Understanding Brain Mechanics through Mathematics

Professor Justin WAN

David R. Cheriton School of Computer Science University of Waterloo

Abstract:

In this talk, we will discuss the use of mathematical and simulation models to study brain mechanics in trauma and brain diseases. In a car crash, the brain gets damaged when it strikes the interior of the skull, causing bruising and bleeding of the brain. It has been observed that not just the front part of the head (point of contact) gets injured but also the back of the head. There are several different theories that try to provide explanations to account for this phenomenon. In this talk, we will provide numerical simulation results to verify the validity of these theories. We will also discuss the brain mechanics of hydrocephalus, a medical condition caused by an abnormal accumulation of cerebrospinal fluid within the ventricles inside the brain. The main treatment protocol involves draining the excess fluid by inserting a shunt into the ventricles. However, failure could occur if the shunts are blocked by the swelling and deflation of the brain tissue. We will discuss how computer modelling is used to help predict the ventricle shape and eventually lead to lower failure rate. Simulation issues such as image registration will also be discussed.