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Thursday, November 30

Thursday, November 30 8:00 - 8:15

Opening

Room: Amphitheater

Thursday, November 30 8:15 - 9:00

Kenote Speech: Dr. Tavakoli

Room: Amphitheater

Thursday, November 30 9:00 - 10:15

S(3): Biosignal Session 1

Room: G13

Chair: Mehran Jahed (Sharif University of Technology, Iran)

9:00 *Investigating Causal Relationships Between Cardiovascular Signals Using Effective Connectivity Assessment Measures*

Shaghayegh Bahrami (Sharif University of Technology, Iran); Mohammad Bagher Shamsollahi (Sharif University of Technology & Shahab Danesh University, Iran); Vahid Ansari (Sharif University of Technology, Iran)

In this paper, we apply a linear and nonlinear causal effects identification approach that has previously been shown to be capable of causality predictions in epileptic EEG data to detect such effects in a cardiovascular dataset obtained from a sleep apnea patient, including heart rate, respiration force, and blood oxygen concentration parameters. The method utilized is based on a nonlinear extension of Granger causality that uses nonlinear autoregressive exogenous (NARX) modeling for causality estimations. Furthermore, the dominant direction of causal interactions in the aforementioned cardiovascular dataset has been determined by assessing the predictability improvement (PI) of one signal alone and a signal under the effect of a second signal. The results of estimating the indexes for identifying linear and nonlinear causal effects demonstrate that there are bidirectional nonlinear causal effects between each pair of examined cardiovascular parameters. In addition, PI evaluation findings show that the dominant direction of causal relationships between heart rate and respiration force is from respiration force to heart rate, and blood oxygen concentration is affected by both parameters of heart rate and respiration force, but respiration appears to have a greater role in setting blood oxygen concentration.

pp. 1-7

9:15 *Applying B-Value and Empirical Equivalence Hypothesis Testing to IDD EEG Data*

Mozhdeh Saghalaini, Zahra Ghanbari and Mohammad Hassan Moradi (Amirkabir University of Technology, Iran)

In this study a new two-step process for hypothesis testing, is applied to compare individuals with Intellectual and Developmental Disorder (IDD) and Typically Developing Controls (TDC), using EEG signals. EEG data were recorded during resting state and music stimuli. Features were extracted from the preprocessed data and utilized in a two-step hypothesis testing framework. This framework combines conventional hypothesis testing with an equivalence testing approach, utilizing an empirical equivalence bound (EEB) estimated from the input data. To our best knowledge this is the first study which applies this method to biomedical data. By employing this method, we can accurately compare the features associated with IDD and TDC, which helps to identify distinct characteristics related to the disorder.

pp. 8-13

S(4): Biofluid Session

Room: G14

Chairs: Nasser Fatouraee (Amirkabir University of Technology, Iran), Aisa Rassoli (K. N. Toosi University of Technology, Iran), Bahman Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran)

9:00 *A Computational Simulation to Reveal Effects of Oscillatory Flow on MSCs on Polymeric Scaffolds Under Dynamic Culture Condition*

Sahar Jianian Tehrani (University of Tehran, Iran); Bahman Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran)

Pharm

Worldwide, over a million bone injuries occur annually, in which bone grafting procedures have to be performed. A bone tissue engineering strategy represents a promising alternative to current clinical treatments. Shear stress is a dominant mechanical stimulus that enhances the osteogenic differentiation of mesenchymal stem cells (MSCs). While the role of mechanical loading in creating a bone graft has been well explored, the effects of oscillatory flow on the biological cellular processes at the cell level: osteogenic differentiation, migration, and proliferation are poorly understood. In this study, we used a fluid- structure interaction computational approach to investigate the nature of the mechanical stimulus being applied to both poly (polyol sebacate) (PPS) and poly (lactic acid) (PLA) scaffolds as cell culture substrates under oscillatory fluid flow regimes, which are considered to be 0.5, 1, and 2 Hz within a parallel plate bioreactor. This system is designed based on an experimental study aimed to apply shear stress to stem cells seeded on the scaffold. However, the role of the oscillatory flow regime within it remains

unclear. Our findings demonstrate that oscillatory fluid flow induces osteogenic lineage commitment of mesenchymal stem cells. At the frequency of 0.5 Hz there was a more significant amount of WSS in both polymeric membranes. However, all the regimes were confirmed to be in the range of osteogenic differentiation (>0.001 Pa). Furthermore, the PPS scaffold's maximum and minimum wall shear stress was 0.02 and 0.005 Pa, respectively. The amount of wall shear stress was 0.001-0.01 Pa in the PLA scaffold. These promising results provide an analytical basis for exploring the MSCs fate on different polymeric scaffolds and frequencies.

pp. 14-19

9:15 *Blood Plasma Separation and Transfer on a Centrifugal Microfluidic Disk: Numerical Analysis and Experimental Study*

Mohamad Mahdi Khajeh and Maryam Saadatmand (Sharif University of Technology, Iran)

Pharm

Lab-On-a-Disk, as a subfield of microfluidic systems, recently draw attention to being utilized in blood biomarker diagnosis, blood typing, and immunoassays because of being high-throughput, highly precise, and easy to use. Blood plasma separation is a most vital unit for pre-processing in these systems, since the blood plasma contains a lot of proteins and enzymes that should be separated, and precisely examined. Therefore, in this paper, for the first time, a mathematical model was proposed to evaluate the plasma separation in various time scales and geometries, and an appropriate design was proposed. Furthermore, because the blood plasma volume is different between patients, and the designed geometry should precisely control the transferred volume between chambers to prevent migration of RBCs along with plasma, the transfer process by a siphon valve was mathematically modeled, simulated and experimentally evaluated. For the separation process, three geometries differing in bottleneck width were evaluated. The purpose of applying a bottleneck in the design was building a barrier-like between plasma and blood cells after completion of separation; therefore, we can highly make sure that no cells will transfer to the plasma section. Subsequently, we interconnected the separation unit with a siphon valve to a secondary chamber to evaluate the process of transferring of plasma for post-processing. The results suggested that more than 95% of separated plasma can transferred without any remixing with cells.

pp. 20-26

S(5): Tissue Engineering

Room: G15

Chairs: Majid Hajihosseinali (Sharif University of Technology, Iran), Ataallah Hashemi (Amirkabir University of Technology, Iran), Afsaneh Mojra (K. N. Toosi University of Technology, Iran)

9:00 *Coaxial 3D Bioprinting of Waterborne Polyurethane Scaffolds for Repair of Bone Defects*

Marziye Gholami, Alireza Shaabani and Roya Sedghi (Shahid Beheshti University, Iran); Hamidreza Motasadizadeh (Tehran University of Medical Science, Iran); Rassoul Dinarvand (Tehran University of Medical Sciences, Iran)

Three-dimensional (3D) printing has transformed tissue engineering, enabling the creation of intricate structures with precise measurements and controlled porosity. Bioprinting, which deposits live cells into a 3D matrix to produce functional tissues, has gained significant attention. However, a major challenge in bioprinting is developing bioink that can sustain cell viability and facilitate tissue growth. In this article, we explored the use of bioprinting technology to engineer bone tissue using core-shell structures with living cells encapsulated in waterborne polyurethane ink. The images illustrate the hydrogels' capacity to form 3D scaffolds with high fidelity and integrity, without significant defects in the patterns. The results indicate that the bioprinted scaffold showed high cell viability and attachment. The cell viability was around 75% immediately after bioprinting for all scaffold formulations, and after one day of incubation, the viability increased to approximately 82%. In addition, according to alizarin red S staining and alkaline phosphatase activity results, the cells were able to differentiate into osteoblasts and produce an extracellular matrix, leading to the formation of bone tissue.

pp. 27-32

9:15 *Comparison of Pedicle Screw Pull-Out Forces Using Two Vertebral Bone Material Mappings: A Patient-Specific Finite Element Modeling Study*

Alireza Rouyin and Mohammad javad Salmani mehrjardi (Sharif University of Technology, Iran); Navid Arjmand (Sharif University, Iran)

Background: There is no consensus regarding the effect of spine pedicle screw misplacement and its pull-out force using patient-specific finite element modeling. Objective: The aim of this study was to investigate the effect of lumbar spine pedicle screw misplacements on their pull-out forces using finite element analyses. Methods: Computed Tomography (CT) Images of a healthy 26 year old subject was used for development of the models. L2 vertebra of the lumbar spine was segmented and meshed using medical imaging software and imported into a finite element software. Three models were created with three different pedicle screw directions: Ideal (perfect) placement without any misalignment, medial misplacement, and lateral misplacement all according to the Abul-Kasim classification. Two different material mappings were assigned to each model. In the first material mapping strategy, the cancellous bone of the vertebra was modeled as voxel-based and the cortical bone was homogeneously modeled, while in the second material mapping strategy, the entire bone was modeled as voxel-based. Pull-out simulations were performed on each model for both material mapping strategies.

Results: Results revealed that the first material mapping strategy produced maximum pull-

out forces ranging from 1535 to 1770 N, whereas the second material mapping strategy generates maximum pull-out forces ranged from 2160 to 2918 N. Notably, for the first material mapping strategy, lateral misplacement maximum forces were 6.3% higher than those of the ideal condition, while the medial misplacement maximum forces were 1.9% lower than those of the ideal condition. In contrast, for the second material mapping strategy, maximum pull-out forces in lateral misplacements were 17.4% lower than those of the ideal condition, and the medial misplacement forces were 23% smaller than the ideal condition. Conclusion: The use of material mappings can predict the risk of pedicle screw loosening in accordance with in vivo data. Nevertheless, it is necessary to perform many simulations on a significant number of vertebrae, and the forces obtained from the simulation should be compared to results of in vitro tests.

pp. 33-38

9:30 *Dual Plate Screw Fixation for Distal Humerus Fractures Based on Stability and Interfragmentary Relative Motion*

Mohammad Abrishamian, Rozhan Kiani, Amir Nourani and Farzam Farahmand (Sharif University of Technology, Iran)

Pharm

Distal humerus fractures are complex injuries with potential implications on patient outcomes, necessitating thorough investigation and understanding of fracture characteristics and treatment options. This study employed a finite element analysis to explore the biomechanical behavior of double-plate osteosynthesis fixation for distal humerus fractures. The effects of screw diameter and angles on fixation stability and interfragmentary relative motion were evaluated using a full factorial design approach. The results revealed that screw diameter significantly influenced stiffness and normalized compression area, while interactions between entrance angles impacted axial motion control. However, no significant effects were observed for normalized shear area. These findings offer valuable insights into optimizing fixation approaches and promoting callus formation during fracture healing. Further research with patient-specific considerations is essential to enhance the generalizability and clinical applicability of the findings.

pp. 39-46

S(6): Biodevices Session 1

Room: 318

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

9:00 *Fabrication of a Low-Cost Multi-Electrode Neural Probe for Brain Signal Recording*

Alireza Irandoost (Superconductor Electronics Research Laboratory, Sharif University of Technology, Iran); Roya Mohajeri (Superconductor Electronic Research Laboratory, Sharif University of Technology & National Elit Foundation of Iran, Iran); Amirreza Bahramani and Ali GhaziZadeh (Sharif University of Technology, Iran); Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran)

A neural probe made from a thin semiconductor material using an affordable microfabrication method is fabricated and characterized based on conventional measurements. The 4 microelectrodes with a surface area of 30 × 100 μm2, as well as the tracks and pads of the probe were constructed using a thin layer of gold (Au) material, with an insulating layer of SU-8 used to cover the corresponding tracks. To assess the performance of the fabricated probe, both Electrochemical Impedance Spectroscopy (EIS) and artificial stimulation methods were used to characterize its properties. The microelectrode dimensions were specifically chosen to provide low impedance characteristics, which are necessary for the acquisition of Local Field Potential (LFP) signals. The in-vivo LFP data were obtained from male zebra finch presented with auditory stimuli. By properly filtering the extracellular recordings and analyzing the data, the obtained results were validated by comparing them with the signals acquired with a commercial neural electrode.

pp. 47-51

9:15 ***Developing a Droplet-Based Microfluidic Device for CTC Single-Cell Encapsulation and Downstream Molecular Analysis***

Sayednavid Tavoosi Valandani, Seyed Mohammadali Hosseinian and Amir Shamloo (Sharif University of Technology, Iran)

Single-cell isolation followed by analyzing them to extract the cellular information of the targeted cell has drawn much attention in recent years. This process could be assigned to the circulating tumor cells to discover significant information utilized in personalized medicine. Due to the low number and micron size of CTCs, stair-like spiral microfluidic, a modified design of simple spiral microfluidic to separate the CTCs, was used to enrich the rare CTCs. This novel design would enhance the separation efficiency and resolution, which is a crucial step in the single-cell isolation of rare cells. Automation and integration of the different steps of a microfluidic platform would provide a wide range of advantages involving reducing labor cost, decreasing time consumption, and increasing the potential for commercialization applications. This step is followed by novel static droplet arrays microfluidic to isolate the CTCs with a resolution of single-cell trapped in a static droplet for downstream analysis. This novel design of SDA could be utilized in applications with low sample input which was the limitation of conventional droplet microfluidics. In this study, numerical simulation was utilized to optimize the efficiency of single-cell encapsulation of CTCs. A stair-like spiral microfluidic with different aspect-ratio in the cross section integrated to a SDA, optimized by placing a venture in the path of the main channel, was developed to enhance the single-cell encapsulation efficiency which was studied by numerical simulation.

pp. 52-58

9:30 *The Effect of Cell Culture Alkalinity Caused by Positive Electrostatic Charge Therapy on Breast Cancer Cells Apoptosis*

Seyedeh Hoda Asnaashari (Amirkabir University of technology Tehran, Iran); Sadegh Mohammadi Hosseinabadi (School of Electrical and Computer Engineering, Iran); Mohammad Karami (AmirKabir University of Technology, Iran); Mehrdad Saviz (University of Amirkabir, Iran); Reza Faraji-Dana (Center of Excellence on Applied Electromagnetic Systems, Iran)

Breast cancer and consequent tumor metastases are the most fatal problems in the last century. The tumor metastases affect treatments adversely. Positive Electrostatic Charge Therapy (PECT) is a new and different method to treat malignant tumors. The evaluated two breast cancer cell lines (MCF-7 and MDA-MB-231) indicated that despite MCF-7 and normal cells, PECT induced significant apoptosis in MDA-MB-231. Positive charge accumulation likely repels cations and the proton is an important cation that affects intracellular pH. In this study, we investigated the effect of alkaline cell culture on Benign and malignant breast cancer cell apoptosis. MCF-7 and MDA-MB-231 cell lines were incubated in alkaline culture with a pH of 8.8. The cell lines' apoptosis was monitored through microscopy and flow cytometry methods. The results showed more apoptosis in MDA-MB-231 than MCF-7 as expected. The obtained result could be due to the higher culture acidity of MDA-MB-231 than MCF-7. The results can suggest new methods for treating malignant breast cancer in the future.

