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Thursday, December 22

Thursday, December 22 8:00 - 9:00

Opening

Thursday, December 22 9:00 - 10:30

Keynote Speakers

Dr. Abbas Erfanian & Dr. Nasser Fatouraee

Room: Ahmadi Roshan

Thursday, December 22 10:30 - 11:00

Catering

Thursday, December 22 11:00 - 12:30

Bioelectrics 1

Biological Signal Processing 1

Room: 13

Chairs: Ali Khadem (K. N. Toosi University of Technology, Iran), Mohammad Bagher Shamsollahi (Sharif University of Technology & Shahab Danesh University, Iran)

11:00 *Compensatory Role of the Amygdala During Motor Timing and Selection in Parkinson's Disease*

Elahe Yargholi (School of Cognitive Sciences, Iran); Sepideh Allahdadian (UBC, Canada); Hossein Rafipoor (University of Oxford, United Kingdom (Great Britain)); Maryam S. Mirian and Saurabh Garg (University of British Columbia, Canada); LinLin Gao (Beijing Institute of Geriatrics, China); Martin J McKeown (University of British Columbia, Canada)

Alterations of amygdala function in Parkinson's Disease (PD) are normally associated with emotion-related clinical features such as impaired facial recognition, but the effects on motor performance in an emotionally-neutral task are unclear. We studied fMRI from healthy and PD subjects while they squeezed a rubber bulb to keep a bar within two parallel "tracks" that were scrolling downward. At discrete intervals, each track had

bifurcations, and the subject had to follow either the inside or outside track requiring squeezing at 5% or 15% of maximum voluntary contraction. During the control condition (Control), subjects had to follow the inside and outside tracks alternately. In the timing (Timing) and selection (Selection) tasks, the time between bifurcations jittered randomly, and the color of the bar determined which path to choose, respectively. We determined which Regions of Interest (ROIs) were activated at the time of bifurcations by assessing both the connectivity between ROIs and the timing of activation. The caudate and putamen were activated in both (Selection-Control) and (Timing-Control) contrasts in all subjects; however, only in PD subjects was the amygdala significantly activated. In addition, the amygdala was activated faster in both Selection and Timing tasks compared to the Control task in PD subjects. In PD subjects, the greatest connectivity was to/from the amygdala, while in healthy subjects, the strongest connectivity was seen between the caudate and putamen. Our results suggest that PD subjects recruit the amygdala to maintain performance in motor timing and program selection even during emotionally-neutral tasks.

pp. 1-8

11:20 ***PTSD Diagnosis Using Deep Transfer Learning: An EEG Study***

Arman Beykmohammadi, Zahra Ghanbari and Mohammad Hassan Moradi (Amirkabir University of Technology, Iran)

Post Traumatic Stress Disorder (PTSD) is a chronic mental and behavioral disorder that can develop following getting exposed to a traumatic event. PTSD is diagnosed according to self-reports, which is prone to error in children and adults due to the fact that avoidance is one of the major symptoms of PTSD. In this paper, an automatic approach for diagnosing PTSD is proposed. We propose an EEG-based method, since it is a low cost easily available imaging modality. Eyes closed resting state EEG signal are recorded from 15 war-related PTSD and 15 matched control participants. After preprocessing, signals are divided into 1s segments. Time-frequency maps corresponding to each segment is achieved applying continuous wavelet transform. RGB images are generated using these time-frequency maps. They are fed to a convolutional neural network. In this paper, we use pre-trained VGG16 with proper modifications in its fully connected and classifier layers. To our best knowledge, this is the first study that uses deep transfer learning for diagnosing PTSD based on EEG signals. Our results declare the proposed approach can be an appropriate method for this purpose.

pp. 9-13

11:40 ***Coupled Hidden Markov Models for Estimating Multivariate Transfer Entropy in Neural Mass Models: A Simulation Study***

Sajjad Karimi (Sharif University, Iran); Mohammad Bagher Shamsollahi

(Sharif University of Technology & Shahab Danesh University, Iran)

Studying complex dynamical systems such as the brain requires identifying causal relationships from brain signal recordings like EEG. In such systems, causal inference is challenging since datasets are often high-dimensional, nonlinear, noisy, and often with small sample sizes. Using multivariate transfer entropy (MTE), causal relationships can be inferred in linear and nonlinear ways. In the current study, latent structure influence models (LSIMs) are adapted to develop a novel MTE estimator that measures effective connectivity in multivariate time series. LSIMs are a specific type of coupled hidden Markov model (CHMM) in which hidden Markov chain interactions are expressed as influence models. Simulated datasets from neural mass models (NMMs) are used to compare the proposed estimator with the existing k-nearest neighbors (kNN) method at different conditions, including data length, signal-to-noise ratio, and network size. Using ground-truth structure networks, we define a binary classification problem for recovering directed edges from NMM simulation datasets in each specific condition. Based on the AUCPR criterion, the proposed MTE estimator for NMMs is more effective than the standard kNN method. The proposed LSIM-based method outperforms the existing kNN method by about 3.7% in AUCPR values for SNRs in the range of 0 dB to 5 dB.

pp. 14-21

12:00 *EEG Artifact Removal Based on Brain Dipoles' Regions Using ICA and DIPFIT in Motor Imagery Tasks*

Neda Abdollahpour (Ragheb Isfahani Institute of Higher Education, Iran); Mohammadreza Yazdchi (University of Isfahan, Iran); Zahra Baharlouei (Isfahan University of Medical Sciences, Iran)

In this article, a new semi-automatic EEG (Electroencephalogram) artifact removal is proposed for MI (Motor Imagery) tasks to improve the performance of the system. There are eight reference clusters whose locations have been calculated based on the precise coordinates of a copious amount of brain dipoles acquired from a large number of users performing Motor Imagery tasks. In this method, called 8 Ref-Clusters, a kind of BSS (Blind Source Separation) algorithm along with the DIPFIT plugin of the EEGLAB platform take on a decisive role. These eight clusters demonstrate which dipoles are brain sources and which ones are artifacts to eliminate. In the case of improving the performance of a system for a particular subject, we defined a specific threshold that could alter the size of clusters in three different dimensions. The elaborate threshold pointed out above is unquestionably user-dependent. This study also addresses the problem of the possibility of generating similar brain components in the studies that perform based on brain sources' analysis. As a matter of fact, a concatenation stage only before applying the BSS method can ease the way of making synchronization among statistically independent brain components in both data training and test. Having made a comparison between

results before and after applying the 8-Ref-Clusters on the BCI- competition IV 2a, the average performance increased by roughly 4% which is promising when the datasets used in these evaluations had been filtered, between 8 and 30 Hz, only before applying ICA (Independent Component Analysis). Making a comparison between the results of the proposed method and those of four other CSP-based methods published in 2008, 2013, and 2021 shows that applying the proposed artifact removal only before CSP can significantly enhance the performance of the system at about 15.6%, in the case of the mCSP method. All in all, the proposed artifact removal method is a semi-automatic method that is computationally fast and able to detect the various types of artifacts like a heartbeat, muscle and head movements, eye blink, line noise, and so on.

pp. 22-27

Biomaterials

Room: 14

Chairs: Mohammad taghi Khorasani (Iran Polymer and Petrochemical Institute, Iran), Sayed Khatiboleslam Sadrnezhaad (Sharif University of Technology, Iran)

11:00 ***Evaluating the Potential of Ellipsoidal Particles for Inhalation Therapy in Comparison to Spherical Particles***

Haniye Abdollahi and Malikeh Nabaei (Amirkabir University of Technology, Iran); Kaveh Ahookhosh (KU Leuven, Belgium); Arash Babamiri (University of Kurdistan Sanandaj, Iran); Ali Farnoud (Helmholtz Munich Center, Germany)

Inhalation therapy using dry powder inhalers play an important role in treatment of human respiratory diseases. In targeted drug delivery, it is necessary to deliver a right amount of drug to the right place for reducing the side effects, which requires a deep understanding of the behavior of inhaled particles in the human respiratory system. The purpose of present study is to evaluate the potential of ellipsoidal particles for targeting drug delivery in a realistic model of tracheobronchial airway extends from oral cavity to the fourth generation. Ellipsoidal particles with fixed minor axis of 3.6 μm and different aspect ratio in the range of 1 to 10 are injected to the airway model at steady state flow rate using the discrete phase model in Fluent software. This simulation includes drag and gravity force acting on ellipsoidal particles. The deposition patterns of ellipsoidal particles are compared to spherical particles. The results showed that flow rate has a direct effect on particle transport and consequently on deposition pattern of both ellipsoidal and spherical particles, and most of the deposition occurs in the mouth-throat. In addition, the

deposition of ellipsoidal particles in the mouth-throat region reduced as the aspect ratio increased. In conclusion, ellipsoidal particles showed more flexibility for targeting drug delivery compared to spherical particles.

pp. 28-33

11:20 *Design and Fabrication of Self-Doped PANI-Coated Nanofibers for Biomedical Engineering Applications*

Mobina Yousefi and Zohreh Daraeinejad (Amirkabir University of Technology, Iran); Iman Shabani (AUT, Iran)

Between conductive polymers, polyaniline (PANI) has elicited much interest among researchers, but one of its issues for biological applications is cytotoxicity and conductivity reduction due to dopant separation. The purpose of this study is to prepare nylon nanofibers by electrospinning and coating them with self-doped PANI to improve the stability of its conductivity without any cytotoxicity. For this purpose, the self-doped copolymer containing aniline/metanilic acid was coated on the nylon nanofibers and its conductivity was compared with hydrochloric acid (HCL)-doped PANI. It was shown that, the conductivity of HCL-doped PANI decreased dramatically with time; The conductivity on the first day was 6.1×10-6 S/cm and, it reached 11.2×10-9 S/cm after 7 days of immersion in PBS. On the contrary, the conductivity of nanofibers coated with aniline/ metanilic acid with ratios of 1:1 and 3:1 was 9.7×10-9 S/cm and 11.3×10-9 S/cm, respectively. But the conductivity of the self-doped scaffolds was stable and reached to 8.8×10-9 S/cm and 9.4×10-9 S/cm during 7 days. The conductive scaffold prepared in this research will have a high potential for biomedical engineering applications, especially tissue engineering.

pp. 34-38

11:40 *Fabrication of Wound Dressing Patches Based on "PVA-Gelatin" Reinforced by Zeolitic Imidazole Framework-8 (Zif-8) Nanoparticles*

Zahra Behrooznia, Abolfazl Anvari and Rohollah Mehdinavaz Aghdam (University of Tehran, Iran)

The skin is the largest organ of the human body, which plays an important role against various infections and diseases. One of the methods of wound healing is the use of hydrogel wound dressings, which accelerates the healing process by moisturizing the wound environment. In this research, an attempt has been made to synthesize a hydrogel dressing with suitable physical and mechanical properties by freeze-thawing cycles. Natural and synthetic biomaterials have exclusive features; Therefore, polyvinyl alcohol and gelatin materials have been used due to their biocompatibility, biodegradability and water absorption properties, and nanoparticles of imidazole zeolite framework

nanoparticles have been used due to their improved mechanical properties and excellent biocompatibility. Field emission scanning electron microscopy analysis, energy-dispersive X-ray spectroscopy, fourier Transform Infrared Spectroscopy, mechanical properties, swelling and biodegradability were performed to characterize hydrogel wound dressings. The microscopic images show the non-porous surface and the surface roughness has increased with the addition of nanoparticles. Energy-dispersive X-ray spectroscopy and fourier Transform Infrared Spectroscopy respectively show the elements and chemical structure of the nature of hydrogels. In the analysis of mechanical properties, the PGZ 70:30 sample had the maximum ultimate tensile strength (344.3876±8.31 kPa) and Young's modulus (448±2.31 kPa), which is suitable for skin patch applications. The swelling of hydrogels decreased and the rate of degradation increased with the addition of nanoparticles. The results show that the synthesized hydrogel can be promising for wound healing.

