WONBUM SOHN

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AREAS OF INTEREST

Deep learning, Machine learning, Brain network analysis, Multimodal brain imaging, Brain machine interface, Neuromodulation

FIELDS OF EXPERTISE

- Development and Application of Deep Learning and Machine Learning
- Digital signal processing and Multivariate data analysis
- Analysis of medical imaging and bio-signal data
- Design and development of bio-signal measuring device

SKILLS

Computer applications: Deep learning (CNN, RNN, GNN, AE, Transformer, Vision Transformer, Detection, Segmentation), Machine learning (SVM, Decision Tree, Random Forest, Regression, KNN), and Programming (Python, R studio, Linux, Git (GitHub), and MATLAB)

Biomedical engineering: Digital signal processing (PCA, ICA), medical imaging analysis (fMRI, MRI, CT, Ultrasound), and bio-signals analysis (Raman Spectroscopy, EMG, ECG)

PAPER

Sohn, W., Di, X., Liang, Z., Zhang, Z., & Biswal, B. (2024). Explorations of using a convolutional neural network to understand brain activations during movie watching. *Psychoradiology*.

Sohn, W., Di, X., Liang, Z., Zhang, Z., & Biswal, B. (2024). Explorations of using a convolutional neural network to understand brain activations during movie watching. *bioRxiv*, 2024-01.

Sohn, WB., Lee, SY., and Kim, S. (2019). Single-layer multiple-kernel-based convolutional neural network for biological Raman spectral analysis. *Journal of Raman Spectroscopy.* (Citation: 38)

Kim, S., Kim, BH., **Sohn, WB**., Byun, KM., and Lee, SY. (2017). Dual modal endoscopic cancer detection based on optical pH sensing and Raman spectroscopy. Optical Fibers and Sensors for Medical Diagnostics and Treatment Applications XVII. *International Society for Optics and Photonics*. Vol. 10058, p.1005813. San Francisco, California, USA.

PRESENTATION

Wonbum Sohn, Xin Di, Bharat B. Biswal. (2023). Analyzing video features related to specific brain networks using deep learning. 2023 Northeast Bioengineering Conference. Philadelphia, PA, USA.

Sohn, WB., Shin, Y., Kim, S., and Lee, SY. (2017). Boundary detection method in skin diseases using confocal Raman micro-spectroscopy. 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society. Jeju Island, Korea.

Sohn, WB., Shin, Y., Kim, S., and Lee, SY. (2017). Spectrum smoothing method to increase reproducibility of Raman signal. *Optical Society of Korea Winter Meeting*. P. 337. Jeongseon, Gangwon-do, Korea.

AWARDS & HONORS

Entrance Examination Scholarship, Kyung Hee University	03/2016, 09/2016, 03/2017, 09/2017
Minister's Prize, Ministry of Science, ICT and Future Planning	12/2014
Practical Talent Scholarship, Kyung Hee University	09/2014
Scholarship for Academic Excellence, Kyung Hee University	09/2012, 09/2013, 03/2014, 09/2014

RESEARCH EXPERIENCES

NEW JERSEY INSTITUTE OF TECHNOLOGY, Newark, NJ, USA   **06/2024- 08/2024**
Researcher Assistant, Clinical Neuromuscular Adaptation Laboratory

Project Title: Analysis of motor neuron characteristics in patients with neuromuscular disease or older adults.
- Supervisor: Dr. Jongsang Son
- Objective: To develop a lab program to analyze motor unit spike train patterns from surface electromyography (sEMG) signals
- Checked several publicly available algorithms for decomposing high-density sEMG signals to compare the differences between decomposition methods (I-Spin, MUedit, etc.).

NEW JERSEY INSTITUTE OF TECHNOLOGY, Newark, NJ, USA   **08/2021-05/2024**
Research Assistant, Brain Connectivity Laboratory

Project Title: Investigation of brain regions activated during movie watching using deep learning technology.
- Supervisor: Dr. Xin Di and Dr. Bharat Biswal
- Objective: To understand which brain regions are activated by which movie elements during movie watching.
- Analyzed which characteristics of the movie activate specific brain regions during the movie watching.
- Low-level and high-level features were extracted from the video using VGG-16, one of the convolutional neural networks (CNN).
- Lower layers of CNN were mostly associated with lower visual regions and posterior cingulate cortex, and deeper layers of CNN were associated with more anterior and lateral portions of the visual cortex and the supramarginal gyrus.
- The results of this study would contribute to the understanding of the brain neural processes in naturalistic stimuli where numerous stimuli are given simultaneously.

