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Thursday, November 25

Thursday, November 25 9:00 - 10:00

Opening

Room: https://vc.sharif.edu/ch/icbme2021_MH

Thursday, November 25 10:00 - 10:45

Keynote Speaker 1

Prof. Norbert Noury

Room: https://vc.sharif.edu/ch/icbme2021_MH

Chairs: Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran), Mehran Jahed (Sharif University of Technology, Iran)

Thursday, November 25 11:00 - 13:00

Bio-instrumentation & Healthcare

Room: https://vc.sharif.edu/ch/icbme2021_H2

Chairs: Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran), Mehran Jahed (Sharif University of Technology, Iran)

11:00 ***Ultra Low-Power System for Remote ECG Monitoring***

Ehsan Hadizadeh Hafshejani (Sharif University of Technology, Iran); Rozhan Rabbani (University of California, Berkeley, Iran); Zoherh Azizi, Matin Barekatain, Erfan Khoram and Ali Fotowat-Ahmady (Sharif University of Technology, Iran)

A complete system solution extracting signals from the patient chest with three leads including motion artifact removal in both analog and digital implementations are described. The resulting ECG signal is transferred via Bluetooth low energy to a mobile phone. Using deep sleep modes, the overall power consumption is less than 300μA and the device can operate for more than 20 days using a 150mAh battery. The screening software looks for suspicious traces such as those with missing pulses, tachycardia, bradycardia, etc. The mobile phone software also eliminates any remaining motion artifact. The traces are subsequently processed in detail in a cloud server and to a

physician's dashboard for long-term monitoring.

pp. 1-8

11:15 *Analysis of the Variability of Gait Cycle Parameters Based on Upper Body Acceleration Data Obtained from Inertial Sensors to Predict the Risk of Falling*

Ali Behbahani, Amir Nourani and Farzam Farahmand (Sharif University of Technology, Iran)

Variability in the values of gait cycle parameters is a measure of walking stability. Mental or physical disabilities usually manifest themselves in hand or foot movements. In this study, using the upper body acceleration data which was obtained from Inertial sensors, the variability of gait cycle parameters was investigated. Then, the reproducibility of the parameters in healthy individuals in this method was compared with the gold standard methods for healthy and sick elderly (at risk). The results showed that the step time parameter can be a suitable criterion as a standard method for separating healthy and sick people (at risk) as it had a good correlation with gold standard methods. Also, the variability of the step time parameter with a slight error compared to the gold standard methods can be considered as a suitable criterion; however, the variability of the swing time parameter showed a significant difference compared to the conventional methods. Investigating the variability of acceleration size in three anatomical directions showed that the acceleration in the anterior-posterior, and lateral directions had the highest repetition among healthy subjects.

pp. 9-14

11:30 *Design and Implementation of an Apparatus for Respiratory Parameters Estimation Based on Acoustic Methods*

Mahsa Khodaie (Amirkabir University of Technology, Iran); Vahid Reza Nafisi (Research Organization for Science and Technology, Iran); Fatemeh Farokhi Moghadam (Iran)

Breathing is one of the most fundamental characteristics in the continuation of life. Today, various contact and non-contact methods are used to monitor patients' breathing and diagnose lung diseases, each of which has its limitations. In this study, we designed a device to record respiratory sounds from the upper airways to evaluate the relationship between sounds and respiratory flow rate. Audio signals were recorded by microphones embedded in the breathing mask, and then amplitude and average power of the signal were extracted in different frequency bands. Using an artificial neural network, a correlation with a coefficient of 0.9 was observed between acoustic characteristics and

respiratory parameters, including peak flow and average flow. This relationship can be used to extract the respiratory pattern, monitor personal health, and identify respiratory diseases. Some of the mentionable advantages of this method are reduction in user restrictions and price and also establishing a non-contact and non-invasive method.

pp. 15-21

11:45 ***Implementing High Definition Combined EEG-fNIRS System***

Mostafa Khavanin Zadeh (Fersowsi University of Mashhad, Iran); Mojtaba Pourdara and Javad Safaie (Ferdowsi University of Mashhad, Iran)

Functional near-infrared spectroscopy (fNIRS) is a useful brain monitoring technique for measuring hemodynamics of body tissues, especially cortical surface. Combination of this technique with electroencephalogram (EEG), which contains information about electrical activity of brain, has provided a more comprehensive view of the brain with no interference between them. In this study, a multi-modal brain monitoring system is designed to record simultaneous 19-channel fNIRS and 16-channel EEG. Some evaluations are carried out, including arterial occlusion, cold pressor, and breath holding tasks for fNIRS and sleep stages for EEG. The evaluation results were interpretable as expected in respect of previous studies in this field so this proves our device's fNIRS and EEG units functionality.

pp. 22-27

Biomechanics 1

Room: https://vc.sharif.edu/ch/icbme2021_H3

Chairs: Navid Arjmand (Sharif University, Iran), Saeed Behzadipour (Sharif University of Technology, Iran)

Biomedical Image Processing 1

Room: https://vc.sharif.edu/ch/icbme2021_H1

Chairs: Gholam Ali Hossein-Zadeh (University of Tehran, Iran), Hamid Soltanian-Zadeh (University of Tehran, Iran)

#1 11:00 *Adapted Coherent Weighting in Photoacoustic Tomography*

Soheil Hakakzadeh, Seyed Masood Mostafavi and Mohammadreza Amjadian (Sharif University of Tech, Iran); Zahra Kavehvash (Sharif University of Technology, Iran)

In this paper, we proposed an adapted coherent factor (ACF), which is applied to a circular scanning photoacoustic computed tomography (C-PACT) arrangement. For validation, ACF is applied to different reconstruction algorithms such as universal-back projection (UBP) and adapted delay and sum (ADAS) with 2 types of SNR levels (80 dB and 20 dB) and 2 types of detectors with different bandwidths (infinite bandwidth and 2.25 MHz central frequency, 70% bandwidth). Simulation results indicate ACF can improve the Full width at half maximum (FWHM) of the imaging system point-spread function (PSF) and contrast ratio (CR) by 16% - 20% and 13.68-30.24 dB, respectively. These quantitative values are different due to the different reconstruction algorithms, SNR levels and detectors bandwidth.

pp. 28-32

#2 11:20 *3D Dilated and Residual Convolutional Neural Network for COVID-19 Detection from the Chest Computed Tomography*

Reza Karimzadeh and Nona Rajabi (Sharif University of Technology, Iran); Emad Fatemizadeh (Sharif University of Technology & Shahab Danesh University, Iran); Hossein Arabi (Geneva University Hospital, Switzerland)

Chest Computed Tomography (CT) is regarded as one of the most effective tools in diagnosing COVID-19 due to its high sensitivity and ease of use. However, analysis of CT images may be time-consuming for the clinicians, which highly influence their performance. Artificial-intelligence-based methods can help automating the process of

interpreting chest CT images and diagnosis of COVID-19 in suspicious patients. In this paper, we propose a 3D deep convolutional neural network for classifying chest CT images into COVID-19-infected and normal classes. Dilated convolution and residual connections are employed to increase the model's performance by enlarging the receptive field of the kernels and direct propagation of the information. The accuracy, precision, sensitivity, specificity, and F1-score achieved by our model are 0.99, 0.98, 1.0, 0.979, and 0.99, respectively. The high sensitivity value of the model demonstrates its efficiency in detecting/identifying all the infected patients correctly, which allows early quarantine and the start of the treatment process.

pp. 33-37

#3 11:40 *Accurate Kidney Tumor Segmentation Using Weakly-Supervised Kidney Volume Segmentation in CT Images*

Mohammadhossein Sadeghi (Sharif University of Technology, Iran); Hoda Mohammad Zadeh (Sharif, Iran); Hamid Behroozi and Ali Royat (Sharif University of Technology, Iran)

Recent leading approaches to medical image segmentation rely on deep convolutional networks trained with human-annotated, pixel-level segmentation labels. However, these methods require training images with pixel-level annotations, which are expensive and time-consuming to obtain. Weakly-supervised approaches have therefore emerged as a solution to address this issue. In CT scan images, due to the large number of slices, pixel-level labeling is very tedious, so applying weakly supervised techniques becomes more necessary. We propose a weakly supervised semantic segmentation approach based on image-level labels for kidney tumor segmentation. Experiments on KITS2019 dataset illustrate that our approach achieves Promising results (Dice score of 0.823 for kidney segmentation and 0.583 for tumor segmentation) with only image-level annotations compared to its fully supervised counterpart in KITS19 challenge (Dice score of 0.974 for kidney segmentation and 0.851 for tumor segmentation).

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Thursday, November 25 13:15 - 13:45

Iranian Society for Biomedical Engineering Annual Meeting

Room: https://vc.sharif.edu/ch/ISBME_2021

Thursday, November 25 14:00 - 14:30

Invited Speaker 1

Prof. Stephan Binczak

Room: https://vc.sharif.edu/ch/icbme2021_MH

Chairs: Serge Dos Santos (INSA Centre Val de Loire & Inserm U1253 iBrain, France), Mehran Jahed (Sharif University of Technology, Iran)

Thursday, November 25 14:30 - 16:30

Bio-devices

Room: https://vc.sharif.edu/ch/icbme2021_H2

Chairs: Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran), Ali Fotowat-Ahmady (Sharif University of Technology, Iran)

14:30 *A Modified Expansion-Contraction Cavity Array with Extra Flow Regulator Applicable for Cell Manipulation*

Zohreh Rostami and Amir Shamloo (Sharif University of Technology, Iran)

Owing to the advantages of microfluidic systems, they have been extensively utilized for cell manipulation in biomedical studies. These investigations have been done either by exploiting particular geometries to control the inertial force or exerting external forces (electric, magnetic, etc.). Since biological cells are vulnerable to high-shear gradients, there is a general tendency to decrease the flow rate, but it is challenging while some methods work efficiently in high flow rates. We have managed to overcome these challenges by designing a flow regulator to decrease the flow rate. As a result, first, we accomplished a numerical simulation for focusing three biological cells, WBC, RBC, platelet, in an expansion-contraction cavity array and validated its results with experimental data. Then, we designed a flow regulator that can make the system more consistent with further cell manipulation processes, while it causes minimum disturbance in the equilibrium focusing streamlines. This flow regulator not only can decrease the flow

rate by twentyfold but also can be used as an extra inertial particle separator to enhance the whole device's efficiency for cell separation purposes while it can separate WBC from RBC and platelet simultaneously.

