기계공학과, 한국과학기술원**

Key words: Motorized minimally invasive indenter, Medical simulation, Soft tissue behavior.

Abstract

The measurement and modeling of soft tissue behavior is essential for virtual reality (VR)-based medical simulations, providing a safe and objective medium for training surgeons. This paper presents a motorized minimally invasive indenter, which is applicable to measure the soft tissue behavior. The indenter is composed of a micromotor, a linear position sensor, a force transducer, and a probe. The micromotor is controlled with an integrated magneto-resistive (MR) sensor as a linear position sensor, and then the device is manipulated within the range of 7 mm with less than 5 μm motion error. The indenter has the diameter of 8 mm and the length of 150 mm. To measure the soft tissue behavior, the reaction force at the probe tip was measured with the force transducer (resolution: 1mN) and recorded with the data acquisition system. The developed device is suitable for measuring accurate soft tissue behavior on live intra-abdominal organs. Furthermore, the measured data can be used to develop the precise tissue models for the VR based medical simulation.

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제 1 회 추계 학술대회

P - 3

근육모델을 이용한 실시간 손가락 힘 예측에 대한 연구

박원일[1], 이해동[2], 김정[3]

Study of Real-time Isometric Finger Force Prediction Using Hill's Muscle Model

Wonil Park [1], Headong Lee [2], and Jung Kim [3]

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Key words: 근전도, 근육모델, 손가락 힘

Abstract

Pinch motion is the most frequent motion which human perform and it is driven by activated 15 muscles of the thumb and index finger. However, due to the difficulties in predicting pinch force only with activation levels of surface extrinsic muscles, predicting pinch force under isometric condition have been an obstacle to the control of a myoelectric hand prosthesis or robotic hand in the field of human robot interaction. This study describes the isometric thumb-tip pinch force estimation based on the Hill's muscle model. Abductor Pollicis Longus (APL) muscle which is the only measurable extrinsic muscle from the surface among thumb muscles was selected for pinch force prediction. The muscle force of APL was estimated using Hill's muscle model. Reported ratio of electromyography between thumb muscles and cadaver data of thumb-tip force vector were used for total thumb-tip pinch force prediction. Before real-time implementation, an offline analysis was performed from the recorded muscle activities. The result showed proposed method was promising with correlation (CORR) = 0.943. This result indicated the possibility of a pinch force prediction method based on the Hill's muscle model for the real-time prosthesis control and natural human robot interaction.

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제 1 회 추계 학술대회

P - 4

실시간 착용형 건강모니터링 장치의 움직임 노이즈 제거

한효녕[1], 김민준[2], 김정[1]

Motion artifact reduction in real time and wearable health monitoring device

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[2] H3system

Key words: wearable, health monitoring, motion artifact reduction

Abstract

This research presents a motion artifact reduction method in a wearable PPG device in daily motion. We designed the wearable device as a sports glove, and sensors of the device are consist of four IR LEDs, one photo diode and tri axial accelerometer are used to measure PPG and motion reference signal. Signals are sampled with 20 Hz frequency, and the third order ANC algorithm is employed to cover the 0.15 sec time range. And advanced zero crossing method reduces counting pulse rates error. As a result, we can obtain real pulse rate signal less than 5 % error compared with the reference ECG signal. The designed device is compared with other commercial devices to validate the performance of the device in daily motion. As a result on comparison of walking, running and typing test data shows the algorithm reduce pulse error less than 5 % and this value means that the device is available to use in daily life.

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제 1 회 추계 학술대회

P - 5

연령에 따른 인체의 자세전략변화 정량화

김세영[1], Fay B. Horak[2], 박수경[1]

Change of postural feedback gain scaling by aging

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[2] Neurological Sciences Institute, Oregon Health & Science University, USA

Key words: gain scaling, aging, postural control

Abstract

We examined how age affects how postural strategies change as perturbation magnitude changes. Previous studies showed that young adults continuously scale postural response gains from ankle strategy to more and more hip strategy with increasing biomechanical constraints but it is now known whether elderly subjects show the same scaling (Park et al.,2004). Postural responses were analyzed with full-state feedback control whose gain parameters characterize the response of each group. The gain scaling indicates that the elderly relies more on hip strategy, while the young continuously changes from ankle to hip with perturbation magnitude.

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제 1 회 추계 학술대회

P - 6

균형 능력과 운동지각의 상관관계

이용우[1], **박수경**[1]