pp. 59-62

Thursday, November 30 10:15 - 10:45

S(7): Break

Room: Third Floor Area

Thursday, November 30 10:45 - 12:00

S(10): Biomaterial Session 1

Room: G15

Chair: Shohreh Mashayekhan (Sharif University of Technology, Iran)

10:45 *High-Throughput Anticancer Screening of Zinc Oxide Nanoparticles Using A549 Tumor Spheroids Generated by a Droplet-Based Microfluidic Device*

Mohsen Besanjideh (Shahid Bahonar, Iran); Fatemeh Zarei, Mohammad Hashem Molayemat, Sona Zare and Amir Shamloo (Sharif University of Technology, Iran)

Pharm

Droplet-based microfluidics is an advanced technique to generate multicellular spheroids. Despite the advantages of this method in generating desired-sized and monodisperse cell-laden droplets, this method needs well-adopted strategies for gelling droplets and extracting them from the oil phase. Herein, we employ a droplet-based microfluidic device to generate multicellular tumor spheroids using A549 cells and alginate hydrogel. The combined in situ and ex situ gelling method employed in our microfluidic device significantly decreases spheroid damage and loss during the spheroid extraction and washing processes. The results of live/dead assays also reveal that our strategy guarantees cell viability in tumor spheroids. Moreover, the anticancer effects of zinc oxide nanoparticles are investigated using the generated tumor spheroids. The results show that the utilized agent is toxic for A549 cells, and toxicity depends on the employed doses of treatments. Although these results are similar to those of monolayer cultures reported previously, drug resistance in our tumor spheroid models is much higher.

pp. 63-67

11:00 *Preparation of a Mechanically Robust Conductive Nanocomposite Hydrogel for Human Motion Sensing*

Milad Nezafati, Nahid Salimiyan and Roya Sedghi (Shahid Beheshti University, Iran)

Hydrogel sensors, which are flexible, stretchable, and conductive, are attracting great interest due to their potential for healthcare and electronics applications. However, developing conductive hydrogels that are cost-effective, highly sensitive, and mechanically robust remains a major challenge. In this study, zwitterionic nanocomposite hydrogels are demonstrated as novel tissue adhesives. These hydrogels exhibit high compressive strength, high strain sensitivity, and desirable electrical conductivity, among other advantages. As a practical strain sensor, the produced ionic hydrogel showed high sensing ability. Thus, flexible epidermal sensors were able to detect various movements of the human body in real-time, including a variety of abnormalities and motions (such as wrist motion and finger bending) as well as slight movements. This research offers a promising strategy for producing conductive hydrogels in creating flexible electronic skins, biomedical devices, and soft robotics.

pp. 68-71

11:15 *Fabrication and Evaluation of Gelatin- Based Nanofibrous Wound Dressings Incorporated with Therapeutic Algae Extract for Potential Wound Healing*

Hasaneh Mashhadi Mohammadi (Amirkabir University of Technology, Iran); Rana Imani (Biomedical Engineering Depatment - Amirkabir University of Technology, Iran); Masoumeh Haghbin Nazarpak (Amirkabir University of Technology & New Technologies Research Center, Iran)

Advanced wound dressings are essential medical tools used to protect wounds, cuts, and burns from infections while aiding the wound healing process through the controlled

release of beneficial biomaterials. However, some wounds face challenges, experiencing prolonged inflammation leading to chronicity. This study addresses this issue by introducing a groundbreaking approach in wound dressing technology, focusing on the fabrication of gelatin nanofiber scaffolds integrated with therapeutic Spirulina algae extracts. Here, water-based spirulina algae extract is loaded into the gelatin nanofibers during electrospinning process. Final nanofibrous structure is cross-linked by glutaraldehyde vapor. Results show that the average diameter of nanofibers containing spirulina is 144 ± 41 nm and this diameter is increased after cross-linking. In addition, through optimized cross-linking of gelatin nanofibers via glutaraldehyde within 90 minutes, the dressing maintains their structural integrity for at least two weeks. This innovative combination offers a promising avenue to potential overcome challenges associated with prolonged inflammation, presenting a novel and effective solution for acute wound treatment and optimal tissue regeneration.

pp. 72-75

S(11): Biomechanics Session 1

Room: G14

Chairs: Navid Arjmand (Sharif University, Iran), Mostafa Rostami (Faculty of Biomedical Engineering, Amirkabir University of Technology, Iran)

10:45 *Evaluating Spinal Load by Geometrically Subject-Specific Musculoskeletal Modeling*

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

Pharm

Musculoskeletal models are typically complicated for use in occupational and clinical biomechanical applications. The objective of the present work was to develop a geometrical subject-specific spine Musculoskeletal model to explore the relations between individual's inherent characteristics and spinal loads. A set of subject-specific musculoskeletal models consisting of single-equivalent muscles was created for 48 individuals. These models were utilized to calculate the compression load at the L4-L5 and L5-S1 discs during various static tasks. The study found that body weight was strongly correlated with spinal load when there was no load in the hands. For males, body height had a moderate correlation with spinal load in all tasks, while for females it was only significant in the upright standing task with load in hand. In upright standing, males had significantly higher spinal compression forces than females, averaging 416(N) vs. 319(N) at L4-L5 and 479(N) vs. 374(N) at L5-S1. This gender disparity decreased at larger flexion angles (>30°), with no significant difference, and spinal compression forces increased with greater flexion angles, peaking at 900(N) for males and 739(N) for females at L4-L5, and 1037(N) for males and 865(N) for females at L5-S1 for a 30° flexion angle. Our model is

a step forward in personalization, as generic models must be used cautiously due to high inter-individual variabilities unless realistic in-vivo mechanical properties are incorporated.

pp. 76-79

11:00 *The Role of Lingual Frame on Stability of Mandibular Subperiosteal Implant: A Patient-Specific Finite Element Study*

Reza Nourishirazi (University of Tehran, Iran); Vahid Dehghan Menshadi (Dehghan Implant Centre, Iran); Hamid Jalali (Tehran University of Medical Siences, Iran); Morad Karimpour (Tehran University, Iran)

Dental reconstruction using conventional implants for patients diagnosed with atrophic ridge is usually impossible because of insufficient bone volume or quality. One treatment option would be using custom-made subperiosteal implants that consist of supporting frames at the buccal and lingual; However, some morphologies include negative geometry and undercut area at the lingual side which makes it impossible to register the implant. A possible solution would be removing the lingual frame. In this study, finite element analyses were performed to compare the resulting micromotion of two subperiosteal implants concept, one with a lingual frame and the other without it. 50 N normal and lateral load was applied on each abutment to extract the resulting stress distribution and micromotion of the model. The results revealed that by the absence of lingual frame, the stress values in U-shaped frames increased from 50 MPa to 160 MPa and the micromotion of the implant ranged between 120 to 180 microns. The presence of lingual frames would result in better implant stability to some extent. However, by considering the design functionality and possible clinical complications with the presence of lingual frames, it was suggested to design this subperiosteal implant without the lingual frames.

pp. 80-82

11:15 *Load-Free State of the Left Ventricular Myocardium of the Human Heart Using Magnetic Resonance Images*

Alimohammad Kooshesh and Sahba Iravanimanesh (University of Tehran, Iran); Mehrzad Tartibi (Delbeat Inc., USA); Zahra Alizadeh sani (Rajaie Cardiovascular Medical & Research Center, Iran); Mohammad Ali Nazari (University of Tehran, Iran)

The aim of this research is to characterize the zero-load shape of the left ventricle of the heart. The shape of the heart in the heart cycle is not at free-loading state. To compute stresses at the diastolic state of the heart a load-free geometry is needed. The heart tissue is not still stress-free at this load-free geometry. In fact, the residual stresses as in all body parts exist. The source of these stresses comes from growth and remodeling which are active in all living tissues. Even assuming the residual stresses to be negligible, the heart tissue at diastolic pressure is not stress-free. Using the shape of the heart at this state to find the maximum stresses at systolic pressure ends in erroneous results. Since the heart works between systolic and diastolic pressures therefore all imaging outputs give its shape between these states. Modeling the heart should accurately represent the real structure of the heart while avoiding unnecessary complexities. Since the pressure in the left ventricle is higher than the other parts of the heart and the more anomalies occur in the left ventricle, this research focuses on load-free state of the left ventricle. The initial geometry of the load-free state of the left ventricle with the corresponding fiber directions was computed. Loading the computed heart geometry with its maximum uniform pressure shows less than one percent error compared to real data.

pp. 83-89

S(8): Biosignal Session 2

Room: G13

Chairs: Sepideh Hajipour (Sharif University of Technology, Iran), Mehran Jahed (Sharif University of Technology, Iran)

10:45 ***Enhancing Mortality Prediction in Heart Failure Patients: Exploring Preprocessing Methods for Imbalanced Clinical Datasets***

Hanif Kia, Mansour Vali and Hadi Sabahi (K. N. Toosi University of Technology, Iran)

Heart failure (HF) is a critical condition in which the accurate prediction of mortality plays a vital role in guiding patient management decisions. However, clinical datasets used for mortality prediction in HF often suffer from an imbalanced distribution of classes, posing significant challenges. In this paper, we explore preprocessing methods for enhancing one-month mortality prediction in HF patients. We present a comprehensive preprocessing framework including scaling, outliers processing and resampling as key techniques. We also employed an aware encoding approach to effectively handle missing values in clinical datasets. Our study utilizes a comprehensive dataset from the Persian Registry Of cardio Vascular disease (PROVE) with a significant class imbalance. By leveraging appropriate preprocessing techniques and Machine Learning (ML) algorithms, we aim to improve mortality prediction performance for HF patients. The results reveal an average enhancement of approximately 3.6% in F1 score and 2.7% in MCC for tree-based models, specifically Random Forest (RF) and XGBoost (XGB). This demonstrates the efficiency of our preprocessing approach in effectively handling Imbalanced Clinical Datasets (ICD). Our findings hold promise in guiding healthcare professionals to make informed decisions and improve patient outcomes in HF management.

pp. 90-97

11:00 ***Depression Detection Using Chaotic Features of EEG Signals and CNN Model***

Seyedeh Zohreh Sadredini (K.N.Toosi University of Technology); Maryam Mohebbi (K. N. Toosi University of Technology, Iran); Naeem Eslamyeh Hamedani (Shahid Beheshti University, Iran); Reza Rostami (Tehran University, Iran)

Depression is a common mental condition often diagnosed using questionnaires, but the accuracy of these methods may be limited. As a result, researchers have been exploring alternative diagnostic tools. One such avenue involves utilizing electroencephalogram (EEG) signals and deep learning techniques to improve depression detection. Numerous studies have focused on extracting temporal and frequency characteristics from EEG signals, aiming to enhance depression diagnosis precision through intelligent algorithms. In this specific study, a novel framework was proposed based on a deep convolutional neural network (CNN) that incorporates the chaotic features of EEGs as input. To evaluate the effectiveness of this framework, a dataset comprising EEG signals from 35 normal subjects and 41 depressed subjects was used. The results showed promising outcomes with an average accuracy of 90.06%, sensitivity of 92.14%, and specificity of 91.36%. Comparing these findings with previous works suggests that combining the CNN model with the chaotic features of EEG signals leads to effective classification performance.

pp. 98-103

11:15 *Enhanced Subspace Alignment with Clustering and Weighting for Cross-Subject Multi-Session EEG-Based Emotion Recognition*

Mohsen Shirkarami (Sharif University of Technology, Iran); Hoda Mohammad Zadeh (Sharif, Iran)

The non-stationary nature of brain activity signals and their many inter-subject differences have created many challenges in the practical applications of electroencephalogram (EEG)-based emotion recognition based, such as brain-computer interfaces. In such a way, using traditional classifiers in classifying these signals would significantly decrease accuracy when applying the classifier to a new subject. Domain Adaptation methods seem to be an effective way to solve this problem by minimizing the difference between the EEG signals of different subjects. But in the basic techniques for domain adaptation, looking at all subjects' data in the same look causes the loss of a part of the potential power of these methods. The present study proposed an extended version of the Subspace Alignment method for Domain Adaptation utilizing the clustering of source subjects. This method can make an effective choice between the available data from the source domain by clustering the source subjects based on the behavioral similarity of their EEG signals. This effective selection among the subjects and the idea of purposeful data weighting have caused the final model to represent the space of the target subject more effectively. To confirm the feasibility of the proposed method, we have conducted experiments on the SEED dataset, which is widely used in the emotion recognition EEG-based task, and it achieved an accuracy of 84.3%. The results show that the presented model has better classification accuracy than several state-of-the-art models.

pp. 104-109

S(9): Biodevices Session 2

Room: 318

Chair: Mehdi Fardmanesh (Superconductor Electronics Reasearch Laboratory, Sharif

University of Technology, Iran)

10:45 ***A New Slopping Micro-Channel Dielectrophoresis-Based System for Non-Invasive Same-Size Cells Separation***

Zeynab Alipour and Reza Vamegh (Sharif University of Technology, Iran); Mehdi Fardmanesh (Superconductor Electronics Reaserch Laboratory, Sharif University of Technology, Iran)

In this paper, we proposed a continuous label-free microfluidic chip design for same-size cell separation. The design is based on dielectrophoresis (DEP) force, a rapid and semiautomated method incorporating the difference in dielectric properties of cells as the basis of the separation. This device employs four pairs of planar electrodes, where the cells under positive DEP (PDEP) phenomenon move away from the central streamline to the bottom outlet, while cells experiencing negative DEP (NDEP) force do vice versa. COMSOL Multiphysics is used to optimize channel geometry and electrode design. Preserving the viability of cells while moving toward their respective outlets, the microchannel is designed in a new slopping manner to decrease the required electric field. The maximum applied electric field of 3.64 × 10^5 V/m (i.e. voltage amplitude of 10v) is lower than similar reported works with planar electrodes. Separation efficacy is tested by separating dead and live yeast at 1 MHz, where dead yeasts experience NDEP force and live yeasts experience PDEP. We utilized an accessible and easy fabrication process. Electrodes are made of gold using a standard lithography process, and microchannel is created by soft lithography using 3d printed mold and PDMS, an accessible and biocompatible material. The flow rates of the main inlet and sheathes are 0.015 µL/min and 0.072 µL/min, respectively, employing accurate homemade injection pumps. Both simulations and experimental results confirm the successful performance of the microfluidic chip in this design.