pp. 39-45

12:00 ***Prediction of Aqueous Solubility of Drug Molecules by Embedding Spatial Conformers Using Graph Neural Networks***

Mohammad Erfan Hamdi, Rasool Dezhkam, Arman Hajizadeh and Amir Shamloo (Sharif University of Technology, Iran)

Aqueous solubility prediction of drug molecules is essential in drug design pipelines. Due to the availability of a vast amount of high-quality data, deep learning based methods of molecular property prediction methods are gaining more and more attention every day and have achieved outstanding results. Graph Neural Networks is one of the most successful classes in deep learning for this specific task, which can be because of the graph-like nature of molecules. In this paper, we proposed to use a new GNN model called ALIGNN, which has achieved the state of the art performance on QM9 dataset tasks by introducing the line graph concept. Training ALIGNN on the Delaney dataset, we have achieved an RMSE of 0.511.

pp. 46-50

Biomechanics 1

Biofluid Mechanics

Room: 12

Chairs: Nasser Fatouraee (Amirkabir University of Technology, Iran), Mahdi Navidbakhsh (Iran University of Science and Technology, Iran)

11:00 ***Dielectrophoretic Separation of RBCs from Platelets: A Parametric Study***

Mahdi Aliverdinia (University of Tehran, Iran); Ermia Azari Moghaddam (AmirKabir University of Technology, Iran); Mohammadmahdi Eskandarisani (University of Tehran, Iran); Mahdi Moghimi Zand (Univ of Tehran, Iran)

Pharm

Dielectrophoresis is an active microfluidic separation method. This method utilizes a non-uniform electric field to manipulate particles, according to their surface charge. In this numeric study, multiple parameters affecting the separation of RBCs and platelets are addressed and investigated. It was concluded that the most important parameter, is a design element; the channel geometry. Lower inlet velocity and higher voltage and frequency were also associated with better separation of the cells.

pp. 51-57

11:20 ***Numerical Analysis of Dual-Phase Lag Effects on Thermal Response During Focused Ultrasound***

Behnam Zeinali and Afsaneh Mojra (K. N. Toosi University of Technology, Iran)

Pharm

Correct estimation of the thermal response is very important in hyperthermia-induced treatment. One of the models used to obtain the temperature distribution in biological tissue is the dual phase lag bioheat equation, which includes two-time delays. Time delays in the dual phase lag bioheat equation are significant in correctly determining the temperature field in the target tissue. In this study, the FU method is used for heat generation. Subsequently, the effect of time delays on the temperature distribution at the focal point inside the cancerous tissue is investigated. The results showed that the focal point's temperature distribution significantly depends on τ_q and τ_T. In the same line, with the increase of both parameters, the maximum temperature tends to have a lower value. Finally, the results show that the temperature distribution has stronger dependence on τ_T compared to τ_q. Results of the study can be used for an effective planning of thermal treatment.

pp. 58-62

11:40 *Flow-Induced Effect of Matrix Fiber Orientation on Endothelial Vasculogenesis*

Pooya Abdi (University of Tehran, Iran); Bahman Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran)

Pharm

Topography of extracellular matrix plays a major role in many biological events including tissue healing, morphogenesis and growth. It is known that matrix constitution and mechanical properties are deciding factors in governing the fate of its inhabitant cells. Besides the direct mechanical cues, matrices also facilitate the release and uptake of certain chemicals and participate in cell-cell and cell-ECM crosstalk. Mechanical strains in the matrix are proved to direct endothelial cell migration and elongation leading to angiogenesis, and there is a consensus that matrix stiffness, fiber density and fiber orientation can enhance angiogenesis in the preferred direction of stiffness gradient. In this study, we specifically investigated the role of topography in guidance of endothelial self-reorganization prompted by the effect of fluid flow hindrance and facilitation in certain directions. We adopted our previous model of fluid flow guided angiogenesis for cellular responses. Lattice Boltzmann model of fluid flow was adopted and modified to study the effect of unidirectional and randomly oriented fibers. To study the effect of fiber orientation, we customized a previously proposed model of porosity in lattice Boltzmann to suit this purpose. This model could reproduce the effects of fiber orientations in matrix on endothelial migration and vasculogenesis. Simulations showed better confluency of formed lumens when prescribed flow is in the direction of fiber orientation. These results can have further implications in understanding endothelial complications in certain diseases as well as in tumor angiogenesis and metastasis.

pp. 63-68

12:00 *Develop a Numerical Model of the Glymphatic System to Investigate the Flow Patterns and Transport Processes*

Mohammad javad Nazari and Nasser Fatouraee (Amirkabir University of Technology, Iran); Effat Soleimani (Graduated Medical Physics Tarbiat Modares University, Iran)

Pharm

The brain is considered the body's most important organ, and the clearance of waste products from the brain is of vital importance. In the past, it was believed that the brain had no efficient disposal system due to its lack of lymphatic vessels. Also, it was thought that the only phenomenon in the brain is diffusion, and substances transportation was purely dependent on it. But not long ago, the ideas about the disposal system and

brain phenomena were challenged after the rediscovery of the Glymphatic system. In this research, using the porous fluid-solid interaction approach, the Glymphatic system and the factors affecting its functioning have been investigated. The findings indicate that the increase in wall displacement does not cause significant changes in the volume exchange fraction of the perivascular space. Moreover, the reduction of displacement leads to a corresponding decrease in velocity magnitude in the perivascular spaces, which makes the conditions favorable for waste products to settle. Another finding of this research is that the wall oscillations are more effective in the paths adjacent to thicker ducts compared to the paths adjacent to narrower ducts so that the increase in wall oscillations causes an increase of 4.38 and 1.73 times respectively in the mentioned paths, which indicates that the influence of these oscillations is fading in the paths adjacent to narrower channels. Based on the results, the perivascular pathways have the ability to experience the Péclet number greater than one, which means that diffusion is not the only phenomenon in the brain. But in the porous tissue of the brain, the Péclet number still has smaller values than one.

pp. 69-75

Biomechanics Posters

Room: Classrooms Floor Corridor

Chairs: Nabiollah Abolfathi (Advisor, Iran), Khalil Alipour (University of Tehran, Iran)

11:00 ***Numerical Study of Particle Focusing and Concentration Under the Effect of Acoustic Waves in a Microchannel***

Mahdi Aliverdinia and Mohammadmahdi Eskandarisani (University of Tehran, Iran); Ermia Azari Moghaddam (AmirKabir University of Technology, Iran); Mahdi Moghimi Zand (Univ of Tehran, Iran); Mehrdad Dehkordi (University of Tehran, Iran)

The importance of particle manipulation methods has highly risen in recent years. These methods have a widespread use in diagnosing and curing different disease such as cancers and infertility. The use of these techniques is based on the required applications. We prefer a method that contains the least side effects on biological cells and fewer limitations. Acoustophoresis is the method which we used for this purpose and it is a particle manipulation technique that has the required qualities. It means migration with sound and uses acoustic waves to manipulate the particles based on their size, density and compressibility. In this paper, we investigated the effect of acoustic waves on particle concentration in a 2-D channel. The results showed that acoustic waves cause a radiation

force which directly affects the motion of particles and guides them toward the center of channel without any distraction. Using a Y-shaped channel for separating the particles would be convenient for future studies.

pp. 76-80

11:15 *IMU-Based Estimation of the Knee Contact Force Using Artificial Neural Networks*

Alireza Rezaie Zangene (Kharazmi University, Iran); Ramila Abedi Azar (Iran University of Science and Technology, Iran); Hamidreza Naserpour (Kharazmi University, Iran); Seyyed Hamed Hosseini Nasab (ETH Zürich, Switzerland)

Pharm

Knee joint contact force (KCF) plays a significant role in the occurrence and progression of knee osteoarthritis (KOA) disease. KCF can be used in monitoring rehabilitation progress after knee arthroplasty surgery and the design of prostheses. Currently, measuring KCF is dependent on the data extracted from gait laboratories. The combination of artificial neural networks (ANNs) and wearable technology can overcome the limitations imposed by lab-based analysis in measuring KCF. Therefore, the present study aimed to investigate the potential of a fully-connected neural network (FCNN) in predicting the KCF via three inertial measurement unit (IMU) sensors attached to the pelvis, thigh, and shank segments. Ten healthy male volunteers participated in this study. The 3D marker trajectories and ground reaction forces (GRFs) were captured at 200 Hz and 1000 Hz sampling frequencies during level-ground walking. Using a generic OpenSim model, the KCF was estimated through static optimization. The resultant KCF estimated by the musculoskeletal model was then used as the target of the neural network, while linear acceleration and 3D angular velocity data captured by three IMUs were considered as the network inputs. The network performance was investigated at intra- and inter-subject levels. Based on our findings, the proposed network of this study enables the prediction of KCF with 89% and 79% accuracy (based on the Pearson correlation coefficient) at the intra- and inter-subject levels, respectively. The results of this study promise the possibility of using IMU sensors in predicting KCF outside the lab and during daily activities.

pp. 81-86

11:30 *Stress Distribution in Femoral Stems for Revision Total Knee Arthroplasty with Three Different Materials: A Comparative Finite Element Study*

Mohammad Hosein Zadeh posti (University of Guilan, Iran); Mohadese Rajaeirad (University of Tehran, Iran); Aisan Rafie (Iran University of

Science and Technology, Iran); Hasan Asadi Gilakajani and Mohammad Khorsandi (University of Guilan, Iran)

Pharm

Knee replacement surgery is a common treatment for patients with end-stage knee arthrosis. Unfortunately, the age of patients suffering from this condition and requiring knee joint replacement is decreasing, leading to an increase in the need for revision surgeries. Therefore, using suitable prostheses can increase the durability of joint replacement and the success of this procedure. For this purpose, in this research, three materials, Co-Cr, Ti6Al4V, and FGM, were examined by the finite element method. An accurate three-dimensional model of the distal part of the femur bone was developed, and after designing the stem, its volume was subtracted from the bone, and the final assembly model and material properties were assigned to it. The models were subjected to jogging (6Km/h) and walking loading conditions. The findings of this research showed that in both loading conditions, the Co-Cr stem was subjected to stress more than twice the stress applied to the other two stems. Also, jogging applies more stress to the stem-bone construct than walking. According to the results of this research, it can be said that the use of FGM and titanium stems is preferable, although the construction costs should also be considered. In addition, examining more active movements can be influential in determining movement limitations after revision surgery.

pp. 87-91

11:45 *Fully Automated Centrifugal Microfluidic Disc for Qualitative Evaluation of Rheumatoid Factor (RF) Utilizing Portable and Low-Cost Centrifugal Device*

Reza Khodadadi (University of Tehran & Iranian Research Organization for Science and Technology, Iran); Alireza Balaei and Manouchehr Eghbal (Iranian Research Organization for Science and Technology, Iran); Jalil Fallah (Lister pathology laboratory, Iran); Karen Abrinia (University of Tehran, Iran)