pp. 44-50

14:50 *Fabrication of Flexible Strain Sensors Using Electrohydrodynamically Printed Silver Nanowires*

Ali Arafi, Ali Akbari, Kaivan Mohammadi and Mohammad R. Movahhedy (Sharif University of Technology, Iran)

Flexible and stretchable sensors are the new class of sensors that are massively investigated. They have wide applications in biomedical engineering such as in human-machine interface and epidermal electronics. However, the conventional methods for fabrication of these sensors (such as photolithography) have critical flaws and a huge part of the research on these sensors belongs to finding new fabrication techniques. In this study, electrohydrodynamic (EHD) printing is used as a new and promising micro/ nanofabrication technique to fabricate flexible strain sensors. To this aim, silver nanowires ink is printed on flexible Kapton sheets. Taguchi method is used to design four different geometries for the strain sensors. using the designed geometries, the effect of width of lines (W), number of turns (N), and length of lines (L) on the sensitivity coefficient of the sensors is investigated. The results show that the parameter that has the most significant effect on the sensitivity is the width of lines (W). The narrower sample sensors with a width of 200 µm have a larger sensitivity compared to wider samples with a width of 420 µm. The fabricated sensors are not suitable for sensing and measuring small strains, while they can sense larger strains with a high accuracy. Largest and smallest sensitivities are equal to 85.60 and 56.53, respectively. The high values of gauge factor of the fabricated sensors indicate their desired performance for sensing and measurement of strain.

pp. 51-57

15:10 *Investigating the Precision of 3D Scanner Systems Based on Digital Fringe Projection Method for Biomedical Engineering Applications*

Mahdi Norouzi (Amirkabir University of Technology, Iran); Mehdi Bostan Shirin (Amirkabir University of Technology (Polytechnic Tehran), Iran)

3D scanners are among the equipment widely used in 3D measurement and are mainly used in various areas such as robotic systems, manufacturing, medicine, etc. There are many types of scanners, including scanners that use the structured light technique,

especially the digital fringe projection method for 3D imaging. This research aims to investigate the accuracy and precision of these scanners for biomedical engineering applications, specifically in prosthesis' socket design. The 3D scanner used in this paper has been developed based on digital fringe projection. The three-dimensional measurement process in this system includes two main steps: calibration and imaging of patterns projected on the object. Also, by applying appropriate adjustments, effective parameters in 3D reconstruction and calibration error were optimized. To evaluate the accuracy, speed, and quality of the output images of this system in measuring objects and their interaction with the human body, two validation and clinical tests were designed and performed, respectively. By examining the available results and obtaining the average system error, it was found that the scanner system can calculate the dimensions of the object with 97% accuracy measurement. This accuracy would be suitable for use in clinical applications.

pp. 58-64

15:30 *Effect of Increasing Porosity as Drug Reservoirs for Local Drug Delivery in an Auxetic Stent*

Mohaddese Shirdel, Sadegh Ghofrani and Ali Abouei Mehrizi
(University of Tehran, Iran)

Stent is a small cylindrical mesh which is implanted in narrowing vessels to prevent the vessel wall from constriction. To provide more energy absorption and radial strength of the scaffold, a stent with a negative Poisson's ratio structure is proposed to be replaced as conventional stents. One of the most after stent implantation challenges is in-stent restenosis. Locally drug release in arteries is one of the solutions to overcome to the problem. Accordingly, drug-eluting stents with different mechanisms of drug delivery are presented. In this paper, micropores are created on the ligaments of a non-porous auxetic stents as drug reservoirs. So, stents are categorized in two groups of non-porous and porous ones to study their mechanical properties and effectiveness. Based on the results of FEA about the mechanical properties of porous specimens, a modified model of partially porous stents is suggested and analyzed. Finally, partially porous auxetic stent is proposed as a proper choice for drug-eluting stents.

pp. 65-69

15:50 *Characterization of Platinum Coated Electrodes Encapsulated in Microfluidic Channel for Impedancemetry Applications*

Roya Mohajeri (Superconductor Electronic Research Laboratory, Sharif University of Technology & National Elit Foundation of Iran, Iran);
Zeynab Alipour, Saeed Hajihosseini and Seyed Iman Mirzaie (Sharif

University of Technology, Iran); Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran)

The impedance properties of a fabricated electrode array coated by a platinum layer were investigated in a microfluidic channel. The platinum layers were electroplated on Au planar electrodes using a hexachloroplatinic acid (H2PTCl6) to increase the surface roughness, and hence decrease the impedance of the electrodes. To examine the adhesion of the coated platinum, the fabricated electrodes were sonicated in propanol solution. The microfluidic channel was fabricated using polydimethylsiloxane (PDMS), formed by a 3D printed mold. The impedance of the encapsulated electrodes in the microfluidic channel, injected by NaCl solution, was measured at 1 KHz frequency. In order to achieve the lowest possible impedance from the electrodes, the effect of the electroplating duration, the amplitude and the waveform of the applied plating current were studied. The electrode/electrolyte interface impedance was also analysed over the frequency range of 100Hz to 4 KHz, and the equivalent resistance and capacitance of the electrodes in contact with the ionic electrolyte were extracted.

pp. 70-73

16:10 *Development of a Controllably Homogenous Conductive Ballistic Gelatin as a Realistic Spinal Cord Phantom*

Fatemeh Mashayekhi, Faezeh Shanehsazzadeh and Amir Reza Vazifeh (Sharif University of Technology, Iran); Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran)

In this paper, we explore a moldable, conductive gelatin-based phantom that provides an average impedance close to that of the spinal cord tissues possible. Such phantoms can be employed to validate spinal cord electrodes recordings and data collection in preclinical stimulation tests, where voltage or current pulses are applied to paralyzed muscles and aid rehabilitation. By using phantoms, some surgery procedures will be eliminated, and a large number of quick tests will become feasible. In this research, ballistic gelatin was chosen as the phantom's primary foundation because it is low-cost, easy-to-use, simple-to-shape, and also can provide a conductivity range similar to that of spinal cord tissue. Doping Sodium chloride (NaCl) is used to modify the ions concentration in the gelatin-based phantom and significantly change the conductivity of the solution. So, the phantom's conductivity can be easily controlled, making it suitable for a range of applications based on the acquired conductivity. The molds were designed using AutoCAD software to be made using a 3D printing technique resulting in similar samples, proper for reliable comparison. We used Ag/AgCl dry electrodes to connect the samples to a designed low noise electrical circuit to measure the phantom impedance as a function of frequency. Then samples with similar conductivity to that of spinal cord tissue

were chosen as the primary material for spinal cord phantom.

pp. 74-77

Biological Signal Processing 1

Room: https://vc.sharif.edu/ch/icbme2021_H1

Chairs: Babak Hossein Khalaj (Sharif University of Technology, Iran), Mohammad Bagher Shamsollahi (Sharif University of Technology & Shahab Danesh University, Iran)

14:30 *A Cubature Kalman Smoother for ECG Denoising*

Hamed Danandeh Hesar (Sahand University of Technology, Iran)

Model-Based Bayesian frameworks have been used extensively in the field of ECG processing. In this paper, an ECG denoising framework based on cubature Kalman smoother (CKS) is proposed. In addition, we used dynamic time warping (DTW) in the 'ECG phase-wrapping' stage of this framework to improve its performance in case of heart rate variability. The proposed filter was evaluated on several normal ECG segments extracted from MIT-BIH normal sinus rhythm database (NSRDB). To do so, artificial white Gaussian and non-stationary real muscle artifact (MA) noise over a range of SNRs from 10 to -5 dB were added to these normal ECG segments. The benchmark methods were the extended Kalman filter (EKF), extended Kalman smoother (EKS), unscented Kalman filter (UKF), Unscented Kalman smoother (UKS) and cubature Kalman filter (CKF) frameworks. Among the benchmark algorithms the EKF framework is the first and CKF is the most recent model-based Bayesian algorithms proposed for ECG denoising. The results showed that the proposed algorithm had a noticeable advantage over EKF, UKF, and CKF methods from SNR improvement viewpoints at all input SNRs. The results also revealed that UKS and CKS perform similar to each other and at low input SNRs, these two algorithms outperform the EKS algorithm.

pp. 78-83

14:50 *A New Formulation of Extended Kalman Filter for ECG Processing in Non-Stationary Environments*

Hamed Danandeh Hesar (Sahand University of Technology, Iran)

Extended Kalman filter (EKF) is a well-known nonlinear Bayesian framework deployed in various electrocardiogram (ECG) processing fields. However, it is not very effective in removing non-stationary noises, such as muscle artifacts (MA) common in ECG recordings. This paper addresses this issue by proposing a new ECG dynamic model (EDM) and a novel formulation for EKF that improves its performance in non-stationary environments. In order to show the effectiveness of the proposed EKF algorithm, its denoising performance is evaluated on the MIT-BIH Normal Sinus Rhythm Database (NSRDB) in the presence real muscle artifact noise. The results showed that the proposed EKF framework significantly outperformed the standard EKF framework in non-stationary

environments from SNR improvement viewpoint.

pp. 84-89

15:10 *ECG Classification Using DTW-Based Learnable Kernels in Deep Neural Networks*

Mohammad Ahmadi-Mobarakeh (Sharif University of Technology, Iran); Hoda Mohammad Zadeh (Sharif, Iran)

Using Time Series Classification (TSC) methods in the study of biological signals like ECG for detecting unusual behavior is one of the most important applications of this field. With this motivation, we used kernel layer(s), as a novel approach, at the beginning of the common deep neural networks. These kernels have been trained based on Dynamic Time Warping (DTW) distance minimization. This new method has tested on two ECG datasets from UCR datasets: ECG200 and ECG5000 to classifying them. We got 91% and 92.3% accuracy for these datasets respectively, which is the best accuracy for ECG200 against other deep and non-deep methods and is an acceptable rate for ECG5000. Beside these results, the best achievement is the very low training time and also simplicity of the proposed network compared to other networks.

