Introduction

The purpose of this laboratory report is to assess your understanding of several concepts of angular kinematics and angular kinetics taught in SP2604 module.

Motion data from a person walking over ground (gait) is being provided in the attached Excel workbook. For the analysis of the participant's gait, you are required to calculate several kinematic and kinetic parameters, as instructed in the Methodology and Results sections below.

Use all information available to you (e.g., data in Excel sheets, instructions provided under Methodology and Results, lecture slides, images, and laboratory notes) **to write a succinct and accurate "Methods" and "Results" section**.

Submit:

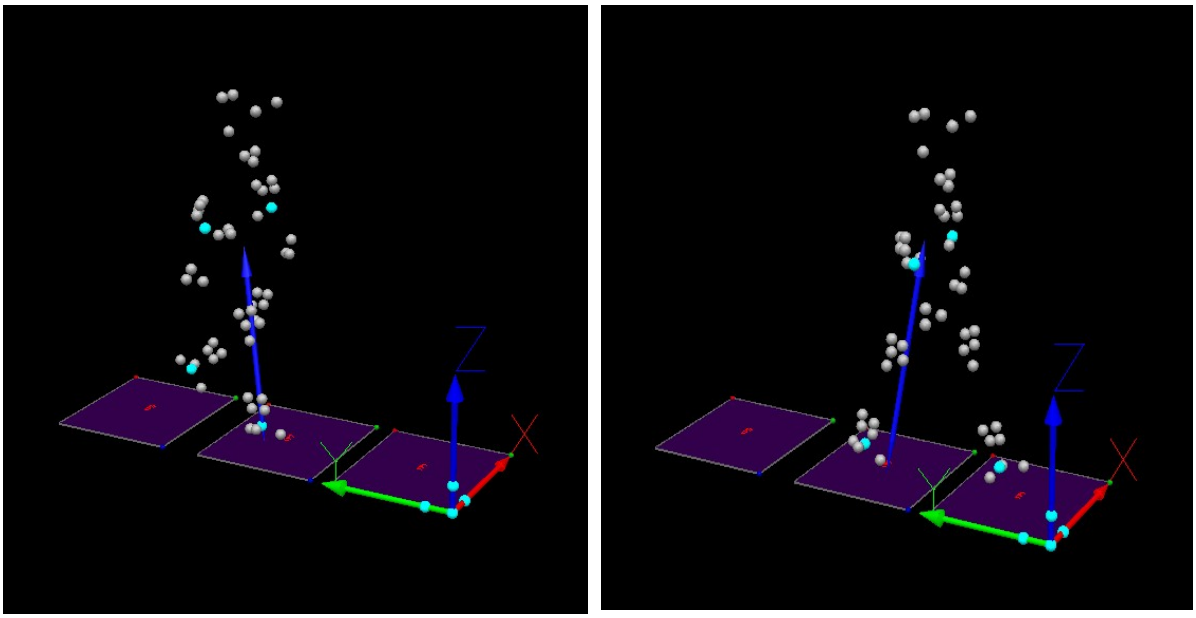
- One Excel workbook **containing your calculations** and **description of the results (within the highlighted areas identified)**.
- **One *Word* or PDF document** containing your **Methodology and list of References**. No other format will be accepted.
- Format your Methodology, and any required graphs in the Results sections according to the APA style.
- Total Word Count: 1500 words (including Methodology, comments provided in the Results section, list of references, etc).

End of Introduction

Methodology – You are required to include the following information in a Methodology section.

A methodology section, usually contains 4 parts: Participant, Equipment & Material, Protocol (Procedure), Data Processing & Analysis.

- Incorporate information provided below under relevant sections (participant, equipment & material, protocol, or data processing & analysis) to write the Methodology section.
- To each sub-section above, add information which should be retrieved and/or calculated from data available to you, and/or biomechanics textbooks (e.g., add equation used in the calculation of instantaneous velocity from a textbook and cite the source) in order to complete the Methodology section.
- Avoid using bullet points when writing Methodology. The section should be written similar to the Methodology of a research paper.



(a) (b)

Figure 1. A full-body marker set was used during the study. (a) Early stance of the right foot on force plate 2 (FP2); (b) Late stance of the right foot on FP2 (participant was propelling himself forward).

Participant:

- Male;
- Healthy;
- Age = 23 years;
- Mass = 104.3 kg;
- Height = 1.80 m;
- Shank length (distance measured between lateral epicondyle of femur and lateral malleolus): 42 cm

Equipment & Material:

- 8-camera Qualysis motion capture system;
- Sampling Frequency of the cameras; **Calculation of the SF should be shown in the highlighted area in Excel sheet called "Angles".**

- 3 Kistler force plates;
- Full-body marker set to identify major segments and joints of the body

Add information and Comment on:

- **Laboratory coordinate system: e.g., walking mainly occurred in what cardinal plane?**

Protocol (Procedure):

Data collection period: This could be obtained based on data available to you. Report time rounded to the nearest 2 decimal points.

Add information and Comment on:

- **Instructions to the participant**
- **Direction of movement (e.g. toward laboratory origin or away from it? Along what axis?).**

Data Processing & Analysis:

- Data provided in the Excel workbook belongs to the right lower limb.
- Sheet called (Angles), contains information on joint (ankle, knee, hip) rotations (angles) around the x, y, and z axes. **Note. Scroll down the page to see all data.**
- Sheet called "Moments" contain moments of force (torques) about the ankle, knee and hip joints around the 3 axes (x,y,z) for the right lower limb. **Note. Scroll down the page to see all data.**
- One stride of the Right lower limb (from heel strike to heel strike) happened between **rows 322 and 431 of the Excel sheet** and should be used for this laboratory report.
- Stance phase of the stride above contained 50 rows (**Excel rows 322-371**) – 45% of the stride length.
- Swing phase of the stride above contained 60 frames (**Excel rows 372-431**) – 55% of the stride length.

