

Raul C. Sîmpetru, M. Sc.

I research the neural control of the human hand, with a focus on using surface electromyography (sEMG) to predict motor intent in both injured and uninjured individuals (e.g., those with spinal cord injuries and amputations).

My goal is to bridge the gap between existing hardware and the software needed to develop near-human-level assistive devices, providing physiological insights that enhance device functionality and improve user quality of life.

Work Highlights

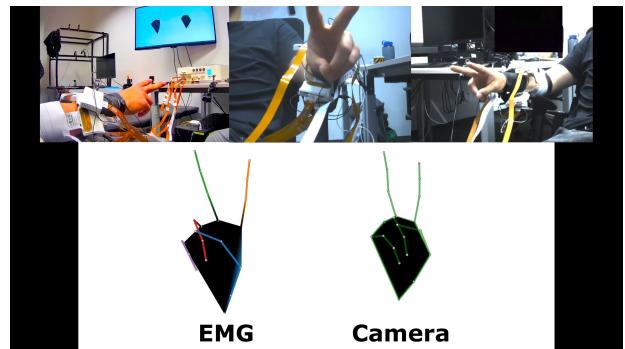
MyoGestic

My lab teammates and I created a real-time interface framework to decode multiple spared degrees of freedom in the hands of individuals with amputations, spinal cord injuries, and spinal strokes.



EMG based real-time control of the hand

In my master's thesis, I developed a custom deep neural network capable of predicting all 21 joints of the human hand in real time.



Experience

Ongoing
12.2023

Research Associate, Neuromuscular Physiology and Neural Interfacing (*N-squared*) Lab, Erlangen, Germany

I am employed by the Bavarian state to conduct my Ph.D. research on neuro-rehabilitation for patients with spinal cord injuries, focusing on developing an intuitive interface for a neuroorthosis to control the paralyzed hand.

Research/Teacher Assistant, Neuromuscular Physiology and Neural Interfacing (*N-squared*) Lab, Erlangen, Germany

I taught a seminar on the neural control of hand movements and conducted research (see publications) on the same topic, focusing on increasing the number of simultaneous degrees of freedom, under the supervision of Prof. Dr. Del Vecchio.

Research Assistant, Fraunhofer Institute for Integrated Circuits (IIS), Tennenlohe, Germany

I integrated a cancer detection pipeline using a few-shot approach into an existing project, ensuring no loss of accuracy, as the pipeline could have significant implications for future patient care.

Teacher and Student Assistant, Machine Learning and Data Analytics Lab, Erlangen, Germany

I held a weekly exercise for the first-semester course "Algorithm and Data Structures for Medical Engineers". In parallel, I developed numerous programs for gait analysis and created a tool for comparing algorithms while maintaining comparative fairness.

Internship, Fraunhofer Institute for Integrated Circuits (IIS), Erlangen, Tennenlohe

I implemented a machine learning solution for semantic segmentation of laparoscopy images.

Student Assistant, University Library, Erlangen, Germany

I automated the transfer of an extensive letter collection (> 18000 letters) from a legacy system into a new international catalogue. The collection can be searched [here](#).

Education

<hr/>	Dr.-Ing. (≡ Ph.D. in Engineering) in Artificial Intelligence in Biomedical Engineering, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany		
Topic	"Rehabilitation of complete motor impaired spinal cord injury patients using non-invasive neural interfaces and artificial intelligence". My work aims to advance rehabilitation techniques and generate knowledge that can be readily applied to the next generation of brain-machine interfaces. These advancements have the potential to benefit the broader public, enabling applications such as accurate muscle force estimation for VR games and enhanced communication with computers through higher-bandwidth interfaces.		
Supervisor	Prof. Dr. Del Vecchio		
<hr/>	MSc Medical Engineering, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany		
Thesis Title	Predicting Hand Movements from Spared Motor Units after Cervical Spinal Cord Injury through an Artificial Intelligence System		
Supervisors	Prof. Dr. Del Vecchio and Dr. Ponfick		
<hr/>	BSc Medical Engineering, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany		
Thesis Title	Robust Prediction of Hand Kinematics from Surface Electromyography using Convolutional Neural Networks and Machine Vision		
Supervisors	Prof. Dr. Del Vecchio and Prof. Dr. Arkudas		
<hr/>	High School, Friedrich-Alexander-Gymnasium Neustadt/Aisch (FAG), Germany		
<h2>Certifications and Awards</h2>			
<h3>Certifications</h3>			
<hr/>	FAU Certificate for Teacher Assistants, Continuing Education Centre for University Teaching (FBZHL) FAU		
<h3>Awards</h3>			
<hr/>	DMEA Young Talent Award, German Health IT Association (bvitg e.V.) I won the 3rd prize for my bachelor thesis.		
<hr/>	Sponsorship Award, Natural History Society Nürnberg My high school science project won an award from the Natural History Society for my experiments on whether the heat of an onion is affected by the amount of light it receives while growing.		
<h2>Skills</h2>			
Programming	Python, Java, JavaScript, Matlab, and C	Engineering	3D Printing, Soldering, and LT-Spice
Machine Learning	High Performance Computing (HPC), Computer Vision, Real-Time Continuous Prediction, and Inference Optimisation	Hardware	Arduino, Raspberry Pi, and NVIDIA Jetson
Technologies	PyTorch, Lightning, Numba, TensorRT, Triton, Gradio, Multi-threading, CUDA, VisPy, and Git	Academia	LATEX, MS-Office, Adobe Photoshop, Adobe Illustrator, Affinity Designer, and Inkscape
<h3>Languages</h3>			
Fluent	English and German	Mother Tongue	Romanian
<h2>Publications and Preprints</h2>			