Correlation between balance ability and linear motion perception

Yongwoo Yi and Sukyung Park

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Key words: **균형, 운동지각**

Abstract

Sensory organs such as eye, vestibular organs, and muscle spindles provide postural sway information to the central nervous system for balancing themselves. The balance ability was evaluated by observing the change of the posture sway. Usually, less posture sway was regarded as better balance ability. It remains unclear, however, whether the reduced postural sway directly demonstrates the improved subjective motion perception. In this study, we investigated the correlation between balancing ability and motion perception.
Young healthy male volunteers (aged 21~ 29 years) were participated. We previously showed that the cetaceous sense of soles played important role to the motion perception. To provide the condition that declined balance ability, subjects were restrained their sole sensation. To focus on the effect of declined balance ability caused restrained sole, the whole trial was progressed with bare foot in the dark room. The balance ability was evaluated by measuring the COP (center of pressure) during quiet standing. Covariance between the ankle angle(θ_{ankle}) and the hip angle(θ_{hip}) was also monitored by using the motion capture system. We investigated the detection of movement direction by measuring perceived direction of linear motion. Subjects experienced linear translational stimuli on the servo-controlled translational platform with and without restraint on the soles, and reported the perception of motion using a button press. We obtained the threshold for the motion perception from a psychophysical procedure.
COP and motion perception showed the positive correlation with and without the restraint. The subject had less posture sway, had also less motion detection threshold. And the covariance between θ_{ankle} and θ_{hip} showed more dependence on the ankle with the restraint.
This result suggests that the motion perception threshold can represent the balance ability without measuring the COP. Moreover, we showed the potentiality that covariance can be used as the index for the balance ability.

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제 1 회 추계 학술대회

P - 7

전정기관 섬모다발의 반 강성을 모사하는 모델링을 이용한 기계적 증폭메커니즘의 시뮬레이션

박혜영[1], 박수경[1]

Simulation of Mechanical Amplification Using the Model Mimicking Negative Stiffness of Vestibular Stereocilia Bundle

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1 **기계공학부, 한국과학기술원**

Key words: mechanical amplification, negative stiffness

Abstract

The ability of hair cells in the inner ear, which is responsible for hearing and balance, achieves broad dynamic range while maintaining remarkably high sensitivity. The two hair bundle's characteristics, negative stiffness and adaptation that betray an amplifying mechanism are the key of this phenomenon. Negative stiffness is explained well by a gating-spring model in which mechanoelectrical transduction channels operating in parallel adopt either an open or a closed state. This amplifying mechanism is a highly mechanical process. In this study, basing on a gating-spring model and mechanical process, we propose and simulate a mechanical model mimicking negative stiffness mechanism on the inner ear hair bundle. The model consists of 5 inverted pendulum array supported by pivotal springs and dampers at the base, which are equivalent to bundle's stiffness and viscous dissipation, and interconnected by tip-link springs at the tips. Bistable gate are connected to one end of tip-link spring in series, and gate opens when force over threshold is exerted on each tip link. Simulation was performed on MATLAB, and the time response to step input is obtained. The result displayed that miniscule stimuli produces a large displacement and a correspondingly significant change in channel open probability. This mechanical amplification maintains high energy efficiency and high sensitivity without noise, because the structure performs amplification physically. Therefore, mimicking the inner ear hair bundle deserves being applied to enhanced inertia sensor

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제 1 회 추계 학술대회

P - 8

Galvanotaxis 시스템을 사용한 세포 레벨의 반응 연구

박나래[1], 송석현[1], 신현정[1]

Dynamic study of cellular responses using a gavanotaxis system

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Key words: dc Electric field, breast cancer, galvanotaxis

Abstract

EIS (Electrical Impedance Scanning) is suggested as a new breast cancer detection technique. Low-level electric currents transmitted through the breast and different impedance of tissue under the scanning probe distinguishes tumor from normal. However, cells are naturally sense and response to electrical fields by changing alignment and the orientation of movement, known as galvanotaxis. Breast cancer cells, especially, are known to be sensitive to electrical stimuli and its metastatic behavior might be influenced. Thus, EIS induced-cell metastasis has to be verified for its safety. In this research, we develop a galvanotaxis chamber designed based on 3-D electric field simulation and connect it to self-perfusion system to supply fresh medium on cell monolayer. Then, we apply dcEFs to two cell types, MCF-7 and MDB-MA-231, weakly and highly invasive breast cancer cells. They shows dcEF strength and direction dependant dynamic behaviors. Cell-substrate junction, cytoskeleton proteins and growth factor receptors expression are observed using conventional microscopy, real-time imaging and immunostaining. Results suggest that external mechanical stimuli play an important role in BCCs metastasis.

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제 1 회 추계 학술대회

P - 9

정상세포와 암세포의 플라즈마 특성에 관한 비교 연구

김대연[1], 권보미[2], 김단비[2], 최원호[2], 신현정[1]

Comparative study of plasma effects on normal and cancer cells

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Key words: Cold plasma, Biomedical engineering

Abstract

Plasma is 4th state of matters, which consists of electrons, neutral, and ionized particles. Plasma can be generated in the atmospheric conditions at low temperature, which is called cold plasma or atmospheric plasma. In biomedical research, cold plasma has been applied to disinfect microorganisms such as bacteria and yeast cells. Because of its low temperature condition, the heat-sensitive medical device can be easily sterilized by the cold plasma treatment.