pp. 90-94

Drug Delivery & Bio-fluid Mechanics

Room: https://vc.sharif.edu/ch/icbme2021_H4

Chairs: Majid Badieirostami (University of Tehran, Iran), Manouchehr Vossoughi (Sharif University of Technology, Iran)

14:30 *Designing a Wireless Power Transfer Harvester for on Demand Implantable Drug Delivery System*

Ali Khorami (Khorasan Institute of Higher Education & DANESH, Iran); Seyed Sajjad Alemi (Khorasan Higher Education Institute, Iran)

In this paper a new design wireless power transfer harvester for on demand implantable drug delivery system is proposed. The implant system optimizes drug delivery as demanded. RF to DC energy harvester simply consists of antenna and rectifier block for receiving electromagnetic radiation signal and to produce a DC voltage, respectively. For this reason, zero bias Schottky diodes are used. For increasing range of input voltage, a multiplayer circuit is used. Proposed circuit works at least with 40 mV. The advantage of proposed circuit is small dimension no need to transformer. Implemented circuit satisfied the limitation of design. Experimental results of the enhanced RF to DC converter measured a maximum output power of 200 mW at a distance of 4 Cm from a transmitter operating at 25 MHz. Thus, the harvested signal was enough to supply a low power wireless device application without battery maintenance.

pp. 95-100

14:50 *Effects of Inhalation Flow Rate on Particle Deposition and Flow Structure in a Model of Tracheobronchial Airway*

Haniye Abdollahi (Department of Biomedical Engineering Amirkabir University of Technology Tehran, Iran); Arash Babamiri (University of Kurdistan Sanandaj, Iran); Kaveh Ahookhosh (KU Leuven, Belgium); Ali Farnoud (Helmholtz Zentrum München, Germany); Malikeh Nabaei (Amirkabir University of Technology, Iran)

Due to the prevalence of respiratory diseases, effective drug delivery to the lungs is important for researchers. The main purpose of this study is to investigate the transfer and deposition of micron-sized particles (1-10 μm) as well as airflow in different respiratory flow rates (i.e. 30 L/min, 60 L/min and 90 L/min) in a realistic airway model based on CT images of a 48-year-old healthy female. Computational fluid dynamics (CFD) is used for simulation of particle transport and deposition in an airway model that included mouth up to the fourth generation of bronchial airways and the results were compared available

data in the literature. To investigate airflow structure, velocity contours with streamlines at different region are obtained. Deposition fraction (DF) is used to present the results of particle deposition pattern. The results show that mouth-throat region and trachea filters out largest inhaled aerosols, which lead to highest particle deposition fractions for these regions. In addition, increasing the inhalation flow rate, increases turbulence level and particles inertia and result in increases deposition fractions.

pp. 101-106

15:10 *Targeted Drug Delivery System Using Ultrasound Transducers: A Numerical Study on Stenosis Artery*

Mojgan Alishiri, Sina Ebrahimi, Parnian Hemmati, Ahmad Boroumand and Amir Shamloo (Sharif University of Technology, Iran)

In the present study, a targeted drug delivery (TDD) system is proposed for enhancing the transfer of drug carriers to the inner wall of carotid artery plaque in case of atherosclerosis disease. First, the incompressible laminar blood flow through a carotid artery that is 50% stenosis is simulated. With the aim of improving drug delivery, an external force of ultrasound (US) waves caused by the disk and focused transducers under different pressures is used. To assess the functionality of each transducer, the surface density of nano-microparticles (SDP) adhered on the atherosclerosis lumen using the ligand-receptor binding is evaluated. Results revealed that the implementation of a disk transducer with 20 MPa pressure for nanoparticles with 200 nm diameter and microparticles with 2 μm diameter results in an increase of 43% and 50% in the SDP adhered on the plaque, respectively. This increase is 26% and 38% in the case of utilizing a focused transducer with 45 Mpa pressure. These results indicate the significant influence of using an external US field on enhancing the function of a TDD system.

pp. 107-111

15:30 *The Effect of Helical and Vortical Structures on Lagrangian Behavior of Particles in the End-To-Side Anastomosis Using Discrete-Phase Modeling*

Mohammadreza Balouchestani asl, Mohsen Saghafian and Mohammad Shumal (Isfahan University of Technology, Iran)

Pharm

Anastomotic blood flow patterns have been extensively studied in relationship to graft failure with the objective of understanding the specific flow environment underlying the stenosis formation at the anastomosis. In the present study, computational modeling of blood flow along with discrete-phase modeling of low-density protein (LDL) and

platelets for end-to-side anastomosis was conducted to assess the effect of vortical/helical structure and hemodynamic parameters on Lagrangian behavior of particles identified by particle residence time (PRT). Simulations were carried out for four models, generated based on two main features of "anastomosis angle" and "the presence of blood flow at distal venous segment". The transport equations were solved in the Eulerian frame of reference, and the discrete phase was simulated in the Lagrangian frame of reference. The continuous phase was assessed using helicity-based descriptors, visualization of the vortical structure, and wall shear stress. Results indicated that the presence of the side vortex observed in 70:30 cases increased the helicity intensity and PRT with forcing particles wrapping around it. With respect to the comparison of anastomosis angle, larger flow separation, flow reversal, and higher helicity intensity in 65° cases resulted in higher PRT. A smaller anastomotic angle lowered peak WSS, the flow separation area, and disturbances at the toe. Hemodynamics of a larger number of models should be studied to elucidate the connection between helical/vortical structures and lagrangian residence time of particles that can contribute to activation of platelets and deposition of LDL particles.

pp. 112-117

Neural Engineering

Room: https://vc.sharif.edu/ch/icbme2021_H3

Chairs: Fariba Bahrami (University of Tehran & ISBME, Iran), Ali GhaziZadeh (Sharif University of Technology, Iran)

14:30 *Analysis of EEG Based Functional Connectivity During Mental Arithmetic Tasks*

Hamed Nejat and Sepideh Hajipour Sardouie (Sharif University of Technology, Iran)

Recent studies in computational neuroscience have shown that functional connectivity graphs contain significant information about mental states. In this research, we analysed functional connectivity graphs constructed based on EEG signals recorded during mental arithmetic tasks. We implemented various functions using mathematical tools in order to construct the functional connectivity to check whether it is possible to classify quality of mental calculations with them or not. We used both unsupervised and supervised methods to ensure that the data can be separated even if we ignore labels. Based on classification and clustering, we show that the subjects can be separated based on quality-quantity characteristics. Using methods like spectral analysis, mutual information and the Granger causality, we also found some channels and connectivity weights statistically more significant than others, mostly close to cortical areas previously detected as related to mental arithmetic.

pp. 118-124

14:50 *Quantification of Spike-LFP Synchronization Based on Mathematical Function of Neural and Synthetic Data*

Mohammad Zarei (Institute for Research in Fundamental Sciences (IPM), Iran); Mehran Jahed (Sharif University of Technology, Iran); Mohammad Reza Daliri (Iran University of Science and Technology, Iran); Moein Esghaei (Cognitive Neuroscience Laboratory, German Primate Center, Germany)

Quantifying the spike-LFP phase coupling strength is a valuable approach to measure the inter-neuronal rhythmic synchronization. This synchronization has been commonly quantified by either the phase-locking value (PLV) method. However, this method suffers from a strong bias to the number of spikes. Although other methods, such as pairwise phase consistency (PPC) were later introduced to overcome this issue, low spike count bias has remained a concern. Given the importance of measuring spike-phase coupling

in short trials or neurons with small firing rates, we introduce a new approach for measuring spike-phase coupling which performs reliably for neurons responding at low spike rates, or neurons from which we have recorded only a small number of spikes. We use an exponential-based model to estimate the ideal spike-phase coupling based on measurements at different spike counts. Our approach significantly enhances the accuracy of spike-phase coupling at small spike counts. This method calculates the spike-phase coupling significantly more accurately than the previous methods using both simulation and experimental data, in conditions with small numbers of spikes (R-squared criterion, >0.98 for the exponential model and >0.65 for the logarithmic model). Importantly, a comparison of the MSE across the three N-spike (20, 35, and 50) shows that our model's estimated SPC is significantly closer to the ideal PLV, compared to that of the original PLV ($P<<0.001$; sign test). The proposed method may aid physiologists in accurate measurement of the degree of spikes' coupling to the phase of LFP in data-starving situations. Therefore, this is an important step towards introducing an accurate computation of spike-phase coupling with the minimum needed data.

pp. 125-130

15:10 *EEG Coherence Pattern Through Recalling Positive Autobiographical Memories and Neurofeedback*

Amin Dehghani, Hamid Soltanian-Zadeh and Gholam Ali Hossein-Zadeh (University of Tehran, Iran)

Emotion regulation plays a key role in human behavior and can be done through different techniques. Neurofeedback (NF) is a non-invasive self-brain training technique used for emotion regulation to enhance brain function or treatment of mental disorders leaded to behavioral changes. In this study, we investigated the connectivity pattern among EEG electrodes through recalling positive autobiographical memories to upregulate positive emotion using EEG neurofeedback and simultaneous recording of fMRI. Coherence pattern among 24 EEG electrodes and between different blocks of experimental group and also experimental and control groups (FDR-corrected for multiple comparisons, $q = 0.05$) was investigated to extract the effect of neurofeedback. The results revealed increased coherence among different EEG electrodes especially between frontal, parietal and central regions in different frequency bands. The result of this study can be used for future neurofeedback studies based on coherence of EEG electrodes with more effectiveness than traditional activity-based neurofeedback calculated based power of one or two EEG electrodes in special frequency band.

pp. 131-134

15:30 *Electrophysiological Responses to Prose-Embedded Linguistic Anomalies: An EEG Study*

Sara Bagheri and Sepideh Hajipour Sardouie (Sharif University of Technology, Iran)

