

Nitzan Luxembourg

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RESEARCH FOCUS

Naturalistic motor control decoded from high-resolution surface electromyography. I build estimation and sequence models that recover movement from soft printed electrode array recordings under unconstrained conditions, including real-time gesture decoding, for assistive interfaces and movement disorders.

Publication record: 4 peer-reviewed papers (3 first-author) and 2 manuscripts in preparation — full list on page 2.

EDUCATION

- Ph.D., Electrical and Computer Engineering** | Tel Aviv University · 2024–present
Supervisors: Prof. Yael Hanein (TAU) and Prof. Hava Siegelmann (UMass Amherst)
- M.Sc., Brain Sciences (Computation & Information Processing)** | Hebrew University of Jerusalem · 2020–2024
Advisor: Prof. Idan Segev · GPA 90.4 · Thesis 92.5 · Final examination 94
- B.Sc., Computer Science (Minor: Computational Neuroscience)** | Hebrew University of Jerusalem · 2017–2020
GPA 90.3 · Class rank 92 / 369

RESEARCH EXPERIENCE

- Naturalistic Motor Control Using High-Resolution sEMG** | Tel Aviv University · 2024–present
- Built and validated an estimation pipeline that recovers finger joint angles and discrete gestures from soft printed electrode array recordings under dynamic hand position, benchmarked against computer-vision hand tracking.
 - Developing sequence models that segment continuous sEMG–IMU recordings into variable-duration tokens, testing whether natural movement decomposes into a reusable vocabulary of elementary actions; manuscript in preparation.
 - Building a real-time decoding pipeline that carries this offline estimation work into online operation, for low-latency gesture-driven interaction; early stage.
 - Developing an IMU-referenced decomposition algorithm for sEMG based on coupled non-negative matrix factorization, validated on lower-limb recordings in Parkinson’s disease with and without freezing of gait; manuscript in preparation.
- Single-Neuron Functional Analysis: An Information-Theoretic Approach** | Segev Lab, Hebrew University of Jerusalem · 2021–2024
- Showed that neurons are not computationally interchangeable: human L2/3 pyramidal cells carry measurably more information than rat L5b, dendritic morphology accounts for part of the gap, and removing NMDA nonlinearity collapses complexity in every model — evidence that single-cell biophysics, not only circuit wiring, sets a neuron’s computational capacity.
 - Built the measures that make such comparisons possible — a firing-rate-invariant entropy and statistical-complexity measure of output spike trains, plus an objective network-depth benchmark replacing subjective model comparison — letting any neuron model be placed on a common complexity scale.
- Neural Decoding of Visual Attention from EEG** | Hebrew University of Jerusalem · 2019–2020
- Applied machine-learning classifiers to EEG recordings to decode covert visual attention; undergraduate research project, exploratory.

TEACHING

- Teaching Assistant, Dynamical Systems and the Neuron — Hebrew University of Jerusalem, 2021–2022
- Teaching Assistant, Brain–Computer Interfaces as Assistive Technology — Hebrew University of Jerusalem, 2021–2022

TECHNICAL SKILLS

- Programming:** Python, C, C++, Java
- Machine Learning:** PyTorch; deep learning, transformers, temporal convolutional and autoregressive sequence models, non-negative matrix factorization
- Signals & Instrumentation:** Surface EMG, EEG, IMU; high-density soft electrode array recording, Arduino/embedded prototyping, computer-vision motion capture
- Interactive Systems:** Unity, real-time gesture-driven interfaces, low-latency decoding pipelines
- Domain:** Motor control, computational neuroscience, brain–computer interfaces; information theory (entropy estimation), biophysical compartmental modeling

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Publications

PEER-REVIEWED PUBLICATIONS

- Teitelbaum, D., Ibrahim, R., Man, H., **Luxembourg, N.**, Re, D., & Hanein, Y. (2026). Multimodal quantification of cognitive load using a printed wearable facial bio-potential system. *Journal of Neural Engineering*, 23, 046029. doi:10.1088/1741-2552/ae89e9
- **Luxembourg, N.**, Fekadu Marew, R., Teitelbaum, D., Ben-Dov, D., Siegelmann, H., & Hanein, Y. (2025). Finger joint angle and gesture estimation under natural conditions with a soft printed electrode array. *APL Bioengineering*, 9(4), 046103. doi:10.1063/5.0270645
- **Luxembourg, N.**, Ben-Dov, D., Fekadu Marew, R., Teitelbaum, D., Vèbraitè Adereth, I., & Hanein, Y. (2025). Capturing dynamic finger gesturing with high-resolution surface electromyography and computer vision. *Journal of Visualized Experiments*, (217), e67766. doi:10.3791/67766
- **Luxembourg, N.**, Vèbraitè, I., Siegelmann, H., & Hanein, Y. (2025). Finger joint angle and gesture estimation under dynamic hand position using a soft printed electrode array. *47th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, Copenhagen, Denmark, 1–7. doi:10.1109/EMBC58623.2025.11254337

MANUSCRIPTS IN PREPARATION

- **Luxembourg, N.**, Siegelmann, H., & Hanein, Y. Deconstructing motor signals: from variable-duration sEMG–IMU tokens to elementary actions and the syntax of natural movement.
- **Luxembourg, N.**, Siegelmann, H., & Hanein, Y. IMU-referenced decomposition of lower-limb sEMG using coupled non-negative matrix factorization: a proof-of-concept study in Parkinson’s disease with and without freezing of gait.

CONFERENCE PRESENTATIONS

- Poster — 47th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Copenhagen, Denmark, 2025.
- Talk — “Finger Joint Angle and Gesture Estimation in Dynamic Hand Postures Using a Soft Printed Electrode Array.” IEEE International Conference on the Science of Electrical Engineering (ICSEE), Jerusalem, June 2026 (presented by a colleague); Physical Electronics Department Meetup, Tel Aviv University, February 2026.
- Poster — Karniel Computational Motor Control Workshop (KCMCW), Tel Aviv University, 2026.
- Poster — 14th Annual Nano Workshop, Jan Koum Center for Nanoscience and Nanotechnology, Tel Aviv University, 2026.