Tamás Karácsony

Ph.D. Candidate

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Summary

I research AI-based diagnosis support systems, focusing on human motion analysis and video-based epileptic seizure classification. My work addresses challenges in action recognition on scarce medical data, requiring efficient data utilization, scalable model design, transfer learning, and synthetic data generation. I integrate AI, biomedical engineering, and neuroscience, applying deep learning to TB-scale clinical datasets while ensuring compliance with medical AI regulations (GDPR, ethics). Over six years of clinical collaboration, my work has led to high-impact publications, two provisional patents, and AI models tested in clinical applications. I am interested in extending action recognition and medical AI models with LLMs and developing generalizable decision support systems, to enhance explainability and adaptability.

Computer Vision	Action recognition, Human Pose Estimation (HPE), Synthetic Data Augmentation [1]–[5], [7], [9]–[11]
Machine Learning	Vision and Motion Transformers, 3D CNNs, GCNs, LSTM, Transfer learning [1], [2], [4], [6]–[11]
AI in Healthcare	Diagnosis support, Advanced Human Sensing, Human Motion Analysis [1], [2], [4], [7]–[11]
Biomedical Engineering	Research and diagnosis support systems for Epilepsy, Neuroengineering, Brain-computer interfaces (BCI) [1]–[11]

Research Experience

INESC TEC - Institute for Systems and Computer Engineering, Technology and Science

Porto, Portugal

Researcher and Ph.D. Candidate — *Sept. 2019 - Present*

- **Machine Learning research:** Developed and trained architectures of action recognition approaches for semiology-based epileptic seizure classification with transfer learning, first based on 3D CNN and LSTM architectures [2], [7], then with 2 stage, Human Pose Estimation (ViTs) [9], [4] and skeleton based action recognition [1], [10], [11] in a distributed computing environment, on GPU clusters. Addressed the blanket occlusion of in-bed HPE with synthetic blanket occlusion data augmentation of HPE datasets for HPE architecture training [9], [4]. Published the research outcomes in leading venues i.e Scientific Reports, Image and Vision Computing.
- **Clinical Collaborations & Data Acquisition:** Research collaboration with clinicians from Neurology departments of Ludwig Maximilian University of Munich (LMU), Germany and São João University Hospital, Porto, Portugal (CHUSJ) on video-based seizure analysis, including setting research agenda for AI-based diagnosis support systems, MLOps and data collection [2], [3], [5]–[7], [10], [11]. Additionally, managed and facilitated the acquisition of multiple novel, large-scale datasets, including 1.2 TB simulated epileptic action dataset [3], [10], 15+ TB clinical 4K RGB-D-IR data, and 720p RGB clinical seizure video data [11]. Developed software for data acquisition systems [3], custom data labeling, processing, and transfer systems [6], and deployed them on-site, while ensuring compliance with GDPR & ethics regulations.
- **Research Leadership & Supervision:** Responsible for setting and carrying out the research agenda of the research line of video-based epileptic seizure diagnosis support. Supervised and co-supervised over the years two contracted researchers, four M.Sc. theses, four B.Sc. internships, and a visiting research scholar in topics of synthetic data generation, and human pose estimation for in-bed scenarios, action and gesture recognition applied for epileptic seizure classification, human motion analysis, MLOps and data acquisition from clinics.
- **Computational Infrastructure:** Managed GPU clusters, Docker containers, and compute resources and advised on hardware requirements based on research needs, code contributions were hosted on institutionally-managed GitLab and internal servers due to regulatory constraints
- **Intellectual Property & Patents:** Two provisional patents in progress related to seizure classification, and AI-based diagnosis support.

Research Assistant — *Febr. - July 2019*

- Writing my master thesis: “Motion-based epileptic seizure classification with deep learning”.

