San Marin High School

Gait Analysis

Matthew Baetkey, Sebastian Dow, Eva Brandis,
and Kelsea Bergerson
Senior Engineering 1
Mr. Tronconi
October 12, 2018

Abstract

In this experiment we analyzed the gait of each one of our group members to see what we could find out about. We downloaded a special app that used an accelerometer to record data on the walking patterns of everyone in our group. We did multiple trails to ensure that our data was as accurate as possible. After gathering lots of data through the app we had to upload it to a spreadsheet which allowed us to easily analyze our data. From here we were able to create multiple graphs based on the data from each individual person. We could easily make comparisons from analyzed each person's graph. We found that a subject's height and gait were related and made an equation that comparing them. We did this by comparing the period of the gait - the steps - to the time which relates to the stride of the person, and their height.

Table of Contents

Introduction to Gait Analysis

A. What is gait?

What is a gait?

Have you ever thought about the way you walk and run?
Or noticed that the people you know have a distinct way of walking? What differences do you see?
Can you recognize certain people by how they walk? How might differences in gaits help you identify people?
What is noticeable about how those people move?
Could you collect data on this and learn from it?

Gait analysis is the study of human motion using visual observations as well as movement measurements. A gait is the way a person walks or moves. I have never thought about the way that I walk or run but I have observed that everyone moves with a slightly different style. Some people have a very odd way of walking, but I've never really noticed anything about gait before, unless someone was walking very slowly or quickly. Everyone has a very distinct way of walking and running that sometimes isn't even noticeable to the standard viewer. You can recognize certain people by the way they walk but sometimes it can be more challenging. For example it can be easy to identify close friends or family members by the way they walk because you spend a lot of time with them and are around them a lot. Sometimes people have a very distinct way of walking so it can be very easy to identify them. Differences in gaits can help us identify people because they are like a personal identifiers or trademarks unique to individuals. We can collect data on this by visually observing people walk or by using specialized apps such as the one we used in class today using an accelerometer. This data can help us learn about how people move and we can start to analyze trends and similarities between people.We would also want to find the length of the subject's legs and height, which foot they start with, and how they were carrying the phone. This could help us to identify certain individuals that may not be walking properly and hurting their health. We could then help them to correct their form to prevent injuries that may have occurred if they continued to walk without good form/posture.

B. Questions to Consider

How would you describe the walking gait of each subject?
What quantities could be measured to analyze walking gaits?
In the context of walking gaits, what do the terms symmetry, variability and dynamicity mean?
How could an accelerometer be used to quantify walking gaits?

The walking gait of each subject will be very different. It will be affected by height, leg length, center of gravity, among other factors. To analyze walking gaits, we will compare people's height, walking speed, dominant foot, and other data that we can find using an accelerometer. Symmetry with gait would refer to the steps taken with the left and right foot being equal.

Variability would refer to the differences between every step. Dynamicity would refer to how many different variables make up a person's gait. We can use an accelerometer to find the acceleration forward and backward, side to side, and up and down.

C. Vocabulary

Accelerometer: A device that measures the physical acceleration experienced by an object.

Dynamicity: In terms of gait analysis, the quantification of variations in kinematic or kinetic parameters within a step.

Gait: The stride of a human as s/he moves his/her limbs.

Metric: A quantitative indicator of a characteristic or attribute.

Model: In technology, a description of observed or predicted behavior of some system, simplified by ignoring certain details. Models allow complex systems to be understood and their behavior predicted.

Symmetry: In terms of gait analysis, the quantification of differences between left-foot and right-foot steps.

Variability: In terms of gait analysis, the quantification of fluctuations from one stride to the next.

D. Materials

- Accelerometer ("Physics Toolbox Accelerometer" by Vieyra Software or alternative software)
- Duct tape, cord, belt, strap, or some way to attach a cellphone to a person's lower back
- Google Sheets or Microsoft Excel®, or similar spreadsheet program

E. Hypothesis

If we take data about different people's gaits, then we will be able to make predictions about other people (based on their gait).