pp. 110-114

11:00 ***Acoustofluidic-Based Motile Sperm Isolation Using Microvortices***

Zahra Saeidpour, Mohammadjavad Bouloorchi, Saeed Javadizadeh, Zahra Habibi and Majid Badieirostami (University of Tehran, Iran)

Separating motile sperm is a crucial step in assisted reproductive technology. In this article, a technique for motile sperm sorting using on-chip manipulation via acoustofluidics is presented. The traveling bulk acoustic waves generated in the ultrasonic range will result in oscillation of air bubbles trapped in the horseshoe-shaped structures embedded within the microfluidic channel. Subsequently, the microvortices formed through acoustic streaming were used to trap sperms within the flow field. To our knowledge, this is the first report on the isolation of motile sperm by acoustic-induced vortices. We used COMSOL simulation to confirm the formation of the microvortices via bulk acoustic waves traveling across the channel. We finally demonstrated that by switching off the source of acoustic waves, the motile sperms can find a way to exit vortices to the output.

pp. 115-120

11:15 ***Optimum Design of the Electrode Structure and Parameters in Electric Cell-Substrate Impedance Sensing and Electrochemical Impedance Spectroscopy***

Ali Monfaredi and Nasrin Sadat Hashemi (Amirkabir University of Technology, Iran); Reza Faraji-Dana (Center of Excellence on Applied Electromagnetic Systems, Iran); Mehrdad Saviz (University of Amirkabir, Iran)

Recently, ECIS (Electronic Cell-substrate Impedance Sensing) has emerged as a popular method for detecting cancer cells. The conventional technique involves fabricating electrodes using expensive photolithography on glass. However, it faces limitations in simultaneously creating numerous electrodes on a single substrate due to the restricted effective radius of ultraviolet (UV) exposure. To address these challenges, we conducted a study to replace glass photolithography with PCB (Printed Circuit Board) technology and explore the design and materials used in electrode construction. Certain materials, including a fiberglass (FR4) substrate and solder mask layer, were toxic to cells and tissues in our experiments. However, this issue was mitigated by employing epoxy-SU8 resin layers, ensuring biocompatibility and making the board suitable for use in biological research and pathology laboratories. The adoption of the PCB approach brings significant cost benefits, as the fabrication of twelve electrodes via photolithography is nine times more expensive than using the PCB method. Moreover, the versatility of this technology allows for the utilization of various biocompatible materials and different electrode patterns. This offers ample opportunities for application in diverse fields.

pp. 121-125

Thursday, November 30 12:00 - 13:00

S(12): Lunch

Room: Basement

S(13): ISBME meeting

Room: Council Room

Thursday, November 30 13:00 - 14:00

S(14): Poster Session

1st Bioelectric

Room: Third Floor Area

13:00 ***VAE and AAE Networks Segment Brain Tumors from MRI***

Mehri Mirani (CICPE, School of Electrical and Computer Engineering, University of Tehran, Tehran, Iran); Mohammad Soltani-Gol and Hamid Soltanian-Zadeh (University of Tehran, Iran)

Brain tumor segmentation is essential in medical imaging for accurate diagnosis and effective treatment planning. Brain tumors are formed during the uncontrolled growth of cells and are divided into two primary and secondary categories. The most common type of primary brain tumors is gliomas, which are examined in this research. In recent years, deep learning models have shown promising results in automating tumor segmentation from medical imaging data. This study compares the performance of Variational Autoencoder (VAE) and Adversarial Autoencoder (AAE) networks for brain tumor segmentation based on an encoder-decoder architecture. The encoder part extracts image features, while the decoder part reconstructs segmentation labels. These two networks are powerful generative models that capture the underlying distribution of the data. This capability makes them suitable for extracting meaningful tumor features. In the VAE network, a variational autoencoder branch is added to reconstruct the input images. In the adversarial network, the discriminator part is added to train the encoder-decode network and helps the decoder to generate outputs that closely match the tumor labels. The results indicate that both VAE and AAE achieve satisfactory segmentation accuracy. However, AAE achieves higher Dice scores compared to VAE, indicating that it is more effective at segmenting tumor regions.

pp. 126-131

14:00 ***Enhancing Epileptic Seizure Detection Using Convolutional Neural Networks and Data Augmentation Techniques***

Raha Pedram, Pooyan Farzanehkari and Ali Chaibakhsh (University of Guilan, Iran)

Epilepsy stands as one of the most prevalent neurological disorders worldwide. Diagnosis is typically conducted by examining electroencephalogram (EEG) recordings in clinical settings. In this research paper, a novel deep-learning model is put forward to detect epileptic seizures. Due to the scarcity of seizure-related epileptic samples and the need for an adequate dataset to train convolutional neural networks (CNNs), the study employs a data augmentation technique called Cubic Spline Interpolation (CSI). After applying the low-pass filter, Cubic Spline Interpolation successfully augments the training data, addressing the challenges associated with limited samples. The Following training and testing sets undergo short-time Fourier transform (STFT) to enable time-frequency analysis. Subsequently, the transformed data is fed into a convolutional neural network (CNN) model, integrated with dropout layers, to facilitate categorizing three distinct states, including healthy, pre-ictal, and inter-ictal. The findings of this study reveal compelling results, with an impressive accuracy rate of 99.3%. These outcomes underscore the effectiveness of the proposed approach, indicating its superiority in achieving higher accuracy when contrasted with conventional methods.

pp. 132-137

15:00 ***Development of a Complementary Integrated Probe for Dynamic Elastography***

Keyvan Babaei Zadfatideh (University of Amirkabir, Iran); Ali Fallah (Amirkabir University of Technology & Amirkabir, Iran); Saeid Rashidi (Science and Research

Branch, Islamic Azad University, Iran); Maryam Mehdizadeh Dastjerdi (Amirkabir University of Technology (AUT), Iran)

Elastography is a medical measurement method that estimates tissue mechanical properties to detect inclusions and their locations. Successful elastography requires effective stimulation together with imaging modality for mechanical property extraction. Axial vibration is optimal, aligning with the ultrasound probe (US) motion for maximal tissue displacement. This paper introduces a novel complementary probe, transforming a conventional ultrasound probe into an integrated elastography one. The proposed probe incorporates an electromagnetic actuator that generates linear excitation. By attaching the US to the actuator using clamps, the reciprocal motion of the electromagnetic vibrator moves the ultrasound probe linearly. The stimulation is transmitted to the tissue through the probe. To enhance diagnostic capabilities, this device offers customizable vibration parameters like desired frequency, force, amplitude, and signal waveform, and can communicate with computers or other devices such as smartphones. Preliminary experiments demonstrate the probe's capability in clinical applications, particularly dynamic elastography. By integrating mechanical vibration and imaging, this novel probe shows promise for advancing elastography. It authorizes clinicians with an enhanced diagnostic tool and opens avenues for practical elastography applications

pp. 138-144

16:00 ***Breast Cancer Detection from Imbalanced Clinical Data: A Comparative Study of Sampling Methods***

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

accurately detecting breast cancer presents a distinctive opportunity for addressing and managing its associated side effects. Collecting data from patients is often costly, resulting in imbalanced clinical data, which poses significant challenges for machine learning algorithms. In this paper, we provide a comparative analysis of sampling methods for breast cancer detection. We initially pre-processed clinical data, followed by a comparison of various sampling methods to balance the data. Subsequently, we utilized a support vector machine (SVM) for the classification of malignant and benign breast cancer. Random over-sampling, synthetic minority over-sampling technique (SMOTE), borderline SMOTE, K-means SMOTE, adaptive synthetic sampling, under-sampling majority class, Edited Nearest Neighbor (ENN), Repeated Edited Nearest Neighbor (RENN), near miss, Tomeklink, SMOTEEN, and SMOTETomek were compared and evaluated for Breast Cancer Detection (BCD) from imbalanced clinical data. We also computed feature importance with the eXtreme gradient boosting method that offers an exclusive chance for pathologists in the data processing. We validated a comprehensive examination of BCD through a dataset comprising 569 recordings from the Wisconsin Diagnostic Breast Cancer Data. The best performance was achieved by SMOTEEN where the accuracy, sensitivity, and specificity were 98.4%, 97.6%, and 98.9%, respectively. It was also found that the mean and worse

concave points were more important features for BCD in WDBC dataset.

pp. 145-149

17:00 ***Breast Cancer Detection Using Deep Convolutional Neural Network: A Pre-Processing-Driven Approach***

Golnaz Hosseini and Kimia Jalalian (Pooyesh Institute of Higher Education, Iran); Razieh Ghiasi (Qom University, Iran); Alireza Bosaghzadeh (Shahid Rajaee Teacher Training University, Iran)

Breast cancer is the leading cause of mortality among women worldwide. Early detection of breast cancer is crucial in preventing the spread of cancerous cells to adjacent tissues. Digital mammography has emerged as a pivotal tool for detecting breast cancer at its early stage. Recent advancements in deep learning have shown remarkable potential for automating breast cancer detection. This paper introduces a completely automated framework that assists radiologists in efficiently diagnosing breast lesions. The proposed framework comprises two phases: a pre-processing phase and a model design phase. The pre-processing phase involves essential steps, format conversion, artifact removal, Wiener denoising, contrast enhancement via CLAHE, ROI patching, resizing, and augmentation, to prepare mammograms for model training. In the model design phase, four pre-trained Deep Convolutional Neural Networks - ResNet34, DenseNet121, Inception V1, and Efficient B0 - are developed to accurately classify breast lesions in mammographic images as normal or abnormal. The proposed model is evaluated using the Mammographic Image Analysis Society (MIAS) dataset, demonstrating significant achievements. The achieved metrics for accuracy, precision, specificity, sensitivity, F1-score, and AUC are 99.2%, 99.2%, 99.2%, 99.2%, 99.2%, and 99.1%, respectively, outperforming state-of-the-art methodologies in breast cancer detection.

pp. 150-157

18:00 ***Design an Accurate BCI System by a Novel Method and the Minimum Number of Channels Based on Five Class Motor Imagery***

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

Motor imagery (MI) is one of the most popular methods to control a BCI system. Each specific MI can be considered as an individual task and a command for controlling an external device. Common spatial pattern (CSP) is one of the most popular methods for feature extraction of MI. This method filters EEG in spatial space and it can be useful for MI recognition. In this project, EEG was preprocessed by common average reference (CAR), bandpass Butterworth and notch filter were used for removing artifacts and noises. For feature extraction, filter bank common spatial pattern (FBCSP) was used. Sequential forward feature selection (SFFS) method was used to select best features and also best

channels. After feature selection, difference between features (DBF) was used and then linear discriminant analysis (LDA), K nearest neighborhood (KNN) and support vector machine (SVM) were used for classification. BCI-Competition iv and also new data were collected were used in this project. The accuracy for new data was 86.72% mean for 25 people and 99.00% mean for 9 subjects in BCI-Competition iv.

pp. 158-163

19:00 *Automated Detection of SDH and EDH Due to TBI from CT-Scan Images Using CNN*

Ava Mazhari (Amirkabir University of Technology, Iran); Ali Allahgholi (Islamic Azad University، Science and Research Branch, Iran); Mehdi Shafieian (Amirkabir University of Technology, Iran)

Traumatic brain injury (TBI) occurs when external forces are suddenly applied to the brain and disrupt the brain's normal functioning. This issue can lead to primary and secondary injuries, such as hematoma, which may cause severe disabilities and even death. Therefore, early and accurate diagnosis is essential. Computed tomography (CT) is the appropriate imaging modality to evaluate intracranial hemorrhage. However, manual diagnosis of hematoma is an operator-dependent and time-consuming task, which can lead to a late or incorrect diagnosis. To address this issue, computer-aided diagnosis (CAD) systems have been developed to assist in the accurate and timely management of TBI. These systems are advantageous in early detection; deep learning, in particular, has shown promising results for automatic detection. Regardless, a challenging aspect in this field is diagnosing two types of hemorrhage: subdural and epidural hematoma, which requires a new, more accurate detecting approach. This study uses deep learning methods to detect intracranial hemorrhage using a Head CT scan to identify two types of hematoma subtypes. Using two convolutional neural networks (CNN), AlexNet and ResNet50 classifiers, for the detection process, the performance of these two architectures was compared, and finally, the best model was proposed and evaluated.

pp. 164-170

20:00 *High Quality Brain Image Reconstruction Based on DBIM and U-Net*

Sayyed Saleh Sayyed Mousavi and Mohammad Saeed Majedi (Ferdowsi University of Mashhad, Iran)

Diagnosing the type of stroke through brain image reconstruction is a widely employed method that initiates the treatment of stroke patients. Microwave imaging has emerged as a recent technique for image reconstruction, yet it suffers from the drawback of low resolution. In this study, we propose a novel approach to enhancing the quality of reconstructed brain images by leveraging the power of the U-Net network. Our methodology involves reconstructing brain 2D images using the distorted Born iterative method and treating these images as input to the U-Net network. We conduct the reconstruction process on brain images obtained at two different noise levels. In both

noise levels, we observe a significant improvement in the quality of the reconstructed images.

pp. 171-175

S(15): Poster Session

1st Biomechanics and others

Room: Third Floor Area

13:00 ***Effect of Action Potential on Axoplasmic Flow in Hippocampal Neurons***

Bahman Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran); AmirAli Saboorian (University of Tehran, Iran)

Pharm

Action Potential (AP) in neural cells is accompanied by displacement and pressure waves. Effect of AP on fluid velocity filed of axoplasm is pivotal in studying physical basis of neurophysiological phenomena, such as axonal transport and tau propagation in neural cells. The goal is to provide a basis for future studies on axonal transport and in this work a report is presented on the effects of AP on fluid velocity resulted from a fluid-solid interaction (FSI) computational simulation. Here it is shown that there exists an axoplasmic flow induced by AP with a magnitude in range of tenths to tens of micrometers per second and it's behavior is proven to be a matter of interest for future studies.

pp. 176-180

14:00 ***Impact-Based Prioritization of Medical Equipment Maintenance for Small Medical Centers***

Mina Ashrafiyan and Mohammad -R. Akbarzadeh -T. (Ferdowsi University of Mashhad, Iran)

The importance of prioritizing medical equipment maintenance in small medical centers (SMCs) cannot be overstated, especially since these facilities often do not have backups for much of their equipment and must run on considerably tighter budgets. When a device malfunctions in a SMC, the impact on the performance of the entire clinic is significant. Repair costs, along with additional costs associated with the failure can also rise. Yet, the current literature addresses maintenance scheduling only for larger medical providers. This study aims to propose an AHP-TOPSIS model to prioritize medical equipment in SMCs. For this purpose, we select the factors that affect prioritization based on previous studies, and we introduce a new "impact" factor to measure the device failure's effect on other equipment. This model helps consider linguistic information as well as numerical information and also considers the effect of device failure. We then implement the model in three round-the-clock clinics in the city of Mashhad. The results indicate that equipment prioritization in different SMCs varies considerably by device impact on other equipment

as well as their actual usage, age, number of failures, cost, and criticality during urgent care.