Language regularities build linguistic knowledge and expectations, so humans comprehend language despite various peculiarities. It has been shown that linguistic anomalies elicit electrophysiological responses, but the specific effect of different types of anomalies on brain signals is rarely studied. In this paper, we examined the electrophysiological responses caused by different kinds of prose-embedded linguistic anomalies. To this end, we recorded Electroencephalogram in two different multi-tasking experiments in the Persian language: 1. reading prose while listening to a recorded version of the prose, and 2. writing prose while listening to a recorded version of that prose. Then, we evaluated how the brain responds to linguistic peculiarities by analyzing the power of recorded EEG in different bands. We found out that grammatical errors changed the power distribution between different frequency bands and increased the percentage of the theta band. Other anomalies affected the power of the delta and theta bands; in the first experiment, an increase occurred in the right and midline central, frontal and parietal channels, whereas in the second experiment, the increase happened in almost all channels. Moreover, in the first experiment, in anomalies except for grammatical ones, a decrease was observed in the beta power of the occipital, left central, right parietal, and right temporal channels. Finally, we compared the two experiments; the writing task causes an increase in the beta and gamma power and a decrease in the delta and theta power of the right frontal, central and temporal channels in comparison to the reading task.

pp. 135-140

Thursday, November 25 16:45 - 17:15

Invited Speaker 2

Prof. Hamid Kokabi

Room: https://vc.sharif.edu/ch/icbme2021_MH

Chairs: Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran), Mehran Jahed (Sharif University of Technology, Iran)

Thursday, November 25 17:15 - 19:15

Bio-fluid Mechanics

Room: https://vc.sharif.edu/ch/icbme2021_H2

Chairs: Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran), Manouchehr Vossoughi (Sharif University of Technology, Iran)

17:15 ***A Computational Simulation for Combined Stimulations of Fluid Flow and Mechanical Vibration to Mimic the Osteocyte Mechanical Environment***

Mohammad Reza Mohseni (University of Tehran, Iran); Bahman Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran)

Pharm

Osteocytes are the primary sensors of mechanical stimuli in bone which regulate activities of osteoblasts and osteoclasts. Experimental studies to quantify the mechanical environment surrounding bone cells are challenging, for the reason that the computational and theoretical approaches should consider both the solid and fluid environments of osteocytes to predict how these cells are stimulated in vivo. Osteocytes are elastic cellular structures that deform in response to the external fluid flow imposed by mechanical loading. In this study, an FSI model was created from an ideal osteocyte lacunar geometry. Due to the fact that during daily activities, the bone is mechanically loaded which causes the interstitial fluid flow in the lacunar-canalicular chamber of the osteocyte, a sinusoidal displacement was used at different frequencies and amplitudes to vibrate the osteocyte enclosed in the extracellular matrix. The results showed that the maximum strain occurs where the cell processes enter the lacuna. Also, the highest shear stress was observed in the canalicular part of the osteocyte. The amount of shear stress at frequency of 1 Hz and amplitude of 1 nm with considering the integrin and primary cilia attachments was 6.65 Pa. When integrins are also considered, the maximum shear stresses increase by about 25%. The simulation results showed that the maximum stress occurs at a frequency of 5 Hz and in the part of cellular processes. The stress and strain experienced by osteocytes also increase with increasing amplitude of vibration.

pp. 141-147

17:35 ***Finite Element Analysis of the Effects of Microgravity Conditions on Shear-Induced Modulation of Stem Cells***

Roza Vaez Ghaemi (University of British Columbia, Canada); Bahman

Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran); Zakieh Alihemmati and Mohammad Hossein Sabour (University of Tehran, Iran); Nooshin Haghighipour (Pasteur Institute of Iran, Iran)

Pharm

Several pieces of evidence are reported on the influence of the physical environment and mechanical stresses, on the fate of stem cells in-vitro. For example, it has been reported that stem cell in the normal gravitational condition is spread with a spindle configuration, while in the simulated microgravity conditions it transforms to a rounded non-spread shape. In this paper, the effects of microgravity on the mechanical behavior of stem cells under flow-induced shear stresses were evaluated through a computational simulation approach. Using computational fluid dynamics and fluid-structure interactions methods, the influence of a well-defined flow passing over a single stem cell was simulated in two different gravitational conditions. The simulation was performed using arbitrary Lagrangian-Eulerian (ALE) formulation and adaptive mesh procedure using a 3D model of a stem cell discretized via finite element method. The results suggest the distribution of the stresses and strains inside the cytosolic region, which may explain the disruption of the cytoskeletal fibers and its effects on cell biological functions. Focusing on fluid-structure interactions (FSI), we developed the first cell-scale model for the investigation of the mechanical behavior of stem cells. The results indicate the changes in mechanotransduction mechanisms as a result of microgravity which in turn affect the stem cell lineage commitment.

pp. 148-153

17:55 *Numerical Investigation of the Effects of Abdominal Aortic Aneurysm Geometry on Multiple Risk Factors*

Ermia Azari Moghaddam (AmirKabir University of Technology, Iran); Aisa Rassoli and Nasser Fatouraee (Amirkabir University of Technology, Iran); Gholamreza Ataei (Babol, Iran)

Pharm

An aneurysm is a vascular anomaly in which the blood vessel widens by over 50% of the original diameter. There are multiple factors contributing to rupture of aneurysm, such as wall shear stress, displacement, etc. which are affected by the geometry of the aneurysm. In this study, the effects of aneurysm geometry on various risk factors are investigated. In order to achieve this purpose, a 2D Fluid-Solid interaction model of three idealized abdominal aortic aneurysm geometries are studied using ADINA 9.6. The results conclude that upstream-bulged aneurysms experience higher displacement and lower shear stress which is the exact opposite in case of downstream-bulged aneurysms.

It is also noteworthy that symmetric aneurysm experience lower displacement but intermediate shear stress in compare to the other two aneurysms.

pp. 154-159

Bio-informatics

Room: https://vc.sharif.edu/ch/icbme2021_H3

Chairs: Babak Hossein Khalaj (Sharif University of Technology, Iran), Hoda Mohammad Zadeh (Sharif, Iran)

17:15 *Wise Feature Selection for Breast Cancer Detection from a Clinical Dataset*

Mahsa Bahrami and Mansour Vali (K. N. Toosi University of Technology, Iran)

Breast cancer is a common cancer, especially in women. Early detection of breast cancer is taken an added importance because it alleviates the rate of mortality and facilitates treatment. Accurate automatic algorithms for the detection of breast cancer are needed. In this paper, we developed a number of different feature selection methods for accurate breast cancer detection. Clinical data was pre-processed and then wise feature selection based on feature importance was applied for feature selection. In addition to this, principal component analysis (PCA), incremental PCA, kernel PCA, independent component analysis, factor analysis, locally linear embedding, modified locally linear embedding, and singular value decomposition methods were implemented and analyzed for feature selection and dimension reduction. Finally, multi-layer perceptron was used for classification. The performance of feature selection methods was evaluated on Wisconsin Diagnostic Breast Cancer dataset with 569 recordings. The best accuracy, sensitivity, specificity, F1-score, and Cohen's kappa on the test data were 97.4%, 98.6%, 95.3%, 97.6%, and 0.94 respectively, with a feature importance method.

pp. 160-164

17:35 *Human Blood Glucose Measurement Based on Infra-Red Spectroscopy*

Afarin Aghassizadeh, Mohammad Reza Nematollahi and Seyed Iman Mirzaie (Sharif University of Technology, Iran); Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran)

A predictive algorithm based on Partial least square (PLS) regression has been developed and optimized for measuring blood glucose levels of in-vitro human blood samples using their infra-red transmission spectrum. The labels - the accurate glucose concentrations - of each blood sample was measured using commercial invasive glucometers. The samples transmission spectra were obtained using a standard Fourier-Transform Infra-Red (FTIR) spectrometer. Using the developed algorithm, the results of the FTIR spectroscopy of the

samples were processed and analyzed to find the glucose concentration in the samples. The obtained glucose concentrations by the algorithm were in good agreement with the results obtained by the standard glucometers, with the mean absolute error of 7.5 mg/dL. This error is in the range of the acceptable errors for an available commercial invasive meter.

pp. 165-168

17:55 *Modified Burst Analysis Spectroscopy for Studying Distributions of Protein Aggregates and Fluorescent Assemblies*

Hasan Abbasi and Zahra Kavehvash (Sharif University of Technology, Iran)

The study of essential cellular functionalities and behaviors highly depends on the awareness from important parameters such as size, form, and distribution of macromolecular complexes. Furthermore, as most macromolecular complexes have heterogeneous and complex distributions, exploring their behavior is difficult. Here, we develop an extension of Burst Analysis Spectroscopy using the Genetic Algorithm and Particle Swarm Optimization. this method is a simple non-correlation-based approach that measures population distributions directly, even at very low sample concentrations. Based on this method, the highest signal-to-noise light bursts generated by single fluorescent particles are used to recursively determine the brightness and size distribution of complex mixtures of fluorescent objects. As this method neglects the non-linear behavior of reflected light by the excited nanoparticles, we propose a metaheuristic-based optimization to find the non-linear coefficients and modify the recursive procedure of particle distribution reconstruction. In order to analyze the reliability and sensitivity of the proposed algorithm, free-solution, time-resolved distribution data of assembled protein aggregates by using two fluorescently labeled proteins are generated by Monte Carlo procedure and utilized for particle distribution reconstruction. This scenario illustrates that the proposed method has superiority over the simple burst analysis method.

pp. 169-173

Biological Signal Processing 2

Room: https://vc.sharif.edu/ch/icbme2021_H1

Chairs: Sepideh Hajipour Sardouie (Sharif University of Technology, Iran), Mohammad Bagher Shamsollahi (Sharif University of Technology & Shahab Danesh University, Iran)

17:15 ***A Novel Feature Extraction Method for Motor Imagery BCI***

Arefeh Nouri and Zahra Ghanbari (Amirkabir University of Technology, Iran); Mohammad Reza Aslani (Shahab Danesh University, Iran); Mohammad Hassan Moradi (Amirkabir University of Technology, Iran)

