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Research of Self-Workout Trainer System Using Ai and Ml

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Abstract

Exercises for fitness are quite good for one's health and fitness. If used improperly by the user, they may also be ineffectual and even harmful. When the user does not adopt the appropriate stance, exercise errors are made. In our work, we provide a software program that recognizes the user's exercise stance and offers customized, in-depth suggestions on how the user can correct their form. People now more often exercise by themselves and without supervision as self-management for the treatment of musculoskeletal ailments becomes more popular. Without feedback, it might be challenging to identify when an exercise is being done properly, hence it is unsafe to try certain exercises. This might result in further harm. We draw attention to these issues and work to provide the best possible solution using an application that detects the user's stance using the most advanced pose estimation technology, then assesses the vector geometry of the pose using an exercise to deliver helpful feedback.

1. INTRODUCTION

As we get closer to the future, we are observing numerous firms' strategies in the fields of artificial intelligence, machine learning, the Internet of things, data analytics, etc. The use of artificial intelligence and machine learning algorithms makes it possible to quickly and simply handle numerous problems that arise in daily life. One of these issues is estimating posture during exercise, which was brought to light during the lockdown among those who exercised at home without the guidance of a professional trainer. It became extremely difficult for them, and it can also be challenging to recognize when one is performing an exercise incorrectly.

When compared to people who are not physically active, those who engage in moderate to vigorous levels of exercise have a lower death risk. By lowering the possibility of inflammation, moderate amounts of exercise have been linked to delaying the aging process.

- **Existing Technologies/Tools/Software**

1.2.1 Open pose: It is the first multi-person real-time system that jointly identifies key places on the human body, hands, facial expressions, and feet on a single image. Researchers from Carnegie Mellon University made the suggestion. They have made their work available in the form of Unity, C++, and Python code.

1.2.2 Open CV: OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. A standard infrastructure for computer vision applications was created with OpenCV to speed up the incorporation of artificial intelligence into products. OpenCV makes it simple for businesses to consume and alter the code because it is a BSD-licensed product. More than 2500 optimized algorithms are available in the collection, including a wide range of both traditional and cutting-edge computer vision and machine learning techniques. These algorithms can be applied to a variety of tasks, including the detection and recognition of faces, the identification of objects, the classification of human actions in videos, the tracking of camera movements, the tracking of moving objects, the extraction of 3D models of objects, the production of 3D point clouds from stereo cameras, and the stitching together of images to create high-resolution scenes.

Features of OpenCV:

1.Cross-platform: Allows installation for different environments (operating systems)
2. Portable: Transferable to any machine that can run C.
3. Open source: OpenCV is free for use under the open-source Apache 2 License.
4. Fast: OpenCV is highly optimized and makes use of NumPy functions.
5. Vast algorithms: OpenCV packages contain more than 2500 algorithms.
6. Fast prototyping: Implemented in the development of real-time applications.
7. Extensive use: Used across various organizations and companies.

2. Literature Review:

The major goal of the LR is to give a methodical and scientific evaluation of the effectiveness of using a self-workout trainer to avoid accidents and muscle fatigue while performing particular exercises. Many new exercisers begin without taking into account the possibility that poor posture can harm muscles and joints. People established a healthy practice of taking care of themselves during the COVID-19 epidemic by exercising or practicing yoga, both of which put the body in danger of harm by requiring flexibility. Fitness exercises are incredibly beneficial to one's health and fitness, but if they are carried out wrongly by the user, they can be unproductive and even harmful. Exercise mistakes are made when the user does not use the proper form, or pose. So, we came up with the idea of a Self Workout Trainer. Self-workout Trainer uses the state of the art in pose estimation to detect a user's pose, then evaluates the vector geometry of the pose through an exercise to provide useful feedback. Based on personal training standards, we used a collection of more than 250 workout photographs of proper and improper form to develop geometric heuristic and machine learning algorithms for evaluation. Pose Trainer supports any Windows or Linux computer with a GPU and works with four common exercises.

