David Akinyemi 15 December 2018

Computational Physics

Optimization of a Vertical Jump

When tasked to choose our computational project ideas, I was fascinated with the idea of using physics and my new understanding of approximations with my curiosity of human dynamical system and my love of sports. My idea was to use Euler’s functions and the relationship between different lower body muscle groups and joints to create a model that self-corrected and adjusted angles in real time in order to optimize a jump. My definition of optimization in this case was to reach a certain height and have it that all joint could comfortably produce their designated angles and those muscles could comfortably produce and absorb the force it was designated. The idea here was to simulate the movement of the different joints similar to how we simulated the double pendulum; using different line segments and Euler’s function to constantly recalculate the angles between them. The issue with this idea was that there was no reasoning and/or data to confirm the force allocation we chose or the relationships for rates at which different joint angles change with respect to others. We then decided to search for reports that could be useful to us. After much research, we concluded that the equations required for the human model we wanted was too advanced for us and decided to take a different route in simulating a jump. We looked into *Lift Off Dynamics in a Simple Jump,* a detailed study of a simple jumping robot, a 1D mass-spring system with an actuated mass. We worked to replicate this experiment using the provided ODEs. It was my responsibility to find the specific constants within our reading necessary to simulate that experiment properly. After a long process filled with syntax errors and non-functioning code, we were able to replicate the actuators vertical velocity and position off the ground as it related to the actuator’s movements. These results and graphs showed us a lot about the pogo jumping like movement of this system. We were able to compare it with that of a pogo jump and learn about the energy of the system. We were able to learn about the constant tradeoff between kinetic energy and potential energy during a pogo jump. The sequence of gravitational potential energy to kinetic energy to elastic potential energy is frequent throughout this experiment. We were able visualize the balance of starting with small high frequency waves and ending with high low frequency waves. This specific paper did not focus much on the damping occurring but it was also interesting to learn about the dissipating energy and how in a real situation it is shown through heat. There is still work to be completed with this project and medium to high confidence with our results but I’ll end similar to how I ended my presentation; I may not be there yet but I am closer than I was yesterday.