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BIOMECHANICS: SOME MULTI-LEVEL CHALLENGES FOR ARTIFICIAL INTELLIGENCE

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1 INTRODUCTION

From more than 30 years ago, the authors have been trying to answer to different challenges in biomechanics, particularly regarding orthopedic applications. It all started with the development of a hip prosthesis of controlled variable stiffness [1, 2, 3], but also considering diagnostic, prosthesis and regeneration [4] and investigating towards the design of an intelligent hip prosthesis [5, 6].

2 CHALLENGES AT DIFFERENT LEVELS

2.1 SENSORS AND ACTUATORS

Sensors and actuators are part of the challenges. From piezoelectric actuators, taking inspiration in nature for osteoblast stimulation to double permanent magnet vibration power generator for smart hip prosthesis have been part of research already done, but still present huge challenges.
It is important to alter the course of technologies to monitor loosening states of endoprosthesis implants [7] and going towards an effective sensing technology to monitor micro-scale interface loosening of bioelectronic implants [8]. The challenges will be to develop sensing and actuating capabilities, look to nature and apply machine learning to generate new knowledge to human locomotion and be able to design more efficient, durable and smart prosthesis [9]. That must be combined with opportunities given by exoskeleton technologies for locomotor assistance [10].

2.2 ARTIFICIAL INTELLIGENCE

The integration of biomechanics and artificial intelligence (AI) presents challenges that demand different and innovative scientific research approaches. Biomechanical analysis (e.g., kinematic, dynamic, and physiological data) of complex biological systems require AI machine learning algorithms that are capable of capturing non-linear interactions. However, the interpretability and validation of AI models in biomechanics are crucial, since they must be in accordance with biological mechanical principles to provide reliable scientific insights, mainly for human practical applications.

The big challenge is to know how to take advantage of AI. Some related biomechanical research areas must include:

1. Data Analysis and Modeling
2. Personalized Medicine and Rehabilitation
3. Wearable Technology
4. Robotics and Prosthetics
5. Sports Performance
6. Surgical Planning and Precision
7. Automation of Research.

2.3 Low-cost prosthesis

Bearing in mind the costs of most updated technologies, it is important to develop solutions less costly and integrate an efficient application. This is applicable to situations where the war brings great needs for limb prosthesis, as well as to normal situations in order to reduce costs of the health services and supplying the population needs.

3 CONCLUSIONS

This paper will present a review of work done by the authors to support a prospective scenario for R&D in biomechanics at different levels and to launch the discussion on the future of integration of AI in biomechanical research contexts. The intersection of these fields promises to enhance our understanding of human health problems. Addressing these challenges will pave the way for adaptive AI systems that will contribute to the future of biomechanics.

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