In recent years, the effects of plasma on mammalian cells have arisen as a new issue. Generally, plasma induces intensity dependent necrotic cell death and detachment of cells. In this research, we investigate the feasibility of cold plasma treatment for cancer therapy by conducting comparative study of plasma effects on normal and cancer cells. We use THLE-2 (human liver normal cell) and SK-Hep1 (human liver metathetic cancer cell) as our target cells. The needle type of cold plasma is generated by the Helium plasma device. Two types of cells have different onset plasma conditions for the necrosis, which may be explained by difference in electrical properties of these two cell types.

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제 1 회 추계 학술대회

P - 10

예쁜 꼬마선충의 회전운동 분석

김대연[1], 황혜진[2], 박성수[2], 신현정[1]

Analysis of *C. elegans*' smooth turning motion

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Key words: *C. elegans*, behavioral study

Abstract

Caenorhabditis elegans (C. elegans) is the model organism with relatively simple anatomy and well characterized genetic information. There has been a great deal of efforts to understand the mechanism of *C. elegans* locomotion. When crawling on a solid surface, *C. elegans* moves forward and backward by propagating dorso-ventral contraction waves toward the opposite direction of its movement, the mechanisms of which have been extensively analyzed through mechanical and neural modeling. In these studies their simple straight motions are mainly considered while the turning mechanism in crawling is mostly neglected.

In this research, we propose a simple mathematical model for the turning of crawling *C. elegans.* It reveals that the worm regulates the curvature of its body bending and the contour length between maximum and minimum of the bend during the turns. These regulations lead to the changes of two major motion parameters, namely the ratio of amplitude to wavelength and body length normalized wavelength. The proposed model indicates that the worm is able to turn by causing the changes in these two parameters, which is consistent with what we observe in experiments.

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제 1 회 추계 학술대회

P - 11

The effects of tensile stimulations on osteogenic differentiation of human bone marrow mesenchymal stem cells

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[1] Department of Mechanical Engineering, KAIST

Key words: Osteogenic differentiation, Mesenchymal stem cell, strain ratio, cell tensile stimulation, 2D elastic membrane, Quantitative analysis, Osteogenic marker

Abstract

Mechanical stimulation is known to have a positive effect on the differentiation of mesenchymal stem cells(MSCs) to pre-osteoblasts. In this research, we developed a tensile cell stimulator composed of a DC motor-driven actuator and LVDT sensor for measuring linear displacement. Using this device, we investigated the effects of tensile stimulation on the osteogenic differentiation by applying a constant strain on cell monolayer cultured on a flexible silicon substrate. The degree of osteogenic differentiation exhibited dependence on the amplitude of the stimulation Quantitative analysis of maker protein, alkaline phosphatase (ALP), by real time PCR indicated that the level of gene expression in the samples with 2% tensile stimulation in addition to the osteogenic media (OM) are 7.6 times and 15.2 times higher than what we obtain for samples with OM only after the 4 day and 7 day stimulations, respectively. At higher stains of 4% and 6%, addition of OM exhibited counter effects by downregulating ALP when compared to samples without the OM. In the absence of OM, a high level strain of 4% and 6% are more effective than low level strain condition.

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제 1 회 추계 학술대회

P - 12

극초단파를 이용한 피부암 열치료 연구 – 세포 실험을 중심으로

이창헌[1], 이애주[1], 윤인찬[1], 김광명[1], 최귀원[1]

Skin cancer thermotherapy research using microwave - Mainly on cell experiments

Changheon Yi, Aeju Lee, Inchan Youn,
Kwangmeyung Kim, Kuiwon Choi

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Key words: cancer, thermotherapy, microwave, apoptosis

Abstract

Thermotherapy is recently introduced to cancer therapy as an invasive method. The thermotherapy is using the properties that cancer cells have low heat dispersibility and weak heat tolerance because cancer cells have weak blood vessel expansion ability. It is reported that apoptosis is developed only in cancer cells with the condition at 43 ℃ for 60 minutes, not in normal cells.

The aim of present study is to identify a condition which apoptosis is developed only in cancer cells using microwave. Cancer cells and normal cells are incubated at 43 ℃ for several ten minutes with 2,450 MHz microwave which have good human body permeability. And TUNEL Assay is used to identify the development of apoptosis in cells. As a result, we controlled apoptosis progression only in cancer cells with microwave heating.

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무릎 관절 보조기의 견인 효과에 따른 무릎 관절 내부 조직의 신전 변이 평가

조승관, 김현동, 손량희, 이태우, 김영호, 김한성, 임도형*

Evaluation of Extension Displacement of Internal Tissues of Knee Joint due to Traction Effects exerted by Knee Brace

Cho, SK., Kim, HD., Sohn, SR., Lee, TW., Kim, YH., Kim, HS, and *Lim, DH.

연세대학교 대학원 의공학과

Key words: Arthritis Knee Brace, Traction Effect, Extension Displacement

Abstract

The current study identified quantitatively extension displacements of internal structures composed of knee joint, which were generated by the traction effects exerted by arthritis knee brace, for evaluation of effectiveness and safety of the arthritis knee brace specialized. For the aim of the current study, fluroscopic X-ray image analysis and finite element analysis were used.