Rheumatoid factor is one of the biomarkers for diagnosing rheumatoid arthritis and other inflammatory diseases, and latex agglutination is a qualitative method for Rheumatoid factor evaluation. In this study, in addition to a portable and low-cost centrifugal device, a microfluidic disc was designed and manufactured to meter 400 µl of a whole blood sample. Next, it separates serum from whole blood and meters 40 µl of serum to mix it with coated latex buffer on the detection chamber surfaces. Finally, Qualitative examinations of the mixed samples were performed, positive or negative in terms of agglutination, by checking the detection chambers. As a result, 100% agreement was observed between manual and the microfluidic disc-based methods. Accordingly,

centrifugal microfluidic discs have excellent potential for integrating and automating several latex-based assays such as C Reactive Protein (CRP), D dimer, and blood type in one disc for utilization in a low resource setting, clinics, and as a point of care test (POC).

pp. 92-96

12:00 *Airflow Dynamics in a Mouse Respiratory Airways Using LSFM Images*

Mohsen Estaji and Malikeh Nabaei (Amirkabir University of Technology, Iran); Ali Farnoud (Helmholtz Munich Center, Germany)

Pharm

Computational Fluid Dynamics (CFD) modeling of airflow through respiratory airways is the basis of particle delivery studies. Lots of researches have been done in this area. Using Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI) images are the most conventional techniques for 3D modeling of airways. Because of the resolution limits, these techniques are not efficient for modeling high order airways. In present study high resolution Light Sheet Fluorescent Microscopy (LSFM) images of a mouse respiratory system were used to construct a 3D model of the left-lobe airways. This model includes the whole conducting zone of the mouse left-lobe. Due to monopodial nature of mice airways, geometry partitioning was done based on airway orders. Finally, the air flow through the airways was modeled considering rigid walls and a steady state condition. Pressure and wall shear stress distribution in the airways were obtained beside the velocity and vorticity profiles near the entrance of each airway order. From trachea toward the terminal bronchioles, decreasing manner was investigated for pressure and mean velocity distribution, while because of geometrical properties of this model maximum wall shear stress was occurred in the entrance of second order.

pp. 97-102

12:15 *Three-Dimensional Finite Element Analysis of a Complete Segment in the Lumbar Region (L3-L4) Under the Influence of Cage with Titanium and Peek Materials*

Masoume Moradiniya (University of GUILAN, Iran); Hasan Asadi Gilakajani (University of Guilan, Iran)

• The vertebrae are irregular bones with very complex shapes, which the study of the stress and strain distribution in them help to identify and evaluate their behavior. • Several biomechanical studies have been performed to improve the use of peek (Poly Ether Ether Ketone) or titanium cage for posterior lumbar intervertebral fusion (PLIF). This study was conducted to evaluate the biomechanical effect of these implants with different levels

of hardness. So that for peek implants, the viscoelastic properties and elastic specific titanium implants are posed. To analyze the mechanical behaviors of a complete segment of the spine, a cage is initially designed in the SALIDWORK software, including the well-known cages for spinal vertebrae fusion, as well as two L3 and L4 vertebrae are designed in Abacus software and it is assembled with cage, the disk between the L3 and L4 vertebrae. According to the results obtained, the stress and strain rate in the vertebrae and cage with the peek material (due to the viscoelastic properties discussed in it) is significantly reduced compared to the titanium material, which is in good agreement with previous studies

pp. 103-108

12:30 *Mathematical Modeling of the Effect of Angiostatin on the Density of the Circular Tumor-Induced Microvascular Network*

Mahya Mohammadi (K. N. Toosi University of Technology, Iran); Mostafa Sefidgar (Pardis Branch Islamic Azad University, Iran); Farshad Moradi Kashkooli, Cyrus Aghanajafi and Madjid Soltani (K. N. Toosi University of Technology, Iran)

Pharm

Angiogenesis is a connection bridge between the avascular and vascular growth phases of the tumor. The rate of tumor growth increases after angiogenesis. Anti-angiogenesis therapy is an effective method that is used in cancer treatment, especially in combination with other strategies such as chemotherapy and radiotherapy. Mathematical models are used for simulating different processes in cancer-related areas, such as angiogenesis and anti-angiogenesis. In this study, the formation of a capillary network from two parent vessels toward a circular tumor of different sizes is studied by considering the anti-angiogenic effects of angiostatin. The discrete model applied in previous studies of our group is developed in this paper to study the effect of angiostatin on the density of capillaries as a parameter that may represent anti-angiogenesis effectiveness. It is concluded that angiostatin decreases the rate of the spread of the parent vessels' sprouts into the tumor with a small non-dimensional size of 0.1. Moreover, it is shown that anti-angiogenesis normalizes the microenvironment of the tumor. Results show that the microvascular network is pruned by the anti-angiogenic agent, which results in a reduction of the microvascular density in all tumor sizes. Based on the findings of the present study, the reduction of neo-vessel density induced by angiostatin administration decreases with increasing tumor size, which can indicate the dependence of anti-angiogenic treatment performance on tumor size as a factor of tumor progression stage.

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Thursday, December 22 11:00 - 13:00

Career Round Table

Talent Search - Introduction of the General Department of Medical Equipment and Technical Officer - Medical Equipment in Hospitals - Entrepreneurship and Production of Medical Equipment

Dr. Sanghari - M.Sc. Alaeddin - Dr. Mohammadi - M.Sc. Shirkavand

Room: Ahmadi Roshan

Thursday, December 22 12:30 - 14:00

Lunch

Thursday, December 22 13:30 - 15:30

Challenge

The Challenge of Detecting Brain Plaques in MRI Images

Room: Library

Workshop 1

Familiarity with Technology Trade Brokerage Services

Dr. Rezaei

Room: 14

Workshop 2

Introducing the Support and Opportunities of the Medical Image and Signal Processing Research Center of Isfahan University of Medical Sciences from Inter-University Activities and Introducing the Remote Health Monitoring System

Dr. Rabbani - Dr. Vafaei - M.Sc. Shirani

Room: Showra

Thursday, December 22 14:00 - 15:30

Bioelectrics 2

Biological Signal Processing 2

Room: 13

Chairs: Mehran Jahed (Sharif University of Technology, Iran), Mohammad Bagher Shamsollahi (Sharif University of Technology & Shahab Danesh University, Iran)

14:00 *Seizure Prediction in Epileptic Patients Using EEG and Anomaly Detection*

Erfan Mirzaei (Sharif University of Technology, Iran); Mohammad Bagher Shamsollahi (Sharif University of Technology & Shahab Danesh University, Iran)

Epilepsy is a neurological disorder in which abnormal brain activity occurs, causing seizures. Seizures may involve convulsions and loss of consciousness and can harm patients and the people around them. Many patients are drug-resistant, and medication does not improve their situation. Predicting the onset of epileptic seizures may improve their quality of life. For this purpose, many studies have utilized EEG signal, which reflects the brain's electrical activity. This paper contains a new seizure prediction method based on Anomaly Detection and with the help of One-Class SVM. The average sensitivity and False Alarms Rate were 94% and 0.89 per hour. The advantage of this method over other methods, such as classification approaches, is that the network needs much less data for training, as only 8 hours of training data have been used for each patient. Low computational complexity and ease of use make it suitable for real-time prediction compared to other studies.

pp. 114-118

14:20 *Respiratory Events Estimation from PPG Signals Using Peak Detection Algorithm*

Muhammad Suleman (Kettering University, USA); Koorosh Motaman and Yasin Hasanpoor (University of Tehran, Iran); Mohammad Ghamari (Kettering University, USA); Khalil Alipour (University of Tehran, Iran); Mehrdad H Zadeh (Kettering University, USA)

Photoplethysmography (PPG) has become an increasingly popular method of measuring vital signals to monitor the health of an individual being. Its compact size, cost, and ease of use have contributed widely to its success. In clinics, PPG can monitor the pulse rate, blood oxygen level, and blood pressure. However, to measure the respiration rate, one has to annotate the breaths manually or use a device such as Pneumograph. There have been several algorithms introduced to estimate the respiration rate from PPG. However, none of them give information about at which point in time did these respiratory events occurred. We propose a simple yet effective way of extracting all respiratory events from a Photoplethysmogram.

pp. 119-123

14:40 *Classification of Motor and Mental Imagery EEG Signals in BCI*

Systems Based on Signal-To-Image Conversion

Soheil Khooyooz and Sepideh Hajipour Sardouie (Sharif University of Technology, Iran)

Brain-Computer Interface (BCI) systems establish a control and communication relationship between the human brain and computers including robots or other devices to help individuals with severe motor disabilities. The classification of motor and mental imagery electroencephalogram (EEG) signals is complicated because these signals are usually case-specific and distinct models must be trained for each patient to process and classify his/her EEG signals. Moreover, in BCI systems EEG signals are processed online, so the time latency must be very low. In this paper, we have proposed a method based on signal-to-image conversion to investigate image processing techniques in the pair-wise classification of motor and mental imagery EEG signals. We first decomposed EEG signals of each trial into four sub-bands. Then, for each sub-band, we converted EEG time series to 2-dimensional (2D) images using covariance between signals of all channels. Then, statistical, textural and PCA-based features were extracted from these images and fed to a support vector machine (SVM) classifier. Our results were promising in the offline processing and achieved an average classification accuracy of 79.57%.

pp. 124-128

15:00 ***Microstate Resting State EEG Analysis for Evaluating the Effect of Electrical Vestibular Stimulation in Parkinson's Disease***

Kosar Sanjar Arani (Tehran University, Iran); Alireza Kazemi (University of California Davis, USA); Maryam S. Mirian (University of British Columbia, Canada); Abdol-Hossein Vahabie (Tehran University, Iran); Wyatt D. Verchere (University of British Columbia, Canada); Soojin Lee (UBC, Canada); Hamid Soltanian-Zadeh (University of Tehran, Iran); Martin J McKeown (University of British Columbia, Canada)

Parkinson's disease (PD) is a neurological disorder characterized by changes in dynamic brain activity, which can be partially ameliorated with invasive Deep Brain Stimulation. Galvanic vestibular stimulation (GVS), a non-invasive method, could potentially improve the motor symptoms of Parkinson's disease, but the mechanisms are unclear. Biomarkers based on the electroencephalogram (EEG) are being actively pursued. Here we examine the properties of EEG microstates as a potential GVS-sensitive EEG biomarker, whereby multichannel, broadband EEG signals are approximated by a sequence of discrete spatial patterns. We used the Microstate Analysis plugin for EEGLAB and compared the characteristics between healthy (n=20) and people with PD (n=22, stimulated/sham and OFF Medication/ ON Medication). We extracted 25 Microstate related features from 4

different microstates ('A' - 'D') and examined their differences between groups (healthy control group considered as the reference to extract the feature values). Overall disease severity, as assessed by the clinical Unified Parkinson's Disease Rating Scale (UPDRS) Part 3, was predictable from microstate features. The duration of microstate A - selected by LASSO during UPDRS prediction- was significantly changed by both types of GVS stimuli (multi-sine 50-100 Hz (GVS1), and multi-sine 100-150 Hz (GVS2)), but not medication. The fraction of total recording time for microstate C, also a key feature in disease prediction, was found to be selectively affected GVS1 only. The above results suggest that GVS may provide benefits complementary to medication but in a stimulus-dependent manner. These results could potentially guide optimal GVS design in the pursuit of complementary therapies.