pp. 181-187

15:00 *Patient-Specific Resorbable Membrane for Guided Bone Regeneration Surgery: A Novel Design to Facilitate the Production Process*

Majid Hajihosseinali and Majid Abedi (Sharif University of Technology, Iran); Golrokh Asadi (Amirkabir University of Technology, Iran); Tahere Sharifi Kanouni (Tarbiat Modares University, Iran)

Although bioresorbable polymers have been used to produce guided bone regeneration (GBR) membranes for many years, the fabrication of such membranes with custom design was prevented by production limitations. However, in addition to less risk of infection and no need for membrane removal surgery, patient-specific resorbable membranes can significantly reduce installation difficulty, time of surgery, and patient bleeding. This paper presented a novel method to design custom GBR membranes which are producible by the common 3D-bioprinters. Results showed acceptable geometrical accuracy and mechanical stability of the fabricated GBR membranes for covering the bone defect site in two real cases.

pp. 188-192

16:00 *Osseointegration Evaluation Can Be Quantified by Mechanical Non-Destructive Acoustic Modal Analysis in an In-Vivo Study*

Mohammadjavad Einafashar (AmirKabir University of Technology, Iran); Mohadese Rajaeirad (University of Tehran & University of Isfahan, Iran); Saman Khodabakhshi (Vienna University of Technology, Austria); Ataallah Hashemi (Amirkabir University of Technology, Iran); Michael Skipper Andersen (Aalborg University, Denmark)

Successful osseointegration of orthopedic implants relies on achieving mechanical stability of screw fixation. Various techniques have been utilizing to assess screw stability; however, some of these methods are destructive or time-consuming. Non-destructive techniques, such as modal analysis, have gained interest in evaluating screw stability. This study aimed to assess the primary and secondary stability of screws in an in-vivo animal experiment by comparing conventional methods with two modal methods, namely Periotest® and acoustic modal analysis (AMA). To achieve this goal, four rabbits were implanted with cylindrical threaded screws. The screw fixation stability was evaluated using four different test methods. Initially, the peak insertion torque (PIT) was measured for each bone screw during the implantation process. Additionally, AMA and Periotest® were employed to assess the natural frequency (NF) and Periotest® value (PTV) of the bone-screw structure, respectively. Finally, a destructive pull-out test was conducted to determine the peak pull-out force (PPF). The average primary stability values were measured 5.15 N.cm for PIT, 2507±59 Hz for NF, 21.85±4.1 for PTV, and 94.45±12 for PPF. In contrast, the secondary stability showed varying results with an average increase of 39% for NF, 101% for PTV, and

194% for PPF. The research also compared the non-destructive AMA with the destructive pullout test, considered the gold standard for stability evaluation of bone screws. The study found that AMA exhibited a linear relationship with the pullout test, making it an accurate method for assessing orthopedic and spinal screw applications.

pp. 193-198

17:00 *Bone Remodeling Response to Different Dental Implant Materials: Titanium vs. FGMS - an in Silico Study*

Mohammad Hosein Zadeh posti (University of Guilan, Iran); Mohadese Rajaeirad (University of Tehran & University of Isfahan, Iran); Sandipan Roy (SRM Institute of Science and Technology, India); Hasan Asadi Gilakajani (University of Guilan, Iran)

Matching the mechanical properties and biocompatibility of dental implants with bone tissue is a crucial aspect of successful implantation. Functionally graded materials (FGMs) have gained significant attention in medical and implantable structures. This study aims to compare FGM materials with different configurations (radial, gradient) to titanium implants in terms of their mechanical behavior within the mandible using a biomechanical model. Finite element analysis (FEA) was employed to simulate the mechanical response of the surrounding bone tissue during 12 months of bone remodeling. The distribution of von Mises stress was analyzed for cancellous bone and the implant in FGM and titanium implants. The maximum stress observed in cancellous bone was found to be 2.40 MPa for titanium implants, while gradient and radial FGM models exhibited reduced stresses of 1.95 MPa and 1.80 MPa, respectively. This represents a decrease of 20.7% and 28.5% in gradient and radial FGMs compared to titanium implants. To assess the risk of stress shielding, a stress ratio (SR) parameter was defined. Among all models, the implant with radial FGM material demonstrated the lowest SR value. The obtained results were consistent with previous clinical and numerical studies, validating the effectiveness of FGMs in promoting a favorable bone-implant interface. However, the specific type of FGM must be carefully evaluated to understand its behavior during the bone remodeling process. This study provides valuable insights into the mechanical behavior of different materials and highlights the significance of utilizing finite element analysis in dentistry applications to predict the performance of dental implants.

pp. 199-204

18:00 *The Improvement of Chemovirotherapy Effectiveness Utilizing Hybrid GA-PSO*

Mohammad Amini, Maryam Niroomandfard, Pariya Khalili and Ramin Vatankhah (Shiraz University, Iran)

This paper investigates the potential of chemovirotherapy as a cancer treatment that combines chemotherapy and virotherapy. The article examines how various factors and initial conditions can affect the treatment's success. The study aims to evaluate the effectiveness of chemovirotherapy using constant and non-constant infusion treatments while minimizing cancer cells and optimizing drug dosage to reduce side effects.

Evolutionary algorithms were utilized to create an ideal treatment schedule to achieve optimal protocol. The results show that only the combined treatment method was successful in permanently suppressing cancer, and by optimizing the treatment, lower doses of chemotherapy drugs could be used with better outcomes.

pp. 205-212

Thursday, November 30 14:00 - 15:15

S(16): Biosignal Session 3

Room: G13

Chair: Mohammad Bagher Shamsollahi (Sharif University of Technology & Shahab Danesh University, Iran)

14:00 ***Heart Sound Reduction from Lung Sound Using ANN Combined with DWT and EMD***

Mehran (Mehdi) HosseinAbadi (K. N. T. U, Iran); Mansour Vali (K. N. Toosi University of Technology, Iran)

Lung auscultation is often obscured by overlapping heart sounds. It's been of great importance to reduce this interference while preserving the integrity of lung sound for pulmonary disease diagnosis applications. This study proposes an adaptive noise cancellation approach using artificial neural networks (ANN), discrete wavelet transform (DWT), and empirical mode decomposition (EMD) for reducing heart sounds in lung recordings. This is compared to a two-step method utilizing heart sound localization and time-domain gating Analysis shows combining time-frequency localization, oscillatory mode decomposition, and nonlinear modeling provides robust separation of heart and lung sounds for improved auscultation. This adaptive data-driven approach enhances respiratory diagnosis by suppressing obscuring heart noises in lung recordings without requiring an additional localization step. Keywords-ANN, heart sound, lung sound, DWT, EMD, adaptive noise cancellation

pp. 213-219

14:15 ***Automatic Classification of Migraine and Tension-Type Headaches Using Machine Learning Methods***

Soroor Shafieizadegan Esfahan and Arezoo Haratian (Isfahan University of Technology, Iran); Azadeh Haratian (Islamic Azad University, Science and Research Branch, Iran); Farzaneh Shayegh (Isfahan University of Technology, Iran); Soroor Kiani (Islamic Azad University Arak Branch, Iran)

Pharm

Migraines and tension-type headaches (TTH) are the more prevalent types of primary

headaches. Usually, the diagnosis of these types of headaches is imprecise. Meanwhile, emotional and cognitive dysfunctions are associated with these disorders and have potential diagnostic power. This paper aims to classify patients with TTH and migraines using machine learning methods. It uses psychological questionnaires and demographic data as features for the classification. The Boruta algorithm is applied to select the most relevant features, and various machine learning models are compared to find the best one. In this study, 79 patients with migraine headaches and 81 with TTH referring to the two neurology clinics in Isfahan City, Iran, from 2019 to 2020 completed the cognitive emotion regulation questionnaire and perseverative thinking questionnaire. Results show that random forest (RF) and naïve Bayes achieve the highest accuracy, sensitivity, and specificity in distinguishing TTH and migraine. In fact, RF and naïve Bayes outperformed other classifiers in training and testing sets with a slight difference. The TTH and migraine were classified with 98% accuracy, 100% sensitivity, and 96% specificity in the testing set. Applying machine learning algorithms to distinguish TTH and migraine using these disorders' psychological roots helps significantly in the more accurate diagnosis and treatment of these two disorders.

pp. 220-225

S(17): Biomaterial Session 2

Room: G15

Chairs: Hamidreza Kalhor (Sharif University of Technology, Iran), Adrine Malek Khachatourian (Sharif University of Technology, Iran)

14:00 ***Exploring Boundary Effects on Oxygen and Cell Distribution in 3D-Printed Helical Hydrogel: Computational Insights***

Mohammad Sadegh Zaman, Maryam Saadatmand, Ahmad Arshadi and Mohammad Amin Tarkhaneh (Sharif University of Technology, Iran)

Pharm

Developing a functional vascular network within thick hydrogel scaffolds is crucial for efficiently exchanging oxygen and nutrients, removing waste materials, and overall performance of engineered tissues. Recently, 3D bio-printing with coaxial nozzles and sacrificial ink has gained significant attention for creating complex structures with hollow perfusable channels. Current technology cannot evaluate mass transport during vascularization and perfusion of the culture medium into the channels of a porous hydrogel scaffold. Here, a simulation was employed to investigate the effects of boundary conditions on oxygen delivery, cellular growth, and viability within a 3D-printed helical hydrogel using the COMSOL Multiphysics software. Navier-Stokes and Brinkman equations were used to simulate fluid flow in the channel and porous medium, respectively. Concentration boundary condition (uniform oxygen concentration at channel walls) significantly increased the cell density from 2×1010 m-3 to over 9×1011 m-3 within one

month. The oxygen concentration at the outlet of the concentration boundary condition remained consistently high at 180 μM. However, in the wall boundary condition (no exchange of oxygen at channel walls), the oxygen concentration at the end of the channel fell below the critical threshold for cell survival (14 μM). Additionally, the average cell density observed was 1×1011 m-3. These findings underline the substantial influence of boundary conditions on cell proliferation within the 3D scaffold.

pp. 226-231

14:15 *Effect of Dip-Coating on Tensile and High Cycle Fatigue Behavior of 3D Printed Bio-Polymer Blends*

Pooya Kiani (IUST, Iran); Amirhossein Jabbari Mostahsan (Sharif University of Technology, Iran); Mehdi Kasaeian (Supervisior, Iran); Mohammad Sedighi (IUST, Iran)

Considering the biodegradable properties and mechanical characteristics of poly lactic acid (PLA) and poly caprolactone (PCL), these polymers are recently widely utilized in medical applications including fabrication of body-compatible implants. One of the most efficient manufacturing method to fabricate polymer implants is 3D printing, due to its ability to produce complex geometries rapidly. In this study, an effort has been made to study the impact of dip-coating process on tensile and high cycle fatigue behavior of 3D printed PLA/PCL blends, using PCL/chloroform solution. The results demonstrate that after applying the PCL coating on the surface of the samples, the fracture strain of the pure PLA, PLA/10wt%PCL, and PLA/20wt%PCL increases by 67.6%, 94.6%, and 9%, respectively, compared to those of the uncoated ones. Moreover, a slight increase was observed in the high cycle fatigue life of both pure and blend samples after coating.

pp. 232-236

14:30 *Simulation of Suture Production by Microfluidic Spinning to Optimise Flow Rates and Channel Length*

Shahabaldin Mahravani Behbahani, Ali Abouei Mehrizi, Amirhossein Khazaei and Azadeh Ghaee (University of Tehran, Iran)

Sutures are still important aids in surgery especially where mechanical support and strength is needed to hold the wound edges together. Microfluidic spinning is one of the newest and most efficient methods to produce fibers, especially sutures due to simplicity of process, high production speed, ability to control chemical composition along the length of suture and the ability to encapsulate cell inside the suture. One of the microfluidic spinning techniques is solvent extraction. In this work, using software simulation with COMSOL along with some experimental date, a quantitative criterion for designing microfluidic channel and flow rates is proposed for solvent extraction technique. Results obtained can be generalized for other polymer-solvent-nonsolvent systems. We have found that if at the end of the channel, the nonsolvent diffuses into the polymer solution in a way that it occupies 40% of its width in a concentration higher than the critical concentration for precipitation, the fiber will be formed without clogging the

microchannel. Also we have found that flow rates have significant effect on suture diameter. The application of the proposed criterion is in designing the length and width of microfluidic channels especially after the junction.

pp. 237-243

S(18): Biomechanics Session 2

Room: G14

Chairs: Saeed Behzadipour (Sharif University of Technology, Iran), Sadegh Naserkhaki (Islamic Azad University Science and Research Branch, Iran)

14:00 *Compensatory Gait Deviations During Single-Limb Stance in Patients with Excessive Tibial Torsion*

Reyhaneh Rostamian and Masoud Shariat Panahi (University of Tehran, Iran); Morad Karimpour (Tehran University, Iran); Hadi Ghattan Kashani (University of Tehran, Iran) Pharm

Lower limb torsion profiles, such as tibial torsion, can influence gait as well as joint biomechanics and potentially cause functional impairment. It is still unknown how morphological variations in tibial torsion would affect joint mechanics. This work investigates the correlation between tibial torsion and joint kinetics and kinematics using numerical modeling. We utilize an optimal control strategy to generate torque actuator simulations of the stance phase of gait for tibial torsion angles ranging from -2° to 58°, with a normally developing baseline of 28° of tibial torsion. The results indicate that while the ankle plantar flexion moment remains largely unaffected by the tibial torsion, plantar flexion angles are greatly affected, especially in higher inward and outward rotations. Both knee extension/flexion moments and plantar flexion angles tend to decrease with an increase in outward tibial torsion. Hip flexion and adduction moments were found to change slightly, while hip rotation moments showed greater variations as a result of tibial torsion, especially in high outward rotations. The findings of this study would help physiotherapist in planning treatments for patients with excessive inward or outward tibial torsion.

pp. 244-248

14:15 *Exploring the Design and Structural Analysis of Innovative Auxetic Coronary Stent*