Education

Carnegie Mellon University

Pittsburgh, USA

Visiting Research Scholar - Carnegie Mellon Portugal Affiliated Ph.D. program — *2023 - 2024*

- **Advisors:** Prof. Fernando De La Torre and Prof. László A. Jeni
- Worked with Human Pose Estimation (VitPose, MotionBERT), Skeleton and Video based Action recognition (PoseC3D, ST-GCN++, Uniformerv2, I3D) for clinical applications. [1], [10]

Faculty of Engineering, University of Porto

Porto, Portugal

Ph.D. in Electrical and Computer Engineering - Carnegie Mellon Portugal Affiliated Ph.D. program — *2021 - (Expected: September 2025)*

- **Advisors:** Prof. João Paulo Cunha (FEUP, INESCTEC) and Prof. Fernando De La Torre (CMU)
- Ph.D. Thesis working title: ”Advancing AI in Healthcare: Action Recognition and Human Pose Estimation for Epileptic Seizure Classification” [1]–[7], [9]–[11]

Technical University of Denmark *Copenhagen, Denmark*

M.Sc. in Biomedical Engineering *2016 - 2018*

- Graduated with **"Highest Honours."**
- Master Thesis: "Hybrid motor imaginary brain computer interface and virtual reality based system for neurorehabilitation of stroke patients, employing deep learning classification" (Grade: 12/12), part of the thesis served as a basis for the publication [8].

Budapest University of Technology and Economics *Budapest, Hungary*

M.Sc. Mechatronics Engineering *2016 - 2020*

- Graduated with **"Excellent with Highest Honors"**
- Master Thesis: "Motion Based Epileptic Seizure Classification with Deep Learning" (Grade: 5/5)

Faculty of Engineering, University of Porto and INESC TEC *Porto, Portugal*

Erasmus Exchange semester *Febr. - July 2019*

Budapest University of Technology and Economics *Budapest, Hungary*

B.Sc. Mechatronics Engineering *2012 - 2016*

- Graduated with **"Excellent"**
- Bachelor Thesis: "Analysis of amputated limb and prosthesis socket connection using the finite element method" (Grade: 5/5)

Skills

Programming languages	Python, Matlab, LaTeX, C/C++, C#
Software libraries	Pytorch, Tensorflow, Scikit-learn, Numpy, Matplotlib, OpenCV, Pandas
Other	Git, Docker
Languages	English (C1), Hungarian (Native), German (Elementary)

Publications

Journal Articles

[1] **T. Karácsony** et al. "Deep learning methods for single camera based clinical in-bed movement action recognition". In: *Image and Vision Computing* 143 (2024).

[2] **T. Karácsony** et al. "Novel 3D video action recognition deep learning approach for near real time epileptic seizure classification". In: *Scientific Reports* 12.1 (2022).

Peer-Reviewed Conference Proceedings

[3] **T. Karácsony** et al. "NeuroKinect4K: A Novel 4K RGB-D-IR Video System with 3D Scene Reconstruction for Enhanced Epileptic Seizure Semiology Monitoring". In: *IEEE EMBC* (2024).

[4] J. Carmona, **T. Karácsony** et al. "BlanketGen - A Synthetic Blanket Occlusion Augmentation Pipeline for Motion Capture Datasets". In: *IEEE ENBENG* (2023).

[5] J. Carmona, **T. Karácsony** et al. "BlanketSet-A Clinical Real-World In-Bed Action Recognition and Qualitative Semi-Synchronised Motion Capture Dataset". In: *IEEE ENBENG* (2023).

[6] **T. Karácsony** et al. "Deepepil: Towards an Epileptologist-Friendly AI Enabled Seizure Classification Cloud System based on Deep Learning Analysis of 3D videos". In: *IEEE BHI* (2021).

[7] **T. Karácsony** et al. "A deep learning architecture for epileptic seizure classification based on object and action recognition". In: *IEEE ICASSP* (2020).

[8] **T. Karácsony** et al. "Brain computer interface for neuro-rehabilitation with deep learning classification and virtual reality feedback". In: *Proceedings of the 10th Augmented Human International Conference* (2019).

Pre-prints and Submissions

[9] **T. Karácsony** et al. "BlanketGen2-Fit3D: Synthetic Blanket Augmentation Towards Improving Real-World In-Bed Blanket Occluded Human Pose Estimation". In: *arXiv preprint arXiv:2501.12318* (2025).

