Docket #: S20-133

Real-time brain strain calculation and visualization using deep learning

Stanford researchers at the Camarillo Lab have developed a neural-network based model that can provide real-time calculation of brain strain based on instrumented mouthguard kinematics signals. This fast and accurate calculation can help better protect athletes wearing the instrumented mouthguard disclosed in Stanford docket S15-432.

Current approaches for head impact measurement such as finite element analysis (FEA) are much slower and do not use real-time models based on the complex dynamics of the head-brain interface to predict and visualize brain strain. This new neural-network model is dramatically faster, easier to interpret, and can calculate detailed spatial resolution of brain strain, showing metrics (maximum principal strain) in each of the elements of the brain.

Figure description:
Flowchart introduction of the model.

Figure description:
The visualization of the effectiveness and accuracy of the deep learning head model.

Stage of Development

- Prototype

Applications

- **Mild traumatic brain injury (mTBI) diagnostics**
- Can be used by **Sports teams and Researchers**

Advantages

- **Accurate and real-time calculation of brain strain calculation**
- **Fast calculation** - the new model is much faster (1s for one impact) compared to conventional FEA (hours for one impact)
- **Detailed spatial resolution of brain strain**, showing metrics (maximum principal strain strain) in each of the elements of the brain
- **Easy to interpret** – users without FEA experience can easily understand results

Publications

- Zhan, Xianghao, Yuzhe Liu, Samuel J. Raymond, Hossein V. Alizadeh, August G. Domel, Olivier Gevaert, Michael Zeineh, Gerald Grant, and David B. Camarillo. Deep Learning Head Model for Real-time Estimation of Entire Brain Deformation in Concussion. arXiv preprint arXiv:2010.08527 (2020)

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