pp. 129-134

15:20 *Blood Pressure Measurement Using a Gaussian Curve Fitting Algorithm*

Ali Najd (Tarbiat Modares University, Iran); Soheil Akhoondi (Shahed University Tehran Iran, Iran); Yaghoob Khezri (AmirKabir university of technology Tehran Iran, Iran); Ali Khadem (K. N. Toosi University of Technology, Iran)

In this paper, blood pressure measurement is done non-invasively and by a corrected oscillometric method. First, the cuff is inflated to the desired value, and then by opening a valve the air pressure in the cuff decreases almost linearly between 2~4mmHg/s. To achieve the oscillometric graph, the output signal during deflation is band-pass filtered and then amplified. To remove different artifacts and noises from the oscillogram, a correction curve based on Gaussian distribution is fitted on it. Then using fixed coefficients with the help of Mean Arterial Pressure (MAP), the values of systolic and diastolic pressure are calculated. The values of R Squared obtained for systolic and diastolic pressures before fitting the curve are -0.178 and 0.389, and after fitting are 0.625 and -0.012, respectively.

pp. 135-139

Biomechanics 2

Room: 12

Chairs: Nabiollah Abolfathi (Advisor, Iran), Bahman Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran)

14:00 *Biomechanical Analysis of A Mini Force-Closed Cemented Hip*

Stem for Juvenile Arthritis Patients

Yashar Ebadi and Farzam Farahmand (Sharif University of Technology, Iran)

Standard implants are available in a wide variety of models and sizes to meet the needs of the normal population. Such implants, however, cannot be used for patients with abnormal hip joint anatomy. This study assessed the mechanical strength and the range of motion of a mini stem, designed for juvenile arthritis patients with substantially small femoral bones. The geometry of the mini stem, designed based on the cemented force-closed philosophy, was determined such that it could accommodate in the very narrow intramedullary canal of a sample patient. A 3D finite element model of the bone-cement-implant construct was developed to assess the strength of the mini stem against yield and fatigue failure, the strength of the cement mantle against yield, and the subsidence of the stem in cement due to the cement creep. Also, the range of motion of the hip implant was estimated by an impingement analysis in which the interference of the femur-pelvis or stem-acetabular cup was examined while rotating the femoral bone in the anatomical planes. Results indicated factors of safety of 7.33 and 4.76 for the mini stem against yield and fatigue failure, and 4 for the cement against yield. The subsidence of the mini stem in the cement over time was obtained as 1.6 micrometers for a 50-hour loading period. Finally, the designed implant could provide large ranges of motion in different planes with no impingement between the implant components and the bones in daily activities. It was concluded that the designed mini stem could satisfy the biomechanical requirements for successful total hip arthroplasty of juvenile arthritis patients.

pp. 140-144

14:20 ***Measurements of the Lumbar Spine Anatomical Parameters for Use in Musculoskeletal Modeling***

Shirin Farsi and Sadegh Naserkhaki (Islamic Azad University Science and Research Branch, Iran)

Pharm

Basic information of anatomical parameters such as cross-sectional area (CSA) and moment arms (MA) of muscles are required for musculoskeletal modeling. Previous studies outlined muscle parameters based on in vivo imaging but extracting these data is invasive and costly. To provide a more realistic musculoskeletal model, for the profile of each individual lumbar spine, 3D vertebral model of each individual was constructed and the anterior-posterior (AP) and medial-lateral (ML) cross-sectional areas (CSAs) and moment arms of all muscles at each lumbar disc level were measured and all these parameters obtained from CT scan images. The CSA of spinal muscles had a significant difference between men and women at all muscles and most levels, as well as the AP

and ML muscles moment arm, were significantly different between men and women at all muscles and spinal levels. The geometrical data of the group of subjects of this study can be utilized for the development of a subject-specific model and can help assess spinal loads in different tasks.

pp. 145-148

14:40 *Kinematic Modularity Analysis of Walking-Based and In-Place Tasks*

Mahziyar Darvishi, Ali Shafiezadeh, Sajjad Daroudi, Shahab Tavasoli and Farzam Farahmand (Sharif University of Technology, Iran)

Unlike the muscle synergies, the modularity of the kinematic synergies during different tasks has not been studied comprehensively. The objective of this study was to derive the shared and task specific kinematic modules for two different movement modes of walking-based and in-place tasks. Kinematic modules were extracted by applying the NNMF technique on the half-wave-rectified kinematic data of six subjects, taken from the CAMS-Knee dataset. A novel clustering methodology, using three steps of k-means, was employed to identify the shared and task-specific kinematic synergies. The results were analyzed for a variety of combined global and local variance accounted for (VAF) criteria. Assuming the VAF global and local to be 0.95 and 0.85, respectively, there were four inclusive shared modules for all walking-based tasks, and two for all in-place tasks, which were activated with different time profiles. In particular, a single module was activated at the beginning of the descending and the end of the ascending in-place tasks. It was concluded that the kinematic maneuvers observed in different tasks could be reconstructed by appropriate activation of a limited number of kinematic modulus.

pp. 149-154

15:00 *Merging Analysis of Muscle Synergies for Cerebral Palsy Gait*

Mohammadreza Taghimohammadi, Shahab Tavasoli, Mahya Shojaeefard and Farzam Farahmand (Sharif University of Technology, Iran)

Cerebral palsy (CP) is a common motor impairment caused by primary brain lesion. Investigation of the altered motor control strategies in CP individuals can lead to a deeper understanding of their neuromuscular disorders. This study sought to evaluate the motor complexity of CP gait, in comparison with that of the TD using synergy analysis. The muscle synergies of 80 children with CP and five healthy children, as the control group, were extracted using the non-negative matrix factorization algorithm from the surface electromyography data of the lower limbs. For each group, the muscle synergies were clustered to find the characteristic muscle modulus which were then analyzed to

explore the existence of the merging patterns. The number of muscle synergies was 5 for the control group, and 4, 3, 2, and 2 for the true, jump, apparent and crouch groups, respectively, in accordance with their level of involvement. Merging patterns were observed in the stance phase and swing phase modules of the CP groups with contributions from non-corresponding modules of the control group. The sparsity in the CP gait, demonstrated by merging pattern, indicates a strategy for reducing the required neural command signals. This strategy, however, causes interference in the gait sub-phases which leads to an abnormally awkward gait.

pp. 155-160

Invited Speakers

Dr. Mohammad Reza Raoufi

Room: Ahmadi Roshan

Thursday, December 22 15:30 - 16:00

Catering

Thursday, December 22 16:00 - 17:30

Bioelectrics Posters 1

Biological Signal & Image Processing

Room: Classrooms Floor Corridor

Chairs: Ali Khadem (K. N. Toosi University of Technology, Iran), Rasool Mahdavifar (Shahed University, Iran)

16:00 *Evaluation of Brain Cortical Connectivity in Drug Abusers Using EEG Data*

Behzad Yousefipour (K. N. Toosi University of Technology, Iran); Sepehr Shirani (Nottingham Trent University, Iran); Maryam Mohebbi (K. N. Toosi University of Technology, Iran); Peyman Hasani Abharian (Institute for Cognitive Science Studies, Iran)

This study implements electroencephalogram (EEG) signals in a data-driven approach based on functional brain connectivity to identify brain abnormal cortical connectivity in opioid abusers. The prime objective here is to identify opioid addiction. A 19-channel resting-state EEG signal was recorded from 22 opioid addicts and 22 normal, closely matched individuals. First, brain networks associated with two groups were constructed

using the Mutual Information (MI) metric in frequency bands of the delta, theta, alpha, beta, gamma, and wideband. The groups were then divided using discriminative graph features. The results from the Support Vector Machine (SVM) classifier, evaluated by the Leave-one-out cross-validation method, achieved accuracy, sensitivity, and specificity of 100% and an F-score of 1.00 in most frequency bands using the AdaBoost subsampling approach. The findings indicate that the implemented pipeline, based on MI quantity between EEG data channels and combined with graph metrics, can help detect opioid addiction.

pp. 161-166

16:15 *Heartbeat Evoked Potential Assessment in Moderate and Severe Obstructive Sleep Apnea Patients*

Yashar Abolfathi and Maryam Mohebbi (K. N. Toosi University of Technology, Iran)

Sleep apnea disorder is defined as more than five apnea events per hour or more than 10 seconds of respiratory airflow ceasing during sleep. Obstructive sleep apnea (OSA) manifests as recurrent attacks of the upper respiratory tract, with an unaltered breathing rhythm. However, it remains unclear if brain responses to cardiac impulses relate with the severity of OSA. In this paper, we aimed to assess heartbeat evoked potentials (HEPs) during non-rapid eye movement (non-REM) and rapid eye movement (REM) sleep stages in moderate and severe OSA patients. The HEP signal is a cerebral reaction to the heartbeat and a measure of brain-body interactions such as interoceptive processing and intrinsic arousal levels. We identified significant clusters over the central region (i.e., C4 electrode) only during non-REM sleep when comparing the amplitude of HEPs between moderate and severe OSA patients independently during non-REM and REM periods. These results show that interoceptive processing impairments may be most prevalent during non-REM sleep.

pp. 167-171

16:30 *A Hilbert-Based Coherence Factor for Photoacoustic Imaging*

Soheil Hakakzadeh (Sharif University of Tech, Iran); Zahra Kavehvash (Sharif University of Technology, Iran)

Among the different configurations of a photoacoustic imaging (PAI) system, the planar configuration has many applications. Due to the limited-view of planar configuration, the resolution and contrast of the imaging system are low. To improve resolution and contrast, the coherence factor (CF) can be applied to the reconstructed image. Although CF improves the resolution and contrast, it causes missed data in the reconstructed image. In this paper, we proposed a Hilbert-based CF (H-CF) method to compensate

for the missed data issue and also increase the contrast. Three numerical studies were conducted to evaluate the proposed method's performance. The numerical results show that applying H-CF increases contrast ratio (CR), and structural similarity index measure (SSIM) up to 0.19 and 19 dB, respectively. Therefore, the proposed method can be a suitable replacement for conventional methods.

pp. 172-176

16:45 *Physiological Indicators of the Relation Between Autistic Traits and Empathy: Evidence from Electrocardiogram and Skin Conductance Signals*

Soroosh Golbabaei and Negar Sammaknejad (Shahid Beheshti University, Iran); Khatereh Borhani (Shahid Beheshti University & Institute for Cognitive and Brain Sciences, Iran)

Difficulty in empathy is thought to be one of the problems in people with autism spectrum disorder (ASD), leading to impairment in social abilities and communication. However, despite the recent evidence on the effect of physiological bodily states on affective experiences, the exact role of physiological signals on different aspects of empathy (i.e., cognitive and affective empathy), as well as empathy dysfunction in ASD is yet unknown. To tackle this problem, in this study, 36 neurotypical subjects with different levels of autistic traits, participated in a well-established empathy for pain task, while Electrocardiogram (ECG) and Skin Conductance (SC) signals were recorded. Several features were extracted from each signal. Our results indicated that both cognitive and affective empathy are positively related to a higher level of cardiac activity (e.g., negative correlation with R-R interval) and arousal (e.g., positive correlation with average SC). More importantly, higher level of autistic traits, measured with Autism Quotient (AQ), was negatively correlated with Heart Rate Variability as measured with HRV-RMSSD and variability in tonic SC. Finally, we classified the participants into groups with high and low cognitive empathy, affective empathy, and level of autistic traits and investigated the extent to which machine learning approaches can automatically classify participants based on ECG and SC extracted features. Using a Support Vector Machine, reasonable results were obtained (in the range of .73 to .84), proving the possibility of implementing automatic detection systems for classifying subjects with different levels of autistic traits. Our results are suggestive of the effect of bodily simulation on empathy, and how the inability to regulate physiological signals leads to empathy dysfunction in individuals with high autistic traits.