Project Title: Development of a new deep learning classifier that utilizes both signals derived from gray and white matter regions of 4D-fMRI.
- Supervisors: Dr. Xin Di and Dr. Bharat Biswal
- Objective: To develop a graph neural network classifier that considers gray and white matter regions.
- Considered signals from both gray and white matter to conduct a comprehensive analysis of the brains of individuals with autism.
- Used graph neural networks for functional connectivity-based autism classification.
- When considering both gray and white matters, the classification accuracy was higher, and the standard deviation was lower than when considering only gray matters.
- The success of this study would provide comprehensive insights into autism by analyzing gray and white matters together and improve classification accuracy with reliable evidence for diagnosis, which will provide a better life for patients with autism and their families.

Project Title: Investigating the differences in functional brain networks related to cognitive behavior between patients with Post-Traumatic Stress Disorder (PTSD) and a healthy group.
- Supervisor: Dr. Hai Sun
- Collected data from MRI, fMRI, and fNIRS while subjects perform the N-back Test (0-back, 2-back, 3-back) and resting-state

- Successful completion of this study will help us understand the characteristics of brain networks related to cognitive behavior in patients with PTSD.

HANYANG UNIVERSITY, Seoul, Korea   **03/2018-06/2018**
Researcher, Computational NeuroEngineering (CoNE) Laboratory

Project Title: EMG-based facial recognition for interactive VR applications (03/2018-06/2018)
- Supervisor: Dr. Chang-Hwan Im
- Classified facial EMG signals using the convolutional neural network, which is one of the deep learning technologies, for the expression of VR avatar
- Analyzed sensor data consisting of the subjects' facial expression patterns from a number of sensors attached to the faces and found specific sensors that were significantly related to emotional expression
- Analyzed raw data to improve classification accuracy

Project Title: Development of ECG measuring device and software for real-time monitoring and storing the measured ECG (05/2018-06/2018)
- Created hardware to measure ECG signals using three bioelectrodes
- Used UART serial communication to monitor the measured ECG on the computer in real time
- Used Python GUI language for users to easily check ECG in real time
- Added a function to store the measured ECG for making data to be used for deep learning

KYUNG HEE UNIVERSITY, Yongin, Korea   **03/2016-02/2018**
Research Assistant, Medical Imaging Systems Laboratory

Project Title: Targeted Precision Treatment
- Supervisor: Dr. Soo Yeol Lee
- Objective: To develop a deep learning algorithm that can accurately classify early subtle changes in skin exposed to UV rays
- Designed an optimized convolutional neural network algorithm to accurately classify Raman spectra
- Measured changes in the irradiated skin for the initial diagnosis of skin cancer
- Researched the method of boundary detection in skin diseases using skin cancer phantoms
- Designed the skin cancer phantoms after considering optical characteristics of skin
- Studied for optimized pre-processing methods in Raman spectroscopy to obtain clearer Raman signals

EDUCATION

NEW JERSEY INSTITUTE OF TECHNOLOGY, Newark, NJ, USA,   **09/2021-08/2024**
Master of Science in Biomedical Engineering (Cumulative GPA: 3.68/4.0)
Department of Biomedical Engineering, Graduate School

Research 1: "Analysis of motor neuron characteristics"
- Extracted motor unit spike trains and action potential from high-density sEMG signals.

Research 2: "Investigating brain functional networks from fMRI data using deep learning technology"
- Analyzed what stimulation in the video during movie watching activates which brain network.
- Developed a new deep learning classifier that utilizes both signals derived from gray and white matter regions

Relevant Courses: Medical Imaging Systems, Modeling in Func Brain Imaging, Behavioral & Cognitive Neurosc , Fundamentals of Neuroscience, Clinical Physiology & Neurophy, Fund of Human Physiology, Research Design & Statistics, Responsible Conduct of Research

KYUNG HEE UNIVERSITY, Yongin, Korea   **03/2016-02/2018**
Master of Engineering in Biomedical Engineering (Cumulative GPA: 4.3/4.3)
Department of Biomedical Engineering, Graduate School

Thesis: "Classifying UV-induced changes of skin Raman Spectra using a deep learning algorithm"
- Studied deep learning technology, convolutional neural network algorithm, and characteristics of Raman spectroscopy
- Classified Raman spectra into three categories using the firsthand-developed, parallel-structured convolutional neural network algorithm
- Concluded that the classification using the convolutional neural network algorithm was more accurate than the conventional classification methods in Raman spectroscopy

Relevant Courses: Advanced Artificial Intelligence, Pattern Recognition, Engineering Mathematics, Medical Imaging system, Digital Signal Processing

KYUNG HEE UNIVERSITY, Yongin, Korea   **03/2009-02/2016**
Bachelor of Engineering in Biomedical Engineering (Cumulative GPA: 3.91/4.3)
Department of Biomedical Engineering, College of Electronics and Information