[10] **T. Karácsony** et al. "Exploring Image and Skeleton-Based Action Recognition Approaches for Clinical In-Bed Classification of Simulated Epileptic Seizure Movements". In: *Submitted, Under review* (2025).

[11] R. Aslani, **T. Karácsony** et al. "Video-based Epileptic Seizure Classification: A Novel Multi-stage Approach Integrating Vision and Motion Transformer Deep Learning Models". In: *Submitted* (2025).

Honors & Awards

International Awards

2024 **Innovation and Contribution to the field of AI** *Dubai, UAE*
IEEE AI Research Hub Competition, at GITEX GLOBAL "Largest Tech & Startup Show in the World"

Certificates

2024 **ACM Europe Summer School on HPC Computer Architectures for AI and Dedicated Applications**
ACM, Association for Computing Machinery

2024 **From Portugal to the World Innovation-to-Business Journey**
Cockrell School of Engineering, The University of Texas at Austin

2024 **INvicta school of VIsion,Computational intelligence, and patTern Analysis**
INVICTA School

2021 **VISUM 2021 (online edition), the 9th edition of the Vision Understanding and Machine Intelligence summer school**
VISUM summer school

2020 **VISUM 2020 - Summer School on Vision Understanding and Machine Intelligence**
VISUM summer school

Professional Services

Reviewer

Conferences

- CVPR 2025, ECCV 2024, MICCAI 2024-2025, IEEE ICASSP 2024–2025, IEEE AIVR 2020–2022, EAI Mobihealth 2022, IEEE TENCON 2019

Journals

- *Computer Methods and Programs in Biomedicine* (2023), *Neural Regeneration Research* (2023)

Program Committee Member

Workshop

- Workshop on AI and Advanced Human Sensing, AIMS Meeting 2021 (INESC TEC, FMUL, Virtual)

Presentations/Invited talks

Computer Vision in Human Motion Analysis for Biomedical Applications *Porto, Portugal*
Biomedical Engineering seminars, FEUP *2024*

3D Scene Reconstruction and 4K RGB-D-IR Video For Epileptic Seizure Monitoring: Introducing NeuroKinect4K *Porto, Portugal*
Ciência 2024, Encontro com a Ciência e Tecnologia em Portugal *2024*

In-bed action recognition for clinical diagnosis support: A two-stage, 3D motion capture and skeleton action recognition based approach *Porto, Portugal*
5th Doctoral Congress in Engineering *2023*

- Best Paper award

Explainable Deep Learning Based Epileptic Seizure Classification with Clinical 3D Motion Capture *Pittsburgh, USA*
CMU Portugal *2023*

- PhD Research Presentation During Visit of Elvira Fortunato, Portuguese Minister of Science, Technology and Higher Education

Explainable Epileptic Seizure Classification: A 2-stage Pipeline *Lisbon, Portugal*
CMU Portugal summit *2022*

3D Motion capture technologies for clinical patient monitoring – a short summary *Lisbon, Portugal*
Ciência 2022, Encontro com a Ciência e Tecnologia em Portugal *2022*

An Epileptologist-Friendly Cloud-Based Remote 3Dvideo-EEG Processing Environment For Quantifed Semiology Analysis *Lisbon, Portugal*
Juntos Pelo Fernando Conference *2020*

Volunteer work

INESC TEC - Institute for Systems and Computer Engineering, Technology and Science

Porto, Portugal

PhD Student Representative

Nov. 2024 - Present

- Building PhD student representation with 11 representatives from 11 centers, advocating for student needs, and bridging communication with the INESC TEC board.

Collage of Engineering - Student Society, Budapest University of Technology and Economics

Budapest, Hungary

Vice-president

2015 - 2016

- Led a student society of ≈400 members, oversaw and coordinated it with 13 section leaders, negotiated and secured industry partnerships, and organized large-scale events.

Section of Mechatronics - Student Society, Budapest University of Technology and Economics

Budapest, Hungary

Member, Team Leader, Vice President

2012 - 2016

- Managed section activities, mentored team members, and built partnerships with external stakeholders.