II. Collecting Data

A. Procedure

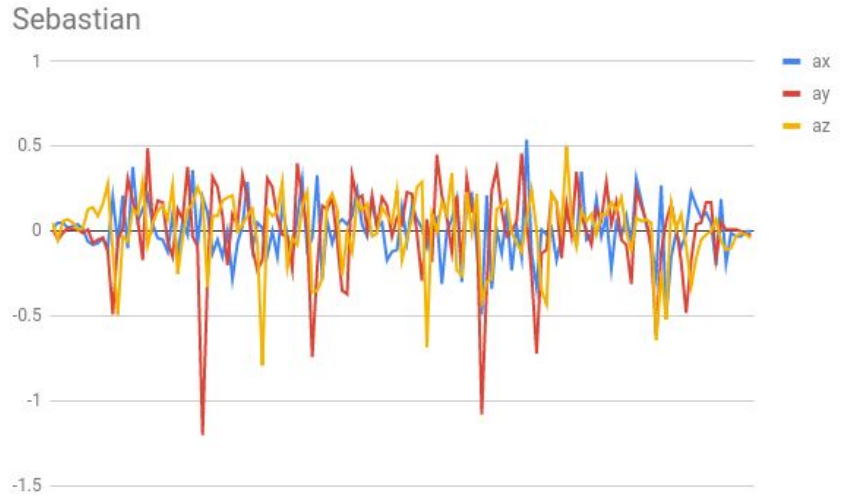
1. Attach a phone with an accelerometer app to someone's lower back with duct tape.

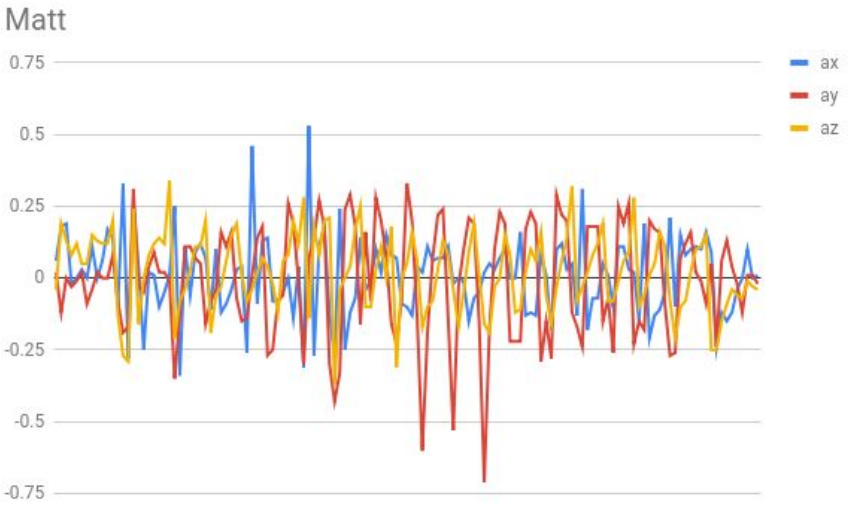
2. Have that person walk a set distance. Have another person follow behind them so they can start and stop the recording on the app.
3. Upload data into a spreadsheet for analysis.
4. Repeat with multiple subjects.

