Abstract

Fitness exercises are very beneficial to personal health and fitness; however, they can also be ineffective and potentially dangerous if performed in correctly by the user.

Exercise mistakes are made when the user does not use the proper form or pose.

The system is planned to detect the exercise pose of trainer and provide a feedback on the user's form.

Our goal is to help prevent injuries and improve the quality of people's workouts without a trainer.

In this document we will present two different systems that provides feedback on the user's body posture without using any sensor.

Introduction

Exercises are beneficial to health and fitness, However, it is difficult for an individual to achieve the correct pose in training, it can also be very dangerous if performed incorrectly.

Many people work out and perform exercises regularly but do not maintain the proper form (pose). This could be due to a lack of formal training through classes or a personal trainer.

For our final project, we seek to aid people in performing the correct posture for exercises by building a model that detects the user's exercise pose and provides useful feedback on the user's form, using a combination of the latest advances in pose estimation and machine learning.

Our goal for the project is to help prevent injuries and improve the quality of people's workouts with just a computer and a webcam.

Related Work

Before assessing the user's movement quality, we will need to assess his posture. Pose assessment allows us to analyze the static posture of humans, which will provide valuable information on posture readiness. The human pose estimation is an important research topic in computer vision. There are several state-of-the-art methods for pose estimation that accurately estimate human poses under a variety of sensor configurations, shots, and counts of individuals per shot.

The articles that focus on giving feedback on users movement and posture without using any sensors, use a model called OpenPose that is used for pose estimation.

OpenPose can provide real-time 2D pose estimation using a nonparametric representation to learn the body parts in an image dataset. This is the first open source library available real time system for multi-person 2D pose detection, including body, foot, hand, and facial key points.

The method takes the entire image as the input for a CNN to jointly predict confidence map for body part detection and PAFs for part association. The parsing step performs a set of bipartite matchings to associate body part candidates. Finally assemble them into full body poses for all people in the image.

There are two systems that are using OpenPose for provide feedback on the user's body posture:

i. Pose trainer, a software application that detects the user's exercise pose and provides useful feedback on the user's form.

   First, the user records a video of themselves performing a selected exercise. The video is recorded from a particular perspective (facing the camera, side to the camera, etc.) that allows the exercise to be seen.

   For pose estimation, they use deep convolutional neural networks (CNNs) to label RGB images. Using Open pose that is composed of a multi-stage CNN with two branches, one to learn the confidence mapping of a key point on an image, and the other to learn the part affinity fields.

   After that, there is key point Normalization and Perspective Detection.

   There are two approach to evaluate the exercise posture given normalized key points:

   - Geometry Evaluation by compute body vectors from key points of interest and use personal training guidelines and their own recorded videos to design geometric heuristics, evaluating on the body vectors.
   - Use more data-driven, machine learning approach and DTW.

   This application provides feedback only for 4 different exercises:

   1. Bicep Curls (precision 89% and recall 86%).
   2. Front Raise (precision 100% and recall 100%).
   3. Shoulder press (precision 76% and recall 73%).
   4. Shoulder shrug (precision 89% and recall 85%).

   To use this model, you should download Posetrainer and Openpose.

   Although the Openpose download is described in the article as simple, we encountered a lot of bugs and difficulties.

   To run the model, the instructions are to write in the command line the exercise and the path of the video or use your Webcam.

   Unfortunately, our output doesn't match to their examples, and we think there is a problem with the model or with the installation instructions

The disadvantages of this method are that it works on a very limited number of exercises, you must train the model for each exercise separately, and for the geometric approach you need to do a lot of pre-analysis of your data.

The advantage is that for some exercises, the accuracy percentage is very high.

ii. Visual Feedback for Core Training with 3D Human Shape and Pose-

A visual feedback system for core training using a monocular camera image. To support the user in maintaining the correct postures from target poses, by adopting 3D human shape estimation for both the target image and input camera video.

Its aim to provide a user interface for visual feedback in sports training using state-of-the-art pose estimation approaches. In contrast to 3D sensing using laser sensors or depth cameras, the proposed system only requires a single image from a standard web camera.

The framework consists of two main components: pose estimation and visual feedback.

To obtain 3D human shape and pose from a single image, the proposed system adopts pose estimation based on OpenPose to realize the bounding box of the human region. It also employs human mesh recovery to estimate the 3D human pose. For the generation of 3D human mesh, an SMPL model is used.

For visual feedback, a runtime user interface is proposed to guide the user on the differences between target pose and the current pose from the captured frame. Both target and current poses are estimated from a single image using the pose estimation method discussed above.

To verify the efficiency and feasibility of the proposed Visual feedback system, the researchers compared the proposed system with the usual visual feedback on skeletal information.

They asked users to use both systems and answer a questionnaire, the results were that the proposed system is more effective in correcting postures when performing core training and requires less time to achieve the correct posture from the usual visual feedback on skeletal information.

The system has tested only on eight participants all of whom are male graduate students around 25 years old, so the results is limited.

In addition, the current execution time of the proposed visual feedback system is about 2 seconds for one frame. Although it may be suitable for core training because the user has to maintain the pose over a long period, it will be bottle-neck for other sports such as gymnastics and ball sports where movement is in high speed.

Another disadvantage that the standard SMPL model was used in this study and the actual human body cannot be captured in real-time.

The system is not available for download and is not provide as an open source library.