

PROFESSIONAL EXPERIENCES

• eBionics Laboratory - University of Waterloo

Waterloo, Canada

Research Assistant

Jul. '18 - Dec. '22

Steady-state Visual Evoked Potentials (SSVEP) Brain-Computer Interface

- ◇ Extracted features from 6-channel EEG signals using magnitude and complex spectrum features for classification of 7 classes
- ◇ Proposed a CNN and fine-tuned hyper-parameters using grid search to optimize SSVEP classification, outperforming CCA
- ◇ Developed user-dependent and user-independent models for SSVEP classification using CNN for generalization purposes
- ◇ Visualized CNN features from different layers using t-Stochastic Neighborhood Embedding (t-SNE) clustering technique

Resulted in: 3 journal manuscripts and conference proceedings, including **Journal of Neural Engineering**

Extracting Cardiac Information from the Upper Arm

- ◇ Designed and conducted an experiment to simultaneously record ECG (Lead II) and high-density EMG signals from healthy human participants at rest and three muscle contraction levels
- ◇ Implemented and evaluated robustness and performance of multiple pipelines for heartbeat detection in various noise levels composed of complete EMD with adaptive noise, SWT, Zero-phase Wavelet, and fastICA using t-test
- ◇ Developed supervised and unsupervised machine learning and feature selection techniques using MVR, PLS, cross-correlation, HRV, and MI
- ◇ Implemented and adapted Pan-Tompkins algorithm for real-time peak detection in noisy environments
- ◇ Optimized SWT using Zephlet and mother wavelet optimization (Lattice parametrization) and significantly improved state-of-the-art performance (Friedman test) in detection accuracy, ECG delineation performance, and detection tolerance

Resulted in: 4 journal manuscripts and conference proceedings and 2 more journal manuscripts under preparation

Hackathon/Course Projects

- ◇ Object Detection from a Fisheye Camera using Transfer Learning on YOLOv4 DNN and K-Means Clustering
- ◇ Prediction of Finger Flexion (BCI Competitions) using 64-Channel ECoG Signals
- ◇ CIFAR-100 Classification using Transfer Learning on ResNet50 DNN
- ◇ Alzheimer's Disease Phase Detection from MRI images using Transfer Learning on ResNet50 DNN

• Grand River Hospital

Waterloo, Canada

Intern

Feb. '22 - Aug. '22

Mitigation of Patient Falls at the Grand River Hospital (GRH)

- ◇ Performed needs assessment by on-site observations, designing questionnaires, and focus groups (needs first approach)
- ◇ Generated concepts to address 47 identified needs in different groups titled: devices, information, accessibility, staffing

• Helpwear

Waterloo, Canada

Machine Learning Intern

Jul. '18 - Sep. '20

ECG Extraction from a Wearable on the Upper Arm

- ◇ Developed an algorithm to optimize wearable electrodes on the upper arm for ECG extraction
- ◇ Delineated separate waveforms (P-, T- wave, and QRS complex) from the upper arm with high performance

• Neuroscience and Neuroengineering Laboratory

Tehran, Iran

Project Manager, Senior Research Assistant

Sep. '15 - Dec. '17

Continuous Force Decoding from Freely Moving Rats

- ◇ Designed rat training setup, trained rats, implanted self-built and industrial 16-channel microelectrode arrays in rat cortex
- ◇ Recorded intracortical data (Spike train, LFP) both during surgery and after implantation from freely moving rats
- ◇ Pre-processed and cleaned data and extracted trials of interest to generate the dataset
- ◇ Extracted various features from LFPs using filter banks, SWT, and delayed data
- ◇ Predicted force amplitude from LFPs using linear regression methods such as PLS and Kalman filter ([Video](#))

Resulted in: 3 journal manuscripts and conference proceedings, including **Scientific Reports**

- **Digital Signal Processing Laboratory**
Researcher

Isfahan, Iran
Sep. '12 - Sep. '13

Designing and Building an Electric Wheelchair Controlled by Self-recorded EOG signals

- ◊ Designed and build an electric wheelchair by modifying a mechanical one
- ◊ Designed electric circuits to record EOG signals from the body surface
- ◊ Processed EOG signals in real-time using a virtual serial port in MATLAB
- ◊ Implemented eye tracking using EOG signals, extracted commands, and controlled the electric wheelchair in real time ([Video](#))