Papers

07.2024

Sîmpetru, R.C., Arkudas, A., Braun, D.I., Osswald, M., Souza de Oliveira, D., Eskofier, B., Kinfe, T.M., Del Vecchio, A., 2024. Learning a hand model from dynamic movements using high-density EMG and convolutional neural networks. **IEEE Trans. Biomed. Eng.** 1–12. <https://doi.org/10.1109/TBME.2024.3432800>

06.2024

Pfenning, S., **Sîmpetru, R.C.**, Pollak, N., Del Vecchio, A., Fey, D., 2024. Analysis of embedded GPU architectures for AI in neuromuscular applications. **IADIS IJCSIS** 19, 1–14.

03.2024

Sîmpetru, R.C., Cnejevici, V., Farina, D., Del Vecchio, A., 2024. Influence of spatio-temporal filtering on hand kinematics estimation from high-density EMG signals. **J. Neural Eng.** 21. <https://doi.org/10.1088/1741-2552/ad3498>

01.2024

Küderle, A., Ullrich, M., Roth, N., Ollenschläger, M., Ibrahim, A.A., Moradi, H., Richer, R., Seifer, A.-K., Zürl, M., **Sîmpetru, R.C.**, Herzer, L., Prossel, D., Kluge, F., Eskofier, B.M., 2024. Gaitmap—An Open Ecosystem for IMU-Based Human Gait Analysis and Algorithm Benchmarking. **IEEE Open J. Eng. Med. Biol.** 5, 163–172. <https://doi.org/10.1109/OJEMB.2024.3356791>

07.2023

Sîmpetru, R.C., März, M., Del Vecchio, A., 2023. Proportional and Simultaneous Real-Time Control of the Full Human Hand From High-Density Electromyography. **IEEE Transactions on Neural Systems and Rehabilitation Engineering** 31, 3118–3131. <https://doi.org/10.1109/TNSRE.2023.3295060>

02.2023

Küderle, A., Richer, R., **Sîmpetru, R.C.**, Eskofier, B.M., 2023. tpcp: Tiny Pipelines for Complex Problems - A set of framework independent helpers for algorithms development and evaluation. **Journal of Open Source Software** 8, 4953. <https://doi.org/10.21105/joss.04953>

07.2022

Sîmpetru, R.C., Osswald, M., Braun, D.I., Souza de Oliveira, D., Cakici, A.L., Del Vecchio, A., 2022. Accurate Continuous Prediction of 14 Degrees of Freedom of the Hand from Myoelectrical Signals through Convulsive Deep Learning, in: Proceedings of the 2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC). Presented at the **2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)**, pp. 702–706. <https://doi.org/10.1109/EMBC48229.2022.9870937>

07.2022

Cakici, A.L., Osswald, M., Souza de Oliveira, D., Braun, D.I., **Sîmpetru, R.C.**, Kinfe, T., Eskofier, B.M., Del Vecchio, A., 2022. A Generalized Framework for the Study of Spinal Motor Neurons Controlling the Human Hand During Dynamic Movements, in: Proceedings of the 2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC). Presented at the **2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)**, pp. 4115–4118. <https://doi.org/10.1109/EMBC48229.2022.9870914>

Preprints

08.2024

Sîmpetru, R.C., Braun, D.I., Simon, A.U., März, M., Cnejevici, V., de Oliveira, D.S., Weber, N., Walter, J., Franke, J., Höglinder, D., Prahm, C., Ponfick, M., Del Vecchio, A., 2024. MyoGestic: EMG interfacing framework for decoding multiple spared degrees of freedom of the hand in individuals with neural lesions. <https://doi.org/10.48550/arXiv.2408.07817>

05.2024

Sîmpetru, R.C., Oliveira, D.S. de, Ponfick, M., Del Vecchio, A., 2024. Identification of Spared and Proportionally Controllable Hand Motor Dimensions in Motor Complete Spinal Cord Injuries Using Latent Manifold Analysis. <https://doi.org/10.1101/2024.05.28.24307964>

Talks and Presentations

Oral Presentations

26.06.2024

Uncertainty aware hand posture classification for better assistive devices in spinal cord injury patients, International Society of Electrophysiology and Kinesiology Congress (ISEK 2024)

13.12.2023

Can we use AI to find the unharmed motor dimensions and give them back to the patient? (one of only eight oral presentations), Neurophysiological Bases of Human Movement (The Physiological Society)

Poster Presentations

14.07.2022

Presenting colleague's paper, 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)

12.07.2022

Presenting own paper, 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)

Professional Affiliations

2023

The Physiological Society, Graduate Student Member

2022

Institute of Electrical and Electronics Engineers (IEEE), Member

2022

IEEE Engineering in Medicine & Biology Society (IEEE EMBS), Member

2021

Fraunhofer Alumni Network, Member