pp. 177-183

17:00 *A Deep Learning-Based Pipeline for Multi-Class Motor Imagery Problems with Small Portion of Labeled Datasets*

Neda Abdollahpour (Ragheb Isfahani Institute of Higher Education, Iran); Mohammadreza Yazdchi (University of Isfahan, Iran); Zahra Baharlouei (Isfahan University of Medical Sciences, Iran)

In this article, a new framework is proposed to address multi-class Motor Imagery Brain-Computer Interface (MIBCI) classification using a small labeled dataset. In this framework, the combination of Independent Component Analysis (ICA), multi-class Common Spatial Pattern (CSP), and a functional Application Programming Interface (API) model assume a pivotal role. In the feature extraction stage of the work, a concatenated altered signal affected by spatial weights is proposed for each trial in three frequency ranges. This distribution of features could provide suitable feature maps for augmentation, preparing data for the deep learning analysis, and underscore distinguishable features of MI classes. In the classification stage, spatial and temporal features is dominated by using the effective combination of a one-dimensional Convolutional Neural Network (CNN) and a two-staged Bidirectional Long Short-Term Memory (BLSTM) in three branches containing different distributions of frequency. The model simultaneously learns past-to-future and future-to-past patterns in two stages. The experimental results on datasets 2a BCI-Competition IV, illustrate that the proposed method could be practical and more competitive than the other popular methods. The resistance of the deep learning model also significantly increases when it comes to a copious amount of labeled trials applying the method. All in all, the proposed framework can alleviate the issue of small labeled datasets in MI problems.

pp. 184-190

17:15 *Feature Extraction with Using S Transform for Classification of Chronic Obstructive Pulmonary Disease*

Mahsa Amineskandari (Islamic Azad University & Science and Research Branch, Iran); Saeid Rashidi (Science and Research Branch, Islamic Azad University, Iran); Salar Mohammadi (Islamic Azad University & Science and Research Branch, Iran)

There are some people all over the world who suffer from lung diseases. Chronic Obstructive Pulmonary Disease (COPD) is one of the most fatal diseases that kills a significant number of people each year. It is the third leading cause of death worldwide. Therefore, early detection of COPD and controlling the early stages of the disease can have a great impact on reducing the mortality of this diseases. firstly, it is necessary to mention that COPD contains 5 levels from COPD0 to COPD4. In this study, the S transform

was used as a tool to extract the features of the lung signals. After extracting the features by using S transform, in order to reduce the number of features, the statistical methods are used. Then, in order to classify the different levels of this disease, SVM classification with K-Fold Cross validation is used, which provided accuracy, Sensitivity and Specificity of 92.59%, 83.33% and 95.23%, respectively.

pp. 191-197

17:30 *Robust Human Movement Prediction by Completion-Generative Adversarial Networks with Huber Loss*

Mojgan Azari (Ferdowsi University of Mashhad & Center of Excellence on Soft Computing and Intelligent Information Processing, Iran); Hamed Rafiei and Mohammad-R Akbarzadeh-T (Ferdowsi University of Mashhad, Iran)

In recent years, wearable exoskeleton robots have been growingly used for rehabilitation or movement assistive purposes. Despite the growing application of these robots in various domains, such as in physical therapy, the movement synchronization between robots and human bodies remains as a challenging problem. This paper aims to achieve better synchronization by predicting human movement. Although several works have been presented in this domain, robustness of these predictions has received less attention. This paper aims to provide a robust prediction using Completion-Generative Adversarial Networks (CGAN) that are learned based on the Huber loss function. Specifically, we reshape the 3D-joint-position-time series (joint×axes×time) into multivariate time series ((joint×axes) ×time) and pass them to a CGAN. We use the Huber loss function to improve the GAN performance and offer higher robustness against noise in real-world applications. The proposed method is evaluated on an actual human gait dataset and compared with several recent works in this domain. Results show that the proposed method is superior to the previous works in prediction error, particularly in terms of achieving a better signal-to-noise ration.

pp. 198-204

17:45 *Deep Learning-Based Diagnosis of Dirofilaria Immitis Microfilariae in Dog Blood*

Fateme Jalousian, Sepide Banihashem Nejad and Shahram Jamshidi (University of Tehran, Iran); Seyed Hossein Hoseini (Hosseini, Iran); Fatemeh Manshori Ghaishghorshagh, Nima Hashemi, Hamid Soltanian-Zadeh and Ershad Hasanpour (University of Tehran, Iran)

Dirofilaria immitis (D. immitis) are the most common canine filarial nematodes presenting

blood circulating microfilariae which also occasionally infect humans. Iran is one of the endemic areas of D. immitis. About 11.5% of dogs in Iran are infected by D. immitis. Microscopic examination, the modified Knott method, is a definitive and very common diagnosis method for detecting microfilariae in peripheral blood. It is inexpensive, relatively quick, and does not require advanced and expensive laboratory equipment. However, identification and differentiation of microfilariae from artifacts depend on the skill and experience of the technician. The aim of this study was to remove this limitation by developing an artificial intelligence, deep learning-based system that detects microfilariae in blood slides and differentiates microfilaria from thread-like artifacts automatically. To this end, blood samples were collected from stray dogs (n=300) in five rural regions of the Guilan province, Iran. The presence of microfilariae was assessed using modified Knott's test by microscopic examinations. The modified Knott's test identified 29 cases infected with microfilaria. These positive results were confirmed with conventional PCR. The Mean length and width of microfilariaes for D. immitis were 295.13±14.9 × 5.8±0.43 µm. The images captured of microfilariae and artifacts were used to train and test the proposed deep learning-based system. The developed system diagnoses D. immitis with an accuracy of greater than 95% and thus, can be widely used for epidemiological studies. Since the microfilariae can be miss-diagnosed with thread-shaped artifacts, the proposed system plays an effective role in accurate and reliable diagnosis of D. immitis and can be used in field studies.

pp. 205-209

Thursday, December 22 16:00 - 18:00

Festival

Festival of Innovation and Inventions of Medical Technologies

Room: Ahmadi Roshan

Workshop 3

Practical Introduction to the Orthopedic Implants

Dr. Goli Malekabadi

Room: Showra

Thursday, December 22 18:00 - 19:00

Meeting

The Annual Assembly and Monthly Meeting of the Iranian Society for Biomedical Engineering

Room: Showra

Friday, December 23

Friday, December 23 8:30 - 10:00

Bioelectrics Posters 2

Room: Classrooms Floor Corridor

Chairs: Mohammad Ali Ahmadi-Pajouh (Amirkabir University of Technology, Iran), Majid Badieirostami (University of Tehran, Iran)

8:30 *QuickHap: A Quick Heuristic Algorithm for the Single Individual Haplotype Reconstruction Problem*

Melina Bagher, Reza Karimzadeh, Mehran Jahed and Babak Hossein Khalaj (Sharif University of Technology, Iran)

Single individual haplotype reconstruction refers to the computational problem of inferring the two distinct copies of each chromosome. Determination of haplotypes offers many advantages for genomic-based studies in various fields of human genetics. Although many methods have been proposed to obtain haplotypes with high accuracy, the rapid and accurate solution of haplotype assembly is still a challenging problem. The largeness of the high-throughput sequence data and the length of the human genome emphasize the importance of the speed of algorithms. In this paper, we proposed QuickHap, a heuristic algorithm to achieve a high speed of haplotyping with acceptable accuracy. Our algorithm contains two phases; first, a partial haplotype is built and expanded during several iterations. In this phase, we utilize a new metric to measure the quality of the reconstructed haplotype in each iteration to achieve the optimum solution. The second phase is applied to refine the reconstructed haplotypes to improve accuracy. The result demonstrates that the proposed method can reconstruct the haplotypes with promising accuracy. It outperforms the comparing methods in speed, particularly in dealing with high coverage sequencing data.

pp. 210-216

8:45 *Low Temperature and Afferent Nerve Damage Affect Pain Sensation: A Simulation Study*

Mohsen Kamelian Rad, Mohammad Ali Ahmadi-Pajouh and Mehrdad Saviz (Amirkabir University of Technology, Tehran, Iran)

Pharm

Hypersensitivity to low temperature is a common problem due to the increased

spontaneous activity of C fibers following nerve injuries. In addition, nerve damage can lead to the loss of A-beta fibers. Pain modulation following these abnormalities is poorly understood. In this study, we modified the latest model of pain processing circuits in the dorsal horn of spinal cord to investigate two cases of neuropathic pain: 1) The effect of exposure to cold and 2) The reduction in the number of Aβ fibers. Results indicate that the mere increased spontaneous activity of the nociceptive fibers in a neuropathic condition does not lead to the arousal of pain. But it has sensitized the projection (P) neurons to an upcoming stimulus. Interestingly in the second case, despite keeping the firing frequency of Aβ fibers intact, decreased efficiency of tactile stimulation or TENS was seen. This reduction was only due to a reduction in the number of fibers entering the dorsal horn. Our results provide considerable insights into the mechanisms of pain processing in the dorsal horn concerning the consequences of receptor injuries, which might be beneficial for clinical interventions.

pp. 217-222

9:00 *Stress Detection Using PPG Signal and Combined Deep CNN-MLP Network*

Yasin Hasanpoor, Koorosh Motaman, Bahram TarvirdiZadeh and Khalil Alipour (University of Tehran, Iran); Mohammad Ghamari (Kettering University, USA)

Stress has become a fact in people's lives. It has a significant effect on the function of body systems and many key systems of the body including respiratory, cardiovascular, and even reproductive systems are impacted by stress. It can be very helpful to detect stress episodes in early steps of its appearance to avoid damages it can cause to body systems. Using physiological signals can be useful for stress detection as they reflect very important information about the human body. PPG signal due to its advantages is one of the mostly used signal in this field. In this research work, we take advantage of PPG signals to detect stress events. The PPG signals used in this work are collected from one of the newest publicly available datasets named as UBFC-Phys and a model is developed by using CNN-MLP deep learning algorithm. The results obtained from the proposed model indicate that stress can be detected with an accuracy of approximately 82 percent.

pp. 223-228

9:15 *How to Correct Goldman- Hodgkin-Katz Ion Channel Models to Include Gating Nonlinearity Based on Available Hodgkin_Huxley Models*

Mohammad Saeid Imani Moqadam (Amirkabir University of technology, Iran); Nasrin Sadat Hashemi (Amirkabir University of

Technology, Iran); Seyedeh Hoda Asnaashari (Amirkabir University of technology Tehran, Iran); Mehrdad Saviz (University of Amirkabir, Iran)
Pharm

To simulate the bioelectric response of cells to electric and magnetic fields, we should model the nonlinear behavior of membrane ion channels by mathematical equations. More than 19 types of ion channels have been identified and modeled by the Hodgkin_Huxley (HH) model. Nevertheless, the Hodgkin_Huxley model has a significant simulation problem. In other words, these models cannot produce the expected nonlinear physical response at high frequencies since they explicitly model gating nonlinearity and not adjustable concentration nonlinearity. In this study, we suggested a complete model representing two kinds of nonlinearity, gating and concentration nonlinearity, to produce the expected nonlinear physical response of different voltage-gated channels. We incorporated the gating nonlinearity into the permeability coefficient defined in the Goldman- Hodgkin-Katz model (GHK), expressing concentration nonlinearity, and eventually achieved a modified GHK model for a wide variety of channels. Also, we verified these results using response diagrams of these channels available on the Channelpedia website.