Resulted in: National Patent

PATENT

Ali Nouri, **Nargess Heydari**, MinaSadat Mahmoudi, Safoura Shahin, Arad Tajmir Riahi, Designing an Electric Wheelchair Controlled by EOG Signals for the Spinal Cord Injured People, National Patent No. 81292, '13, Iran

SKILLS

- ◊ **Programming Language:** C, Python (NumPy, Scikit-Learn, Pandas, TensorFlow, Keras, Pytorch), C++, Visual Basic
- ◊ **Software:** MATLAB, PyCharm, Visual Studio, Simulink, Altium Designer, CodevisionAVR, Arduino, Proteus, ActiveHDL
- ◊ **Biomedical Systems and Signals:** *Systems:* Designed and implemented multiple biomedical systems from scratch, *Signals:* Solid understanding of physiological data processing (EEG, EMG, ECG, EOG, ECoG, LFP, and Spike Trains) and applications
- ◊ **Techniques:** *Machine Learning:* Regression, Classification, Clustering, Statistical Analysis, *Signal processing:* Feature Extraction, Source Separation, Feature Selection, Event Detection

ACADEMIC TRAININGS

- **University of Waterloo** Waterloo, Canada
Ph.D. in Systems Design Engineering Jul. '08 - Dec. '22
- **Iran University of Science and Technology** Tehran, Iran
M.Sc. in Biomedical Engineering Sep. '13 - Aug. '16
- **Isfahan University of Technology** Isfahan, Iran
B.Sc. in Electrical Engineering Sep. '09 - Sep. '13

SELECTED PUBLICATIONS

- Nargess Heydari Beni**, Ning Jiang, "[Heartbeat Detection from the Upper Arm using an SWT-based Zero-Phase Filter Bank Incorporated with a Voting Scheme](#)", *44th Annual International Conference of the IEEE Engineering in Medicine Biology Society (EMBC)*, 2022
- Nargess Heydari Beni**, Ning Jiang, "Heartbeat Detection from Single-lead ECG Contaminated with Simulated EMG at Different Intensity Levels: a Comparative Study", under 2nd revision in *Biomedical Signal Processing and Control*, 2022
- Nargess Heydari Beni**, Ning Jiang, "[Heartbeat Detection from High-Density EMG Electrodes on the Upper Arm at Different EMG Intensity Levels using Zephlet](#)", under revision in *Computer methods and Programs in Biomedicine*, 2022
- Nargess Heydari Beni**, Ning Jiang, "ECG delineation from the upper arm using mother wavelet optimization incorporated with Zephlet at four EMG contamination levels", ready to submit, 2022
- Aravind Ravi, **Nargess Heydari Beni**, Jacob Manuel, Ning Jiang, "[Comparing User-Dependent and User-Independent Training of CNN for SSVEP BCI](#)", *Journal of Neural Engineering*, 2020
- Nargess Heydari Beni**, et al., "[Force Decoding using Local Field Potentials in Primary Motor Cortex: PLS or Kalman Filter Regression?](#)", *Australasian Physical and Engineering Sciences in Medicine (APES)*, 2020
- Aravind Ravi, **Nargess Heydari Beni**, Ning Jiang, "[User-Independent SSVEP BCI using Complex FFT Features and CNN Classification](#)", *IEEE International Conference on Systems, Man and Cybernetics (SMC)*, Bari, Italy, 2019
- Aravind Ravi, Jacob Manuel, **Nargess Heydari Beni**, Ning Jiang, "[A Convolutional Neural Network for Enhancing the Detection of SSVEP in the Presence of Competing Stimuli](#)", *41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, Berlin, Germany, 2019
- Abed Khorasani, **Nargess Heydari Beni**, Vahid Shalchyan, Mohammad Reza Daliri, "[Continuous Force Decoding from Local Field Potentials of the Primary Motor Cortex in Freely Moving Rats](#)", *Scientific Reports*, 2016
- Nargess Heydari Beni**, et al., "Unsupervised ECG Removal from EMG Electrodes on Right Pectoralis Muscles using Zephlet", Under Preparation