Analysis of Coupled Nonlinear Dynamic Phenomena Using Sensors To Detect Abnormal Motion in Quadrupeds

Close, Sabine (School: Sequoia High School)
Morrow, Natalia (School: Notre Dame High School Belmont)

The purpose of this project was to determine if accelerometer data be used in conjunction with a coupled nonlinear dynamics model to detect mode interactions and abnormal gaits in equines to prevent abuse caused by repetitive injury. Coupled oscillators are commonly found in nature, primarily in quadrupedal locomotion that is controlled by a central pattern generator (CPG) capable of producing rhythmic gaits. One of the most remarkable quadrupeds is the horse, which can perform a variety of complex gaits, including walk, trot, canter and gallop. Yet horses also frequently experience muscle and bone injury, often due to excessive training or undiagnosed disease. This injury, commonly referred to as a lameness score, is typically determined through a visual inspection by a medical expert while the horse is walking and trotting. The lameness score has an inherent error due to the methodology, resulting in missed diagnoses. By designing an accelerometer system for commonly used equine tack, we collected multi-point motion data and performed both a wavelet and symmetry analysis. We then compared these data to equine motion output from a model we developed called the DYnamics Model for Equine Movement (DYMEM). Analysis of the spectral content and symmetry of variance revealed a characteristic pattern that identified abnormal motion. These data can be further used to diagnose and prevent lameness and future injury.

Awards Won:

Fourth Award of $500