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저강도 초음파를 이용한 골다공증 골절 예방

김치훈, 우대곤, 박지형, 고창용, 김한성, #임도형

Effect of Low Intensity Ultrasound Stimulation on Bone Strength Improvement for Prevention of a Risk of Fracture Related Osteoporosis

Kim, CH., Woo,DG., Park JH., Ko, CY., Kim, HS., #Lim, D.

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Key words: **초음파, 골다공증 골절**

Abstract

The aim of current study is to identify quantitatively if the low intensity ultrasound stimulation (LIUS) is effective mechanically on prevention of bone fracture related osteoporosis. Eight 14-week-old virgin ICR mice (approximate weight 25g) were used and ovariectomized (OVX) to induce osteoporosis. Right hindlimb was then stimulated with the LIUS (1.0 kHz frequency, 30mW/cm2 intensity, 200μs pulse width, and stimulation for 20 minutes/day and 5 days/week over a 6-week period), whereas left hindlimb was not stimulated. Both hindlimbs were scanned by in-vivo micro-CT at 0 week (before stimulation), 3 weeks and 6 weeks (after stimulation). Finite element analysis was performed to determine quantitatively the effect of the LIUS on the bone strength. The structural moduli in US group were significantly increased over time ($p<0.05$), whereas the structural moduli in CON group were statistically constant over time ($p>0.5$). These findings may indicate that the LIUS may prevent effectively a risk of the bone fracture related osteoporosis through achievement of the bone strength improvement.

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동시수축 운동 시 근력추정을 위한 혼합 정적 최적화 알고리즘

손종상[1], 김영호[1,2]

A hybrid static optimization algorithm to determine muscle forces for the co-contraction movement

Jongsang Son and Youngho Kim

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[2] **의료공학연구원, 연세대학교**

Key words: co-contraction, optimization, muscle force, EMG

Abstract

The estimation of muscle force is important to understand the roles of the muscles, and enables clinicians to judge the patient's potential for function. The static optimization method is useful to obtain the individual muscle force. However, it has been inappropriate under co-contraction conditions. In this study, a hybrid static optimization method was developed by combining general static optimization and EMG-assisted optimization. To validate the algorithm, results from the inverse dynamics approach were compared with those from the developed optimization method. Developed algorithm could provide to estimate the acceptable muscle forces during heel-rise movement. These results imply that the developed algorithm could be used to obtain reasonable muscle forces under co-contraction conditions.

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무부하 환경이 쥐의 해면골에 미치는 영향

서동현, 고창용, 강순영, 임도형, #김한성

Effects of Skeletal Unloading Induced by Denervation on Trabecular Bone of Mice

Seo, DH., Ko, CY., Kang, SY., Lim, D., # Kim, HS.

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Key words: **무부하, 해면골**

Abstract

The aim of this study was to identify effects of skeletal unloading induced by denervation on trabecular bone of mice, through a detecting and tracking analysis for a period of growth of the mice. Six-week-old twelve male and fifteen female ICR mice were used and randomly allocated into two groups; unloading group (male: UM, female: UF), wild type group (male: WM, female: WF). Denervation was performed for right hindlimb in the unloading group. The right hindlimbs of all mice were scanned by *in vivo* micro computed tomography (μ-CT) at day 0 (before denervation) and day 14 (after denervation). The structural parameters were calculated. Between unloading and the wild type groups, BV/TV, Tb.Sp and Tb.Pf were significantly different for the male mice, whereas all morphological characteristics were significant different for the female mice ($p<0.05$). These results showed that the bone adaptation in the skeletal unloading condition may be different between male and female mice even the same skeletal unloading condition

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편마비환자 FES보행의 전기자극 시작시점결정을 위한 Foot-off 이벤트 검출

문기욱[1], 김지원[1], 강곤[2], 엄광문[1#]

Detection of Foot-off Event for the Determination of Stimulation Start in FES Locomotion of Hemiplegic Patients

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Key words: FES, gyro sensor, toe-off, gait event

Abstract

The purpose of this study was to determine the initiation time of stimulation (S-on-time) for the FES locomotion of hemiplegic patients by using minimally constraint sensor system replacing foot-switches. The S-on-time was determined as the time of swing phase initiation i.e. the time of foot-off event. The angular velocity of lower leg (forward swing as positive) was measured by a gyrosensor. There were two negative (backward swing of lower leg) peaks in the angular velocity: one at the early period of stance phase and the other at the early period of swing phase. The latter was selectively amplified by using a digital bandpass filter and the foot-off event was detected as the instance where the filtered angular velocity crosses the designated threshold. The proposed method was applied to three normal subjects and four hemiplegic patients. The foot-off event was properly detected (once per one gait cycle) in all subjects and the error in the detected foot-off time was 0.02 0.16[s] in normals and 0.07 0.30[s] in patients.

The proposed method do not need the foot-switches which limits the clinical practicality, so that it is expected to be useful for the FES during activities of daily living after further reduction of the S-on-time error and more elaborate experiments.

