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2015 SEMINAR SERIES PRESENTS

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Co-sponsored with the Department of Mechanical & Materials Engineering

Dr. Shailesh Ganpule

Hopkins Extreme Materials Institute
John Hopkins University

Keep your Head in the Game: The Mechanics of Traumatic Brain Injury in Sports

The human brain is an extraordinary organ that is arguably the most important part of the body. It is also a complex soft structure that is subjected to dynamic loading through a human lifetime. This seminar describes how this structure is protected, and examines the conditions under which the protection fails, leading to traumatic brain injury (TBI). Our particular interest is in injuries arising within sports.

We present here a subject-specific computational modeling approach that integrates information on the events that cause TBI with high-fidelity models of the anatomy and physiology of the living human brain to study the onset and specific forms of traumatic brain injury. Our approach (viewed as an “upstream” approach by the clinical community) provides guidance on the likely domains of injury, the likely cognitive deficits, and on the potential approaches to treatment. The model captures the essential features of diffuse axonal injury, which is characterized by damage to neural axons, using an axonal strain injury criterion. A subject-specific model incorporates detailed structural information of the brain tissue obtained using MRI and DTI. Brain tissue is modeled as an anisotropic and viscoelasticity is also included. Further, each subject-specific model is validated against experimentally measured full-field, in-vivo brain deformations. The modeling framework was extended to simulate concussive loading events in collegiate football. Our results indicate that, under this loading, brain deformation is dominated by shearing modes. Further, global shearing leads to significant local stretching in neural axons due to the anisotropy of the brain tissue. Through event reconstruction, we demonstrate the ability of the computational model to estimate the degree of axonal injury in various substructures of a subject-specific brain and consider the consequences for likely cognitive impairment.

Our results may be used to develop protocols for reducing concussions in sports, to design protective helmets in sports and other applications, to develop protective restraints in automobiles, and to develop a better understanding of the mechanisms that lead to TBI.

Dr. Ganpule is a postdoctoral fellow at the Hopkins Extreme Materials Institute of the Johns Hopkins University (JHU). He has received his PhD in mechanical engineering and applied mechanics from the UNL 2013. His research at JHU is focused on developing high-fidelity multi-scale models of the anatomy and physiology of the living human brain to study the onset and specific forms of traumatic brain injury. Dr. Ganpule’s broad research interests pertain to computational and experimental mechanics with emphasis on applications of these topics in biology and biomedical engineering.

Host:
Dr. Linxia Gu

Department of Mechanical& Materials Engineering

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Tuesday, October 13, 3:30 pm | 110 Jorgensen Hall