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

A novel approach is presented to address the drawbacks associated with traditional stents. Through the utilization of a stent featuring an auxetic structure, characterized by a negative Poisson's ratio, the objective is to enhance energy absorption and radial strength of the scaffold, potentially providing advantages over conventional stents. The implementation of

an auxetic stent shows promising potential for performance improvement. Consequently, this study focuses on the design of three stents by enhancing a tetrachiral unit cell and conducting numerical investigations using SS 316 L alloy. The modified auxetic stents exhibit higher auxeticity and a negative Poisson's ratio (NPR) of -1.13 and -0.67. Such applications hold great significance in the medical field, as the enhanced radial support can help prevent recoil and maintain stent size, effectively preventing stent migration and enhancing patient safety. We aim to gain valuable insights into the behavior of this innovative unit cell, which may significantly impact the advancement of stent.

pp. 249-252

14:30 ***Comparison of Different Risk Assessment Tools to Manage Musculoskeletal Disorders Among Workers in an Automobile Manufacturing Company***

Mohadeseh Jafarian, Nesa Hosseini and Amirhossein Safahieh (Sharif University of Technology, Iran); Mohammad Sadegh Namnabat (EPFL, Switzerland); Navid Arjmand (Sharif University, Iran)

Awkward postures and manual material handling activities are important risk factors for musculoskeletal disorders in workers. To avoid the harm and costs caused by these injuries, there are several ergonomics (e.g., MAC, ManTRA, NIOSH, OWAS, QEC, REBA, WISHA, Snook, and V3) and biomechanical (i.e., biomechanical models such as AnyBody Modeling System, Jack, Regression equations, HCBCF and 3DSSPP) risk assessment tools. This study is conducted to compare these tools to evaluate working conditions in the cylinder finishing unit of Malleable Saipa Company as well as to suggest interventions to reduce the risk of injury. Results indicate that our case study work situation has a high risk of musculoskeletal injuries due to the cylinder's heavy weight and workers' improper posture; therefore job interventions are required. The recommended interventions, including load height adjustment, worker training, job rotation, and team working significantly reduced the risk of injury. Comparisons between the risk assessment tools indicate that QEC, ManTRA, and V3 tools are more comprehensive than other ergonomics tools. Moreover, All methods show compression more than 50% higher than AnyBody which is the most accurate method. The fact that the load's weight (36 kg) exceeded the maximum permissible load for these tools (20 kg) is probably what caused this issue.

pp. 253-259

14:45 ***Evaluation of Rigid, Semi-Rigid, and Dynamic Stabilization of the Cervical Spine***

Reza Pakbin (Amirkabir University of Technology, Iran); Mohammad Nikkhoo (Science and Research Branch, Islamic Azad University & National Taiwan University, Iran); Mostafa Rostami (Faculty of Biomedical Engineering, Amirkabir University of Technology, Iran)

Pharm

Laminectomy following rigid or semi-rigid rod and screw stabilization is one of the most

common approaches in treating spinal stenosis in the cervical region. Fusion-related problems such as altering the motion pattern and degenerative changes in adjacent tissues have led to the development of dynamic rod and screw stabilizers. The present study has been conducted to investigate the effects of rigid, semi-rigid, and dynamic rod and screw systems on the biomechanical performance of the subaxial cervical spine. Using a validated finite element model of the intact subaxial cervical spine, laminectomy following lateral mass screw fixation was simulated at the C4-C5 level. Operated models were stabilized using rigid, semi-rigid, and dynamic rod and screw systems, and the ROMs and FJCFs were assessed at the index level. The results of the simulations showed that the dynamic stabilizer provided better performance in restoring the intact model range of motion in flexion, extension, lateral bending, and axial rotation up to 120%, 340% 60%, and 4.9%, respectively, when compared to other stabilizers. While rigid and semi-rigid stabilizers in all motions and the dynamic stabilizer only in axial rotation inhibited facet contact, the dynamic stabilizer restored 24% and 40% of the facet joint contact forces in extension and lateral bending, respectively. This research will help understand the biomechanical performance of patients' spine after post-laminectomy stabilizing surgery.

pp. 260-265

S(19): Rehabilitation Session 1

Room: 318

Chairs: Mahdi Navidbakhsh (Iran University of Science and Technology, Iran), Amir Nourani (Sharif University of Technology, Iran)

14:00 ***Impact of Varus Ankle Deformity on Tibiotalar Joint Articular Cartilage: A Finite Element Analysis***

Mohadese Rajaeirad (University of Tehran & University of Isfahan, Iran); Morad Karimpour (Tehran University, Iran); Mohammad Reza Hairi-Yazdi (University of Tehran, Iran)

The distribution of forces within the ankle joint is crucial for its health and longevity. Loading disorders affecting the ankle joint can significantly impair daily life and activity levels. This study employs finite element analysis (FEA) to investigate the effects of Varus ankle deformity on the mechanical behavior of tibiotalar joint articular cartilage. Utilizing CT scan images, a personalized model of the Varus ankle was constructed. Four static loading scenarios were simulated at the center of pressure (COP), coupled with the hindfoot complex. For each cartilage, the contact area, contact pressure, and von Mises stress were computed. The results reveal an altered contact pattern in all loading conditions, consistent with clinical studies. The contact area shifted medially, and a critical region beneath the medial malleolus exhibited an average von Mises stress of 1.2 and 1.5 MPa on tibial and talar cartilages, respectively. Additionally, the study demonstrates a 9.4% reduction in contact area and a 14.3% increase in maximum von Mises stress

compared to healthy ankles. These findings emphasize the significance of early diagnosis and treatment of ankle deformities to prevent further damage. Moreover, the utilization of patient-specific modeling offers improved insights into joint behavior under various conditions and aids in guiding clinical decision-making.

pp. 266-271

14:15 *Computational Prediction of Varied Feed Rates in Controlled Cortical Bone Drilling: A Bovine Animal Study*

Mohammadjavad Einafashar (AmirKabir University of Technology, Iran); Mohadese Rajaeirad (University of Tehran & University of Isfahan, Iran); Ahmad Babazadeh Ghazijahani (Amirkabir University of Technology, Iran); Michael Skipper Andersen (Aalborg University, Denmark)

Pharm

Cortical bone drilling plays a critical role in orthopedic and dental implant surgeries, but it can pose risks of thermal necrosis. However, previous studies have generated conflicting results, necessitating further investigation for a better understanding. This study sought to validate a Finite Element (FE) model through experimental validation and leverage it to predict challenging-to-measure parameters. The impact of initial temperature (IT), feed rates, and point angle on maximum temperature (MT) and maximum thrust force (MTF) was examined in 10-cm bovine cortical samples using a 3.2 mm drill bit diameter. The FE model was validated and developed using the Johnson-Cook (JC) model, exhibiting a reverse correlation between MT and feed rates with an RMSE value of 4.29 °C, as well as a direct relationship between MTF and feed rates with an RMSE value of 39.8 N. These findings indicated good agreement between FE simulations and experimental data. Predictions were also made for MT and MTF by varying point angles, IT and diameters to assess the influence of IT and point angle. Notably, IT had a significant effect on MTF, with a 35.4% increase for every 20-degree Celsius rise. Moreover, increasing the point angle from 70 to 120 degrees resulted in a 13.1% increase in MT and a 26.9% decrease in MTF. These findings enhance our understanding of the factors involved in the drilling process and offer valuable insights for optimizing future surgical procedures.

pp. 272-278

14:30 *Biomechanical Investigation of the Impact of Femoral Stem Size on Stress Distribution in Total Hip Arthroplasty: A Finite Element Analysis Study*

Shahabedine Rezaei (University of Guilan, Iran); Mohadese Rajaeirad (University of Tehran & University of Isfahan, Iran); Zeinab Kamal (University of Groningen, The Netherlands); Hasan Asadi Gilakajani and Mohammad Khorsandi (University of Guilan, Iran)

Pharm

Total Hip Arthroplasty (THA) is a commonly performed procedure for treating hip joint

damage. Aseptic loosening represents a leading cause of implant failure, and inadequate femoral stem sizing has been implicated in this complication. The primary objective of this study was to explore the influence of stem size on the distribution of stress within the bone and stem. To accomplish this, ten stem models with varying sizes were created, and a biomechanical finite element model of the right femur was developed using CT scans of an adult male patient. The study found that the largest femoral stem size exhibited a 26.5% increase in stress shielding compared to the smallest size. On average, each incremental size change led to a stress increase rate of 1.63%. Furthermore, the stress disparity between the largest and smallest femoral stem sizes at the bone interface was approximately 59.73%, with an average stress increase rate of 4.56% per size. Based on these results, it can be inferred that employing smaller stem sizes may offer advantages in terms of enhancing implant longevity and mitigating the risk of stress shielding-related implant failure. It is crucial for clinicians to consider patient-specific factors when determining the most appropriate stem size, as this decision plays a pivotal role in optimizing outcomes and minimizing complications in THA procedures.

pp. 279-283

14:45 ***Long Cracks Can Alter Failure Mechanism of Meniscus in Radial Direction: An Animal Experimental Study***

Ahmad Babazadeh Ghazijahani (Amirkabir University of Technology, Iran); Mohammadjavad Einafashar (AmirKabir University of Technology, Iran); Ataallah Hashemi (Amirkabir University of Technology, Iran)

Pharm

This study investigates the potential for fracture failure in the knee meniscus under tensile loading with different crack lengths and its response in the femoral and tibial layers. Bovine knee meniscus tissue was used to prepare specimens with crack-to-sample-width ratios of 20%, 40%, and 60%. Results showed that cracks of 60% or more in both layers caused significant reductions in ultimate tensile strength (UTS), indicating fracture failure. The tibial layer demonstrated higher sensitivity to crack length, with a decrease in UTS of 62% compared to the femoral layer's 40%. These findings provide quantitative insights into the meniscus' vulnerability to fracture and highlight the importance of considering layer-specific responses in injury assessments and treatment strategies. However, further investigations are needed to replicate real-life conditions and improve our understanding of meniscus failure mechanisms.

pp. 284-289

Thursday, November 30 15:15 - 15:45

S(20): Break

Room: Third Floor Area

Thursday, November 30 15:45 - 16:30

S(21): Keynote Speech: Dr. Bouri

Room: Amphitheater

Thursday, November 30 16:30 - 18:00

S(22): Workshop 1: Image-based Surgical Navigation Systems

Room: G14

S(23): Workshop 2: Introduction to 3D Bioprinting (bioprinting)

Room: G15

Friday, December 1

Friday, December 1 8:30 - 9:45

S(24): Biosignal Session 4

Room: G13

Chair: Mehran Jahed (Sharif University of Technology, Iran)

8:30 ***Enhancing EEG Spellers Through Natural Language Processing***

Milad Yazdani and Sepideh Hajipour Sardouie (Sharif University of Technology, Iran)

Electroencephalogram (EEG) spellers are a vital communication tool for people with severe motor impairments, allowing them to express themselves by choosing letters or symbols on a screen. However, current EEG spellers face challenges such as low speed, low accuracy, and the lack of a universal method. This paper presents a novel approach that integrates a visual EEG-based speller with a Natural Language Processing (NLP) model to overcome these limitations. We use a hybrid SSVEP-RSVP model and augment it with an NLP model to create a speller that can write meaningful sentences. We evaluate our method on a between-subject scheme with four subjects and show that it significantly improves the accuracy of the basic hybrid speller (average accuracy increase by 16%). This research could potentially transform the field of assistive technology, offering a more effective and accurate communication tool for disabled people.

pp. 290-293

8:45 ***Analysis of the Effect of Cross-Frequency Coupling in the Diagnosis of Depression Using Resting State EEG Signal***

Parisa Raouf Emamzadeh Hashemi (Graduated in MS Degree, Iran); Vahid Shalchyan (Iran University of Science and Technology, Iran); Reza Rostami (Tehran University, Iran)

Depression is currently a prevalent mental illness and is recognized as a social problem worldwide, characterized by low mood and impaired functioning. Therefore, the accurate and early identification of depression is one of the current challenges. The objective of this study was to investigate the effect of three types of Cross-Frequency Coupling (CFC) in the diagnosis of depression. Since any type of brain dysfunction can be manifested in Electroencephalogram (EEG) signals, in this study, EEG signals from 19 channels during a resting state were utilized, consisting of data from 22 depressed patients and 15 healthy individuals. The three types of CFC, including Phase-Amplitude Coupling (PAC), Phase-Phase Coupling (PPC), and Frequency-Amplitude Coupling (FAC), were computed within each electrode and between all electrode pairs. Ten features with the highest statistically significant differences were selected and fed into five machine learning classifiers: Support Vector Machine (SVM), Linear Discriminant Analysis (LDA), k-Nearest Neighbors (KNN), logistic regression (LR) and Decision Tree (DT). The KNN classifier, utilizing a combination of five features extracted from the FAC measure, achieved a classification accuracy of 100%. Therefore, this approach can be considered as an auxiliary tool for psychiatric purposes.

pp. 294-300

S(25): Biodevices Session 3

Room: G14

8:30 *Introducing a Respiratory Phantom Device with the Ability of Recording Electrical Impedance Tomography: A Step Towards the Real-Time Intelligent Monitoring of Lung Aeration*

Maryam Beigzadeh (Iranian Research Organization for Science and Technology, Iran); Vahid Reza Nafisi (Research Organization for Science and Technology, Iran)

This study introduces a respiration simulating phantom device which is designed, built and evaluated experimentally. The device, as a mechanical-electrical simulator of the respiratory process, is used for studying and real-time monitoring of the local aerations during the respiratory-simulating behavior of the phantom, by adopting the Electrical Impedance Tomography (EIT) technique. This work serves as a proof of concept for automatically and intelligently select the ventilator settings and choose the treatment strategies optimally, in order to reach better patient specific treatments. The device's physical appearance and structure resemble a chest cage and consist of a plastic chamber with an elliptical cross-sectional shape filled with normal saline and a movable compliant wall, eleven pairs of movable curved plastic pieces (simulating ribcage), air balloons (simulating lungs), connecting tubes and specialized valves for air intake from the ventilator, a movable base with adjustable height for positioning EIT electrodes around the cage, and electronic circuits for EIT recording. Experimental results support the applicability of the phantom.

pp. 301-306

8:45 *Strain Elastogram Improvement Through Dynamic Programming Refinement Using Multi-Objective Optimization Technique*

Mohammadhossein Kalani (Amirkabir University of Technology (AUT), Iran); Ali Fallah (Amirkabir University of Technology & Amirkabir, Iran); Saeid Rashidi (Islamic Azad University Science and Research Branch, Iran); Maryam Mehdizadeh Dastjerdi (Amirkabir University of Technology (AUT), Iran)

