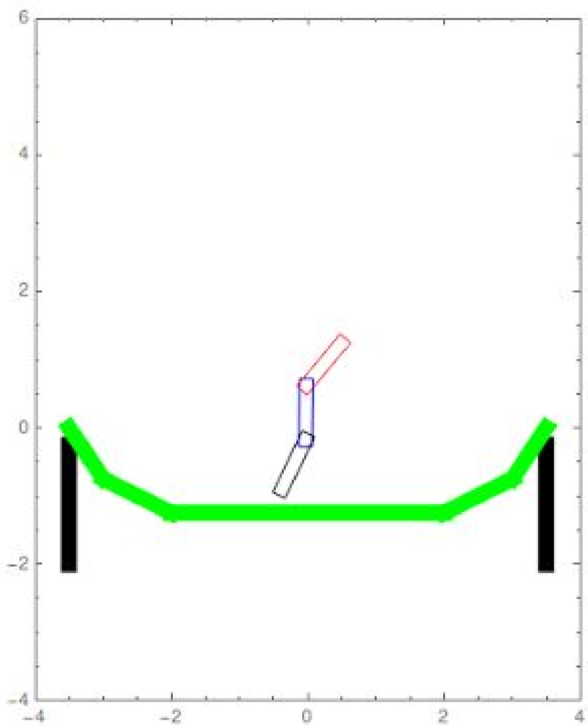
ME 314 - Final Project

Project Title: Modeling a somersault on a trampoline

Ahalya Mandana

Explanation:

This Mathematica simulation demonstrates the motion of a person doing a backward somersault on a trampoline. The simulation is in two dimensions, and since the problem is quite complex, the human body is represented by three links in the simulation. The red link represents the upper body, the blue link represents the upper leg section, and the blue link represents the lower leg section of the body. The trampoline is the green structure at the bottom of the image.



Setup of the system:

The individual segments are each assigned a mass and a rotational inertia value. They are also represented using a transformation matrix, to represent the rotation and translation of the segment.

Forces:

There are forces that are given to each segment, that represent the muscular forces in the body. These forces hold the body in specific positions. The body also experiences an upward force upon contact with the trampoline, which takes into account the elastic collision that occurs.

Constraint Equations:

There are constraint equations that are applied to the body segments to control the motion of the segments over time, and to ensure that the limbs do not violate certain rules, such as rotating beyond the joint limit.

***Euler-Lagrange Equations**:*

The kinetic energies and potential energies of the individual segments are calculated, and then the Lagrangian of the system is calculated, with the following formula:

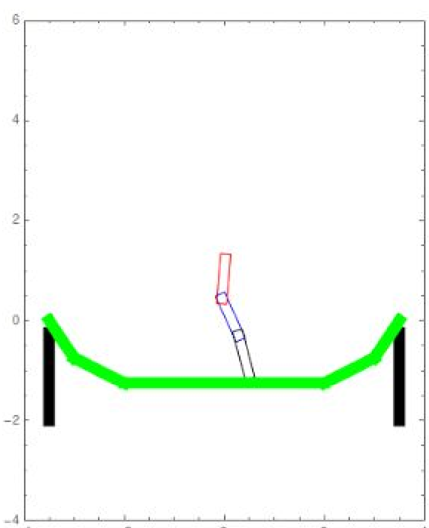
Lagrangian L = Total Kinetic Energy - Total Potential Energy

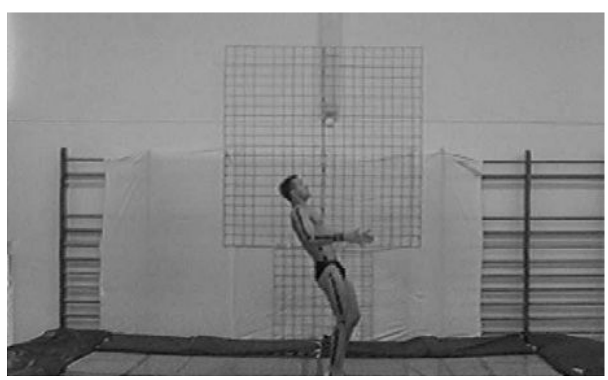
The Euler Lagrange equations are solved to obtain solutions to the equations of motion.