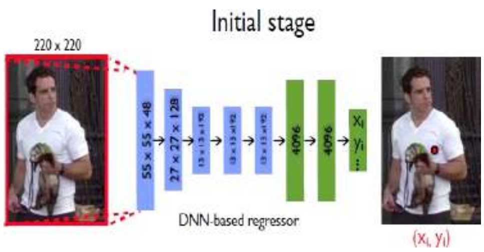
- **Deep Pose:**

The first significant paper[1], titled Deep Pose, used deep learning to estimate human position. It was published in CVPR 2014. In 2014, it outperformed current models and attained SOTA performance. The model features an Alex Net backend and estimated poses holistically, meaning that some poses can be predicted even when some joints are hidden. The publication launched research in this area by applying Deep Learning (CNN) to pose estimation. Regression was employed in the model for certain regions' XY positions. This increased complexity and decreased generalization, led to poor performance. For Pose Estimation, Deep Pose was suggested by Google researchers at the 2014 Computer Vision and Pattern Recognition conference. They are attempting to formulate the pose estimation problem as a body joint-based DNN regression challenge. They offer a series of DNN-regressors that produced highly accurate pose assessments.

4. Architecture:

4.1 Pose Vector:

• The authors of this study encode the locations of all k body components into joints to express the human body as a pose. A posture vector is defined as follows.
(1) Where represents the x, and y coordinates of the location of the body joint.
• The image is represented in the form of (x, y) where x is image data and y is data of ground truth pose vector.
• Since the coordinates listed here are those of the whole image, they are absolute image coordinates. The issue can arise if we resize the image. As a result, we normalized the coordinates relative to a bounding box (b) that contains the entire human body or certain portions of it. These boxes are denoted by the formula b = (, ,), where is the bounding box's center, is its height, and is its width.
• We normalized the location coordinates using the following formula.
(2) Finally, we get the normalized Pose vector coordinates.
(3) **CNN Architecture**



• The author of this paper uses Alex Net as their CNN architecture because it had shown great results on the Image Localization task.

(4)The predicted output y * can be produced by denormalizing the output, where theta represents the trainable parameters (weights and biases), shi represents the neural architecture applied to the normalized posture vector N(x), and ().
• This neural network architecture takes an image of size 220×220 and applies a stride of 4.
• The CNN architecture contains 7 layers which can be listed as : C(55×55×96) — LRN — P — C(27×27×256) — LRN — P — C(13×13×384) — C(13×13×384) — C(13×13×256) — P — F(4096) — F(4096)
• Where **LRN** stands for local response normalization, P for pooling, and F for fully connected, the convolution layer (C) uses ReLU as its activation function to bring nonlinearity into the model.
• The last layer of architecture outputs 2k joint coordinates.
• The Total number of parameters is 40 million.
• The L2 loss function is used by the architecture to reduce the separation between the anticipated coordinates and the ground truth loss function.
(5) Where k is the number of joints in the image.
DNN regressor:
• Since there would be an increase in the already considerable amount of factors, expanding the input size to obtain a finer posture estimation is difficult. To improve posture estimation, a cascade of pose regressors is therefore suggested.
• Now, we represent the first stage with the following equation.
(6) Where represents a full image or bounding box obtained by a person detector.
• Now for the subsequent stages s>= 2:
(7) Where *diam(y)* is the distance of opposing joints, such as left shoulder and right hips, and then scaled by? to make it? *diam(y).*
• The following images show how the accuracy was increased by a DNN regressor cascade.

5. CONCLUSION:

In this article, we lay out our strategy for giving exercise aficionados an AI-enabled posture-correction feedback system. We analyze exercise photos using important points from the human pose estimation's output. We employ machine learning techniques to automatically identify posture correctness using only labelled input Datasets, as well as geometric heuristic algorithms to deliver individualised feedback on specific exercise improvements. This program is still in its infancy. Our current attention is only on the plank workout dataset, but we have many other exercises and yoga stances planned for the future.

6. Future Scope:

For recorded videos, the application provides bicep curl identification and posture analysis. The reps are appropriately counted, and the feedback mechanism is appropriate. In the near future, we recommend a few goals:
1. To add such exercises as well, train models for the front raise and shoulder press individually.
2. Create a web application to provide this service over the cloud.

3. Redesign the application's user interface, and add a button to toggle between recorded movies and the live camera feed.

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