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가속도 센서를 기반으로 한 트레드밀에서의 에너지 소비량의 측정

강동원, 최진승, 문경률, 탁계래#

Measurement of energy expenditure on treadmill by using accelerometer

D. W. Kang, J. S. Choi, K. R. Moon and G. R. Tack

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Key words: 에너지 소비, 가속도 센서, 트레드밀, 회귀분석

Abstract

본 연구는 동작분류 모니터링 시스템 개발에 관한 선행연구의 추가연구로 수행되었다. 분류된 동작 상태에 따른 에너지 소비량 측정을 목표로 하는 초기연구로써 에너지 소비와 가속도 센서와의 상관관계를 분석하였다. 실험은 피험자가 트레드밀에서 총 7가지의 다른 속도(1.5, 3.0, 4.5, 6.0, 6.5, 7.0, 8.5km/h)로 호흡가스분석기(Metamax 3B, Cortex Biophysik GmbH Co., Germany)와 3축 가속도 센서모듈을 허리에 부착하여 실시하였다. 피험자는 병적사항이 없는 성인남자 6명으로 구성되었으며 트레드밀 속도가 6.0km/h 이하일 경우 걷는 동작을, 6.5km/h 이상일 경우는 달리기 동작을 실시하였다. 운동의 누적효과를 줄이기 위해서 7가지의 속도를 랜덤하게 선정하였다. 실험결과에서 속도가 증가함에 따라 에너지 소비가 높아지고 그에 따라 가속도 센서의 3축의 합인 벡터크기(Vector Magnitude, VM)도 함께 증가(r=0.923, P<0.001)를 나타내었고 이 관계를 다중회귀분석을 통해 수식화 하였다. 본 결과로 가속도 센서를 통한 에너지 소비량 예측이 가능하다는 것을 알 수 있었고 이것을 이용하여 현대인들의 건강 유지 및 증진을 위한 매우 중요한 정보로 활용될 수 있다고 사료된다.

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전신 진동을 통해 하지의 등속도 운동효과 구현을 위한 EMG Biofeedback 시스템의 구성

최진승, 강동원, 문경률, 탁계래#

EMG biofeedback system for isokinetic exercise on lower extremity using whole body vibration

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Key words: 바이오피드백, 음파진동, 하지 등속도 운동, 근전도

Abstract

고령 인구가 증가함에 따라 고령자의 건강에 대한 관심이 증가하고 있다. 이러한 고령자의 건강에 가장 큰 변화는 이동 능력의 저하이다. 이것은 신체의 노화로 인한 하지 근육의 약화에 따른 보행능력의 감소가 큰 원인 중 하나이다. 따라서 저항성 운동을 통한 하지근력운동의 필요성이 부각되고 있다. 고령자와 같이 근력이 약화된 경우, 장시간 혹은 강도 높은 훈련이 불가능하여 처방된 적정 수준으로 꾸준히 운동하는 것이 필요하다. 따라서 본 연구의 목적은 진동자극의 크기변화를 이용해 고령자가 단순 저항운동만으로도 유사 등속성 운동을 수행할 수 있는 EMG 피드백 장치를 제안하는 것이다. 하지의 외측광근(Vastus lateralis m.)과 내측광근(Vastus medialis m.)에 EMG 전극을 부착 후, 사전에 Biodex를 통해 등속도운동을 수행한 상태의 EMG 패턴을 측정한다. 이 패턴을 이용해 발판에 진동장치가 부착된 레그프레스에서의 운동수행 시, 진동 조절을 통해 등속도 운동 시의 EMG 패턴과 유사하게 근육에 작용하도록 고안하였다. EMG 측정은 Biopac(BIOPAC system Inc., USA)의 MP100 EMG모듈을 사용하였고, 피드백 구현은 Labview를 통해 구현하였다. 추후 구성된 피드백 시스템을 이용한 등속성 운동 효과에 대한 실험을 수행할 예정이다.

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무릎 근력지원을 위한 착용형 로봇 개발

이희돈[1], 이승훈[1], 유승남[1], 장재호[1], 한창수[1], 한정수[2]

Design of Wearable Robot Mechanism of Shoulder and Elbow Joint

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Chang-Soo Han, Jung-Soo Han

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Key words: Knee-Assistive System, Weaeable Robot, Exoskeleton, MSS(Muscle Stiffness Sensor)

Abstract

We used a lower limb robotic exoskeleton controlled by the wearer's muscle activity to study human locomotors adaptation and feasibility. A healthy and normal subject walked while wearing a electrically powered knee exoskeleton on two knee that effectively increased plantar flexor strength of knee and its neighboring muscles. We examined the ability and feasibility of proposed knee assist robot by testing adapted motor pattern and EMG (Electromyography) signal variance for exoskeleton walking. This system is designed for specific tasks which are level walking and step walking while user carrying heavy materials. This system is constructed using electric plat motor, commercialized harness and custom-made muscle stiffness sensors (MSS). We analysis muscles activity patterns while walking and generate operating algorithm and examined its feasibility. These results demonstrate that robotic exoskeleton controlled by muscle activity could be useful tools for assisting human walking.