Imagination of limb movement is reflected in EEG signals, which is called motor imagery (MI). MI can be used in brain-computer interface (BCI) applications. In this paper, a new feature extraction method is proposed for MI-based BCI. A Gaussian spatial filter is used in the pre-processing stage, to map the effect of brain sources on the electrodes. Enhanced signals, obtained by preprocessing, are decomposed into standard frequency bands. A practical BCI system should be simple and fast, as much as possible. Therefore, to reduce the computational cost, signals of each frequency band are fed to the common spatial pattern (CSP) block for channel selection. In this paper, a blind source separation (BSS) based technique is proposed to improve feature extraction. As a result, the learning quality of the BCI system has been increased. To assess the proposed BCI system, it is applied to dataset IVa of BCI competition III. The average values of accuracy, sensitivity, specificity, Mathew's correlation coefficient, and F1 score on five subjects for two MI-tasks, are 99%, 98%, 99%, 97%, and 99%, respectively. Results indicate satisfactory performance of the proposed approach.

pp. 174-177

17:35 ***Staging Combat-Related PTSD***

Ali Rajabi Mashhadi (AmirKabir University, Iran); Mohammad Hassan Moradi (Amirkabir University of Technology, Iran); Zahra Ghanbari (AmirKabir University, Iran)

Post-traumatic stress disorder (PTSD) is a chronic mental condition that may emerge after experiencing a life-threatening trauma. Symptoms severity may differ in PTSD patients. In this paper, we study combat-related PTSD severity based on resting-state eyes-closed EEG signals. Severity score is calculated according to a questionnaire. Four severity classes are defined. After preprocessing, signals are filtered to frequency bands, and segmented to 1s epochs. Power is calculated for above epochs corresponding to the whole band signal and all frequency bands. Statistical analysis is performed using repeated measure

ANOVA with Bonferroni post-hoc test. According to our results, there are significant differences between pairwise classes at the significance level of 99%, especially in beta and alpha bands which is in align with a previous study on another PTSD type. Moreover, studying channels in each class reveals the crucial role of CP3.

pp. 178-181

17:55 *Emotion Recognition Using Sparse Graph Analysis of Brain Connectivity*

Shirin Shoushtari (Sharif University of Technology, Iran); Hoda Mohammad Zadeh (Sharif, Iran); Arash Amini (Sharif University of Technology, Iran)

Emotion recognition has gained more importance in recent years due to its various applications in artificial intelligence (AI). Because of high temporal resolution and low acquisition costs, EEG signals have become one of the dominant brain signals for the analysis and recognition of the emotions induced by the nervous system. In this study, we aim to explain brain connectivity using graph models and assess the performance of graph features extracted from brain connectivity. We propose two models to build graphs for brain connectivity and compare their capabilities in expressing the emotional state of a subject. We have used the DEAP dataset for this experiment. Our proposed models show an accuracy increase of approximately 5% compared to solely using brain connectivity features. Another advantage of this approach is that by making the connectivity graph sparser, we could considerably reduce the size of the feature vector compared to the conventional brain connectivity feature vector.

pp. 182-187

18:15 *A Deep Transfer Learning Training Strategy for Inter-Subject Classification of EEG Signal*

Javad Sameri, Hesaam Zarooshan and Mohammad-Reza Jahed-Motlagh (Iran University of Science and Technology, Iran)

Electroencephalogram(EEG) signals are generally available in small limited quantities, and there is considerable variability between individual and recording sessions. Thus finding a model that is capable of finding discriminative features that are invariant to these differences is crucial. For this purpose, Convolutional Neural Networks (CNN) proved to be suited for finding Spatio-temporal features that are discriminative from these signals. This paper introduces Stage training, a novel strategy to train an end-to-end CNN model designed for learning discriminative features from EEG recordings. Stage training and fine-tuning approach specifically address the challenges for finding an invariant

model to inter-subject differences. Using these approaches we significantly increased the overall accuracy of the EEGNet by 9%. Our strategy's implementation can be found at https://github.com/mj-sam/stage-trans

pp. 188-192

Friday, November 26

Friday, November 26 9:15 - 9:45

Invited Speaker 3

Dr. Sedat Nizamouglu

Room: https://vc.sharif.edu/ch/icbme2021_MH

Chairs: Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran), Hamid Kokabi (Laboratory of Electronics and Electromagnetism (L2E), Sorbonne University, Canada)

Friday, November 26 9:45 - 11:45

Biochemicals and Biomaterials

Room: https://vc.sharif.edu/ch/icbme2021_H3

Chairs: Amir Shamloo (Sharif University of Technology, Iran), Manouchehr Vossoughi (Sharif University of Technology, Iran)

9:45 *Designing and Modeling a Centrifugal Micromixer for Continuous Circulating Tumor Cells Lysis*

Amir Shamloo, Ali Shafie Souderjani, Rasool Dezhkam and Ali Mashhadian (Sharif University of Technology, Iran)

Nowadays lysis of Circulating Tumor Cells (CTCs) has a vital role in diagnosis and treatment of cancer diseases. Microfluidic techniques have great potential in this subject and Lab on CD (LOCD) devices are one of the branches of these techniques. In this study, a device on a disk is simulated using LOCD applications. CTC separated from whole blood, is then injected into the mixer for continuous chemical cell lysis. For this purpose, an omega shaped (Ω) channel is considered for creating stronger dean flow and improving mixing quality. In order to survey the efficiency of this device, mixing quality is introduced in this study to access the efficiency of mixing. The effect of adding an extension to the cross section is investigated to show desirable mixing efficiency in only 100 [rpm]. Moreover, the positions of inlet flows are studied and the best result is presented. The presented study concludes the lysis buffer and particle flow mixes to 99.77% quality.

pp. 193-198

10:05 *Breast Cancer Detection from a New Ultrasound RF Time Series Based Approach: Phantom Studies*

Elaheh Norouzi Ghehi (University of Amirkabir & Ultrasound and Elastography Group, Bimedical Engineering Faculty, Iran); Ali Fallah (Amirkabir University of Technology & Amirkabir, Iran); Saeid Rashidi (Science and Research Branch, Islamic Azad University, Iran); Maryam Mehdizadeh Dastjerdi (University of Amirkabir, Iran)

In breast cancer which is a women common cancer, the treatment will be more successful in early stages. Due to the lack of sufficient accuracy of each nowadays method to determine the type of lesions, a biopsy is used. But it's invasive and causes a lot of mental and financial costs on the patient. Thus, it is necessary to contemplate a non-invasive and non-radioactive method to ensure about the type of lesion. Researches on

echo patterns of radiofrequency RF ultrasound data have shown that it had information about the propagation environment and can be used for tissue typing. In another work we suggested extracting RF time series features in the progress of stimulating breast tissue added more information to the RF time series and improve tissue classification results. Data were recorded from two types of agar-gelatin phantom mimicking breast tissue. Data collection was performed under a fixed probe, static and vibrational excitation. Finally, SVM classifiers have been used to classify healthy and cancerous tissues. In this study, the effect of some recording parameters (depth and probe central frequency) on this classification has also been investigated. A Supersonic Imagine US system equipped with a linear probe was used to record this signal. The most improvement in classification accuracy was achieved by using vibration stimulation and 6.4 central frequency at 2cm depth. This result is for ultrafast beamformed data with 98.78±2.77 % accuracy.

pp. 199-205

10:25 *Chitosan/Alginate Polyelectrolyte Composite Scaffolds Containing Bioactive Glass Nanoparticles for Bone Tissue Regeneration*

Mostafa Mokhtari and Abdoreza Sheikh-Mehdi Mesgar (University of Tehran, Iran)

chitosan (Ch) and alginate (Al) as natural biopolymers that could form polyelectrolytes, have been widely studied for tissue engineering applications. In this study, Ch/Al scaffolds containing bioactive glass nanoparticles have fabricated and their physicochemical characteristics as well as cell response to the prepared scaffolds were studied. Results proved that the addition of bioactive glass nanoparticles did not affect the morphological properties, while the bioactivity, osteoblast cells viability and attachment considerably improved by increasing the amount of bioactive glass component to 10 wt%.

pp. 206-211

10:45 *Designing a Unit Cell to Investigate the Effect of Collagen Type IX on Mechanical Properties of Human Cartilage*

Fatemeh Jalali and Mohammad Ali Nazari (University of Tehran, Iran)

Collagen is one of the most abundant proteins in the human body, which is found in almost all tissues, thus, it has always been considered. Collagen type II fibril is one of the important constituents of cartilage which has the function of providing strength. It has been found that collagen type II is not alone, and collagen type IX periodically attaches to its surface and interacts with other components in cartilage. In this research, the extent and magnitude of their effect are investigated. A unit cell is designed based on the microscopic structure of collagen type IX. These collagen fibers are composed of rod fragments and a flexible non-collagenous kink. Assigning the proper mechanical

properties to each part, the mean stress and elasticity tensor were calculated by applying appropriate boundary conditions and loads in different states. The behavior of the resulting unit cell resembles a transversely isotropic material. Computing the equivalent Poisson's ratios and Young's moduli justify the varying mechanical properties of cartilage through the depth.

pp. 212-216

11:05 *A Novel Electrospun Scaffold for Collagenous Connective Tissue Regeneration*

Elham Rahimtoroghi and Mehran Kasra (Amirkabir University of Technology, Iran); Homa Maleki (University of Birjand, Iran)

Connective tissues contain collagen fibers bound together. A suitable scaffold for regenerating connective tissue should be able to help collagen synthesis. Electrospun nanofibers are highly used in tissue engineering applications as scaffolds. It has been determined that fibrous scaffolds with aligned structures are more suitable substrates for cell orientation, proliferation, and adhesion. In this study, we fabricated a novel electrospun scaffold. At first, we fabricated an electrospun layer from gelatin. Afterward, we put electrospun PLLA yarns on the layer's surface and then fabricated another electrospun gelatin layer on them to have an aligned fibrous structure (sheet+yarn). The morphological properties of the sheet+yarn were measured. We studied fibroblast's behavior in contact with the sheet+yarn using MTT and Sirius red assays. The morphological results showed that there was not a significant difference between the sheet+yarn and a simple electrospun gelatin layer that did not contain yarns (sheet). But, the results of in vitro assays showed that fibroblasts produced more collagen and proliferated better in contact with the sheet+yarn in comparison with the sheet. So, the sheet+yarn as a novel electrospun scaffold can be used for collagenous connective tissue regeneration.

