

Post-Doc position 12 months in video-based gait disorders recognition with multimodal LLM

Summary:

Profil	: PhD in Automation / Computer Science / Biomedical Engineering / Electrical Engineering / Biomechanics
Subject	: Automatic learning and recognition of gait disorders based on video data
Mission	: Development of diagnostic tools for gait disorders based on a pose detection system and a multimodal LLM

Context:

The LAMIH UMR CNRS 8201 has been conducting research into mobility and disability for almost 20 years. Numerous projects have been carried out, ranging from the creation of mechatronic and robotic devices [1] to biomechanical modeling for fall risk analysis [2]. One of the main strengths of this laboratory is its multi-disciplinary approach, which translates into a biopsychosocial [3] approach to scientific problems, giving equal importance to environmental and personal factors in the study of mobility. In this way, the quantified analysis of movement has evolved towards the consideration of multimodal data.

This research project stems from a paradigm shift in the field of motion capture for healthcare, following recent advances in multimodal learning analysis systems. The main motion capture tools, based on optoelectronic systems, have been used for the past 40 years to distinguish and classify gait disorders, whether of neurological or orthopedic origin. These costly and cumbersome tools restricted motion capture to laboratories equipped with these systems. Recently, however, advances in motion analysis based on pose estimation using video streams [4] have made it possible to capture motion freely under ecological conditions. In addition, advances in the use of large language models (LLM) for multimodal analysis combining video and text [5] open the way to a combination of pose detection and classification according to factors known from the medical scientific literature.

In this context, this research project aims to provide new answers through the design and production of a platform based on a pose detection system and a multimodal LLM, enabling the development of diagnostic tools for gait disorders.

Research work will be carried out in close collaboration with researchers from the LAMIH UMR CNRS 8201 in Valenciennes (France) and the LIVIA, LIO and IRL CNRS ILLS laboratories at the École de Technologie Supérieure (ÉTS) in Montreal (Canada). The project will involve several months' mobility in Canada.

Goals:

- Optimize pose detectors (using, e.g., OpenPose, MMpose, and Theia) for the analysis of human movements in video sequences.
- Identify the main factors associated with gait disorders and the risk of falling.
- Develop specialized machine learning and computer vision models to recognize risk behaviors associated with gait and balance disorders.
- Integrate an LLM to analyze and interpret video and text data associated with gait disorders.
- Design and implement a diagnostic support platform using the technologies developed.
- Validate the tools and platform through experiments under ecological conditions.

Missions:

- Conduct collaborative research with LAMIH in France and LIVIA, LOI and IRL ILLS at ÉTS Montréal in Canada to develop innovative tools for detecting gait disorders.
- Specification of the platform, participation in its design: definition of its architecture, technological choices, etc.
- Publish research results in scientific journals and international conferences.
- Participate in writing reports and technical documents.
- Collaborate with researchers, engineers, clinicians and other partners to integrate research results into practical applications.

Applicant profil:

- PhD in automation, computer science, biomedical engineering, biomechanics, electrical engineering or related field.
- Demonstrated experience in computer vision, machine learning and video analysis.
- Knowledge of pose detection and human motion analysis techniques.
- Familiarity with large multimodal language models (LLM) and their application.
- Programming skills (Python, C++, etc.) and use of machine learning libraries (TensorFlow, PyTorch, etc.).
- Good written and oral communication skills in English.
- Ability to work independently and as part of a team.

Salary: 2 221,30 € minimum per month (adaptable according to experience)

Application : CV, motivation letter, recommandations sent to :

Mathias Blandeau (Mathias.Blandeau@uphf.fr) and Philippe Pudlo (Philippe.Pudlo@uphf.fr)

[1] <https://www.uphf.fr/lamih/departements/automatique/projets/rehabbyexo>

[2] <https://www.uphf.fr/lamih/departements/automatique/projets-departement-automatique/serich>

[3] Engel G. L. (1977). The need for a new medical model: a challenge for biomedicine. *Science (New York, N.Y.)*, 196(4286), 129–136. <https://doi.org/10.1126/science.847460>

[4] Stenum, J., Hsu, M. M., Pantelyat, A. Y., & Roemmich, R. T. (2024). Clinical gait analysis using video-based pose estimation: Multiple perspectives, clinical populations, and measuring change. *PLOS digital health*, 3(3), e0000467. <https://doi.org/10.1371/journal.pdig.0000467>

[5] Tang, Y., Bi, J., Xu, S., Song, L., Liang, S., Wang, T., Zhang, D., An, J., Lin, J., Zhu, R., Vosoughi, A., Huang, C., Zhang, Z., Zheng, F., Zhang, J., Luo, P., Luo, J., & Xu, C. (2023). Video Understanding with Large Language Models: A Survey. *ArXiv*, abs/2312.17432.