Gait Analysis with Unity and OpenPose

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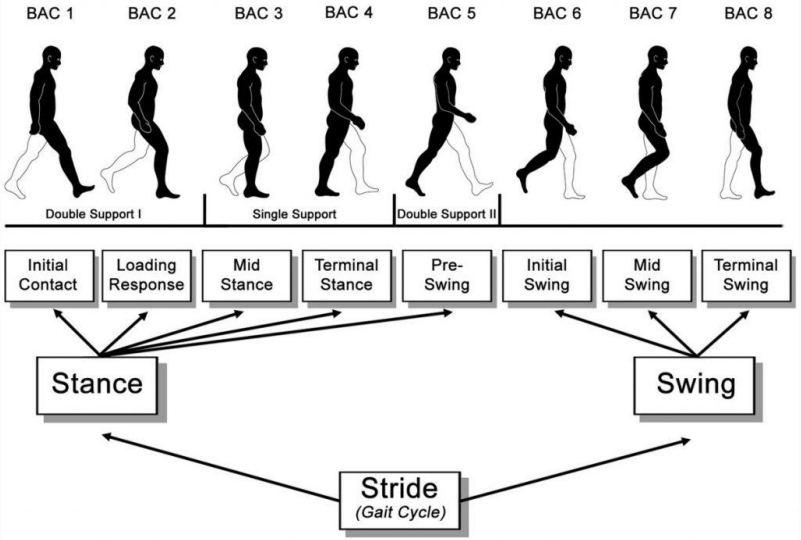
Gait Analysis: introduction

Definition

Gait analysis is a method for identifying biomechanical abnormalities in the **gait cycle**.

A complete cycle of gait begins at initial contact of one limb and ends at the repeated initial contact of the same limb.

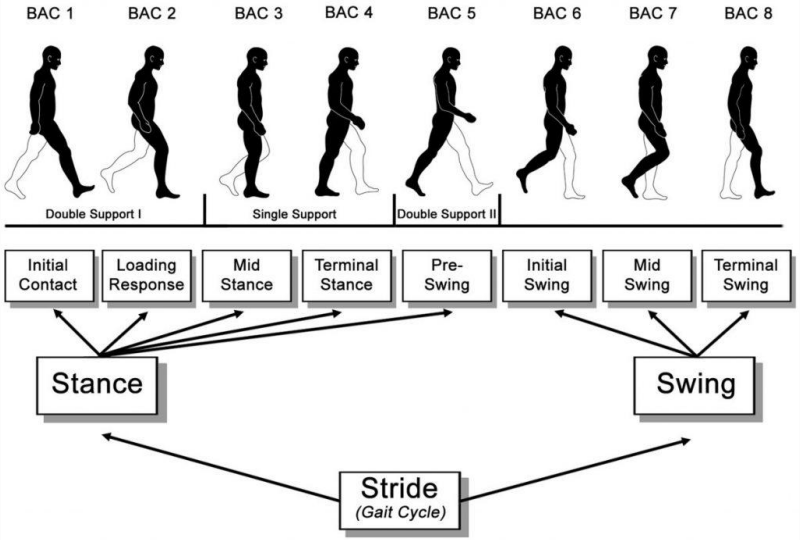


Gait Analysis: introduction

Usage

When we study the way a person walks or runs, we can :

- identify individuals' unique movements
- determine normal gait patterns
- diagnose issues causing pain
- implement and evaluate treatments to correct abnormalities



Analysis Techniques

IMU

Inertial **M**easurement **U**nits are **wearable sensors** that can provide information about joint angles, joint moments, and joint power during walking

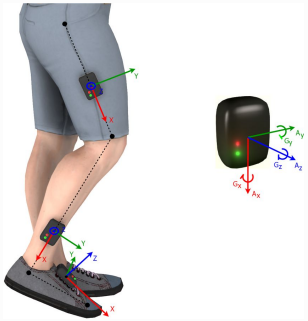


Image Processing

Image processing involves using **cameras** to capture images of the body during walking . These images can be used to track the motion of the body

Floor Sensors

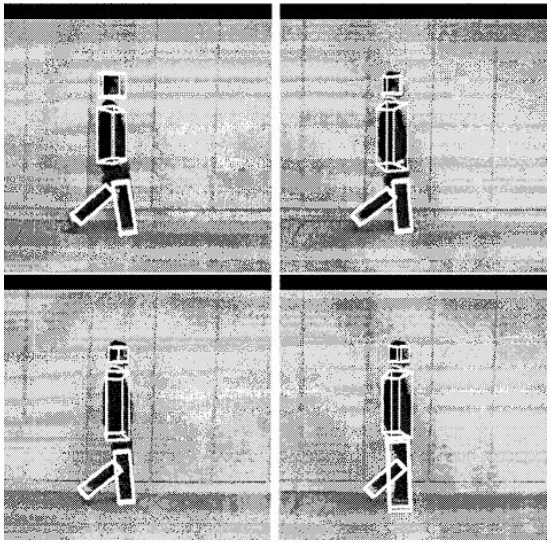
Sensors on the floor are used to **measure pressure distribution** during walking. They can provide information about foot pressure distribution, step length, step time, and step width

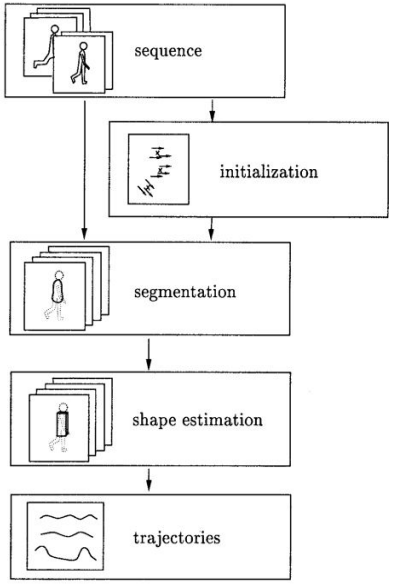
Image processing: state of the art

Model Based Extraction

Proposed in 1997, this method is a **three step** model based approach which does not need markers or good features for tracking.

