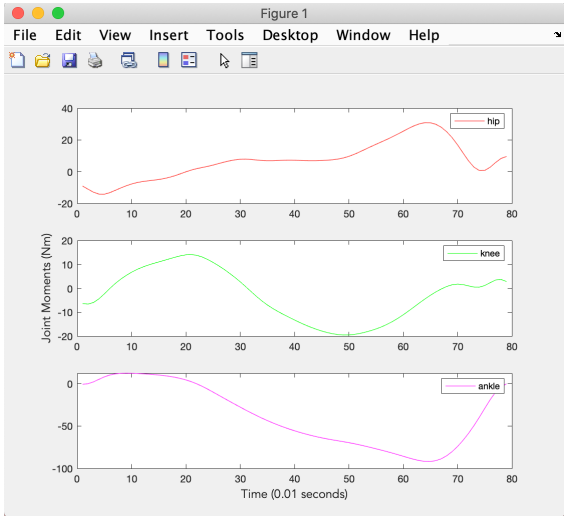
Liliko Uchida
ME0021 – Mechanics II
Biomechanics Project

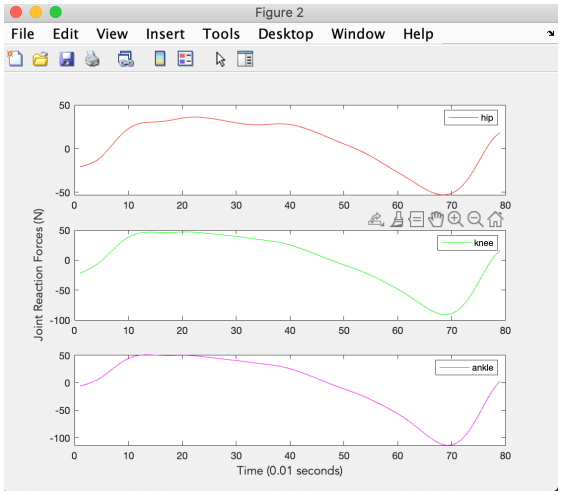
Introduction. The objective of this project was to find all of the net reaction forces and moments developed at the ankle, knee, and hip during the stance phase of a human gait. By studying these forces and moments, various physical considerations can be made in the designing of biomechanical technologies which may improve athletic performance, reduce the risk of injuries to the joints, determine gait pathology, and evaluate the performance of assistice devices such as prosthetics, braces, and others.

Methods. In order to gather relevant data for this project, motion capture was used to determine the position of the center of mass (COM) of each body segment. Anthropometric data was used to find masses and mass moments of inertia of each segment along with the location of the COM. A force plate was used to determine the ground reaction force and also to determine the position of center of pressure (COP) under the foot. 79 data points were taken total.

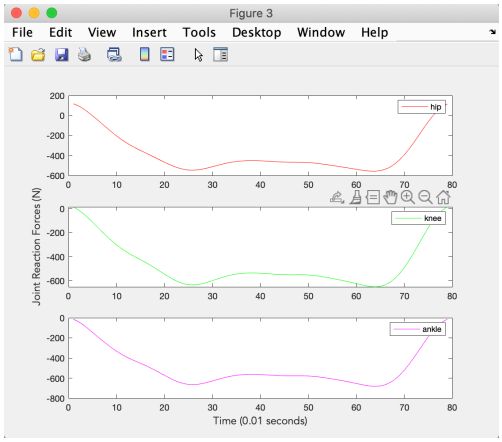
Results.



Joint moments against time



Reaction forces in the x-direction against time



Reaction forces in the z-direction against time

Discussion.

(Q1) For which joint does the reaction force in the z direction have the largest magnitude? Why?
(A1) The ankle joint has the greatest reaction force in the z direction. This is because the ankle is supporting all of the weight above it, including the shank, thigh, and upper body.

(Q2) What does the large peak of the ankle moment (during terminal stance) represent? Why is it negative?
(A2) This trough represents the instant in which the walker shifts their weight onto the other leg. It is negative because when the walker is preparing to shift weight to the opposite leg, the ankle is now "rotating" clockwise which requires a negative moment.

(Q3) What does the large peak of the hip moment (during terminal stance) represent? Why is it positive?
(A3) At this instant, the opposite leg from that under motion study swings forward, causing all of the weight to rest on one hip instead of being supported by both.

(Q4) How does the magnitude of the ankle moment peak compare to the magnitude of the hip moment peak? What causes this difference?
(A4) The magnitude of the ankle moment is greater than that of the hip moment. Examining the equations of motion and data points, it is shown that the ankle has a much larger angular acceleration and:
moment → torque → inertia * angular acceleration.

(Q5) What do the first and second peaks of the knee moment represent? Can you comment on their signs?
(A5) The first peak represents the moment the foot under study is being set down. The second peak represents the moment the foot under study is being lifted off the ground to prepare the weight shift to the opposite foot. The first peak is positive because when the foot is set down on the ground, the knee bends in a counterclockwise direction, while when the foot is lifted, the knee bends in a clockwise direction.