pp. 229-233

9:30 *Which Policy is Used by the CNS to Control Human Standing Posture: Intermittent or Impulsive Control?*

Neda Bayat (University of Tehran, Iran); Fariba Bahrami (University of Tehran & ISBME, Iran); Mohammad Javad Yazdanpanah (University of Tehran, Iran)

The aim of this research is to model the function of the Central Nervous System (CNS) when controlling human standing posture which paves the way for designing external skeletal structures for rehabilitation or in a totally industrial direction, for building human like biped robots. We used a simple inverted pendulum with one degree of freedom to model body skeletal dynamics. Three different feedback control policies were used to describe the function of the CNS, and the stability of the whole closed loop model under each policy was studied. The policies we considered for the CNS as a controller are: 1) intermittent control, 2) impulsive control, and 3) a hybrid control, which is a combination of the intermittent and impulsive. Stability of the closed loop model under each policy was evaluated numerically using Lyapunov stability criteria. Our simulation results indicate that while the intermittent policy results in a stable system, the impulsive control is more efficient in terms of energy consumption. Consequently, a hybrid control strategy will result in a system that compromises between stability and energy-efficiency.

pp. 234-239

9:45 ***Antiepileptic Capacity of c-tDCS: A Computational Modeling Study***

Hossein Soroushi (University of Tehran, Iran); Fariba Bahrami (University of Tehran & ISBME, Iran)

Pharm

Transcranial Direct-Current Stimulation (tDCS), as a safe and non-invasive neuromodulator, has been recently the center of attention for the treatment and management of neurological disorders. However, the intervening mechanisms of tDCS are not completely understood, and in consequence, it was not possible or advisable to utilize it as an effective treatment. In this work, by integrating a neural mass model of the thalamocortical system, which can generate and induce different types of seizures, and the physiological aspects of the interaction between tDCS and the brain, such as permissible current and how it must be involved in different neural populations, we have proposed a basic model. Then, by connecting several units of the basic model and applying a learning rule to calculate properly the connectivity weights between units, a multi-zone model is established. Our simulation results explained the ever-increasing connectivity between pre- and post-stimulation, an accepted feature of tDCS. Then, we described computationally (based on bifurcation analysis) how this change in connectivity can lead to a reduction in epileptic susceptibility.

pp. 240-244

10:00 ***Employing Deep Learning and Discrete Wavelet Transform Approach to Classify Motor Imagery Based Brain Computer Interface System***

Ali Selkghafari (Sharif University of Technology-International Campus, Iran); Elnaz Azizi (Sharif University of Technology International Campus, Iran)

In recent years, Brain Computer Interfaces (BCI) attempted the attention of many researchers. In Motor Imagery (MI)-BCI, central nervous system directly connected to a computer or an automation system. Features of the electromyographic (EEG) signals can be extracted to utilize in MI-BCI systems. Variety of methods has been developed to extract EEG signal features during recent years. The main scope of this study is to employ a novel deep learning approach for EEG signals feature extraction using combination of discrete wavelet transform and convolutional Neural Network utilized in the BCI system. The deep learning approach presented in this study has rarely been explored to employ for EEG features extraction. The simulation results indicates that the proposed method achieve remarkable accuracy and high performance compared with conventional methods such as support vector machine and artificial Neural Network

methods and provides a powerful diagnostic decision tool to assist physicians in the treatment of left-hand and right-hand features in real time motor imagery classification system. Furthermore, the most advantages of employing the proposed method are to eliminate the feature selection level and reducing the processing cost significantly.

pp. 245-249

10:15 ***An Optimal Data-Driven Method for Controlling Epileptic Seizures***

Siavash Shams and Sana Motallebi (University of Teharn, Iran);
Mohammad Javad Yazdanpanah (University of Tehran, Iran)

The regions of the brain may be viewed as nodes in a complex network where information is dynamically transferred through synchronization. Synchronization plays an important role in learning, emotions, and motion. However, neurological disorders such as epilepsy are known to result from abnormal brain synchronization. Coupled Kuramoto model by a little integration of the neurological factors can be a suitable model of the brain network. In this paper, we present an open-loop data-driven control strategy to effectively desynchronize the activity of brain regions during a simulated seizure episode without making any assumptions about the dynamics of the brain. In order to quantify the significance of network nodes, we used an energy-based optimization problem. Then, we evaluated our control methods using a genuine connectome with 80 regions and demonstrated that our approach remarkably decreased synchrony between phases of the oscillations of the brain during the epileptic seizure. Finally, we conclude that brain epilepsy synchronization can be controlled by applying external inputs to the chosen optimal set of driver nodes.

pp. 250-255

Biomaterials & Tissue Engineering Posters

Rooms: 12, 13

Chairs: Elaheh Jooybar (Amirkabir University of Technology, Iran),
Fatemeh Yazdian (University of Tehran, Iran)

8:30 ***Investigating the Cytotoxicity of Montmorillonite Nanoparticles as a Carrier for Oral Drug Delivery Systems***

Alireza Ghannad Sabzevari (Faculty of New Sciences and Technologies University of Tehran Iran, Iran); Hosein Sabahi (University of Tehran, Iran)

Montmorillonite (MMT), a nanolayered silicate, is recently used as an oral drug delivery vehicle and also as a functional component in many oral bio-organic drug delivery nanosystems, resulting in increasing the drug bioavailability. This raises concerns about the possible toxic effects of MMT on the intestine and liver as the first and second organs exposed to MMT after oral administration. Here, we investigated the effects of MMT on human intestinal HT-29 (as an enterocyte model) and hepatic HepG2 cells in cellular and molecular levels using MTT assay, flow cytometry and qRT-PCR. The results showed that the tolerable MMT concentrations for HT-29 and HepG2 cells were up to 500 and 300 µg/mL in the presence of serum proteins and reduced to 50 and 25 µg/mL in the absence of serum proteins, respectively, indicating that MMT is much more toxic before absorption into the body. At the higher concentrations, MMT arrested HT-29 and HepG2 cells in G0/G1 and S¬ phases, respectively. Also, MMT induced apoptosis in both HepG2 and HT-29 cells, and necrosis in HT-29 cells. These results suggest that, although MMT over a wide range of concentrations is safe for the intestinal and hepatic cells in the presence of serum proteins, in the intestinal lumen, where serum proteins are absent, high concentrations of MMT may cause cell damage if other free proteins are not present. Also, MMT may cause hepatotoxicity if it is accumulated in the liver following long-term/high-dose administrations.

pp. 256-260

8:45 *An Experimental and Numerical Study of Microfluidic Preparation of Chitosan Nanoparticle*

Sara Movahedi (Shahid Beheshti University of Medical Sciences, Iran); Farshad Bahramian (Khaje Nasir Toosi University of Technology, Iran); Fatemeh Ghorbani Bidkorpeh (Shahid Beheshti University, Iran)

This study aims to optimize nanoparticle characteristics (size, polydispersity) for further investigation. We used both numerical study and experimental study for this purpose. The coaxial microfluidic device was fabricated for the semi-automatic synthesis of NP. A real three-dimensional model of the chip was modeled in COMSOL 5.5 to evaluate the optimum mixing condition. Consequently, the correlation between NPs size, flow ratio, and mixing condition was discussed briefly.

pp. 261-264

9:00 *Fabrication and Characterization of Polylactic Acid Nanobiocomposite Scaffolds Containing LDH and ZIF-8 Drug Carrier*

Kvan Jelodare and Mehrdad Khakbiz (University of Tehran, Iran)

In the past, many people lost their lives due to superficial wound infections. Over time, the importance of wound healing as the reconstruction of the body's first defense barrier, the

skin, became more important. Today, traditional medicine has given way to reconstructive medicine. Tissue engineering has always been a pioneer in the development and application of new methods as the main branch of reconstructive medicine. In this research, a Nano-Scaffold was designed and fabricated for skin Tissue engineering with unique properties using electrospinning method. In this project, to increase the function of the scaffold, two nanoparticles containing two types of drugs have been used, which is considered as a hybrid drug delivery system. Concomitant use of double layer hydroxide hybrid (LDH) nanoparticles containing curcumin and imidazole zeolite (ZIF-8) containing aspirin in poly-lactic acid scaffolding will accelerate wound healing and reduce inflammation. After processing two double layer hydroxide nanoparticles containing curcumin and imidazole zeolite containing aspirin, these two nanoparticles were loaded on poly-lactic acid nanofibers. By adding 3% by weight of nanoparticles to poly-lactic acid, the tensile strength increased from 1.31 MPa to 1.6 MPa, the contact angle increased from 59 ° to 120 ° and cell viability (within 72 hours) increased from 49% to 88%. Tests performed on the scaffold confirmed its biocompatibility.

pp. 265-272

9:15 *Fabrication of MIL-100 (Fe) Metal-Organic Framework Nanocarrier for the Controlled Release of Paclitaxel Against MCF-7 Breast Cancer Cells*

Navid Reza Darban Razavi and Nahid Hassanzadeh Nemati (Islamic Azad University Science and Research Branch, Iran); Soroush Sardari (Pasteur Institute of Iran, Iran)

Metal-organic frameworks (MOFs) are suitable as carriers for drug delivery systems (DDSs) due to their large specific surface area and high biocompatibility. In the present study, Paclitaxel (PTX) as an anticancer drug was loaded into MIL-100 (Fe) to reduce the abuse side effects of PTX and enhance its efficacy through the controlled release of PTX from MOF. MIL-100 (Fe) was synthesized via the hydrothermal technique and characterized through BET, FESEM, FTIR, and XRD analysis. The BET surface area of MIL-100 (Fe) was found to be 1336 m2g-1. Drug release profiles from synthesized MIL-100 (Fe) and pharmacokinetic studies were investigated. The PTX release data of MIL-100 (Fe) was evaluated under pH values of 5.5, and 7.4, at temperatures of 37 °C. The biocompatibility of drug-loaded MIL-100 (Fe) was also assessed by incubating them in MCF-7 breast cancer cells. The maximum cytotoxicity of MCF-7 cancer cells treated with MIL-100 (Fe)/PTX 10 µg mL-1 was found to be 77%. It can be concluded that MIL-100 (Fe) can be used as an effective pH-sensitive carrier to load anticancer drugs. Therefore, all these findings indicate that MIL-100(Fe) is a promising drug delivery platform for PTX and the treatment of various cancers.

pp. 273-278

9:30 *Fabrication of a Biocompatible Electroconductive Scaffold Based on Ascorbic Acid-Doped Polyaniline for Bone Tissue Engineering*

Houra Rezagholi and Zohreh Daraeinejad (Amirkabir University of Technology, Iran); Iman Shabani (AUT, Iran)