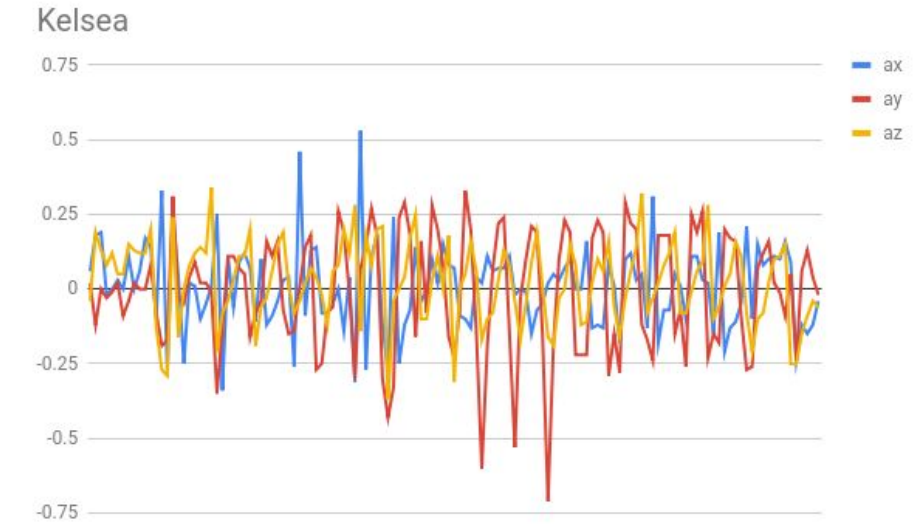
B. Focus Question

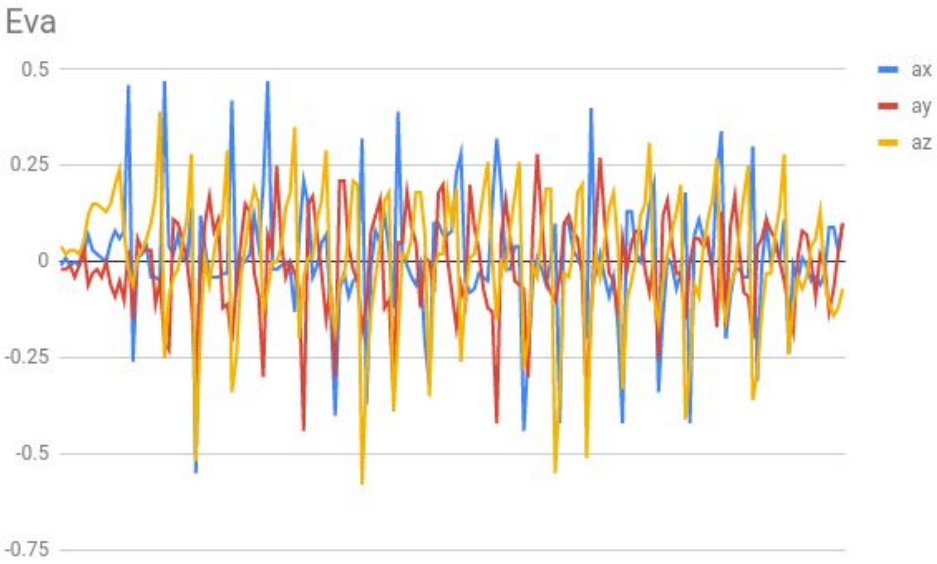
What is the relationship between the height and gait frequency for walking humans? Can we create an equation to better predict a certain trait about a person?

C. Graphs









Subject	**Dominant Foot**	**Height**	**Other Factors**
Sebastian	Right	176 cm	No injuries
Matt	Right	179 cm	No Injuries
Kelsea	Left	180 cm	No Injuries
Eva	Right	163 cm	No Injuries

III. Data Analysis

A. Introduction

In this project, we constructed a model to represent the gait of different people using data that we collected. We can use this model to predict the gait of other people. Our model uses the subject's acceleration frequency to find their estimated height.

B. Predictive Model

We believe that by finding the frequency of a person's acceleration we will be able to predict their height. We can use this because it shows how long a person's step or stride is and we found that people with longer strides tend to be taller.

Periods/time= stride=height

C. Analysis

By counting the number of peaks or periods in an individual's set of data we will be able to find that individuals height. We are able to do this by dividing the number of periods by the time which will tell us the individual's stride length. Then since we know that stride length is equal to height we now know the individual's height.

D. Discussion

The data collected is supposed to give us an accurate representation of human height based on stride length and periods of a graph, but what does the data not show?

This simple question is very important to understanding our findings. Human nature is unique, and much like all things in the natural world, is unpredictable. Our findings are from a focus group of relatively predictive and average walkers, but many people have unique Gaits based on their height, like a short person with long strides, that skew our findings.

How can you use a predictive model to understand the data?

Predictive modeling is key to all scientific findings based on loosely connected data and trends. We can use our model and our data to look at averages and determine an approximate numerical value based on where you lie on the data sheet. Predictive models are not always completely accurate, but a very important tool in understanding correlations between height, stride, and periods over time.

E. Conclusion

Our margin for error was low because of the way we gathered our data. Everyone in our group walked the same exact distance in the same exact area. This made is so that there were no variables that one person had to overcome which others didn't. Also we all walked over level ground to keep things consistent. One thing that might have affected our error could be the placing of the phone on different people. We tried to put it in generally the same area on

everyone's lower back but it would be nearly impossible to put it in the same exact spot on each person. Based on the placement location the phone could sense more or less acceleration in different directions. As for our hypothesis, we were correct in the aspect of seeing correlation between average acceleration per stride and height, but there is error in human nature that skews the findings.

IV. Additional Information

A. References

1. Accelerometer App

"Physics Toolbox Accelerometer" by Vieyra Software or alternative software/app

B. Appendix

1. Raw Data

Access the full document here