Kinesiology 530 Assignment 1- 2D joint kinematics

Due Date September 15th 11:59pm. Submit via CANVAS. ***All documents should be combined into a single pdf for submission. Please use the following standard filename: Lastname_Kin530_Assignment_1***

The goal of this assignment is to review 2D kinematics and to become familiar with basic Matlab/Python programming. The instructions are written for MatLab but students may choose to use Python if that is their preferred platform.

> ***GenAI use policy for this assignment:*** *GenAI is a powerful tool for supporting the development of code, including debugging. Well developed prompts can provide example code that can accelerate your coding skills development. You may use GenAI (preferably a UMass enterprise supported version) as a tool to help you generate your own code. You may not copy and paste this entire assignment into a public GenAI model. GenAI should not be used to generate complete or substantial portions of code for this assignment.* ***E.g. You should not copy and paste code directly from a GenAI output without significant modification and understanding****. You must document the GenAI model (e.g. ChatGpt, CoPilot etc), input prompt, output given and any follow-up prompts and output provided in an assignment appendix.* ***Failure to do so will result in 30 point deduction.***

Tools needed.

a) MatLab program
b) 2D kinematic marker data file – available on CANVAS

Assignment tasks.

Part 1

1. Open MatLab and familiarize yourself with the different windows. Solve some simple math problems in the command window. Try naming a variable, creating and naming a vector. Look in the workspace to see if the variables and vectors you create have the expected values and size. Try working through some or all of this online tutorial. https://matlabacademy.mathworks.com/details/calculations-with-vectors-and-matrices/otmlcvm

2. Open and save a new .m-file

3. Create variables in MatLab for each of the following marker coordinates
    a. *Illiac crest (pelvis)={-1063, 955.7}*
    b. *Greater trochanter (hip)= {-1113, 823.9}*
    c. *Lateral plateau (knee) = {-1254, 433.8}*
    d. *Lateral malleolus (ankle) = {-1523.84, 178.9}*

4. Using the appropriate marker coordinates create a position vector for each body segment (trunk, thigh and shank).

5. Calculate the absolute segment angle (angle of each segment relative to the right horizontal). Double check that the values are in degrees. Convert from radians to degrees if necessary.

6. Calculate the joint angles for the hip and knee.

Part 2. Open and save a new .m-file

1. Read in file – "*Kin530_2D_Kinematics_2023.txt*". Each column in this file is a time series for a single marker coordinate. The column headers can be found in a separate file "*Kin530_2D_DataHeaders2023*".
2. Create logical variable names for each column. Note X is the direction of motion and Z is vertical.
3. Create a loop to calculate for each row (i.e time sample) the following: Hint: The code should be similar to Part 1.
    a. A position vector for each segment
    b. Angle of each segment (trunk, thigh, shank) relative to the horizontal. *Double check that the values are in degrees. Convert from radians to degrees if necessary.*
    c. Joint angles for the hip and knee and ankle
    d. Store the joint angles calculated at each timepoint so you can plot angles as a function of time.
    e. Calculate the knee joint angular velocity at each time point.
4. Identify the time of Heel-strike (foot hitting ground). Calculate vertical velocity and acceleration of the marker on the heel (heel Z). Plot the vertical velocity and acceleration. Identify the 2 timepoints where there are sharp peaks in the heel marker acceleration. These indicate the time of impact. See O'Connor et al., 2007 Automatic detection of gait events using kinematic data. Gait and Posture 25 469-474.
5. Create a graph for the joint angles (knee and hip) and joint angular velocity (knee) as a function of time sample. Label the plot and the axes. If possible add a vertical line or label to indicate the time of the first heel-strike.
6. Repeat the above steps for *Kin530_2D_Kinematics_2023ALT.txt*".
7. Plot the joint angle for each joint and knee angular velocity for both files on the same plot so that you can directly compare the values.

Write-Up

In addition to the code, figure with figure caption, students should provide a narrative summary of the findings. This should include

a) Describe the motions of each joint including the anatomical interpretation of the angles and the direction of motion of the limb (e.g. angular velocity).
b) Compare the angles calculated from the primary file and the "Alt" file. In what ways are the joint angles/velocity similar and different. What do these angles tell you about how the participant was walking.

Students should hand in

a) A screenshot or copy of the workspace for part 1.
b) m.file for part 2. The .m-file should be well commented. Students may use Python and should submit the equivalent file.
c) *Plots showing the output of the code. Provide captions/axis labels etc for the plot describing the joint angles using anatomical terminology.*
d) Written summary paragraph.
e) GenAI appendix, if appropriate.
f) All documents should be combined into a single pdf for submission. Please use the following standard filename: Lastname-Kin530-Assignment_X .

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Grading Rubric

Part 1. Vectors, segment angles, joint angles	*10 points*
Part 2. Data reading, loops, vectors, segment angles, joint angle, timing of heel-strike	*20 points*
.m-files comments	*5 points*
(what does each line of code do; are there comments?)	
Plots	*10 points*
Write-up	*10 points*
Overall quality (complete sentences, punctuation, filename)	*10 points*
Total assignment value	*65 points*