One of the main challenges of using polyaniline (PANI) in tissue engineering, is the cytotoxicity of PANI dopants, which compromises their biocompatibility. Herein, we aimed to substitute a biocompatible dopant instead of other cytotoxic dopants such as, camphor sulfonic acid (CSA). For this purpose, poly-L-lactic acid (PLLA) was used as a carrier polymer, PANI as a conductive agent, and AA as a biological factor and PANI dopant. Conductive scaffolds were fabricated via electrospinning. Finally, the morphology of the scaffolds was evaluated using a scanning electron microscope (SEM). By adding PANI, CSA, and AA dopants to PLLA, we observed a decrease in the diameter of nanofibers from 841 ± 181 nm to 468 ± 62 nm and from 841 ± 181 nm to 546 ± 77 nm, respectively. The conductivity of the scaffolds was measured by the two-point probe, which was 9.7 × $10^{-}5$ in the PANI-CSA scaffold and 4 × $10^{-}5$ in the PANI-AA scaffold. Considering that the acidity of CSA is higher than the acidity of AA, its polymer solution has more conductivity and leads to a decrease in the diameter of nanofibers. Therefore, we proposed that PANI-AA-based nanofibers can be used as a bioactive conductive scaffold for bone tissue engineering. Since AA does not have the cytotoxicity of CSA and in addition to playing a biological role that causes bone differentiation, it also has the role of a dopant for PANI.

pp. 279-281

Friday, December 23 8:30 - 10:30

Workshop 4

Medical Equipment Production Requirements (Risk Class - Technical File - CE)

Dr. Taki

Room: Showra

Friday, December 23 9:00 - 9:45

Invited Speaker

Dr. Iman Borazjani

Room: Ahmadi Roshan

Friday, December 23 10:00 - 10:30

Catering

Friday, December 23 10:30 - 12:00

Bioelectrics 3

Biological Image Processing

Room: 13

Chairs: Emad Fatemizadeh (Sharif University of Technology & Shahab Danesh University, Iran), Amir Hossein Foruzan (Shahed University, Iran)

10:30 *Fault Detection of Piezoelectric Array Element Using Acoustic Field and Particle Swarm Optimization*

Mohammad Saeed Zare Dehabadi and Mehran Jahed (Sharif University of Technology, Iran)

Medical ultrasonic array transducers are prone to various defects due to hardware malfunction, mechanical damages, aging, and fatigue issues. Faulty elements result in distorted acoustic field, higher side lobe level (SLL), and image resolution degradation. Fault detection of piezoelectric array element is an obvious and important prerequisite for any restoration or compensative reaction. In this work, an inverse optimization approach on the few measured samples of the radiated acoustic field is proposed to estimate the contribution of the element, its position and severity of its faulty condition. The proposed method is evaluated by 100 random simulated test datasets, based on finite element model (FEM) of a linear array transducer. Three element faulty types inclusive of Intact, Weak, and Dead, are considered in the datasets to measure a lateral profile of the radiated far-field acoustic field from the transducer. The problem on the acoustic field is solved by Particle Swarm Optimization (PSO) algorithm. The high detection accuracy of about 99%, as depicted in the results section, demonstrates the effectiveness of this method to detect Weak and Dead elements. The proposed method outperforms the electrical test equipment to check the sensitivity and capacitance of individual elements, especially for the 2D transducers containing large number of elements and physically unavailable sub-elements for the electrical tests.

pp. 282-286

10:50 ***Two Convolutional Neural Networks for the Rigid and Affine Registration of Two-Dimensional CT-MRI Images of the Human Brain***

Keyvan Ansarino (Sharif University of Technology, Iran); Emad Fatemizadeh (Sharif University of Technology & Shahab Danesh University, Iran)

Image registration is the process of matching the coordinate systems of two or more images. Medical image registration has been used in a variety of applications such as segmentation, motion tracking, etc. Recently, the use of deep neural networks has been demonstrated as a useful approach to registration problems. In this article, we propose two separate novel Convolutional Neural Network (CNN) architectures for multi-modal rigid and affine registration of the CT-MRI images of the brain. A dataset consisting of CT-MRI images of 37 subjects was used for training and evaluation of the networks. For both networks, the proposed models achieved a high mutual information value between predicted CT images and their corresponding MRIs and a mean dice score of 0.984 for rigid registration.

pp. 287-292

11:10 ***Use of Discrete Cosine-Based Stockwell Transform in the Binary Classification of Magnetic Resonance Images of Brain Tumor***

Mohammad Hossein Gohari Raouf (Amirkabir University of Technology, Iran); Ali Fallah (Amirkabir University of Technology & Amirkabir, Iran); Saeid Rashidi (Science and Research Branch, Islamic Azad University, Iran)

Magnetic Resonance Imaging (MRI) is an important medical diagnostic tool for the detection of tumors in the brain as it provides detailed information associated with the brain's anatomical structures. MRI images help the radiologist find the presence of abnormal cell growths or tumors. MRI image analysis plays the main role in diagnosing and treating brain tumors in the earlier stages. This paper investigates an approach for tumor detection using MRI brain images, where the MRI brain images are classified into normal and brain tumors. Nowadays, advantages in machine learning allow researchers to develop robust Computer-Aided Diagnosis (CAD) tools for classifying normal brains and tumors. Feature extraction is a critical step in any machine learning model. Time-frequency analysis methods provide localized information that makes them more efficient for image classification applications. After the pre-processing and segmentation stage, According to the advantages of the Discrete Cosine-based Stockwell Transform (DCST), we propose to use it to extract the efficient features from brain MRI images and obtain the feature matrix. The chi-square test is used to reduce the dimension of the feature

matrix. Finally, a Support Vector Machine (SVM) classifies the selected features. We use a dataset containing 7023 human brain MRI images classified into four classes: tumors of glioma, meningioma, pituitary, and no tumor. We achieved an accuracy of 97.71% for binary classification into brain tumors and no tumors.

pp. 293-298

Biomechanics 3

Hard & Soft Tissue

Room: 12

Chairs: Malikeh Nabaei (Amirkabir University of Technology, Iran), Mehdi Shafieian (Amirkabir University of Technology, Iran)

10:30 *Patient-Specific Study of Post-Ischemic Cardiac Ventricular Remodeling: A Passive Simulation of Structural Changes in Myofiber Orientation and Stiffness*

Saeed Torbati (University of Tehran & Tehran University of Medical Sciences, Iran); Alireza Heidari (McGill University, Canada); Alireza Daneshmehr (University of Tehran, Iran); Hamidreza Pouraliakbar (Iran University of Medical Sciences, Iran); Seyed Hossein Ahmadi Tafti (Tehran University of Medical Sciences, Iran); Dominique Shum-Tim (McGill University, Canada)

Despite recent advances in the computational modeling of cardiovascular diseases and therapies, the effect of post-ischemic remodeling has not been thoroughly studied while considering the unloaded ventricles. Further evaluation is, therefore, needed in order to better understand the effect of alterations in myocardial structure. Herein, we have developed a patient-specific computational model of ischemic cardiomyopathy to assess the influence of microstructure and material change on passive ventricular mechanics. The biventricular geometry has been built and unloaded based on cardiac magnetic resonance (CMR) images of a 64-year-old male patient at end-diastole (ED). Different fiber orientations and material scales were assumed for the model. Results indicated that although some fiber structures produce similar end-diastolic pressure-volume relationships (EDPVRs), differences in initial stress-free shapes and strain patterns determine the subsequent damage to the myocardium. Moreover, stiffening the healthy region means lower myofiber strain. However, material change in the ischemic areas of the ventricles does not alter the passive fiber strain considerably. Such evaluations are required when choosing optimal therapies to alleviate the adverse effects of ischemic

cardiomyopathy.

pp. 299-304

10:50 *Biomechanical Analysis of Hip Replacement Stem Design: A Finite Element Analysis*

Zahra Shamsipour azbari (University of Guilan, Iran); Mohadese Rajaeirad (University of Tehran, Iran); Amirreza Nahvi nejad, Hasan Asadi Gilakajani and Mohammad Khorsandi (University of Guilan, Iran)

Pharm

The hip joint is one of the largest joints of the body, which plays an important role in bearing the body's weight. When arthritis progresses to its higher levels, arthroplasty is performed to reduce pain and increase joint range of motion. This surgery is a common treatment worldwide, the quality of which depends on several factors. One of the critical factors is the geometry of the stem, which is implanted into the femur bone and receives support from it. For this aim, in this study, the geometry of three available stems in the orthopedic devices market was investigated by the finite element method (FEM). An accurate model of the proximal part of the femur was generated, and after modeling each stem, the final model was assembled. After developing the FE model, three loading conditions were applied to the stems. Maximum values of stress were observed in the middle part and neck of the stem. Moreover, it was observed that thickness is a key parameter in addition to the offset and neck shaft angle parameters and their effect on the amount and distribution of stress in the implant and bone. The results of this study can help improve the design of hip joint stems.

pp. 305-309

11:10 *Biomechanical Study of Fused Lumbar Spine Comparing Ti and PEEK as Connecting Rod Considering Bone Degeneracy Using FEA*

Aisan Rafie and Mohammad Haghpanahi (Iran University of Science and Technology, Iran)

Pharm

Nowadays, orthopedic fixation devices are used in treating spine diseases, but osteoporosis is the most common challenge for lumbar interbody fusion with pedicle screws. In the elderly population of the world, osteoporosis has become a common disease, which is a concern for spine surgeons because most of the patients who need lumbar interbody fusion are older people with osteoporosis. In this study, a finite element spine model of a healthy 15-year-old teenager was built. The finite element model of the lumbar spine from the L2 to L4 vertebra was acquired from the computed tomography

scan data. The 3D spine model entailed three lumbar vertebrae and two intervertebral discs and the implant system comprises 4 pedicle screws with the precise geometry of threads and two types of titanium and polyetheretherketone (PEEK) connecting rod. The loading and boundary conditions were exerted on the L2-L4 lumbar model. Considering the applied loads and bending moment on the model, stress distribution was appraised on intervertebral discs and the whole model with implant systems for titanium and PEEK rods fixation systems. To repute degeneracy, bones were categorized into four groups, i.e., weak bone, normal bone, strong bone, and very strong bone. The developed FE model was subjected to various axial compressive loads (270 and 510 N), and a pure moment of 10 Nm was applied for flexion, extension, lateral bending, and twist movements at the upside surface of the L2 vertebra, whereas the lower surface of the L4 vertebra settled fixed. 'Abaqus CAE 6.14-1' software was utilized to simulate the model with different fixed systems. A comparative study between different fixation systems showed that stress distribution values with the PEEK-based fixation system decreased over time with increasing osteoporosis. Likewise, lower equivalent stress values were recorded with the PEEK-based fixation system, especially in the whole model for cases with poor bone quality. In addition, both spine implant systems authorize to reduce the throughout loading stress in the entire spine models. It was derived that the PEEK-based spinal implant system significantly reduces the load on the whole model and also appears as a better option in reducing stress and load sharing for cases with poor bone quality compared to the titanium spinal implant system.

pp. 310-316

11:30 *The Role of Glial Cells in the Mechanical Behavior of Brain Tissue: A Mechanobiological Approach*

Anis Allahdiniyan, Faezeh Eskandari and Mehdi Shafieian (Amirkabir University of Technology, Iran)

Pharm

According to the available statistics, brain injury and concussion have been the most common causes of death in recent years. Progress in biomechanics has led to the recognition of many of the current limitations and various advantages in diagnosis and treatment planning, especially in surgeries. Evaluation of different characteristics of brain tissue under mechanical loading has led to a better understanding of the mechanisms of traumatic injuries. In this study, we used a microstructural finite element approach to investigate the contribution of the tissue components to the mechanical behavior of white matter. Axons and extracellular matrix (ECM) were assumed as hyperelastic materials, and glial cells that connected axons together were depicted via a spring-dashpot model. Dirichlet boundary conditions were applied to the model to evaluate the effect of the presence of glial cells in different tension and compression loading scenarios. The results showed that the presence of glial cells could change the tissue stiffness compared to its

absence. It could be suggested that changes in the mechanical properties of injured brain tissue can be attributed to the contribution of glial cells to the mechanical behavior of brain tissue.