Simulation Results:

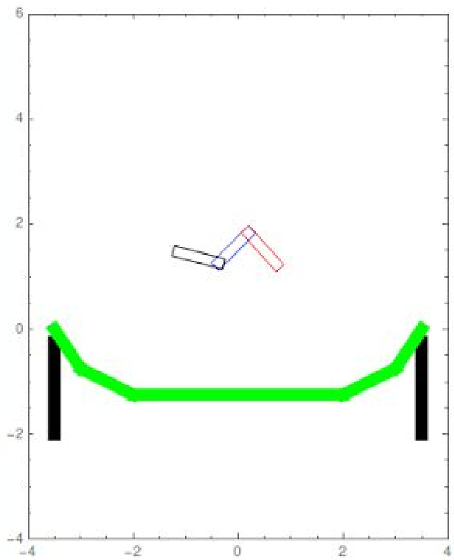
The system is simulated using the solved equations of motion. The simulation represented the backward somersault motion quite accurately. The frames from the animation are shown here along with corresponding images of a person doing a backward somersault. [1]

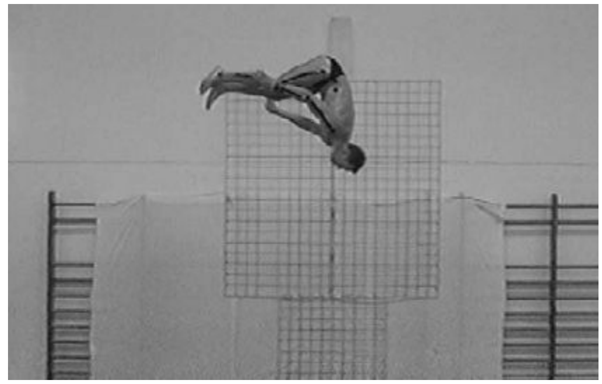
1. *Take-off:*



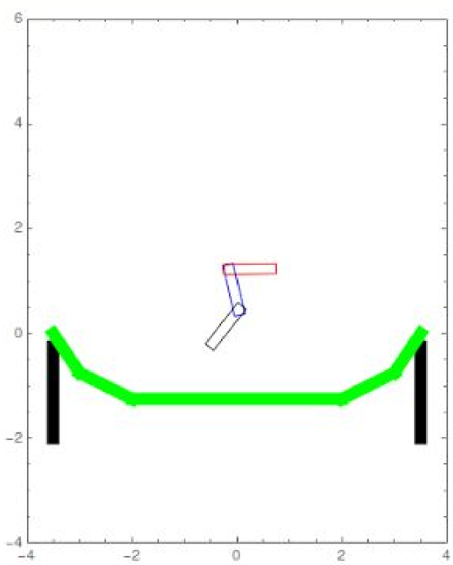


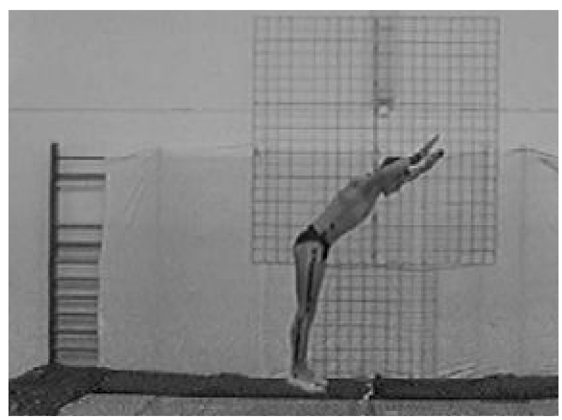
2. In mid-air:





3. Landing:





References:

[1] *‘Modeling and inverse simulation of somersaults on the trampoline’*, Wojciech Blajer and Adam Czaplicki, Journal of Biomechanics 34 (2001) 1619–1629