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3 차원 공배양을 통한 중간엽 줄기세포의 chondrogenesis: 간헐적 정수압의 효과

김동화[1,2], 이슬비[1], 오연숙[1], 정미진[1], 최성우[1], 신정욱[1,2*]

Chondrogenesis of Mesenchymal stem cells through 3D Co-culture :Effects of Intermittent Hydrostatic Pressure

DH. Kim[1,2], SB. Lee[1], YS. Oh[1], MJ. Jung[1], SW. Choi[1], JW. Shin[1,2*]

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Key words: 3 **차원 공배양, 중간엽 줄기세포, 간헐적 정수압, 연골화**

Abstract

손상된 연골을 치료하기 위한 세포 치료적 방법으로는 자가 연골 세포 이식법 등이 있으나, 세포를 채취하는데 있어서 그 양이 제한적이며, 체외 배양 시 세포의 탈분화로 인해 세포 표현형의 변화가 발생되는 한계점이 있다. 이러한 한계점을 극복하기 위해, 증식이 쉽고 연골 세포로 분화가 가능한 중간엽 줄기세포 (MSC)와 연골세포 (chondrocyte)를 3 차원 공배양 하여 기질 생성을 촉진하는 물리적인 자극을 가하여 그 효과를 보고자 하였다. New Zealand white rabbit **에서** chondrocytes**와** MSCs**를 분리하여 배양하였다.** Alginate**에 고정한 후,** PET membrane**으로 분리하여** 3 **차원 공배양 하였다. 실험군은 자극의 유, 무에 따라 두 그룹으로 나누었으며** MSCs, chondrocytes **각각** 10^5 cells/ml, 5 × 10^4 cells/ml**로 파종하였다. 배양 후** 3 **일째부터** 3 **일간** 0.2 MPa**의 정수압을** 2**분/**15**분 (가압/휴식)을 주기로 하루** 4 **시간씩 가하였으며, 분화 배지에** 1, 7, 14 **일간 배양하였다. 세포 외기질 형성 정도를 평가하기 위해** GAG (glycosaminoglycan) contents**를 측정하여** DNA**로 정량화 하였다. 분석 결과, 자극에 상관없이** chondrocytes**는 원활한 증식을 보였고,** 14 **일차 자극을 받은 그룹의** MSCs**는** chondrocytes**로 부터 분비되는 물질과 자극에 의해 자극을 받지 않은 그룹의** MSCs**보다 유의한 차이를 나타내었다. 이를 통해 공배양 시스템의 효과를 확인 할 수 있었으며, 물리적인 자극 환경은** MSCs**의** chondrogenesis **유도에 유용한 것으로 사료 된다.**

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인공 추간판 치환술이 경추에 미치는

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생체역학적 영향

박원만 [1], 김윤혁 [1], 김경수 [2]

Biomechanical Effect of Total Disc Replacement on Cervical Spine

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[2] **수학과, 경기대학교**

Key words: total disc replacement, artificial disc, cervical spine, finite element analysis

Abstract

Recently, total disc replacement have been used for alternative surgical method for cervical spine. In this study, we analysed effects of kinematic characteristic of artificial discs on cervical spine using analysis. A finite element model of C2-C7 spinal motion segment was developed and validated. Two different types of artificial discs, semi-constraint and un-constraint, were inserted at C6-C7 segments. Inferior plane of C7 vertebra was fixed and 1Nm of moment were applied on superior plane of C2 vertebra with 50N of compressive load along follower load direction. Mobility of un-constraint artificial disc was higher than semi-constraint one in all loading conditions. High mobility of un-constraint artificial disc led higher facet joint force than semi-constraint one. Also, a tendency of axial stresses of ligaments varied with slip of polyethylene core. The results of present study could be used not only to choose surgical method and implant but also to develop new implant for cervical spine.

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노인 개개인에 맞는 보행훈련기의 개발을 위한 범용보행모델의 개발 및 보행훈련기 설계

황선희, 서상진, 박승훈, 강곤

A Study on a Generic Walking Model and a Customized Gait Training System for the Elderly

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Key words: Walking Model, Gait Training System, Elderly People

Abstract

노인의 최적보행훈련을 유도하기 위해서는 개인의 신체조건에 적합한 보행속도, 보폭 등을 적용할 수 있는 맞춤형 보행훈련시스템의 개발이 요구된다. 따라서 본 연구에서는 노인 보행에 대한 범용컴퓨터모델을 개발하고, 시뮬레이션을 통해 개개인에 맞는 최적 보행패턴을 추출하고자 한다. 또한 임의의 보행패턴(궤적)을 재현할 수 있는 보행훈련기기를 개발하고 추출된 최적보행패턴을 훈련에 제공하여 보행능력 향상을 모니터링하는 시스템을 개발하는 것이 본 연구의 최종목적이다.