Elastograms suffer from noise and undesirable artifacts, making it necessary to enhance their signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) for accurate detection of tissue deformations, determination of its displacement fields, and representation of tissue characteristics to medical professionals. This research aims to improve the quality of elastograms. Among various displacement estimation methods, the dynamic programming (DP) approach is chosen due to its superior speed, accuracy, and lower computational complexity and cost. The research objectives are defined as enhancing the SNR and CNR metrics and evaluating the resulting improvement in elastogram quality. To achieve DP refinement, a perturbation is employed. The variables of the DP cost function are evaluated, and finally, the design variable (w) is selected for adjustment. After assessing different multi-objective optimization algorithms, the Electric Fish Optimization (EFO) algorithm with non-dominated sorting is chosen. In the designed optimization process, the DP cost function is considered as the objective function, SNR and CNR as objectives, and w as the design variable. To evaluate the improved performance of DP, two RF samples are used, recorded from a CIRS phantom and a Polyvinyl alcohol (PVA) single-layer mammary gland phantom. Following the determination of the optimal w, the SNR and CNR values are computed for both one-dimensional (1D) and two-dimensional (2D) models under different conditions. The results indicate that the SNR and CNR values for the CIRS phantom, on average, increased respectively by 556.74% and 853.72% in the 1D model and by 83.56% and 127.91% in the 2D model, compared to the primitive values. For the single-layer glandular phantom, the SNR and CNR values, on average, increased respectively by 66.98% and 33.03% in the 1D model and by 102.67% and 2178.99% in the 2D model, compared to the primary values.

pp. 307-312

9:00 *Supervised Classification of Sleep Events Suitable for a Minimized Home-Operated Recording System*

Ali Akbarii (Sharif University of Technology, Iran); Zahra Moradi Shahrbabak (Tehran University of Medical Sciences Tehran, Iran); Mehran Jahed (Sharif University of Technology, Iran); Rasool Baghbani (Hamedan University of Technology, Iran)

In this paper, we present a novel approach that uses a non-invasive recording device based on the respiratory rate, SpO2 (oxygen saturation), and heart rate (HR) to represent respiratory effort and function. We also use these signals to classify apnea, arousal, and hypopnea events. We based our recording device on the APPELS dataset, a publicly

available dataset that we used a set of 120 patients with sleep apnea who underwent overnight polysomnography recordings. We extracted time and frequency domain features from the respiratory signals after using wavelet decomposition and denoising of the abdomen effort signal. We trained machine learning models, such as support vector machine (SVM) and gradient boosting algorithm (XGBoost), using grid search for hyperparameter optimization. The Receiver Operating Characteristic (ROC) curves showed an overall area under the curve (AUC) of 0.89 for the classification task. Our approach achieved an accuracy of 0.8673, and an F1-score of 0.8670 using the XGBoost model. Additionally, a separate test set resulted in an accuracy of 0.8343 and an F1-score of 0.8341 for the XGBoost model. We compared our approach with existing methods using different vital signals, such as SpO2 and HR, and showed that our approach achieved superior performance in terms of AUC values for apnea (0.9), arousal (0.88), and hypopnea (0.82) using SpO2 signals; and apnea (0.92), arousal (0.91), and hypopnea (0.86) using HR signals.

pp. 313-320

S(26): Rehabilitation Session 2

Room: 318

Chairs: Saeed Behzadipour (Sharif University of Technology, Iran), Soroush Sadeghnejad (Amirkabir University of Technology, Iran)

8:30 ***Statistical Analysis of Triaxial Acceleration Data of Different Fall Scenarios***

Fateme Delavarkhalafi, Mohammadreza Taghimohammadi and Farzam Farahmand (Sharif University of Technology, Iran)

Fall is a common event among elderly people which can cause significant injury and even death. Investigating the most common fall scenarios can lead to a better understanding of their differences and similarities and unveil their specific discriminative features. Triaxial acceleration signals were captured during the simulated falls of 1 elderly and 10 young persons, using a single Inertial Measurement Unit (IMU) mounted on their waist. In total, 12 different fall scenarios (direction/activity) were examined and their acceleration signals within a fall window, defined between 50 milliseconds before and after the main peak (range: 2-10 g), were compared via ANOVA test. Results indicated significant differences ($p<0.05$) between the forward accelerations of several fall scenarios, whereas the lateral and gravity accelerations displayed relatively comparable patterns across the scenarios. Also, comparison of the directional jerk data revealed larger forward jerks in the fast-forward falls. These findings exhibit the importance of considering the directional acceleration signals as an effective factor for detecting different fall scenarios.

pp. 321-327

8:45 ***Design and Development of a VR-Based System for Training Response to Joint***

Attention in Autistic Children: A Preliminary Study

Hassan Yazdanian (Tose'e Darman Sarv Inc., Iran); Sajjad Zareii (Tose'e Darman Sarv Inc., Iran); Zohre Bagheri Rekhne (University of Social Welfare & Rehabilitation Sciences, Iran); AmirMohammad Vakili and Ariana Soltani (Tose'e Darman Sarv Inc., Iran); Talieh Zarifian (University of Social Welfare & Rehabilitation Sciences, Iran)

Joint attention (JA) is a fundamental social-communication skill that is often deficient in individuals with autism spectrum disorder (ASD). As a result, JA is frequently targeted in early intervention programs. Previous research has suggested that virtual reality (VR) technology may provide new opportunities to enhance JA skills in children with ASD. In this study, we describe the design and development of a VR-based system that allows children with ASD to practice responding to JA cues through virtual scenarios. The content and face validity of the designed scenarios were evaluated by a panel of ASD experts. Furthermore, we have tested the usability of the developed system in a small group of five ASD children. The positive attitudes of the participants, the absence of harm, and the potential for the system to practice JA skills at a low economic cost suggest this system is worth investigating further in a future clinical trial.

pp. 328-332

9:00 ***Hammering Sound Analysis in Total Hip Arthroplasty Using a Novel Musical Approach***

Alireza Hakiminejad and Amir Hossein Sajedi (Sharif University of Technology, Iran); Mohammad Soleimani, Farhad Shaker and Sina Esmaeili (Tehran University of Medical Sciences, Iran); Seyyed Hossein Shafiei (Tehran University of Medical Sciences Tehran, Iran); Amir Nourani (Sharif University of Technology, Iran)

Pharm

Total hip arthroplasty (THA) is considered one of the most efficient orthopedic operations. Patients with symptomatic hip osteoarthritis, hip osteonecrosis, congenital hip dysplasia, inflammatory arthritis, and femoral head fracture can benefit from THA through pain relief and functional restoration. Various articles have analyzed acoustic features during broaching and stem insertion. Still, they could not provide a conclusive and clinically usable approach to ensure the success of the surgery. In this study we aimed at investigating sound characteristics with a musical approach using a chromatic tuner. Surgeries were performed by two experienced orthopedic hip fellowship surgeons via the direct anterior and lateral approaches. To capture the sound of the stem insertion, a smartphone was employed. After collecting the data, all the hammer impacts were isolated separately and looped at least 100 times to prepare for the precise determination of the musical note. Finally, chromatic tuner was employed to obtain musical notes and pitch. Our results indicated that in certain cases, the pattern of sounds identified can be unpredictable, while in other patients, there is minimal change in the hammering sound throughout the procedure. On average, the musical note produced during 60% of the operations is nearly

identical to the note Bb6 (1864 Hz) and in the insertion process, the stem vibrates around this note. Furthermore, it is more probable to identify a trend in the last set of impacts.

pp. 333-337

9:15 ***Synthesis of Natural Squat-To-Stand Motion Using Single-Term Cost Functions***

Hassan Sayyaadi, Mahdi Mohammadi and Farzam Farahmand (Sharif University of Technology, Iran)

By utilizing predictive simulations, it becomes possible to generate natural human movements without relying on the experimental data. Nevertheless, accurately predicting motion still presents a considerable obstacle due to the complex nature of comprehending and replicating human motor control. In this research, a muscle-driven musculoskeletal model was employed, along with a direct collocation optimization method, to synthesize the squat-to-stand motion. We employed seven different single-term cost functions during the process and compared the resulting joint angle and velocities and the muscle activation patterns, with those healthy subjects. In general, the cost function minimizing the joint forces showed the best overall match with the experimental data, resulting in root mean square errors of 2.5 degrees for the ankle, 6.1 degrees for the knee, and 21.3 degrees for the hip joints. It was concluded that with a single-term cost function, some essential aspects of the motor control strategies are missed and for more accurate predictions, employment of multi-term cost functions is inevitable.

pp. 338-343

Friday, December 1 9:45 - 10:15

S(27): Break

Room: Third Floor Area

Friday, December 1 10:15 - 11:00

S(28): Keynote Speech: Dr.Bull

Room: Amphitheater

Friday, December 1 11:00 - 12:15

S(29): Biomechanics Session 3

Room: Amphitheater

Chairs: Mohammad Ali Nazari (University of Tehran, Iran), Amir Nourani (Sharif University of Technology, Iran)

11:00 ***Evaluating Abdominal Aortic Aneurysm Stress Distribution: Effect of Asymmetry***

Faeze Jahani, Nasser Fatouraee and Malikeh Nabaei (Amirkabir University of

Technology, Iran)

An abdominal aortic aneurysm (AAA) is a gradual enlargement of the aorta that can threaten the patient's life if it ruptures. Several factors are effective in reducing the chance of aneurysm rupture. One of the important factors is the geometric characteristics of the aneurysm; its relationship with the risk of rupture helps in making decisions about the treatment and monitoring the treatment process. Geometrical parameters have an effect on wall stress, which is the cause of aneurysm rupture. In this study, a three-dimensional fluid-solid interaction model of two abdominal aortic aneurysm geometries was evaluated using ADINA. Wall stress distribution in symmetric and asymmetric geometries (eccentricity) has been investigated. Uniform thickness and an isotropic linear elastic material were considered for the wall. In the asymmetric aneurysm, the central line of the aneurysm was shifted. The results showed that in the asymmetry geometry, the magnitude of Von Mises stress and the maximum displacement increased by 5% and 19%, respectively. Also, the place of maximum stress was transferred from the anterior wall to the posterior wall.

pp. 344-348

11:15 ***A Subject-Specific Finite Element Model of Tilting Bone Anchor***

Mohammad javad Salmani mehrjardi, Ali Abedi, Alireza Rouyin and Farzam Farahmand (Sharif University of Technology, Iran)

A subject-specific finite element model was developed to simulate the complex mechanical interaction between a nonsymmetrical tilting anchor and bone. A heterogeneous voxel-based bone model was reconstructed from quantitative computed tomography (QCT) images of a human cadaveric humeri specimen. An anchor pull-out test was then performed on the same bone specimen, and the ultimate force of suture breakage, as well as the final radiographical configuration of the anchor inside the bone were recorded. In the finite element model, the bone was assumed to be an elastoplastic material with large deformation capability and strain-hardening behavior in the plastic region, and the anchor as a rigid material. A comparison of the model predictions with the results of the pull-out experiment indicated a very good agreement. At the ultimate pull-out force of 324 N, the model predicted a rotation angle of 53.8 degrees and an eyelet-to-bone surface distance of 6.9 mm, which were close to the experimental results of 55.2 degrees of rotation and a 6.7 mm distance. It was concluded that the model could successfully simulate the complicated mechanical interaction between the anchor and bone, and provide a valuable tool for design optimization of the tilting anchors.

pp. 349-354

S(30): Modeling Session

Room: G14

Chairs: Mehran Jahed (Sharif University of Technology, Iran), Maryam Saadatmand (Sharif University of Technology, Iran)

11:00 ***Investigating the Learning Curve Through Residency Training Using a Newly Developed VR-Based Laparoscopic Surgery Simulator***

Mehrnaz Aghanouri (Tehran University of Medical Sciences, Iran); Alireza Mirbagheri (Tehran University of Medical Sciences & Research Center for Biomedical Technologies & Robotics, Iran); Mohammad reza Keramati and Mahroo Rezaeinejad (Tehran University of Medical Sciences, Iran)

Laparoscopy, as a minimally invasive surgery has gained attention in recent years. It is important for the surgeons to train how to use this technique before entering the surgical room to reduce life and financial risks. This paper presents an experiment for validation of a new virtual reality based laparoscopic simulator called SinaSim. The effectiveness of using the simulator on skills improvement including controlling the handle, grasping an object, working with two hands simultaneously, hand-eye coordination and spatial perception is investigated. 6 tasks are presented and the criteria for accomplishing each task are represented. 10 residents of general surgery and gynecology participated in the study. Each participant was asked to accomplish each task. The paired t-test is employed to analyze the skill improvement for each task. According to the results, P values less than 0.05 are obtained for all tasks except for one task which is shown to be easy to accomplish and doesn't need too much effort. This outcome implies the successfulness of SinaSim in training the novices to improve their laparoscopic skills.

pp. 355-359

11:15 ***A Fully Automated Pipeline of Cam-Type FAI Parameters Measurement from Clinical Computed Tomography (CT) Images in Asymptomatic Patients***

Sareh Tayyebinezhad (Tehran University of Medical Science, Iran); Mansoor Fatehi (Iranian Society of Radiology, Iran); Hossein Arabalibeik and Hossein Ghadiri (Tehran University of Medical Sciences, Iran)

A fully automated pipeline, CAM-FAI-CAD, was used to automatically obtain slice selection, segmentation, landmark detection, and measurement of parameters related to femoral deformity to establish an auxiliary measurement algorithm for developmental screening or diagnosis of cam-type FAI using clinical computed abdomen tomography (CT) images of asymptomatic patients. The novel CAM-FAI-CAD pipeline consists of two components: (i) the use of a convolutional neural network (CNN) based on Le-Net to generate accurate slice selection to identify hip in clinical CT images(ii) the use of image processing algorithms for diagnostic landmark detection to quantify cam-type FAI-related parameters in asymptomatic patients. The CAM-FAI-CAD pipeline was used to train CNN for hip slice selection (n=14500 slices) and analyze clinical CT images of the femur to measure the alpha angle (AA) and femoral head-neck offset (FHNO) in male (n=17) and female (n=13) asymptomatic patients. Automatic CAM -FAI-CAD results were obtained for slice selection, segmentation, and center of femoral head detection as demonstrated by the accuracy (98.5%), Dice similarity index (DSI; 0.9 in the axial plane and 0.92 in the coronal

plane) and accuracy (94% in the axial plane and 0.96 in the coronal plane). While the accuracy of the automatically acquired parameters for AA and FHNO was around 88% and 88%, respectively, compared to the radiologist's manually calculated angle. AA and FHNO measurements using the fully automated CAM-FAI-CAD pipeline were highly in agreement with radiologists' measurements and could be used to assess cam-type FAI with high diagnostic accuracy and efficiency or evolutionary screening.

pp. 360-363

11:30 *Effect of Nano-Microparticle Shape on Targeted Drug Delivery: A Numerical Study on Abdominal Aortic Aneurysm*