بر اساس آمارهای موجود، آسیب مغزی و ضربه مغزی شایع ترین علت مرگ و میر در سال های اخیر بوده است. پیشرفت در بیومکانیک منجر به شناخت بسیاری از محدودیت های فعلی و مزایای مختلف در تشخیص و برنامه ریزی درمان، به ویژه در جراحی ها شده است. ارزیابی ویژگی های مختلف بافت مغز تحت بارگذاری مکانیکی منجر به درک بهتر مکانیسم های آسیب های تروماتی شده است. در این مطالعه، ما از یک رویکرد اجزای محدود ریزساختاری برای بررسی سهم اجزای به عنوان مواد هایپرالاستیک (ECM) بافت در رفتار مکانیکی ماده سفید استفاده کردیم. آکسون ها و ماتریس خارج سلولی در نظر گرفته شدند و سلول های گلیا که آکسون ها را به هم متصل می کردند از طریق یک مدل فنری-دشپات به تصویر کشیده شدند. شرایط مرزی دیریکله برای ارزیابی اثر حضور سلولهای گلیا در سناریوهای مختلف بارگذاری کششی و فشاری به مدل اعمال شد. نتایج نشان داد که وجود سلول های گلیا می تواند سفتی بافت را نسبت به عدم وجود آن تغییر دهد. می توان پیشنهاد کرد که تغییرات در خواص مکانیکی بافت مغز آسیب دیده را می توان به سهم سلول های گلیا در رفتار مکانیکی بافت مغز نسبت داد.

pp. 317-320

11:50 ***Microstructured Droplet Based Porous Capacitive Pressure Sensor***

Mohammadmahdi Eskandarisani, Mahdi Aliverdinia and Reza Javidi (University of Tehran, Iran); Shaghayegh Mirhosseini (School of Electrical and Computer Engineering, College of Engineering, Iran); Mahdi Moghimi Zand (Univ of Tehran, Iran)

Devices that imitate the functions of human skin are known as "electronic skin," and they must have characteristics like high sensitivity, a wide dynamic range, high spatial homogeneity, cheap cost, wide area easy processing, and the ability to distinguish between diverse external inputs. Here, we describe a flexible droplet-based microfluidic-assisted emulsion self assembly (DMESA) method for producing highly efficient capacitive pressure sensors based on three dimensional microstructures for electronic skin applications. Our method may produce evenly sized micropores that self-assemble across a vast area in an ordered close-packed manner, leading to excellent spatial homogeneity. Dynamic amplitude and sensivity were readily regulated to as high as 0.62 kPa -1 and up to 100 kPa by adjusting the micropore size, which can be simply adjusted from 100 to 600 µm. Our gadget may be molded into a variety of forms and printed on curved surfaces. These examples show how our method and sensors may be used to a broad range of e-skin applications.

pp. 321-324

Invited Speakers

Dr. Mehdi Hasani Sadrabadi & Dr. Aidin Taghilou

Room: Ahmadi Roshan

Friday, December 23 11:00 - 13:00

Workshop 5

Medical Equipment Production Requirements (PMS - GMP - ISO)
Dr. Taki

Room: Showra

Friday, December 23 12:00 - 13:30

Lunch

Friday, December 23 13:30 - 15:00

Bioelectrics 4

Room: 13

Chairs: Fariba Bahrami (University of Tehran & ISBME, Iran), Mohammad Pooyan (Shahed University, Iran)

13:30 *A Personalized Deep Neural Network to Recognize Human Activities in Healthy Subjects*

Faeghe Fereidoonian and Mohammad Ali Ahmadi-Pajouh (Amirkabir University of Technology, Iran)

Human Activity Recognition (HAR) using smartphone sensors is among the most demanding Artificial Intelligence (AI) topics for its growing applications in clinical healthcare monitoring. Although implementing an accurate HAR model is essential, developing a personalized one and adapting it to the end-user is challenging in real-life applications. There are various personalization methods in HAR. This research combines two personalization methods to adapt the proposed HAR model to individual subjects. Accordingly, we developed an Android application to capture the accelerometers of fifteen subjects during six predefined daily activities, such as standing, sitting, lying down, walking, going upstairs, and going downstairs. Subjects were instructed to carry the phone in predetermined positions in fixed or free modes. These positions include locations where people mostly carry their smartphones. The proposed personalized HAR model consisted of two main steps: (1) the dataset was divided into multiple groups based on the subjects' physical similarities, e.g., such as weight and height. Then, (2) based on multiple data splitting configurations (user-independent, user-dependent, and hybrid), the HAR model is generalized to the end-user in each group using a Long Short-Term Memory (LSTM). After normalization and windowing, the collected data were fed to the LSTM network. The model was trained and validated by 80% and 20% of the

dataset, respectively. Finally, we evaluated our proposed model using the Human Activity Sensing Consortium (HASC) corpus 2011, a large, publicly available dataset. The proposed LSTM network with the user-dependent personalization method produced an average F-measure of 0.99 and 1 for our dataset and the HASC dataset, respectively.

pp. 325-332

Biomechanics 4

Rehabilitation & Biorobotics

Room: 12

Chairs: Khalil Alipour (University of Tehran, Iran), Farzam Farahmand (Sharif University of Technology, Iran)

13:30 *Fuzzy-Based Gait Events Detection System During Level-Ground Walking Using Wearable Insole*

Amin Hoseini, Seyed Hooman Hosseini-Zahraei and Alireza Akbarzadeh (Ferdowsi University of Mashhad, Iran)

Gait analysis is one of the major topics in rehabilitation and sport. Tracking and determining gait phases can be done using various sensors and methods. In this paper, a fuzzy logic method is proposed to analyze and detect the five phases of a gait cycle using ground reaction force (GRF) and its gradient. The proposed method enables better detection adaptability at different walking speeds and bodyweights compared with the traditional threshold algorithms. In this algorithm, the GRF, measured by an insole equipped with force sensing resistors (FSR) and GRF gradient, which represent the plantar pressure transmission during a cycle, is passed through a set of fuzzy rules to detect the five gaits. Genetic algorithm (GA) is also applied for optimizing the fuzzy logic membership functions to reach minimum detection delay. A cost function is defined based on the difference between the normal reference gait and the output of the fuzzy logic gait phases. Detected phases are IC (initial contact), LR (loading response), MS (mid-stance), PS (pre-swing) and SW (swing). It is shown that the proposed method reaches a highly reliable performance of phase-detection, especially for the initial contact (IC) and toe-off (TO). The average detection delays for the IC and TO phases, using the fuzzy-based method for three walking speeds of 0.4, 0.85, and 1.3 m/s, were -14.3 ±16.9ms and 1.24 ±17.0ms, respectively, and the average duration of stance and swing phases are 61.42% and 38.58%, respectively.

pp. 333-339

13:50 *Three-Dimensional Finite Element Modeling of the Shoe Sole to*

Investigate the Impact of Various Geometries on Foot Heel Stresses and Energy Absorption

Sobhan Honarvar, Amir Nourani, Ava Yarandi and Fatemeh Farrahi Ghehi (Sharif University of Technology, Iran)

Pharm

The force applied to the foot is noticeable, and the foot is subjected to the limits of repetitive, prolonged muscular loading on a bone in some activities like sports that are not as heavily loaded in typical activities such as walking. Thus, it is mandatory that optimal footwear be designed with the lowest stress acting on the foot and maximum energy absorbed by the soles. In this study, the effects of some geometric features on the energy absorption of shoe soles were investigated using a finite element model (FEM). Auxetic structures showed some beneficial properties, including improved energy absorption. In addition, different types of holes in the midsoles of shoes were considered to reduce their weight. Therefore, this study investigated the effect of geometry by comparing auxetic shoes with re-entrant structures, shoes with weight-reducing holes with the same geometry as auxetic shoes, auxetic shoes with an auxetic structure similar to Nike RN 2017 shoes in the outsole, and shoes without auxetic structures and weight-reducing holes. A 3D finite element modeling was used to evaluate the effect of geometry on stress, displacement, and energy absorption. It was found that the strain energy of soles with re-entrant auxetic structures and with an auxetic structure in the outsole was 153 and 7% higher, respectively, than that of plain soles. Similarly, adding weight-reducing holes increased the strain energy of the sole by almost 157%.

pp. 340-345

14:10 *Design and Construction of an Artificial Thumb Prosthetics Controlled by Index Finger*

Ali Selkghafari (Sharif University of Technology-International Campus, Iran); Javad Loghmani (Sharif University of Technology International Campus, Iran)

The main scope of this article is to present design and fabrication of a simple active robotic prosthetics thumb which is activated by the motion of the index finger. In the proposed single degree-of-freedom mechanism output signal of the strain gauge attached to the index finger is utilized to activate the driving mechanism of the assistive robotic thumb. Stepper motor is employed as a driving system in the proposed mechanism. Experimental investigation was performed to evaluate the performance of the constructed prototype for catching, grasping, and lifting activities of various objects with different weights and shapes. The experimental results indicate very good performance of

the proposed artificial thumb prototype and illustrate the assistive system's action is very compliant to the motion of the able-bodied hand. As a result, it can be mentioned that the key factor for successful design of a portable in-home robotic-assistive prosthetics is to consider the anatomy compliancy in actuation system guarantees the opportunity of successful post-stoke treatment.

pp. 346-350

14:30 *Inverse Kinematics Associated with the Degree of Freedoms and Constraints of Shoulder Models During the Middle Direct Punch*

Hamidreza Barnamehei (Washington State University, Iran)
Pharm

The shoulder complex consists of various joints which correspond to specific degrees of freedom (DOF). Musculoskeletal modeling is a method to reconstruct the real motions that involved a big challenge to simulation accuracy. Different shoulder models with various DOF and constraint definitions are available although the accuracy of the simulation is still debated. Thus, the objective of this study was to evaluate DOF and constraint definitions of shoulder models for inverse kinematics (IK) simulation during the middle direct punch (MDP). The experimental marker data in twenty elite martial arts players (65.4±5.8 kg, 172±7.8 cm, 29.5±8.5 years) were collected during the MDP. Four models were chosen as base models (M3, three-DOF between humerus and trunk Glenohumeral joint; M9, three-DOF for Scapulothoracic joint, three-DOF for Acromioclavicular joint, and three-DOF for Glenohumeral joint; Mst, coupled motions for scapula, clavicle, and humerus; Mel, an ellipsoid mobilizer for the Sternoclavicular joint). The subject-specific models were generated for each subject and model by marker data in static posture and scaling tools of OpenSim. The inverse kinematics tool of OpenSim was used to reconstruct MDP motion via models. RMS of marker error was used to compare models as indicators. Results represented significant differences in RMS of marker error for various models during the MDP tasks ($P<0.05$). Results illustrated the RMS of marker error for model Mel was minimum (12.87±0.09mm), whereas the RMS of marker error for all subject-specific models was lower than generic models. Based on the results the best model is model Mel which indicated this musculoskeletal model of the shoulder complex can reconstruct the MDP motion better than other represented models. In addition, our results indicated using the subject-specific model instead of generic models is vital to access reliable results.

pp. 351-358

Invited Speakers

Dr. Gholamali Hoseinzade - Dr. Sajad Shafiei

Room: Ahmadi Roshan