본 연구실에서 앞서 개발된 사이클링 모델을 바탕으로 보폭과 지면으로부터 발의 높이 등을 임의로 조절할 수 있는 측평면 보행모델을 개발하였다. 보행모델에서 양 발은 보행훈련기기 양단의 페달 위에 고정되어있고, 몸통, 머리와 팔은 하나의 강체(rigid body)이며, 이 강체는 지면에 대하여 수직을 유지하고, 크랭크 중심으로부터 양 발까지의 거리는 크랭크 각도 궤적에 따라 각각 독립적으로 변한다고 가정하였다. 본 연구에서는 근·골격 범용 소프트웨어 SIMM 을 사용하였다. 보행모델에서 추출된 보행 궤적을 구현하는 보행훈련기는 다음과 같은 사양을 갖도록 설계되었다. 사용자의 최대 신체조건은 185cm 의 신장과, 150kg 의 체중, 290mm 의 발사이즈로 정하였다. 정상보행과 같은 훈련효과를 제공할 수 있도록, 최대보행 높이는 100mm, 발바닥 각도는 -10~50° 까지 제어가 가능하도록 하였다. 보격은 80mm, 보폭은 700mm 까지 제어 가능하고 최대 8km/h 의 보행속도가 가능하도록 설계하였다. 또한 4 극로드셀을 사용하여 사용자의 압력중심을 실시간으로 측정할 수 있도록 하였다.

지금까지 건강한 젊은 성인의 보행 시뮬레이션을 완성하였고, 보행훈련기기는 보폭과 발의 높이, 지면과 발의 각도 등이 독립적으로 제어 가능하도록 제작되었다. 현재 보행 속도의 변화에 따른 각 근육의 신경입력에 관한 연구가 진행 중이며, 임의의 보행궤적을 구현할 수 있는 제어기를 설계하고 있다.

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공압인공근육을 이용한 능동형 족관절 보조기 개발

김 경 [1,4], 김동욱 [2], 권대규 [2,3], 김남균 [2]

Development of Active Ankle Foot Orthosis Using Pneumatic Artificial Muscle

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Key words: ankle-foot orthosis, active control, pneumatic artificial muscle

Abstract

Ankle-foot orthosis(AFO) with a pneumatic rubber actuator, which is intended for the assistance and the enhancement of ankle muscular activities was developed. In this study, appropriate amount of power pattern of the device and the effectiveness of the system was investigated. To find the appropriate amount of power pattern and the effectiveness of the system, the subjects performed maximal voluntary isokinetic plantarflexion contraction on a Biodex-dynamometer. Plantarfexion torque of the ankle joint is assisted by subject's soleus muscle that is generated when ankle joint do plantarflexion motion. We compared the maxmal plantarflexion torque between with active control of the AFO and without it. The subjects were performed the gait motion with and without the active control using muscle. We made a comparison the muscular activities between with and without the active control. The experiment results in gait motion showed that the muscular activities wearing the AFO were reduced and the peak torque values wearing it were increased. Therefore, we confirmed the effectiveness of the developed AFO.

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IPMC 카테터의 변형 특성의 유한요소 해석

정우원[1], 이장열[2], 조재영[2], 이계한 [1]

Finite Element Analysis of Deformation Characteristics of IPMC Catheters

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Key words: **능동형 카테터**, **열등가모델**, IPMC, **유한요소해석**

Abstract

Catheters have been used in intravascular treatment, such as thrombectomy, coil embolization and stent application. Placing the catheter tip to the target region has been a formidable work for surgeons, therefore, steerability of a catheter has been required in order to accommodate complex curvatures and bifurcation of blood vessels. Efforts have been performed to develop active steerable catheter using electroactive polymers, because they can provide large deformation with relatively low voltage. In order to develop a steerable catheter using an ionic polymer metal composite (IPMC), we have developed a finite element model of IPMC catheter using electro-mechanical-thermal analogy. Simulated bending performance of an IPMC catheter was compared with the experimental results. The results showed that a simple bimorph model using thermal analogy could predict the maximum tip displacement of an IPMC catheter with reasonably good accuracy.

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3자유도 병렬형 매니퓰레이터 구조를 이용한 노인용 지팡이의 메카니즘 설계 및 보행분석

장대진[1], 김정훈[2], 양현석[2], 문무성[1]

Mechanism Design and Gait Analysis of Cane-Like Passive-Type Walking Aid for the Elderly, Using 3-DOF Parallel Manipulator

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Key words: Parallel manipulator, Stewart platform, gait analysis, cane-like walking aid

Abstract

The elderly experience trouble in walking because they inherently have dull senses and weak musculoskeletal systems. These lacks of mobility lead to kinematic and kinetic changes in walking patterns compared with normal people, instability in body balance and the ability to properly control their motion. Canes include mono, tripod, and quadruped canes. Mono canes provide only single-point ground contact, so they are inherently unstable when the elderly ambulate. Tripod and quadruped canes are comparably more stable than mono canes because they provide multipoint ground contact and resist rotation about their vertical axes. However, their principal disadvantage is the need for all legs of the cane to be in simultaneous contact with the ground.

In this paper we suggest a three-link in-parallel (TLP) cane which can stand upright on the floor when not in use, provides an increased base of support and permits contact with the ground about any direction. A TLP cane consists of an upper part and a lower part. The upper part is a vertical component made of a lightweight material and the lower part is a parallel platform connected with a 3-RPS (revolute, prismatic, and spherical) joint. The following section provides a description of the design procedure using screw theory, tests of the elderly during locomotion, and results for mono cane and this proposed walking aid.