Relevant Courses: Probability and Random Variables, Signals and Systems, Biomedical System Design and Experiment, Neuro Physiology for Biomedical Engineers, Human Physiology for Biomedical Engineers, Biomedical System Modeling, Biomedical Instrumentation, Applied Electronic Circuits, Applied Electronics Laboratory, Logic Circuit

ACTIVITIES

Volunteer, Autistic Children's Art Education, Give Chances	10/2024 - Present
Student Member, BCI Society	09/2024 - Present
Student Member, Organization for Human Brain Mapping	04/2024 - Present
Student Member, Korean Society of Artificial Intelligence in Medicine	11/2019 - Present
Visitor, Brain Machine Interface Summit 2024	08/2024
Visitor, NeuraSeed BCI Expo 2024	08/2024
Visitor, Smart Healthcare Conference	09/2019
Visitor, WIS 2019 Global ICT Trend Insight	04/2019
Visitor, 35th Korea International Medical & Hospital Equipment Show 2019	03/2019
Visitor, AWS Innovate Online Conference 2019	02/2019
Supporter, Funding for Green Children's Foundation	01/2016-Present
Manager, Public Relations Department, OVAL (Our Vision for Asian Leaders) KOREA	09/2011-02/2013

    *an organization consisting of Korean, Chinese, and Japanese university students who jointly hold international business management competitions

Volunteer and event assistant, Korea New Life Welfare Foundation	11/2011
Volunteer, Math and science tutoring	03/2009-08/2009
Volunteer, Korean language assistance	03/2009-05/2009

TEACHING EXPERIENCE

NEW JERSEY INSTITUTE OF TECHNOLOGY, Newark, NJ, USA   **09/2021-07/2023**
Teaching Assistant, Department of Biomedical Engineering

Course: Principles of Medical Imaging, FDA Regulation of Medical Devices (Fall 2021, Spring 2023)
- Supervisors: Dr. Bharat Biswal and Dr. Tara Alvarez
- Evaluated assignments and solved practice exercises and problems.
- Proctored, graded, and marked examinations.

Course: Fundamentals of Engineering Design, Processing Fundamentals for Biological Signals, Intro Biomedical Engineering1, Biomedical Computing, Biomedical Electronics (Fall 2021 - Spring 2023)
- Supervisors: Dr. Xiaobo Li, Dr. Mesut Sahin, Dr. Joel Schesser, and Mr. John Vito
- Created class materials and conducted the classes for some classes.
- Assisted students with their experiments.
- Evaluated assignments and solved practice exercises and problems.

- Proctored, graded, and marked examinations.

KYUNG HEE UNIVERSITY, Yongin, Korea   **03/2016-06/2017**
Teaching Assistant, Department of Biomedical Engineering

   Course: Electromagnetic Fields and Waves, Probability and Random Variables (Spring 2016 - Spring 2017)
- Supervisor: Dr. Soo Yeol Lee
- Evaluated assignments and solved practice exercises and problems
- Proctored, graded, and marked examinations

   Course: Applied Electronics Laboratory (Spring 2016)
- Supervisor: Dr. Kyung Min Byun
- Taught how to use the program used for circuit design and simulation
- Helped and assisted students with their experiments during the classes
- Evaluated students' team projects

COURSE TEAM PROJECTS

Advanced experiment project using an ECG measurement device   **03/2014-06/2014**
- Applied Electronics Laboratory course, Supervisor: Professor Tong In Oh
- Developed a bio-signal measuring device that would detect heart changes and effects of caffeine by measuring ECG and heart rate before and after drinking caffeine
- Selected as an outstanding project

Real life application simulation project using Quartus program   **09/2013-12/2013**
- Logic Circuit course, Supervisor: Professor Yunmo Chung
- Developed a system that would manage parking spaces automatically

Hardware development project using AVR   **09/2013-12/2013**
- Biomedical System Design and Experiment course, Supervisor: Professor Min Hyoung Cho
- Developed automatic volume control earphone that could be applied to more advanced smart hearing machines in the future according to the loudness level of outside sounds using AVR and various IC chips

Software development project using C language   **03/2012-06/2012**
- Programming Basics course, Supervisor: Professor Sungwon Lee
- Developed an electronic ordering system that could be used in restaurants

MILITARY SERVICE

REPUBLIC OF KOREA ARMY, Yongin, Korea   **11/2009-08/2011**
Sergeant, 172nd Regiment, 55th Division

- Took charge of overall administrative works for management of soldiers and reserve forces (furlough, training, etc.)
- Received regular training and learned emergency countermeasures