**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.

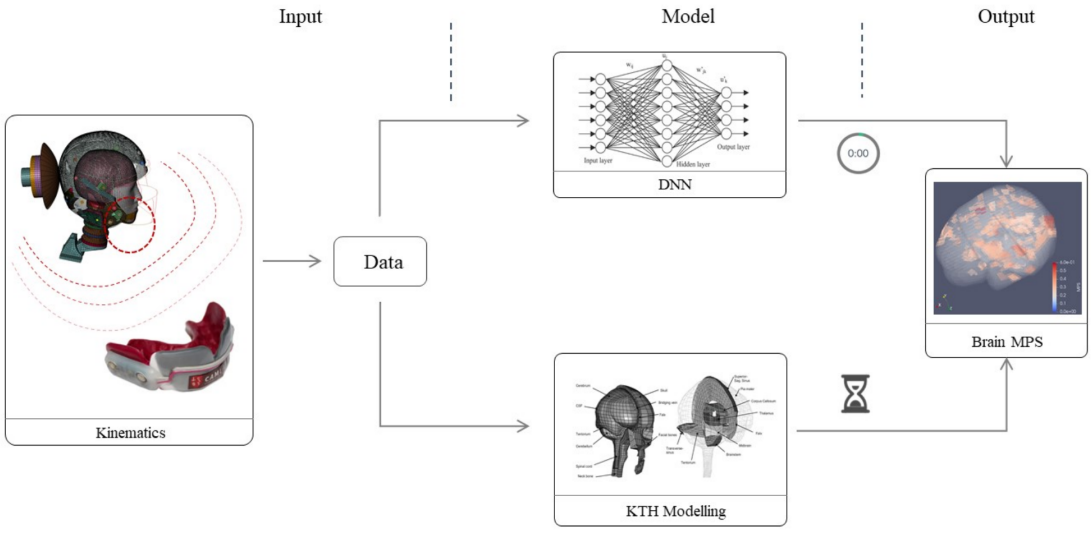



**Figure description:**
Flowchart introduction of the model.

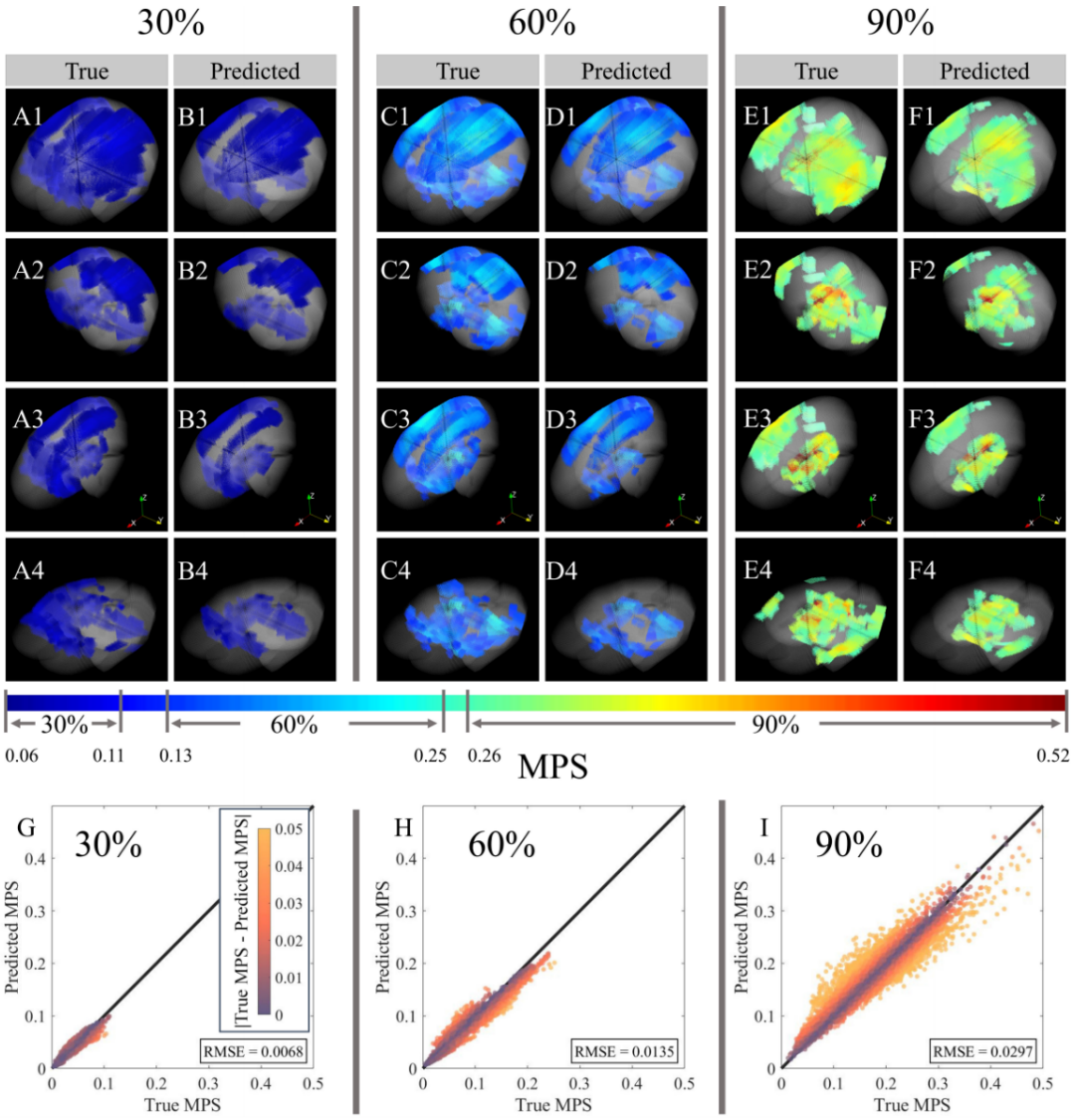



**Figure description:**

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)


## Innovators

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