Sina Ebrahimi, Ali Rahbary, Iman Mirafzal and Amir Shamloo (Sharif University of Technology, Iran)

Abdominal aortic aneurysm (AAA) is a serious medical condition that poses life-threatening complications. Due to the associated risks and potential ruptures from open surgery, targeted drug delivery (TTD) has been considered an alternative treatment method. Researchers have conducted numerous studies to understand the diseases' nature, including mechanical properties and blood flow patterns, revealing that cardiovascular diseases exhibit turbulent factors such as swirling flows and fluctuations. This study examines the effects of drug carrier size, shape, and dimension on TTD to the AAA. The patient-specific AAA geometry was reconstructed and modeled using the finite volume method, incorporating non-Newtonian blood flow based on the Carreau Yasuda and $k-\omega$ turbulence models. The study evaluated drug carrier efficiency by assessing the number of particles remaining in the AAA. Findings indicate that drug carrier shape and dimensions significantly affect drug delivery efficiency, with non-spherical particles showing higher retention in the AAA. The study's results could be applied to other drug delivery applications, and future research should investigate the potential of geometrically shaped nano-microcarriers in other blood vessels, including those with stenosis and aneurysm complications. Improving drug delivery system efficiency and safety can have a significant impact on treating various medical conditions and enhancing patient outcomes. In summary, this study highlights the importance of considering drug carrier shape and dimensions for targeted drug delivery to the AAA and could potentially improve treatment outcomes for patients with complicated medical conditions.

pp. 364-370

11:45 *Patient-Specific Virtual Endovascular Treatment Model*

Reza Abdollahi (University of Montreal & CRCHUM, Canada); Amirali Shahi, Simon Lessard and Daniel Roy (Centre Hospitalier Universitaire de Montréal, Canada); Gilles Soulez (CRCHUM, University of Montreal Hospital, Canada)

Pharm

In recent years, different virtual endovascular treatment models have been developed

to assist endovascular interventionists in preoperatively assessing procedures' feasibility, efficacy and safety. The development of numerical biomechanical methods is a promising tool for accurately anticipating the interactions between tissue structures and medical devices, which could be used to evaluate potential risks and complications of a given procedure. The presented virtual endovascular treatment model introduces an efficient method that can be adjusted for patients with different anatomical and physiological features. The advantages of the current model include its capacity to recreate vascular wall deformability and the validation process of this model against real-time treatment results. The maximum vascular displacements recorded during stent deployment and after removing the delivery system were 8.20 mm and 4.80 mm, respectively. These displacements resulted from the deformation of the vascular structure during treatment. A similar vascular deformation was observed in real-time patient procedures. Therefore, the current virtual endovascular treatment model is reliable with the predictability of vascular tissue deformation.

pp. 371-375

Friday, December 1 11:00 - 12:30

S(31): Biomedical Imaging Session

Room: G15

Chair: Amir Hossein Foruzan (Shahed University, Iran)

11:00 *Retinal OCT Image Denoising Based on Adaptive Bessel K-Form Modeling*

Sahar Jorjandi (School of Advanced Technologies in Medicine, Isfahan University of Medical Sciences, Iran); Zahra Amini (Medical Image & Signal Processing Research Center, Isfahan University of Medical Sciences, Isfahan, Iran); Maryam Samieinasab (Baylor College of Medicine, USA); Hossein Rabbani (Medical Image & Signal Processing Research Center, Isfahan University of Medical Sciences, Isfahan, Iran)

In this study, an adaptive approach is addressed to reduce the noise of retinal Optical Coherence Tomography (OCT) images. Since the layered structure of retinal OCT images creates a dependency between adjacent pixels at particular distances, the presented method is based on the adaptive selection of variable neighborhood windows for each pixel of OCT images. Indeed, by defining this spatial adaptivity, we extend our earlier work in which a pixel-wise fixed window was considered. Here, the variance is calculated in an optimal window for each pixel; so that the ultimate distribution of the variance image follows a gamma model. Besides, the asymmetry observed in the distribution of retinal layers led to suggest Asymmetric Bessel K-form (ABKF). This model is easily transformed into a Gaussian distribution through dividing the image into the root of the variance image. Then, it can be used with Gaussian-based algorithms for OCT denoising application. The results show the impressive performance of the proposed adaptive local BKF model in

noise reduction and increasing image contrast as visual and quantitative criteria.

pp. 376-380

11:15 ***Pyramidal Deep Neural Network for Classification of Retinal OCT Images***

Mohammad AlmasGanj (Sharif University of Technology, Iran); Emad Fatemizadeh (Sharif University of Technology & Shahab Danesh University, Iran)

Retinal optical coherence tomography (OCT) images are widely used to diagnose and grade macular diseases, such as age-related macular degeneration (AMD). However, manual interpretation of OCT images is time-consuming and subjective. Therefore, automated and accurate classification of OCT images is essential for assisting ophthalmologists in clinical decision-making. This paper proposes a pyramidal deep neural network that can diagnose normal and two types of AMD (dry and wet) in OCT images. Our network leverages features from different scales of a pre-trained convolutional neural network (CNN) and integrates them with two advanced versions of feature pyramid networks: bidirectional feature pyramid network (BiFPN) and path aggregation network (PANet). We evaluate our network on the NEH dataset and compare it with its predecessor. Our results show that our BiFPN-VGG16 and PAN-VGG16 models achieve accuracies of 94.8% and 95.0%, respectively, which are 2.8 to 3% higher than the previous models. Our approach demonstrates the potential of multi-scale feature networks for OCT image classification and can serve as an auxiliary diagnostic tool for ophthalmologists.

pp. 381-385

11:30 ***IQ Estimation Using Resting State fMRI and Regression Dynamic Causal Modeling***

Zahra Sadeghi Ziazi and Hamid Soltanian-Zadeh (University of Tehran, Iran)

Intelligence is a multifaceted concept that is generally defined as the ability of comprehending the environment, reasoning, planning, thinking, and learning. The Intelligence Quotient (IQ) is a well-known measure of cognitive abilities associated with intelligence. Recent neuroimaging studies have shown that brain structure and function are related to IQ, which varies from person to person. In this study, we investigated the potential of neuronal effective (directional) connectivity, computed using regression Dynamic Causal Modeling (rDCM) applied to resting state-fMRI data from 100 unrelated subjects in the HCP database, as a source of information for IQ estimation. We used permutation t-test and step-wise wrapper methods to select 24 significant features derived from directional connectivity and applied machine learning algorithms of Support Vector Regression (SVR) and Multi-Layer Perceptron (MLP) with 7-fold cross-validation to predict IQ. The results showed a reasonable IQ estimate, with a mean absolute error (MAE) of about 2 points and a prediction determination coefficient (R2) of about 70 percent. Our findings suggest that neuronal effective connectivity may provide valuable information for IQ estimation and support further investigation into its potential as a biomarker for intelligence.

pp. 386-390

S(32): Rehabilitation Session 3

Room: 318

Chairs: Morad Karimpour (Tehran University, Iran), Alireza Mirbagheri (Tehran University of Medical Sciences & Research Center for Biomedical Technologies & Robotics, Iran)

11:00 ***Experimental Study on Walking and Jogging***

Zahra Rabieefard, Razieh Mahootchi, Ahmadreza Arshi and Soroush Sadeghnejad (Amirkabir University of Technology, Iran); Yassaman Djafari (Amir Kabir University of Technology, Iran)

Pharm

Walking and jogging are very popular activities in daily life. Identification of stiffness and damping structure during these activities is significant in understanding movement mechanical behavior. This study aimed to provide a fundamental mathematical model for describing these activities and finding stiffness and damping coefficients in order to compare movements. A mass-spring-damper model was used to analyze the motion patterns of a group of individuals (n = 8) for jogging and walking. Nonlinear oscillating structures for damping and stiffness were extracted, and the coefficients of damping and stiffness for each participant were determined. Findings of this study show that the stiffness coefficient is higher during jogging, suggesting that the leg has a more significant spring effect in jogging compared to walking.

pp. 391-397

11:15 ***Design, Optimization and Fabrication of a Sensorized-Insole Using Taguchi Method***

Amin Hoseini, Amirmohammad Mohammadzadeh and Alireza Akbarzadeh (Ferdowsi University of Mashhad, Iran)

The human foot plays a vital role during locomotion, being the primary point of contact with the environment. Detecting foot-related issues early is crucial for injury prevention and well-being. Assessing foot irregularities requires measuring parameters like pressure, center of pressure, and force. The Ferdowsi University of Mashhad Center of Advanced Rehabilitation and Robotics (FUM-CARE) has developed an insole with eight Force-Sensing Resistor (FSR) sensors to address these needs. The FUM insole optimizes sensor placement to accurately detect the standard gait pattern. Experiments, following the Taguchi methodology, were conducted on the insole, considering three cost functions to determine two sensor arrangements. The cost functions attempt to follow the various aspects of the vertical ground reaction force, vGRF, of a gait cycle. The arrangements aim to mimic different aspects of the vertical ground reaction force (vGRF) during a gait cycle. The first arrangement maximizes valley and peak magnitudes in the standard vGRF diagram, with the first, third, and seventh factors as key influencers. The second configuration, targeting precise vGRF replication, is influenced primarily by the first, third, and sixth

factors. Remarkably, the first sensor placement has a 2.4% error at detection of peaks and valleys magnitude. Also, the second arrangement exhibits a 97% cross-correlation with the standard vGRF diagram, confirming its alignment. Additionally, the FUM Insole's construction employs the laminate method, effectively countering susceptibility to surface scratches and shear forces. This strategic approach significantly enhances sensor durability for prolonged functionality.

pp. 398-404

Friday, December 1 12:15 - 13:00

S(33): Lunch

Room: Basement

Friday, December 1 13:00 - 14:00

S(34): Poster Session

2nd Biomechanics and others

Room: Third Floor Area

13:00 *Computational Simulation of Calcium Peroxide Based Hydrogels as an Oxygen-Generating Scaffolds for Wound Healing*

Bahman Vahidi (Faculty of New Sciences and Technologies, University of Tehran, Iran); Amir Mohammad Danesh Pajooh (University of Tehran, Tehran, Iran)

Pharm

Finite element methods are now widely used to solve structural, fluid, and multiphysic problems numerically[1]. The methods are used extensively because engineers and scientists can mathematically model and numerically solve very complex problems especially in biomedical related fields. Biomimetic hydrogels have been developed in the fabrication of multifunctional microenvironments for cell culture and tissue fabrication. In the current study, different concentrations of Calcium peroxide (CaO_2) were incorporated in Carboxy-mehtylcellulose(CMC)/Gelatin hydrogels to enhance the wound healing procedure by releasing oxygen to the epidermis. A bright comparison between different concentrations of CaO_2 was investigated. By increasing the concentration of CaO_2, the concentration of Oxygen increased; however, the optimum concentration was investigated to be 0.5 mol/mg. In addition, it was shown that there is a clear difference in healing procedure of wounds with hydrogel or without it. The result of this study demonstrates that CMC/Gelatin/CaO_2 would be an idol scaffold for wound healing due to its oxygen-generating property.

pp. 405-409

14:00 ***Real-Time Slip Detection and Force Control for Prosthetic Hands***

Hediye Hakkak, Mohsen Ghanaei and Soroor Zakerikalat (Ferdowsi University of Mashhad (FUM), Iran); Mohammad -R. Akbarzadeh -T. (Ferdowsi University of Mashhad, Iran); Alireza Akbarzadeh (Ferdowsi University of Mashhad (FUM), Iran)

Object slippage is a significant challenge toward stable grasp for prosthesis hands due to uncertainties, such as changes in object weight or fast maneuvers. Slippage can negatively affect a user's inclination for long-term use of a prosthesis. The present study suggests a control algorithm for object slippage using surface electromyography (sEMG) and a force-sensitive resistor (FSR) mounted on the prosthesis fingertip. For this purpose, the grasp procedure is divided into four phases, labeled as open, stay open, close, and stay closed, based on the sEMG signals. In addition, a proportional-integral (PI) controller is used to adjust for the desired grasp force. The algorithm uses a decision tree (DT) classifier to determine either the occurrence of slippage or the presence of a stable grasp. A data set is experimentally collected using the FUM 3-Fingered Myo hand. Objects with increasing weight are used, and the corresponding FSR changes are recorded. Results show that the proposed DT method predicts slippage occurrence with 95.6% accuracy with an average detection time of 16.26 ms. Moreover, the proposed method can successfully anticipate slippage at least 80 ms before it actually occurs and, consequently, avoid object slippage by increasing the grasp force.

pp. 410-417

15:00 ***Biomechanical Evaluation of Pi Clamp Fixation Method Under Torsional Loading for Distal Radius Fractures***

Asma Nadeali Jelokhani, Amir Nourani and Alireza Hakiminejad (Sharif University of Technology, Iran); Mojtaba Khajeh Alizadeh Attar, Asma Mafhoumi, Mohammad Hossein Nabian, Leila Oriadi Zanjani and Reza Shahriar Kamrani (Tehran University of Medical Sciences, Iran); Farzam Farahmand (Sharif University of Technology, Iran)

Distal radius fractures are prevalent injuries. Unstable fractures with joint involvement generally require surgical fixation to optimize outcomes. One of the ways to treat unstable fractures is percutaneous pinning, which usually has less stiffness compared to the common method of plating in treating this type of fracture. Still, it has some advantages compared to the plating method. Pi clamp fixation method is one of the novel approaches for stabilizing distal radius fractures that utilizes a set of K-wires and a small clamp. This study uses the finite element method (FEM) to examine the effect of the four factors that are expected to have an effect on the stability of fixation. To conduct this research, first, a Taguchi design of experiments was performed to determine the effects of parameters. A geometric model of a fractured bone with an extra-articular transverse fracture, including cortical and cancellous bones, was created. Then, according to the experimental design, eight different fixation patterns were modeled and subjected to torsional loading 1 N.m. The goal of optimization was to increase stiffness, which is equivalent to reducing rotation

against torsion. Therefore, each experiment's maximum rotation under torsion loading was calculated using finite element analysis, and Taguchi analysis was performed on the results. so that the average maximum rotation for two levels of pin diameter is about 1° and for two levels of number of pins is about 0.9°, and for the corresponding levels of the angle relative to the transverse plane in the planes A and B are less than 0.5°. This study showed that pin diameter and number of pins are more influential factors on stiffness, and increasing their values leads to increased stiffness. Additionally, a smaller angle of the pins relative to the transverse plane is desired for higher stiffness under torsional loading.

pp. 418-423

16:00 *A 3D Passive Micromixer for Synthesizing Nanoparticle with Bio-Applications: Computational Study*

Amirhossein Khazaei and Ali Abouei Mehrizi (University of Tehran, Iran)