Kinematic and kinetic data of the Right lower limb joints for one stride (Excel rows 322-431) in the sagittal plane (unless stated otherwise) are of interest to this laboratory report, and all calculations and plots required should use the Excel rows above.

In the Methodology section under a (one of the four) relevant subheading stated above, add information on how the following parameters were decided and/or calculated (provide relevant formulae where required from biomechanics textbooks):

1. **What two axes defined the sagittal and frontal planes for the stride above?**
2. **Stride length (for the one stride above)**
3. **Instantaneous Velocity and Acceleration values for the Ankle, Knee and Hip joints**
4. **Angle-Angle diagram (for Ankle-Knee)**
5. **Phase Plots or Phase Space (for Ankle, and Knee)**
6. **Continuous Relative Phase (for Ankle-Knee)**
7. **Curvilinear distance covered by the lateral malleolus during rotation of the knee joint through its range of motion**

8. **Power of the Ankle, Knee, and Hip joints in the sagittal plane for the stride above, and maximum power of Ankle, Knee, and Hip joints.**

In Summary, your methodology should describe how the requested parameters 1-8 above were retrieved/calculated.

Methodology – 30 Marks (30%)

3 marks for referring to each of the 8 points above and providing relevant information for calculating parameters requested (24 marks). Incorporation of the 4 parts requested and Cohesiveness of the written section (6 marks).

End of Methodology

Results – You are required to include the following information in a Results section.

- **Calculate and Show your work in separate Excel sheets in the highlighted areas identified.**
- **All calculations must be in the Excel workbook in the relevant sheets (i.e., do not scatter results or put them randomly in the Excel sheets).**
- **Show all your work.**

Plot of the Ankle, Knee, Hip joints

- In the sheet called "Angles":
  i. Calculate sampling frequency of the cameras (Remember - Report sampling frequency under a relevant subheading in the Methodology); 2 Marks
  ii. Plot Ankle joint rotation in the **sagittal plane** (place plot in the highlighted area allocated), and Report ankle range of motion (ROM) in the sagittal plane (round the value to the nearest integer); 3 Marks
  iii. Plot Hip joint rotation in the **frontal plane** (place plot in the highlighted area allocated), and Report hip range of motion in the frontal plane (round the value to the nearest integer); 3 Marks

  Total: 8 Marks

- In the sheet called "Stride Length", 3D (x,y,z) coordinates of a marker placed on the right limb heel (RHE) are provided (scroll down the page to see where marker coordinates were identified and motion data became available). In this sheet:
  i. Calculate length of the stride (in the highlighted area allocated).
  ii. Remember - Description of how the stride length was measured should have been provided in the Methodology section.

  Total: 4 Marks

- Use sheet called "velocity-acceleration". In this sheet:
  i. Calculate instantaneous velocity and acceleration of the ankle, knee, and hip joints (in the highlighted columns allocated). Clearly provide relevant headings to identify different columns which contains your calculations; 6 marks
  ii. Remember - Description of how the instantaneous velocity and acceleration were calculated should have been provided in the Methodology section.
  iii. In the highlighted area, also report maximum velocity of the knee joint observed during the stride and comment whether this maximum velocity was during flexion or extension of the knee joint. 4 Marks

  Total: 10 Marks

- Use sheet called "Phase Angle&Angle-Angle". In this sheet:
  i. Calculate Phase Angles for the Ankle and Knee joints in the sagittal plane. DO NOT ADJUST CALCULATED PHASE ANGLES TO EXPRESS THEM FROM A RIGHT ZERO. 4 Marks
  ii. Plot Phase Plots (Phase Space) for the Ankle and Knee joints; 4 Marks
  iii. Plot Angle-Angle diagram for the Ankle-Knee; Use few arrows to identify direction of the unfolding movement (stride).

3 Marks

iv. Calculate Continuous Relative Phase (CRP) for Ankle-Knee.
3 Marks

v. As stated before, your Methodology section should include information on how Phase Angles and CRP are calculated. Cite the reference(s) used.

vi. Plot CRP. 1 Mark

vii. Comment on whether the ankle and knee joints were coordinated in-phase or out-of-phase for the majority of the stride based on CRP values observed.
3 Marks

Total: 18 Marks

- Use sheet called "Ankle linear displacement". In this sheet:
  i. Calculate (8 Marks) and Report (1 Mark) linear distance covered by the lateral malleolus due to knee rotation during the one stride under study in the highlighted area.
  ii. Remember - Your Methodology should have a description on how linear distance of the lateral malleolus was calculated.

  Total: 9 Marks

Excel sheet called "Moments" contain ***normalised to body weight*** moments of force (torques) of the ankle, knee and hip joints around the 3 axes (x,y,z) for the right lower limb (scroll down the sheet to see data).

- Use sheet called "Powers". In this sheet:
  i. Calculate and Report power values around the ankle, knee and hip joints in the sagittal plane during stance. 15 Marks
  ii. Calculate and Report maximum powers (around ankle, knee, and hip) during stance phase. 6 Marks
  iii. Remember - Your Methodology should have a description on how you calculated power.

  Total: 21 Marks

Results – 70 Marks (70%)

<u>End of Results</u>