pp. 217-219

Biological Signal Processing 3

Room: https://vc.sharif.edu/ch/icbme2021_H1

Chairs: Farnaz Ghassemi (Amirkabir University of Technology, Iran), Ali Khadem (K. N. Toosi University of Technology, Iran)

9:45 *Classification of Faller and Non-Faller Parkinson's Disease Patients Using Wavelet-Based Multifractal Spectrum of Center of Pressure Signal*

Kosar Barati, Saeed Behzadipour, Mehrdad Boroushaki and Zahra Rahmati (Sharif University of Technology, Iran)

The Center of pressure (COP) signal has an erratic behavior. Quantifying this behavior using the time-scale multi-resolution analysis provides valuable information to the prediction of fall risk in Parkinson's disease patients. In this paper, multifractal spectrum measures, as complexity or smoothness measures of signal, were used to classify faller Parkinson's disease patients from the non-fallers. From data previously gathered, in 11 faller PD participants and 49 non-fallers, the center of pressure signal was recorded on a rigid and foam surface with open and closed eyes. Multifractal spectrum (MFS) measures were calculated using discrete wavelet transform (DWT). Based on MFS measures, several classification algorithms including decision trees, naive Bayes, logistic regression, artificial neural network (ANN), and support vector machine (SVM) were tested searching for the best one. With the aim of better classification performance, stratified cross-validation, as a sample balancing method, and ensemble methods such as Bagging and Adaboost were applied. Results showed the most prevalent smooth behavior in MFS (□□) on the rigid surface can separate the faller PD participants effectively. Additionally, proprioception (standing on foam or rigid surface), as compared to vision, had a more important role in signal smoothness. A decision tree based on the ID3 algorithm with Bagging showed an acceptable performance (accuracy=0.88, sensitivity=0.57, precision=0.75). Multifractal spectrum analysis of COP disclosed the postural instability characteristics in faller PD patients, that dispose patients to fall, and which is discriminable by fine-tuned classifiers.

pp. 220-227

10:05 *A CNN Model for Cuffless Blood Pressure Estimation from Nonlinear Characteristics of PPG Signal*

Naeem Eslamyeh Hamedani, Seyedeh Zohreh Sadredini and Mohammad Bagher Khodabakhshi (Hamedan University of Technology, Iran)

Continuous and non-invasive monitoring of blood pressure (BP) is of high importance in preventing cardiovascular diseases. Currently, blood pressure control is widely performed

by non-invasive cuffless-based devices. Major studies focus on the extraction of temporal and frequency characteristics of electrocardiograph (ECG) and photoplethysmograph (PPG) signals in improving the accuracy of BP estimation using intelligent algorithms. In this study, a novel framework based on a lightweight deep convolution neural network (CNN) is proposed, in which the sequences of the PPG are applied to the input. Also, a set of non-linear features called recurrence quantification analysis (RQA) have been used to improve the ability of the model in estimating the systolic blood pressure (SBP) and diastolic blood pressure (DBP). The proposed framework was evaluated on the data extracted from the benchmark MIMIC-II dataset. The impact of the RQA features in BP estimation was investigated based on Spearman's statistics. The results obtained from the statistical analysis indicated that all RQA features could significantly distinguish between the levels of the actual values of both SBP and DBP ($p < 0.001$). Moreover, The results of the CNN model showed that the set of augmented inputs from RQAs and PPG sequences could provide high accuracy in BP estimation. In particular, the Pearson's correlation coefficient (R) for the proposed model was achieved to be 0.94552 and 0.93916 for SBP and DBP, respectively.

pp. 228-235

10:25 *A Non-Contact HR Estimation Framework Based on PPG Amplitude Variation Elimination and Data Fusion*

Arash Rasti-Meymandi (Iran University of Science and Technology, Iran); Reza Karimzadeh (Sharif University of Technology, Iran); Asghar Zarei (Tarbiat Modares University, Iran); Aboozar Ghaffari (Iran University of Science and Technology, Iran)

The evaluation and assessment of Heart Rate Variability (HRV) from contact-based methods have had quite a journey throughout the annals of medical diagnosis. However, non-contact measurement of heart rate (HR) is gaining lots of attention recently. In this paper, we introduce a framework to make a robust contact-less estimation of HR from facial recorded videos. Our framework exploits various color space representations of the video frames and different techniques to extract initial Photoplethysmography (PPG) signals. The acquired PPG signals are then enhanced using the novel PPG amplitude variation elimination technique (AVET) embedded in our framework which is based on their analytic signals. Various HR is estimated from the refined PPGs in order to be fed to the fusion algorithm which is intended to procure a more accurate estimation of the true HR. The evaluation on the publicly available UBFC-Phys dataset shows that the proposed framework has a superior performance compared to the baseline techniques such as ICA and Green methods.

pp. 236-241

10:45 *Cross-Subject fNIRS Signals Channel-Selection Based on Multi-Objective NSGA-II Algorithm*

M. Moein Esfahani and Hossein Sadati (K. N. Toosi University of Technology, Iran)

In brain-computer interface (BCI) systems, finding an optimal channel set to decrease the cost of computation and portability of the signal acquisition system to achieve higher classification accuracy is vital. This study presents a multi-objective meta-heuristic algorithm to select optimal channels in the multi-channel fNIRS signals. We proposed non-dominated sorting multi-objective Genetic Algorithm (NSGA-II) to perform channel selection. We will find an optimal solution to the channel selection problem in brain-computer interface (BCI) systems to obtain the best channels in the multi-channel fNIRS signal dataset. Toward the classification of the fNIRS signals, a preprocessing task should be applied, followed by selecting the channels set and extracting related features of every trial. In the next step, in order to apply the feature selection method, the mRmR algorithm was applied. Classification accuracy with 10-fold cross-validation is then performed as an objective for the presented algorithm to select the best accuracy and best channel set. Finally, the results illustrate that the proposed selected method obtained an average of 27.25 best optimal channels per subject. Moreover, classification results are 67.9±11% for the subjects. It was found that the LDA classification method resulted in the best performance compared to other methods.

pp. 242-247

Biomedical Image processing 2

Room: https://vc.sharif.edu/ch/icbme2021_H2

Chairs: Emad Fatemizadeh (Sharif University of Technology & Shahab Danesh University, Iran), Hoda Mohammad Zadeh (Sharif, Iran)

9:45 *Attention-Based Deep Learning Segmentation: Application to Brain Tumor Delineation*

Reza Karimzadeh (Sharif University of Technology, Iran); Emad Fatemizadeh (Sharif University of Technology & Shahab Danesh University, Iran); Hossein Arabi (Geneva University Hospital, Switzerland)

Brain tumor segmentation is an important step in brain cancer diagnosis and treatment. Manual segmentation is highly time consuming and tedious. To address these issues deep learning-base methods have been employed and demonstrated tremendous improvement in terms of performance accuracy and time-efficiency compared to the conventional segmentation methods. Due to varying size, location and shape of tumors, tumor segmentation task is highly challenging in comparison to the anatomical organ segmentation, thus it seems essential to develop robust, accurate, and efficient deep learning-based solutions for this task. In this work, we proposed a method that utilized UNet architecture as backbone (referred to as Attention-based UNet (AbUNet)) to establish an efficient tumor segmentation framework. AbUNet consist of two basic components, attention and segmentation modules. The purpose of attention module is to estimate approximate location of tumor through a rough/coarse segmentation with high true positive rate to guarantee the inclusion of the entire tumor. To this end, a new cost function was introduced and the dilated masks of ground-truths were employed for training of the attention module. The outcome and some feature maps from decoder part of attention module were fed to the segmentation module to guide the segmentation network focusing on the confined regions of the image which contain tumor. In the last step, the segmentation module predicts final mask of the tumor. To evaluate our proposed method, we used the BraTS dataset which contains brain MRI scans with manually defined tumor masks delineated by an expert. Our baseline UNet without attention module achieved a Dice score of 0.68 compared to AbUNet with Dice score of 0.79 that indicates significant improvement in segmentation accuracy. It was demonstrated that incorporation of the proposed attention module in the deep learning-based segmentation network would significantly enhance the robustness and accuracy of the segmentation.

pp. 248-252

10:05 *Functional and Effective Connectivity in Major Depressive Disorder Patients with Suicidal Thoughts: A Resting-State fMRI Study*

Morteza Fattahi (University of Tehran, Iran); Reza Rostami (Tehran University, Iran); Gholam Ali Hossein-Zadeh (University of Tehran, Iran)

Major Depressive Disorder (MDD) is one of the most prevalent psychological disorders all over the world. Suicide ideation is the most dangerous and crucial consequence of this mental disturbance that can lead to suicide attempting. In this study, we compared both functional and effective brain connectivity of female MDD patients having suicide thoughts with female healthy controls. We used the COMBI algorithm for identifying independent components in resting state fMRI data (rsfMRI) of 32 female subjects (16 MDDs with suicide ideation and 16 healthy controls). We performed Group Information Guided Independent Component Analysis (GIG-ICA) as a back-reconstruction step and finally, extracted the static and Dynamic Functional Connectivity (DFC) for all participants. Besides that, Dynamic Effective Connectivity (DEC) was characterized using Dynamic Granger Causality (DGC). Significant connectivity differences were detected between some network pairs including: Auditory Network with right Executive Control Network (ECN), ventral Default Mode Network (DMN) with Visuospatial, right ECN with anterior Salience Network (SN), ventral DMN with Precuneus, dorsal DMN with Precuneus, Language with dorsal DMN, Language with posterior SN and Primary Visual with dorsal DMN. Except the connectivity difference between right ECN and anterior Salience network, other connectivity changes were consistent with previous studies. As far as we know, this is the first study to investigate the effective connectivity by the information extracted from ICA in this specific study group.

pp. 253-259

10:25 *Effect of Neurofeedback on Brain Functional Connectivity in Adult ADHD Patients: A Resting-State fMRI Study*

Milad Esmaeilzadeh, Hamid Soltanian-Zadeh and Yousef Moghadas Tabrizi (University of Tehran, Iran)