One of the main applications of micromixers is nanoparticle synthesis. Nanoparticles can be utilized in many bio-applications, for example they can used in many bio-applications, for example they can used as drug carriers to deliver and release drugs to targeted cells and tissues. Faster mixing process creates small and uniform nanoparticles, while slower mixing process results in larger nanoparticles with varying sizes. In this paper, a 3D passive micromixer with novel geometry is presented. Numerical study has been done, Navier-Stokes, species transport, and continuity equations are solved with finite element method in order to analyse the mixing index, effective Reynolds numbers, and the pressure fall. for Reynolds numbers 10 to 420. Mixing time was also calculated with Falk and Commenge equation and Results was compared with previous experimental data to see whether the micromixer's performance producing nanoparticles is satisfactory or not. All in all, the proposed micromixer demonstrate a significant performance in a wide range of Reynolds number and can be suitable for high-throughput nanoparticle production.

pp. 424-429

17:00 *Investigation of Hemodynamic Behaviors in the Liver*

Sevda Zarei and Farzan Ghalichi (Sahand University of Technology, Iran); Majid Ahmadlouydarab (University of Tabriz, Iran)
Pharm

Precise assessment of perfusion and flow parameters within the liver holds considerable significance and bears broad implications across diverse medical fields. Thus far, distinct functional facets of hepatic activity and blood circulation have been delineated across various vascular scales. A holistic examination of blood flow within this intricate vascular network can furnish a comprehensive comprehension of flow distribution spanning the entirety of the liver. This study innovatively employed a realistic integrated liver model to investigate perfusion. A comprehensive model encompassing the hepatic artery, portal vein, hepatic vein, and parenchyma was constructed, and hemodynamic parameter values

were deduced through computational fluid dynamics simulations utilizing pressure boundary condition values. The findings highlighted the heightened vulnerability of downstream vessels and branches across all three vessels, wherein local velocity increases in response to geometrical alterations. Moreover, the outcomes underscored the predominant blood supply allocation to the right lobe of the liver, amplifying its clinical significance for surgical interventions and treatment strategies.

pp. 430-433

18:00 *Influence of Material, Design, and Loading on the Biomechanical Behavior of Femoral Stems: A Comparative FEM Study*

Mohammad Zamani Roudbaraki and Shahabedine Rezaei (University of Guilan, Iran); Mohadese Rajaeirad (University of Tehran & University of Isfahan, Iran); Sandipan Roy (SRM Institute of Science and Technology, India); Hasan Asadi Gilakajani and Mohammad Khorsandi (University of Guilan, Iran)
Pharm

The longevity and success of total hip arthroplasties (THA) depend on various factors, including material selection, design, and the activity level of the patient. However, the combined effect of these factors on implant performance is often overlooked. This study aims to address this gap by investigating finite element analysis (FEA) on three commercially available femoral stem designs made of titanium and cobalt-chromium (CoCr) alloys. Specifically, the influence of four neglected activities' load cycles, namely stand-up, stairs-up, sit-down, and stairs-down, was examined. The assignment of materials was based on Hounsfield units (HU) obtained from CT scan images, ensuring accurate representation of hip geometry. Von-Mises stress distributions and their maximum values were analyzed, and a maximum stress ratio (MSR) parameter was introduced to quantitatively assess the risk of stress shielding. Our findings revealed that titanium exhibited lower MSR values overall, while the stem design variants demonstrated varying levels of MSR. Moreover, between four loading scenario stairs up and stand up had the most and least criticality and showed 52.6% and 38.5% percentage higher and lower than the mean stress values experienced by femoral stem. These findings have significant implications for clinicians in offering improved treatment and guiding patients who have undergone THA towards safer and longer-lasting replacements. Additionally, engineers can utilize these results to design and manufacture tailored implants for THA, enhancing overall implant performance

pp. 434-438

19:00 *How Saddle Height Parameters Alter the Lower Extremity Motion Patterns During the Cycling: The Musculoskeletal Modeling Study*

Alireza Zohari (University of Azad, Iran); Tarane Salehsari (Islamic Azad, Iran)
Pharm

Some of the mechanical parts of bicycles have direct contact with human bodies and may impact the musculoskeletal system directly. One of the important bicycle variables is saddle heights. The saddle height is an important factor in controlling the lower limb joint stability and balance control. The goal of the current research was to compare lower extremity kinematics by musculoskeletal modeling for different saddle heights during cycling. Twenty professional cycling athletes participated in this study (Mass: 75.3±6.5 kg, Heights: 180±6.3 cm, Age: 28.5±6.5 years). Twelve Vicon motion captures (Vicon MX, Oxford, UK, 100 Hz) were used to measure the marker positions. The smart trainer (Tacx Flux, Netherlands) was used to measure the output power of the bicycle. The inseam quantity (the distance from the uppermost part of the thigh to the ankle) of each subject was measured and then multiplied by 0.883 to find the standard saddle height that was chosen as a lower saddle. The highest position of the right crank (when the right toe is at the highest height) was defined as the start time of cycling where the crank angle (CA) is CA=0°. The subject-specific musculoskeletal model for each subject was produced by the scaling tool of OpenSim. The inverse kinematics tool of OpenSim was used to calculate the joint angles in two saddle height positions. The main effect of saddle heights is in the hip and ankle kinematics where the motion pattern of the hip is extremely altered by changing the saddle heights. These results indicated that human joints approve the kinematics chain and each change in joint causes a change in other joints.

pp. 439-446

S(35): Poster Session

2nd Bioelectric

Room: Third Floor Area

13:00 *Deep Learning-Based Determination of Hip Geometrical Features from X-Ray Images*

Mahdie Aghasizade (University of Tehran, Iran); Morad Karimpour (Tehran University, Iran); Masoud Shariat Panahi (University of Tehran, Iran); Alireza Almasi Nokiani (Iran University of Medical Sciences, Iran); Ramin Jafarzadeh Khaledi (Rad Radiology and Sonography Clinic, Iran); Hadi Ghattan Kashani (University of Tehran, Iran); Amir Kiyoumarsioskouei (Sahand University of Technology, Iran)

Hip morphological disorders could lead to joint wear that, in severe cases, would require a total hip replacement. We propose a deep learning-based approach to determine hip geometrical quantitative features from raw X-ray images. Those features include femoral head diameter (HD), intertrochanteric distance (ITD), shaft width (SW), center edge angle (CEA), medial proximal femoral angle (MPFA), and neck shaft angle (NSA). The VGG-16 network was trained and tested using an 853 lower limb radiographs dataset. Results from the test samples showed 4.6, 5.48, 6.5, 16, 7, and 3.3% errors on HD, ITD, SW, CEA, MPFA, and NSA respectively, indicating that the proposed approach performs as well as

traditional techniques.

pp. 447-451

14:00 *Leveraging Multi-Task Self-Supervised Learning for Accurate Facial Keypoint Detection in Thermal Images*

Poorya Aghaomidi, Sadaf Aram and Zahra Bahmani (Tarbiat Modares University, Iran)

In the field of computer vision, the pursuit of precise keypoint detection is constantly evolving, finding applications in diverse domains such as face recognition, facial region tracking, and facial expression analysis. While extensive research has been directed towards the visual spectrum, the potential of infrared imaging, rich in physiological cues, remains largely untapped due to limited annotated datasets. The thermal domain offers a unique avenue to extract intricate indicators of both mental and physical states in humans. A key component of autonomous mental state recognition is a robust face tracker capable of pinpointing facial landmarks with utmost precision. In this pursuit, we present a meticulously designed algorithm tailored for accurate facial keypoint detection in thermal images. We harnessed a dataset manually annotated with 68 facial keypoints across 94 subjects, providing a solid foundation for our exploration. To overcome the challenges posed by limited samples, we harnessed the cutting-edge paradigm of self-supervised learning. Guided by this approach, our Convolutional Neural Network (CNN) underwent comprehensive pretraining with three pretext tasks: image rotation prediction, subject classification, and 5-point facial keypoint detection. Notably, these tasks achieved high accuracies of 100%, 97.92%, and 2.37% mean absolute percentage error, respectively. The intrinsic knowledge distilled through these tasks enriched our network's comprehension of thermal facial data, effectively unraveling distinctive features inherent to each countenance. With a fine-tuned CNN, we ventured into the domain of keypoint detection, strategically relinquishing the fully connected layers. This transformation, fortified by the insights gleaned from self-supervised pretraining, resulted in a discernible boost in keypoint detection precision. Demonstrating the efficacy of our approach, the achieved Normalized Mean Error (NME) stood at an impressive 1.05, distinctly surpassing the NME recorded through traditional fully supervised learning (NME=3.19). This outcome underscores the prowess of self-supervised learning in elevating the accuracy of keypoint detection, aligning with the broader theme of our work: capturing the intrinsic cues that guide the path to enhanced facial analysis.

pp. 452-457

15:00 *Design and Simulation of an Oxygen Gradient Generator for Heart-On-a-Chip*

Mahya Mosayebzadeh, Sogol Fathi and Ali Abouei Mehrizi (University of Tehran, Iran)

Microfluidic science in heart-on-a-chip devices mimics human heart structure and function, offering a realistic model for studying heart diseases. Concentration gradient generators can control oxygen levels, aiding in understanding hypoxia and potential treatments. In this study, by synergizing precision design, advanced fluid dynamics, and computational

simulations, we have established a framework capable of authentically recreating the microenvironment of cardiac oxygen supply. By leveraging serpentine channels and controlled inlet velocities, we can achieve unparalleled mastery over generating oxygen gradients and facilitate optimal mixing efficiency. This innovative design enables the creation of various oxygen levels for different types of heart cells simultaneously, thus heightening experimental accuracy. The platform's emulation of physiological shear stress with the range of 0.5 to 1.2 Pa further enriches its authenticity, underscoring its potential to cardiovascular research. By using six loops in the serpentine channel and moving at a speed of 1.2 m/s, we ultimately achieved the desired concentrations with a concentration efficiency of over 90%. Ultimately, our work serves as a beacon guiding breakthroughs in cardiac healthcare for patient.

pp. 458-463

16:00 *Estimation of Size and Depth of a Breast Tumor Using Thermal Analysis; A Numerical Study*

Faeze Jahani, Mehdi Shafieian and Malikeh Nabaei (Amirkabir University of Technology, Iran)

As the most common type of cancer in women, breast cancer has a high death rate. One effective way to lower this rate is by breast screening. Thermography is used as a non-invasive, painless, non-contact, and cost-effective method to show breast abnormalities and lesions. A breast tumor generates more heat than normal tissue, which affects the skin temperature and can be quantified by thermal patterns. In this study, in order to assess the temperature distribution in a breast with a tumor, an axisymmetric finite element model was presented. The tumor metabolism rate was considered according to its grade. A parametric study was conducted to investigate the surface temperature distribution according to the size and location of the tumor. The maximum observed temperature difference was 1.3°C, which can be fully recognized by thermal imaging. The temperature difference drops from 0.93 to 0.14 °C when the tumor's depth rises from 20 to 35 mm. The results showed that the tumor's location and size can be estimated by considering the two main features of the maximum temperature difference on the surface of the skin and circumferential distance from the axis of symmetry where the temperature differential equals half of its maximum. Also, the effect of blood perfusion rate on temperature distribution was analyzed. The temperature differential at the axis of symmetry increased from 0.50 to 0.82°C when the blood perfusion rate was increased four times. A transient process was used to analyze the impact of employing a cooling load and investigate the thermal recovery profile. In the recovery phase, the maximum temperature difference was 0.6°C between normal and cancerous breasts, and after 10 minutes, the temperature contrast stabilized. The results of this study showed that, although thermography and thermal analysis are not known as the most accurate diagnostic tools, they can be useful tools in the early and non-invasive screening of breast abnormalities.

pp. 464-470

17:00 ***Development and Validation of an Optimal GATE Model for Pencil Beam Scanning (PBS) Proton Beam Delivery***

Ali Asadi (Sharif University of Technology, Iran); Seraj Varnaseri (Amir-Kabir University of Technology, Iran); Shirin Moshiri (Sharif University of Technology, Iran); Azadeh Akhavanallaf (Geneva University Hospital, Iran); Hossein Arabi and Habib Zaidi (Geneva University Hospital, Switzerland)

We conducted a study to explore the potential use of the Gate Monte Carlo code as an independent platform for dose commissioning. A unified framework for dose planning of pencil beam scanning (PBS) proton therapy facilities was developed. The SIEMENS IONTRIS active scanned-base proton therapy system was simulated using the GATE toolkit. To validate the beam modeling, we compared profiles and depth dose distributions obtained from simulation with experimental measurements. Additionally, we used the clinical test case from AAPM TG-119 to assess the accuracy of treatment planning and delivery through spot scanning proton beams. The results of the Monte Carlo simulation showed excellent agreement with measurements, with a maximum relative error of 0.95% in range, 3.4% in entrance to peak ratio, 2.3% in mean point to point, and 0.852% in peak location. The mean relative absolute difference between the Monte Carlo simulation and the measurement in terms of absorbed dose in the SOBP region was 0.93%±0.88%. The results from TG-119 phantom simulation demonstrated excellent agreement compared to commercial treatment planning systems, with a 2.4% deviation in target mean dose. These results confirm the capability of GATE simulation as a reliable surrogate for quality assurance in proton therapy facilities.

pp. 471-474

18:00 ***Modification of a Herbal MRI Contrast Agent: Biological Effect and Relaxivity***

Ali Yazdani and Hamid Soltanian-Zadeh (University of Tehran, Iran); Ahmadreza Okhovat (Central Herbarium of University of Tehran, Iran); Raheleh Doosti (Shahrood University of Technology, Iran); Maryam Saber (Royan Institute for Stem Cell Biology and Technology, Iran)

We modified a modern herbal MRI contrast agent for biological applications. This modification was realized by omitting salinity and free ions of the contrast media. As a result, both the toxicity and the relaxivity of the product improved. We also chemically analyzed the modified agent and confirmed the elimination of some annoying free ions and molecules.

pp. 475-478

Friday, December 1 13:30 - 15:00

S(36): Workshop 3: Sina Remote Robotic Surgery Systems

Room: G13

S(37): Workshop 4: Exoskeleton Robots; Rehabilitation Applications

Room: G14

Friday, December 1 14:00 - 15:00

S(38): Keynote Speech: Dr. Vafaei

Room: Amphitheater

Friday, December 1 15:15 - 15:45

S(39): Break

Room: Third Floor Area

Friday, December 1 15:45 - 16:30

S(40): Keynote Speech: Dr. Ploeg

Room: Amphitheater

Friday, December 1 16:30 - 18:00

S(41): Closing Session

Room: Amphitheater