Human Motion Analysis in Daily Life

A Low-Cost and Unobtrusive Gait Analysis System

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Introduction

In physiotherapy, e.g. stroke rehabilitation, patients are monitored and treated by a physiotherapist, but after discharge from the rehabilitation centre they are often isolated at home. Without any monitoring, it is difficult to continuously quantify the individual's post-release progress, e.g. to predict the risk of falling. This problem raises the need for novel, unobtrusive measurement methods that can work at home without expert knowledge and operators. This work utilizes the recent advances in the field of human pose estimation on images to quantify the gait variability of patients.

Method

The system developed here consists of a two-stage process. The first phase is a 2D skeleton tracking process using machine learning to locate human joints in monocular images. The method consists of a convolutional neural network (CNN) predicting 2D heatmaps, which indicate the joint positions to the corresponding locations from the input RGB image (refer to Figure 1). The ground truth heatmaps are generated by using a 2D Gaussian at the center of the corresponding (x, y) joint position. In the second phase the CNN tracks the ankle-keypoints of a person in a video sequence to obtain a walking profile. The person walks on a treadmill and is filmed by a stationary mounted camera at a 90° angle. The images are regarded as a 2D Cartesian coordinate system, where the origin is the upper left corner and the y-axis expands in height and the x-axis expands in width. The user is walking in positive x direction. Figure 2 shows the tracked ankle data. The peaks of the curve indicate the point where the heel touches the ground, while the valleys indicate the initialization of the swing phases.

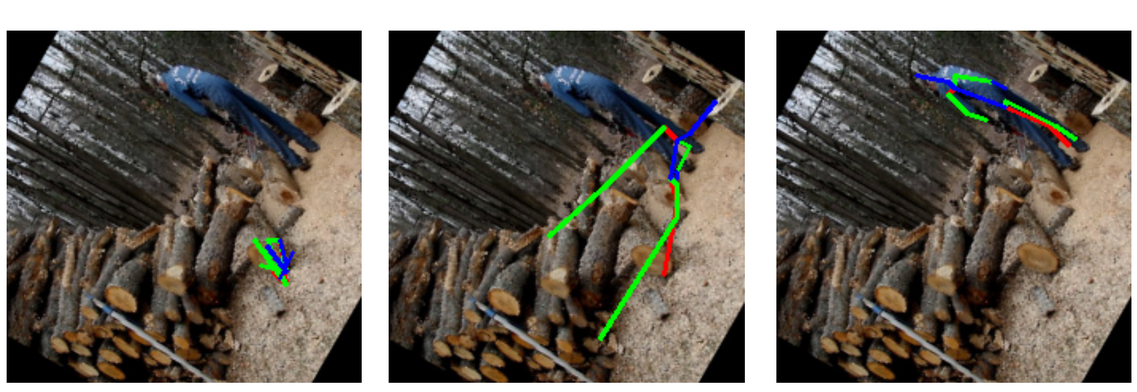

Figure 1: Training Process of the 2D Human Pose Estimation Algorithm.

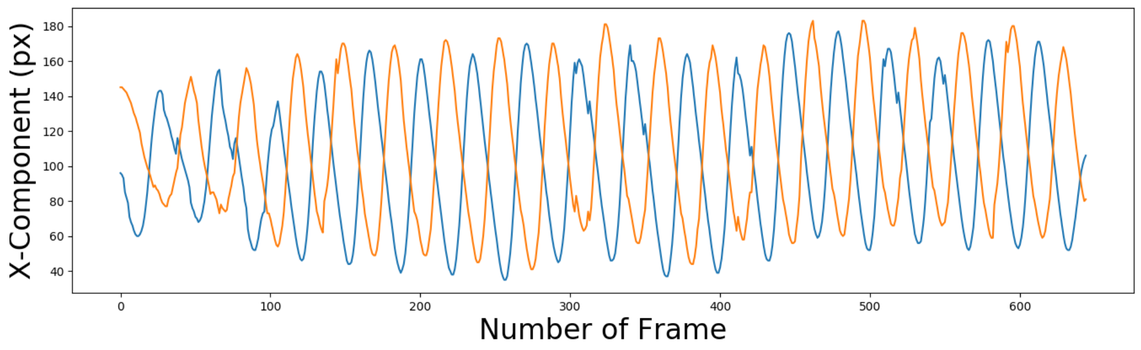

Figure 2: Tracked Left and Right Ankle Positions While Walking on a Treadmill.

Preliminary Results

A video sequence of 650 frames of one healthy subject was recorded. A sinusoidal and symmetric pattern can be noticed. The data was processed by calculating the velocity vectors and using their sign changes as an indicator when a gait phases has changed. The mean stance phase duration is $\bar{x}$=0.84s, s=0.006, the swing phase is $\bar{x}$=0.5s, s=0.001 for both feet. This result aligns with those parameters reported in the literature, as the ratio of stance and swing phase is equal to 60% (0,604).

References

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