Assessment of squat motion and posture

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Introduction

The squat is a compound physical exercise and often forms an integral part of training and conditioning programs. It is a fundamental exercise for strengthening the lower body and core muscles as well as often presenting other benefits. During a squat, the lower body can incur greater forces than generally accustomed to and so a degree of coordination and balance is required throughout the motion.
An individual performing a squat improperly can be subject to knee and back injuries and it is therefore vital that the exercise is executed with proper form.

1. Project Outline

This project will explore a method of obtaining a posture analysis on squats and classifying them as correct or incorrect (including the type of incorrect behaviour, for example a squat where the individual leans too forward).

The aim is to achieve this classification using just video recordings of the squats and not rely on the use of motion capture technologies such as the Kinect.

2. OpenPose

⇒ OpenPose is a multi-person key-point detection library for body, face, and hands estimation
⇒ OpenPose achieves detection on single images making it useful for tracking joints in video recordings

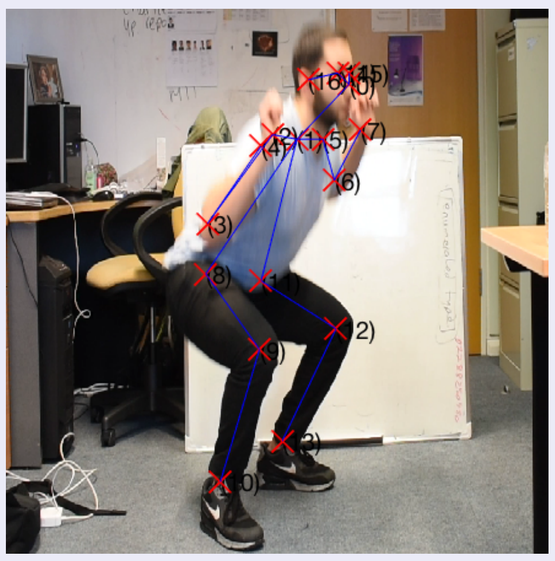

Figure: OpenPose joint detection on a single frame of a video recording

⇒ OpenPose occasionally estimates occluded joints incorrectly and with low confidence scores. In such cases, an interpolation between the last and next confident positions is calculated to produce a better estimate
⇒ OpenPose tracks multiple persons, and so a method of tracking only the person squatting was added

3. Dataset

⇒ The classification model should improve with a larger dataset and therefore a collection of various individuals squatting will need to be recorded.
⇒ Each squat in the video recording will need to be extracted and re-sampled.

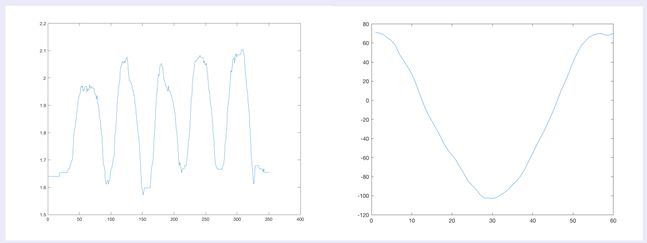

Figure: Single feature time series of a recording (left) and an extracted squat re-sampled (right)

⇒ Each squat will be given a class label, determined by an expert opinion
⇒ The position of each squat will also be normalized
⇒ With each squat normalized, re-sampled and assigned a class label, the classifier can then be trained

4. Progress and Status

A simple training dataset has been collected from two individuals performing various squats. The following classes have been included: Correct, incorrect leaning too forward, incorrect feet too close, incorrect chin tucked, incorrect not deep enough.

Completed

⇒ Make slight modifications to OpenPose
⇒ Collect simple dataset
⇒ Evaluate success of using joint positions as features following PCA
⇒ Evaluate different features
⇒ Evaluate classifier using simple dataset and features

Next Steps

⇒ Collect larger dataset
⇒ Normalize scaling
⇒ Comparatively analyse different types of classifiers
⇒ Explore other dimensionality reduction techniques

5. Business Plan/Research Proposal

The nature of this project will allow for video recordings to be used for squat analysis. This makes squat recordings taken on phone cameras feasible for obtaining an analysis. Therefore, creating a service which can be used at any gym or even at home.

Similar Services

⇒ Similar products currently use fixed cameras and sensors
⇒ High cost to purchase this equipment
⇒ The service is only available in well facilitated gymnasiums

Target Audience

⇒ Individuals looking to reduce damage incurred through squatting
⇒ Individuals looking to improve their posture for strength improvements
⇒ Individuals looking for a low cost alternative and the accessibility to use in multiple locations

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