1. Optical flow based **initialization** of the segmentation
2. Contour based **segmentation** and tracking of different parts of the human body
3. Model based 3D **shape and position estimation** of the different parts of the human body





Model Based Extraction of Articulated Objects in Image Sequences for Gait Analysis
- *Dorthe Meyer, Joachim Denzler and Heinrich Niemann*

Image processing: state of the art

Microsoft Kinect motion capture

A study was carried out for using the Microsoft Kinect as a low-cost tool for gait analysis

The Kinect consists of an **infrared (IR) light projector**, an **IR camera**, and a **RGB video camera**. Reflected IR light is converted into **depth data** and is calibrated with RGB data to distinguish shapes.

However, as it was designed to track a human figure in the frontal plane, it is not able to produce consistent hip measurements

While the Kinect's ability to track a human figure is acceptable for some applications, the measurement accuracy was **not acceptable for clinical measurement analysis**

Comparative abilities of Microsoft Kinect and Vicon 3D motion capture for gait analysis
- *Alexandra Pfister, Alexandre M. West, Shaw Bronner and Jack Adam Noah*

Image processing: state of the art

OpenPose

A marker-less 2D human pose estimation system based on **CNN** to measure knee flexion/extension angles

It relies on a **bottom-up** approach, where first the entire image is processed to obtain the possible joint locations and then connects them to form a **pose model**.

The CNN has been designed to estimate key anatomical coordinates from images taken under a wide range of conditions, for this reason it does not drop in accuracy in particular conditions as the Kinect does

Human Gait Analysis Using OpenPose

- *Aditya Viswakumar, Venkateswaran Rajagopalan, Tathagata Ray and Chandu Parimi*

Project goal

The presented project tries to address the problem of gait analysis through **video processing** of a walking person.

Through the combination of **Unity** and **OpenPose,** the gait analysis of a walking simulation has to be performed.

Project details

1

Unity animations

The walking animations were downloaded from *Mixamo*, imported in *Unity* and used for the simulation

2

Openpose library

The *OpenPose* library was used to extrapolate the joints position from the walking animation

3

External application interaction

The joints data was sent to an external web application, made with *FastAPI*, in order to save it to documents.

4

Plot of gait analysis data

Through the *Plotly* library, the gathered joints position were plot into charts to perform the gait analysis.

Gait Analysis with Plotly library

FastAPI plotly

Analysis Person 1 walking

Select other document:

Person 1 walking

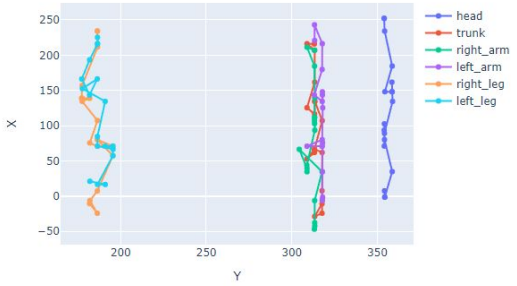
or

Real-time Data Analysis

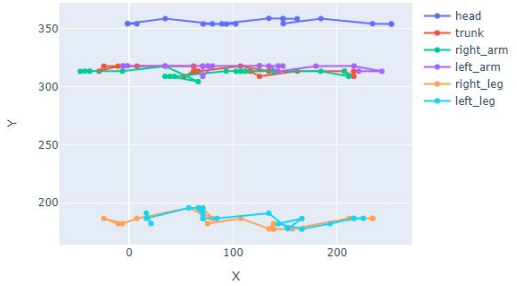
Part type:

- [x] Head
- [x] Trunk
- [x] Right Arm
- [x] Left Arm
- [x] Right Leg
- [x] Left Leg

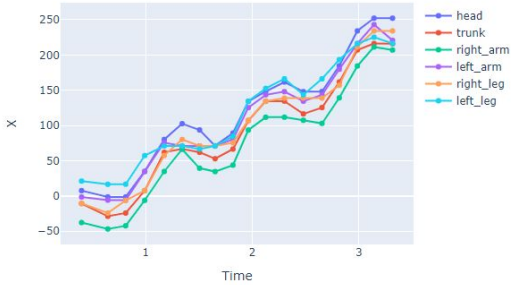
Graph X vs Y



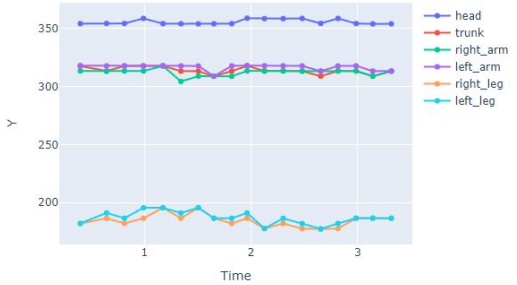
Graph Y vs X



Graph X vs Time



Graph Y vs Time



Conclusion

Gait analysis is a technique used to identify possible issues causing pain during the walking process caused by bad posture.

The project exploits the *Unity* software to create a 3D simulation of a walking person and uses the *OpenPose* library to efficiently extrapolate the human joints. This data is then sent to another application that plots it into charts and performs the gait analysis.