MODERN AI MEETS BIOMECHANICS: A NEW PARADIGM FOR *IN SILICO* MEDICINE

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Modern AI

Modern artificial intelligence (AI) has been intensively investigated in many fields ranging from computer vision to precision medicine. Different learning strategies such as deep learning, transfer learning or reinforcement learning have been developed to shift from applied artificial intelligence to the general artificial intelligence level. Advanced AI-driven models and tools have been developed to deal with multimodal biomedical data (scalar, text, image, signal, video).

Modern AI meets Biomechanics

In this new era, the Biomechanics field has been also metamorphosed with new AI-driven models and decision supports. AI technologies have been deployed with different perspectives such as computation speed augmentation, data interpolation/assimilation and physics/biology augmentation (synthetic data, in silico trials, hybrid modeling). Different methodologies to use AI have been also proposed such as single-AI approach, combination-AI approach or hybrid Physics-AI (Physics-Informed, Physics-Augmented, AI-embedded) approach.

Recent Advances

In this talk, we will present our recent discoveries in human locomotion learning [1-3] (Fig. 1), face/skull metamorphosis processes [4] (Fig. 2), and real-time soft tissue deformation [5-6] (Fig. 3) using different modern AI approaches (deep learning, transfer learning and reinforcement learning). Clinical applications related to ageing fall recovery and prevention, facial palsy rehabilitation and childbirth decision support will be presented and discussed.

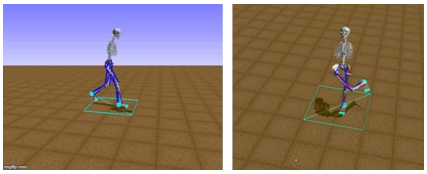

Figure 1: Reinforcement learning and transfer learning for human falls learning and recovery.

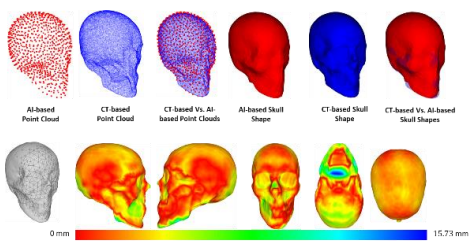

Figure 2: Deep learning for face/skull metamorphosis.

Tien-Tuan Dao is Professor at the Department of Mechanical Engineering, Centrale Lille Institut (France). He is coordinating the Biomechanics of Soft Tissues group. Prof. Dao's research interest focuses on the study of the pathogenesis and salutogenesis processes of complex bio-systems (face, lumbar spine, pelvis, lower limbs) toward novel predictive and preventive cares. He is an author of around 50 publications in peer- reviewed journals, 13 book chapters and more than 100 contributions to international and national conferences. He has been a chairperson, session organizer and program committee member at leading international biomechanics meetings (e.g. International Conference on Computational Bioengineering 2017, World Congress of Biomechanics 2018, 2022, ESB 2022, Virtual Physiological Human 2022).

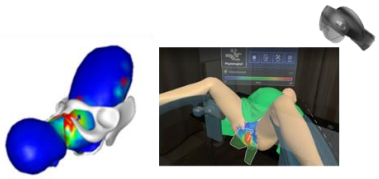

Figure 3: Deep learning for real-time soft tissue deformation: physiological and forceps-assisted childbirths.

Future directions

Modern AI brings new predictive and preventive capacities with emerging data and behaviors to study the human body systems and associated disorders. Before deploying in the clinical routine practice at a large scale, model explainability, user safety, ethical issues (error responsibility, data privacy) should be carefully addressed.

References

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Acknowledgements

The author would like to thank the Métropole Européenne de Lille (MEL) and ISITE ULNE (R-TALENT-20-009-DAO), SCAI, Hauts-de-France region and Labex MS2T for funding.