Attention Deficit Hyperactivity Disorder (ADHD) appears with symptoms such as inattentiveness, hyperactivity, and impulsivity. ADHD is most common in childhood but sometimes, consequences associated into can continue to adulthood. There are several treatments for ADHD. A non-pharmacological method is to use neurofeedback therapy. Neurofeedback is a biofeedback in which an EEG signal is recorded from a person's brain and given to a processor. The processed signal is fed back to the person in various ways such as image or sound, and the person is taught a kind of self-regulation. In this study, we investigated the effect of neurofeedback on brain functional connectivity in ADHD patients using resting state functional Magnetic Resonance Imaging (rs-fMRI) data. We

used the rs-fMRI data of adult ADHD patients before and after neurofeedback treatment. After preprocessing, we analyzed the data using Independent Component Analysis (ICA), and compared brain functional connectivity before and after neurofeedback treatment. Using a two-tailed paired t-test, we showed that 20 sessions of neurofeedback in adults with ADHD generated significant changes in their brain functional connectivity.

pp. 260-264

10:45 *Detection of ADHD Disorder Using Dynamic Connectivity Tensors in Bidirectional Circular Reservoir Computing*

Mohammadreza Bakhtyari (University of Tehran, Iran); Sayeh Mirzaei (University of Tehran & College of Engineering, Iran)

attention deficit hyperactivity disorder (ADHD) is a type of neurodevelopmental disorder. These disorders affect the development of the human nervous system and lead to abnormal brain function, which may influence a person's emotions, ability to learn and memory. It is also possible that the effects of neurodevelopmental disorders will continue throughout a person's life. Due to the lack of biomarkers to diagnose ADHD, the risk of misdiagnosis is high. The physician diagnoses the disorder with a description given to him by the patient or designed tests. Since biological signals such as electroencephalography (EEG) can record and measure brain function, they can help diagnose this disorder. In this study, an innovative method for extracting the characteristics of EEG signals is presented, which includes two steps. EEG signals are first converted into temporal segments, and then the spatial features are encoded using a dot product between the time frames of the channels. This data constructs the input of the model, which consists of three parts. In the first stage, the data enters reservoir computing module to extract dynamic features of data. After performing the required calculations, we use the Principal Component Analysis (PCA) technique for dimensionality reduction. In the last step, a Support Vector Machine (SVM) classify the data. This method obtains 99% accuracy, which is the highest achieved accuracy on the data used in this study.

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Friday, November 26 12:00 - 12:30

Invited Speaker 4

Dr. Serge Dos Santos

Room: https://vc.sharif.edu/ch/icbme2021_MH

Chairs: Zahra Kavehvash (Sharif University of Technology, Iran), Hamid Kokabi (Laboratory of Electronics and Electromagnetism (L2E), Sorbonne University, Canada)

Friday, November 26 13:30 - 15:30

Biological Signal Processing 4

Room: https://vc.sharif.edu/ch/icbme2021_H1

Chairs: Mohammad Reza Daliri (Iran University of Science and Technology, Iran), Babak Hossein Khalaj (Sharif University of Technology, Iran)

13:30 ***An Automated EEG-Based Mild Cognitive Impairment Diagnosis Framework Using Spectral and Functional Connectivity Features***

Reza Akbari Movahed (Tarbiat Modares University, Iran); Naeem Eslamyeh Hamedani, Seyedeh Zohreh Sadredini and Mohammadreza Rezaeian (Hamedan University of Technology, Iran)

Accurate and early diagnosis of mild cognitive impairment (MCI) is essential for preventing the progress of Alzheimer's and other types of dementia. However, the MCI diagnosis is very challenging due to its complicated manifestations. On this subject, many studies proposed automatic techniques for MCI diagnosis based on electroencephalogram (EEG) signals. In this study, an automatic EEG-based MCI diagnosis framework is presented, which uses spectral and functional connectivity EEG features. The sequential backward feature selection (SBFS) algorithm is utilized to select the best subset of features. K-nearest neighbor (KNN), support vector machine (SVM) with linear kernel (LSVM), and SVM with radial basis function (RBF) kernel (RBFSVM) are evaluated to select the best ones for the proposed framework. The proposed framework is validated using a public dataset consisting of 16 and 18 EEG signal of healthy control (HC) and MCI subjects. It is validated using 10-fold cross-validation by the metrics such as accuracy (AC), sensitivity (SE), and specificity (SP). The best performance of the proposed framework was achieved by LSVM classifier, which provided an average AC of 98.8%, SE of 98.5%, and SP of 98.8%. These results indicate the accurate classification performance of the proposed framework. Moreover, these results indicate the proposed framework is more accurate than previous works for EEG-based automatic MCI diagnosis. This framework could be developed to use it as a computer-aided diagnosis (CAD) tool for clinical applications.

pp. 271-275

13:50 ***Brain Network Analysis Based on Frontal Cortical EEG Sources in Major Depressive Disorder (MDD)***

Najmeh Amirkhan and Fatemeh Hasanzadeh (Khajeh Nasir Toosi University of Technology, Iran); Maryam Mohebbi (K. N. Toosi

University of Technology, Iran); Reza Rostami (Tehran University, Iran)

Studies on functional connectivity and brain networks have suggested that major depressive disorder (MDD) affects brain networks. This paper investigates the abnormalities in MDD brain networks. To this goal, we constructed brain networks based on electroencephalographic (EEG) source space in 32 patients and 32 healthy controls. The studied sources that are located in the prefrontal cortex, including the subgenual (SGPFC), medial (MPFC), and dorsolateral (DLPFC) prefrontal cortex, are extracted by eLORETA (exact low resolution brain electromagnetic tomography). The effective connectivity between extracted sources is assessed by transfer entropy (TE). After constructing 6*6 connectivity graphs between 6 sources (3 in the right and 3 in the left hemisphere), the topological characteristics of these graphs is quantified by graph theory measures. The applied measures include density, global efficiency, local efficiency, node betweenness centrality (BC), and node degree. The graph measures are statistically compared between two groups. The results show statistically significant differences in degree and BC between depressed and normal groups. Moreover, depressed patients revealed lower prefrontal connectivity at the delta frequency band. The obtained results indicate that degree and BC of networks based on TE might have the potential to apply as depression biomarkers.

pp. 276-282

14:10 *A Novel Convolutional Neural Network for EEG Source Localization with FEM Forward Model*

Ashkan Mahdavian (School of Electrical and Computer Engineering, College of Engineering & University of Tehran, Iran); Fariba Bahrami (University of Tehran & ISBME, Iran); Behzad Moshiri (University of Tehran & University of Waterloo, Iran); Ahmad Kalhor (University of Tehran, Iran)

The electroencephalogram (EEG) is a non-invasive and safe method of recording brain electrical activity. Although EEG has a high temporal resolution, its spatial resolution is low. Hence, source localization of EEG or the EEG inverse problem is a highly important and mathematically ill-posed problem. In this work, we implemented a novel parametric approach with Artificial Neural Networks (ANNs) to solve the inverse problem for a single source from a single time point instance of EEG signals. Our method outperformed the state-of-the-art methods of solving the inverse problem. Our network shows less than 2 mm error for single-source localization. Its computational speed of solving the inverse problem is under 1 second. Compared with other classical methods, it is more reliable on both simulated data and real Event-Related Potential (ERP) signals.

pp. 283-287

14:30 ***A Novel Algorithm for Detection of Social Joint Attention from Single-Trial EEG Signals of Autistic Spectrum Disorder (ASD)***

Mahdie Ghaneezabadi (Amirkabir University of Trchnology, Iran);
Mohammad Hassan Moradi (Amirkabir University of Technology, Iran)

Brain-Computer Interface (BCI) plays an important role in the rehabilitation of patients with neurological disorders, such as autism spectral disorder (ASD). People who suffer from ASD have poor performance in different abilities such as social joint attention. Social joint attention can be detected in EEG signals using P300 which is one of the most popular components of Event-Related Potential (ERP). In this study, a novel algorithm based on a Convolutional Neural network will be introduced which can detect P300 in single-trial EEG signals more precisely. As a dataset, IFMBE MEDICON 2019 challenge dataset will be used in which autistic adults were learning social joint-attention with the help of the BCI system. Results show that it can improve the performance of detecting P300 from single-trial EEG signals effectively in comparison to other algorithms. This method increased final target detection accuracy from 92.37% to 94.85%.

pp. 288-293

Biomechanics 2

Room: https://vc.sharif.edu/ch/icbme2021_H2

Chairs: Mehdi Ammi (Université Paris 8, France), Mohammad Ali Nazari (University of Tehran, Iran)

13:30 *A Biomechanical Study of the Effect of Pins Number on Stability of Persian Fixation Technique for Distal Humerus Fractures*

Alireza Mahmoudi and Amir Nourani (Sharif University of Technology, Iran); Narges Ghias (Sharif University, Iran); Alireza Hakiminejad (Sharif University of Technology, Iran); Reza Shahriar Kamrani and Mohammad Hossein Nabian (Tehran University of Medical Sciences, Iran)

Distal humerus fractures are common in people with Osteoporosis and remain one of the challenges in orthopedic surgery. Persian fixation method was introduced as a novel technique to treat distal humerus fractures. In general, the Persian fixation surgery is performed in two ways, L and Delta, in which some pins and a plate are used to fix the fragments. This study aimed to investigate the effect of the number of pins used in surgery on the stiffness of the fixation. In the Delta method simulation, according to surgeon's suggestions, 1 to 3 number of the pin were considered. In most surgeries, they use these number of pins unless the patient has a large fragment that has enough space to use more pins. The diameter of each pin was 2 mm, and the height of the plate fixation ranged from 4.5 to 6.5 cm. Three CAD models with a variable number of pins and Delta structure were prepared. Finally, for these three models, simulations were performed by applying anterior bending force to the humerus bone to evaluate the stability of the Persian fixation with varying number of pins. According to obtained results, increasing the number of pins used in the Persian fixation method with Delta structure helped increase the stability and reduce the displacement of fragments.

pp. 294-298

13:50 *Medial-Lateral Position of Hand Changes Shoulder Muscle Synergy During the Push-Up Exercises*

