The Institution of Engineering and Technology

IET National Travel Award Report

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The conference I have attended is the International Mechanical Engineering Congress and Exposition 2022. The conference is one of the most famous and largest conferences in the field of mechanical engineering, which covers the topics of energy, biomechanics, aerospace, control, sensors and actuators, etc. My participation in this conference was in the section of “Injury and Damage Biomechanics” section, which focuses on the biomechanics and computational modeling of traumatic brain injury and spinal and musculoskeletal damage.

In this section, I presented my research work entitled “Mouthguard denoising for more accurate brain strain calculation with one-dimensional convolutional neural network”. In this study, I focused on how to leverage artificial intelligence to make head kinematics measurement more accurate for the detection of dangerous head impacts. This work centers on the topic of traumatic brain injury (TBI). TBI has become a global health threat. In 2016, over 27 million cases of TBI were reported globally. The fast diagnosis and early warning approaches of TBI are significant to helping prevent repetitive sport-related TBI. Conventionally, brain injury criteria (BIC) have been developed to estimate TBI risks. More recent studies have shown brain strain (maximum principal strain, MPS) and strain rate (MPS rate, MPSR) based on brain-physics-based finite element modeling (FEM) are promising mechanical parameters well correlated with TBI pathologies including blood-brain-barrier disruption and axonal injury. The head kinematics are the input to compute BIC, brain strain and strain rate. Researchers have developed wearable sensor technologies to precisely measure the head kinematics with systems like head impact telemetry system (HITS), Xpatch and instrumented mouthguard. The instrumented mouthguard attaches the sensors to the dentition and enables the rigid coupling with the skull for more precise measurement of the head rotation. Although the instrumented mouthguards showed the capability to precisely measure the head kinematics that correlates well with TBI results, the measurement are far from the reference kinematics measured by sensors directly implanted into the anthropomorphic test dummy (ATD) head due to the potential loosening of the mouthguard and electronic noises of the sensors. In this study, we apply deep learning to denoise the mouthguard kinematics to better represent head kinematics measured by sensors in a dummy head. The presentation was recognized by the colleagues working in this field and I got a significant sense of achievement.

As for my personal career planning, I am planning to be a professor and educator in the TBI biomechanics field. The IET National Travel Award really supported my career planning by providing me with a great ladder to have a panorama of the research now happening at the leading edge of injury biomechanics. The attendance in the IMECE 2022 conference in Columbus, Ohio, really broadened my horizon. It was during the talks and the communication with the mechanical engineers that I understood that there is a huge stage full of research opportunities in the field of injury biomechanics. Data driven research work as well as artificial intelligence can really play an important role in solving the problems we have seen in the traumatic brain injury field. Meanwhile,

I passionately presented my work of deep learning mouthguard denoising at the conference, which was recognized by many colleagues in the field. This also further motivated me with a strong sense of achievement. All of the technical and mental development was enabled by the IET National Travel Award. From my point of view, this award serves as the motivation for me to start another journey on my research work. I will dedicate myself to delve into the missing link between the brain deformation and the TBI pathologies and model the relationship for the benefit in TBI prevention.

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