From the results, in walking without a cane, a significant decrease of the lower limb joint angles was founded, but the elderly presented ankle plantar flexion and hip extension in walking with a mono and TLP cane. There was a remarkable discrepancy of stance percentage between both legs in walking without a cane and with a mono cane, but there was no difference between walking without a cane and with a mono cane in terms of a discrepancy of stance percentage. On the other hand, the discrepancy of the stance percentage in walking with a TLP cane was reduced ($p<0.05$).

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기계적 자극이 골세포의 OPG/RANKL 발현에 미치는 영향

박소희 [1,2],김동화 [1,2],이시우 [1,2],장지연 [1],정재영 [1,2],지경수 [1],신정욱 [1,2,*]

The effects of flow-induced mechanical stimuli on OPG/RANKL expressions in stromal cell-line

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Key words: Fluid flow, Stromal cell, RANKL, OPG

Abstract

골의 생성과 흡수에 있어서 기계적 자극은 중요한 자극요소 중 하나이다. 많은 연구자들에 의하면 골세포에 기계적 자극을 가하면 파골전구세포를 파골세포로 유도하는 Osteoprotegerin (OPG)와 파골세포로의 유도를 억제시키는 receptor activator of NF-κB ligand (RANKL)은 서로 상반되게 발현 된다고 한다. 지금까지 연구에서는 골세포에 자극을 가한 후, 자극의 크기나 시간에 따른 gene expression 를 관찰했을 뿐, 자극을 받은 세포가 자극 받기 전의 상태로 돌아오는 시간에 대한 연구는 부족했다. 이에 본 연구에서는 간헐적인 fluid flow (1 dyne/cm^2, 5 min(on)/15 min(off), 2 h/12 h)를 준 후, 경과 시간에 따른 OPG/ RANKL gene expression 을 관찰하여 세포에 자극의 영향이 지속되는 시간을 보고자 하였다. M2-10B4 (pluripotent marrow stromal cell line)을 laminin 으로 코팅된 slide glass (75 mm × 25 mm)에 1×10^5 cell/glass 로 파종하여 배양하였다. 48 h 동안 안정화 시킨 다음 1 dyne/cm^2, 2 h/12 h 총 4 번의 자극을 인가하였다. 자극 전, 자극 후 0, 3, 6, 9, 12, 24, 72 h 에 세포를 회수하여 OPG/ RANKL gene expression 을 분석하였다. 분석 결과 OPG 는 자극 직 후, gene expression 의 발현이 자극 전 보다 증가 했으나, 자극 후 경과 시간이 지남에 따라 발현이 감소함을 확인하였다. 반면 RANKL 은 자극 직 후, gene expression 의 발현이 자극 전보다 감소함을 확인할 수 있었으며, 72 h 이 경과된 후, 자극 받기전의 상태로 회복됨을 알 수 있었다. 이를 통하여 골세포에 자극이 인가된 후, 회복되는 시간을 고려해야 할 것으로 사료된다.

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조직공학용 polyurethane/gelatin 나노 섬유 지지체

허동녕[1], 김성은[1], 정성린[1], 권일근[1]

Electrospun polyurethane/gelatin nanofiber scaffolds with tissue engineering

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Key words: Polyurethane, Gelatin, Electrospinning, Nanofiber, Tissue engineering

Abstract

Cells of tissue are residing within a complex three-dimensional extracellular microenvironment that contains numerous bioactive molecules to control cellular activities such as cell adhesion, proliferation, and survival. Recently, there is growing evidence that mechanical stimulus in the microenvironment plays an important role in regulation of cell function. Also, much attention has been paid to the fabrication of tissue engineering scaffolds with nano-scaled structure to stimulate cell adhesion and proliferation in a microenvironment similar to the natural extracellular matrix milieu. In this study, blends of polyurethane (PU) and gelatin (blending ratio: 0, 25, 50, 75, and 100 wt% of PU to gelatin) were prepared nano/macro-structured non-woven fibers for the development of mechanically functional engineered vascular grafts. The resulting nanofibers demonstrated the uniform and smooth fibers with mean diameters ranging from approximately 200 to 900 nm with interconnected pores regardless of the composition. The contact angle increased with increasing the amount of PU in the blend and the water content of the nanofibers decreased concurrently. PU nanofibers retained significant levels of recovery following application of uniaxial stress; PG-4 with 75% PU blend returned to the original length within less than 8% of deformation following 150% of uniaxial elongation. The overall tensile strength was affected by increase in the PU content and degradation rates of the nanofibers were accelerated as the gelatin-concentration increased. When seeded with endothelial cells on the nanofibers, both initial cell adhesion and proliferation rate increased as a function of the gelatin content in the blend. Taken together, PU/gelatin blend nanofiber scaffolds may serve as a promising artificial extracellular matrix for regeneration of mechanically functional soft tissue.