Research Group: Connected Health
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Digital Health Center
by Hasso-Plattner-Institut
HPI

Learn to Move like a Pro

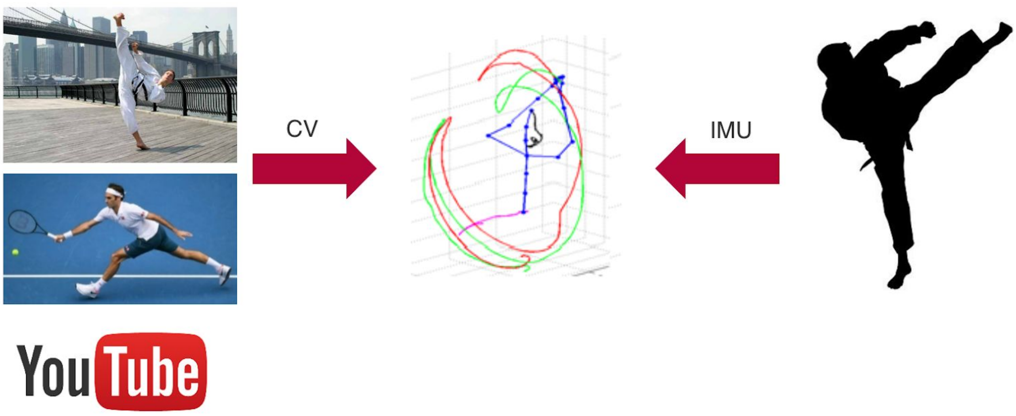
Human Motion Analysis in the Wild

Motivation

Human motion analysis is an important instrument, e.g. for assessing gait in neurological diseases or for exercise recognition. Established gold standard methods for capturing Human 3D motion data for human motion analysis such as OptoGait[1] or the Vicon[2] camera system are rather expensive (e.g. Vicon > 100.000€). Furthermore, conventional motion capture systems are performed in a controlled lab setting, which limits the possibility of use cases outdoors. These disadvantages lead to the need for low-cost, unobtrusive (markerless) and mobile methods for capturing human movements.

Project Goals

The main objective of this master project is to develop a low-cost and mobile measurement system, which integrates both Computer Vision as well as Inertial Measurement Units (IMUs, see description in Methodology part) for tracking human motion. Recording trajectories of both optical and inertial measurement methods will result in a different representation of the movement as well as different locations of the body (or joints). The goal of this project is to compare the two different motion representations and evaluate whether it is possible to identify similar movements based on two different measurement methods. For example, one could track a particular movement trajectory (front or side kick in Taekwondo) of a professional athlete, and track the same movement for a beginner athlete. By observing the difference between the two trajectories, the beginner can improve his / her movements.



Video Sources   Tracked Trajectory   Measurements in Daily Life

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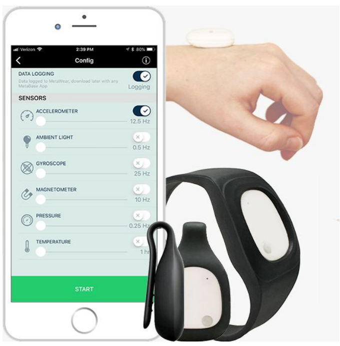
[1] www.vicon.com
[2] www.optogait.com

Methodology
An established and cost-effective alternative motion capture system is the Microsoft Kinect camera, which is able to track the user's joints to obtain a skeleton view. However, these camera systems require wire connections to a computer, and is therefore not suitable for out-of-the-lab scenarios. Due to the recent success of Deep Learning, it has become possible to estimate a 3D human skeleton based on 2D images[3,4]. As an alternative, the latest smartphone models come with stereo cameras, allowing to create a depth vision using multi-camera geometry[5]. This leads to the idea of using a regular smartphone to record human motion data. The advantage of such a system is the possibility to work outside the controlled laboratory environment.

The second low-cost and unobtrusive measurement method are the Inertial Measurement Units (IMUs)[6]. These are small sensors that combine accelerometer, gyroscope and magnetometer, and are able to record data with high temporal resolution (sampling rate > 100 Hz). Acceleration, as well as the angular velocity values in all three axes (x, y, z) are mostly used for calculating the movement trajectories. The IMU sensors can be easily attached to the user in order to record the motion of the respective location. In the past, research has shown that these sensors can also be used for unobtrusive measurements in a clinical context, e.g. gait analysis for patients suffering from Parkinson's Disease[7]. IMUs from mbientlab[8] and Bonsai Systems[9] are already available for the current Master's project at our chair.




https://mbientlab.com/   https://www.bonsai-systems.com/

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[3] Mehta et al. VNect: Real-time 3D Human Pose Estimation with a Single RGB Camera, ACM Transactions on Graphics, 2017
[4] Hartley, Zisserman, Multiple View Geometry, Cambridge University Press, 2004
[5] www.gsmarena.com/understanding_the_dual_camera_systems_on_smartphones-news-27516.php
[6] https://en.wikipedia.org/wiki/Inertial_measurement_unit
[7] Caramia et al. IMU-Based Classification of Parkinson's Disease From Gait: A Sensitivity Analysis on Sensor Location and Feature Selection, IEEE Journal of Biomedical and Health Informatics, 2018
[8] https://mbientlab.com/
[9] https://store.bonsai-systems.com/19-motion-capturing

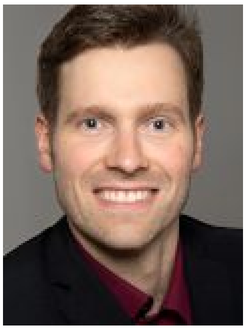
Learning Expectations

In this project you will learn how to use IMU sensors and Computer Vision approaches for tracking the motion trajectory of a person. For the Computer Vision part, you can choose from a selection of camera devices. Furthermore, you will learn how to process the recorded sensor data using modern tools from the field of machine learning. As a last step you will apply the developed method to a real world use case.

About You

You should be interested in working with a multidisciplinary team with backgrounds ranging from computer science to biomedical informatics and medicine. Good programming skills are required. You should show interest in working with sensors and/or computer vision and be eager to learn about use cases in the field of digital health.

Contacts



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