Hamidreza Barnamehei (Washington State University, USA); Sahar Abbasizadeh (Islamic Azad University, Iran)

Pharm

The aim of this study was to compare muscle synergy among different medial-lateral positions of the hand during the push-up exercises: narrow, normal, and wide. Fifteen fitness athletes participated (weight: 68.35±7.18 kg, height: 175±3.40 cm, age: 24.50±7.5

years, and experience: 12±3 years). The kinematics data were recorded via ten motion captures. The EMG activities were collected for selective muscles: the anterior deltoid, middle deltoid, posterior deltoid, infraspinatus, upper pectoralis major, middle pectoralis major, lower pectoralis major, latissimus dorsi, triceps lateral, triceps medial, biceps brachii, upper trapezius, middle trapezius, and lower trapezius muscles. An NMF (Non-negative matrix factorization) algorithm was applied to extract muscle synergy from EMG data for three different medial-lateral hand positions of the push-up exercises. The scalar product (SP) is a similarity index that was used to quantify the similarity of muscle synergies among different conditions. Based on the results, two synergies were extracted from the EMG of 14 muscles. Synergy 1 activated at the lowest position. While synergy 2 contains the before and after the lowest position. Therefore, the most active muscles correspond to shoulder and elbow extension/flexion. Each synergy was controlled groups of muscles with similar biomechanical action and associated with the push-up phases. The minimum similarity of synergy coefficient was observed between normal and wide positions for both synergy 1 (SP=0.88) and synergy 2 (SP=0.79). The minimum similarity of synergy weight was observed between normal and wide positions for both synergy 1 (SP=0.91) and synergy 2 (SP=0.84). We have demonstrated the presence of muscle coordination in the push-up and examined their relationship with biomechanical variables. These results indicate how athletes and coaches can improve their performances by understanding the muscles synergies.

pp. 299-304

14:10 *Gait Data Analysis: Investigation of Normal Gait Response to Different Speeds Using Inertial Measurement Unit*

Seyed Mohammad Hashemi, Mahdi Norouzi and Ahmadreza Arshi
(Amirkabir University of Technology, Iran)

Pharm

Gait data analysis has many applications in clinical and sports evaluations. Walking and running are two types of gait which represent similar cyclic behaviour while exhibiting different gait parameters. This study investigates the changes in human gait parameters caused by changing speed and thus provides a viable modelling approach that could be used effectively by medical and athletic practitioners. Inertial measurement units were mounted on the sacrum to monitor Spatio-temporal changes of both right and left legs. Continuous Wavelet Transform (Morlet) was applied to the raw gait signal to obtain two representative gait events, Initial Contact and Pre-swing, allowing the extraction of other gait parameters. Results indicate that cadence and step length increase 8.6 ± 1.5 % and 13.4 ± 2.8 %, respectively, as the walking speed grew from 1.11 to 1.38 m/s. However, the step time decreased by 8.6 ± 1.6 %. For running, on the other hand, as gait velocity grew from 1.96 to 2.22 m/s, an increase of 2.6±3.5 is observed in cadence. At the same time, step length and flight ratio experienced a considerable rise of 12.3±4.3 % and 7.1±2.6 %,

respectively. This study has provided a clear gait modelling methodology for practitioners in the medical and sports sciences.

pp. 305-309

14:30 *Musculoskeletal Injury Risk Assessment in a Car Dashboard Assembly Line Using Various Quantitative and Qualitative Tools*

Mohammadreza Bahramian, Mohammad Amin Shayestehpour, Mohammad Yavari and Hossein Mehrabi (Sharif University of Technology, Iran); Navid Arjmand (Sharif University, Iran)

Musculoskeletal disorders are among the most prevalent conditions in workers performing manual material handling (MMH) activities. In this study, MMH of a dashboard was investigated in a car assembly line. Several quantitative (i.e., biomechanical models) and qualitative (e.g., NIOSH, RULA, REBA, and OWAS) assessment tools were used to evaluate the musculoskeletal injury risk of sequential lifting, carrying, and lowering of the dashboard. The lowering (installing the dashboard) task had the highest risk of injury. Two easy-to-apply interventions were proposed to successfully reduce injury risk according to most of the assessment tools.

pp. 310-316

Modeling & Numerical Simulation

Room: https://vc.sharif.edu/ch/icbme2021_H3

Chairs: Fariba Bahrami (University of Tehran & ISBME, Iran), Bijan Vosoughi Vahdat (Sharif University of Technology & Bisipl Laboratory : Biological Signal Processing Lab, Iran)

13:30 *Cell Dynamics in Chondrocyte Encapsulated Microcarries Used for Cell Delivery: Insights from Computational Modeling*

Parisa Torabi Rahvar and Mohammad J. Abdekhodaie (Sharif University of Technology, Iran)

Pharm

One promising therapeutic method for cartilage regeneration is tissue engineered-based cell delivery using cell encapsulated microgels. Mathematical models are attracting considerable interest in tissue engineering to interpret biological phenomena and determine the key parameters. In this paper, we use a continuum reaction-diffusion model to study the effect of encapsulation parameters on cell response. Nutrient-dependent cell and extracellular matrix (ECM) distribution are modeled. The results indicate that the inhomogeneous distribution of ECM is due to the sharp nutrient gradient, and microgels with a radius smaller than 200 μm demonstrate almost homogeneous ECM deposition. Besides the microgel dimension, the effect of initial cell loading was investigated. Numerical simulation of the model reveals that initial cell density has no significant influence on the ECM distribution in small-size microgels. The method presented herein proposes the insight to improve cell-delivery constructs. Also, the results have the potential to provide a design reference for preparing cell encapsulating microgels as building blocks for tissue-engineered cartilage to achieve a construct with homogeneous ECM distribution, which is still a challenge of cartilage tissue engineering.

pp. 317-321

13:50 *A Deep Learning Approach to Determine Age-Related EEG Features in Parkinson's Disease*

AmirAli Mirian (Shahid Beheshti University, Iran); Hossna Shirshekar and Maryam S. Mirian (University of British Columbia, Canada); Ramy Hussain (Stanford University, USA); Soojin Lee and Martin McKeown (University of British Columbia, Canada)

Pharm

Oscillatory biomarkers are useful for development of Brain-computer interface (BCI) and

EEG-based neuro-feedback systems, which may have therapeutic implications for seniors and those with the disease. Although many biomarkers for age and disease exist, the EEG has the benefit that it widely available, inexpensive, and potentially may act as a biomarker over rapid time scales, which might be beneficial during, e.g., the performance of a specific task such as neurofeedback games. Parkinson's disease (PD) is ideally suited for the exploration of oscillatory biomarkers since abnormal oscillations have been widely implicated in the pathophysiology of PD. Specifically, beta-band oscillations may be broadly considered "anti-kinetic" and seen as inhibiting movement, while gamma-band oscillations are considered "pro-kinetic" and appear to facilitate movement. However, many domain-based EEG features in people with PD overlap considerably with those just seen in normal aging. Here, we contrast the age-related EEG features in PD subjects and age-matched healthy controls (HC). We employed an end-to-end training strategy and built deep recurrent neural network models with Long Short-Term Memory (LSTM) cells to predict age from 60-s of rest EEG recorded from PD and HC. When reliable models with reasonable errors were found for both groups (MAE = 1.897 for HC and MAE = 2.172 for PD), we investigated their deterioration of predictive power when fed frequency band-limited data. In PD subjects, beta and gamma bands in channels T7, FP2, and F7 were significantly more important for predicting age in PD than in HC. After medication, differences in the frequency bands predicting age between PD and controls become more prominent when PD subjects were on medication. Our results suggest that after the development of PD, beta and gamma become more strongly associated with age, implying that future studies examining beta and gamma changes in PD will need to take particular care in controlling for the age of subjects.

pp. 322-328

14:10 *Design and Implementation of a Reaction Timer Device Based on Visual Stimulation and Motor Reaction*

Mahdis Tebbikhorram and Hesam Pourshabanian (Hamedan University of Technology, Hamedan, Iran); Mohammad Bagher Khodabakhshi (Hamedan University of Technology, Iran)

Reaction time (RT) is one of the most essential characteristics of people, which depends on the speed of the information processing in their brains. It is a crucial ability of the athletes, and they usually try to improve their RT by practice and mental concentration. In this study, a novel device is designed to measure the motor response of the subjects to the visual stimuli. First, the visual stimulation, through the halogen lamps placed in a unique circular surface applied. Then, the practitioners should touch the sensors connected to the lamps with their feet in the shortest possible time. Finally, the total time between the visual stimuli and the motor responses will be measured as the reaction time. The implemented device consists of an Arduino UNO controller, 8 halogen lamps, and TTP223 Touch sensors. To approve the performance of the device, 40 subjects

were invited to participate in our experimental trials, which were categorized into two groups of athletes and non-athletes. The differences between the RTs of the groups were investigated based on the analysis of variance statistics. Our results showed that the reaction times associated with the athletes were significantly lower than those of non-athletes ($p<0.001$). Also, the implemented device can be an appropriate tool for quantifying the performance of the athletes and designing practical training.

pp. 329-334

Friday, November 26 15:30 - 16:00

Invited Speaker 5

Prof. Mehdi Ammi

Room: https://vc.sharif.edu/ch/icbme2021_MH

Chairs: Stéphane Binczak (Université de Bourgogne, France), Mohammad Ali Nazari (University of Tehran, Iran)

Friday, November 26 16:15 - 17:00

Keynote Speaker 2

Prof. Miguel Nicolelis

Room: https://vc.sharif.edu/ch/icbme2021_MH

Chairs: Stéphane Binczak (Université de Bourgogne, France), Ali GhaziZadeh (Sharif University of Technology, Iran)

Friday, November 26 17:00 - 18:30

Closing

Room: https://vc.sharif.edu/ch/icbme2021_MH

2021 28th National and 6th International Iranian Conference on Biomedical Engineering (ICBME)

Modeling & Numerical Simulation

Bio-devices

Biomedical Image Processing 1

Biological Signal Processing 2

Biological Signal Processing 3

Neural Engineering

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Biochemicals and Biomaterials