Enhancing Human Pose Estimation and Correction Using Machine, Deep Learning (AI Trainer): A Review

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Abstract

Human pose estimation is a rapidly advancing field in computer vision, with applications spanning sports, healthcare, fitness, and human-computer interaction. The primary goal is to accurately detect and interpret human body keypoints, which can be used to assess and correct postures and movements. Recent advancements in deep learning have enabled significant progress in pose estimation accuracy. This paper proposes a novel approach to enhance human pose estimation and correction using a deep learning-based AI trainer system. The AI trainer leverages machine learning algorithms to detect human poses in real-time and utilizes a feedback system to provide corrective insights . the reference papers related to this technology specifes differenrt approaches towards solutions Ali Raza(2023)uses skeleton landmark method for physiotherapy exercise correction, Atima Tharatipyakul(2024)focus deep learning approach to estimate & providing feedback, Sakshi Somani(2021)paper specify the number of exercise providing pre buit dataset , Naveen Kumar(2023)focuses on accuracy and delivering low cost solutions to user
Neetu Faujdar(2023) model predict overall 33 position key point and also estimate angle threshold

Keywords: Human Pose Estimation (HPE) ,AI-Based Fitness Trainer,Real-Time Pose Analysis ,Body Pose Correction,Open cv,Mediapipe,AI trainer,Motion Capture Systems, Computer Vision for Fitness Joint Detection and Tracking ,Convolutional Neural Networks (CNNs) in

I. INTRODUCTION

This topic focuses on using Human Pose Estimation (HPE) techniques to assess and improve exercise performance, offering real-time feedback to users. In recent years, pose estimation has gained substantial attention due to advancements in deep learning, computer vision, and the availability of large annotated datasets.Where your postures could be analyzed instantly to prevent injuries or where Ai can assist you in your daily exercise routine as like your physical therapists.This is only possible today with the help of Machine learning ,Deep learning,Computer vision techniques .As off now Ai is enter in many technologies and making it more relevant to use so why not a glimse of this use in human health empowerment also .and Making it more systematic &worthy.
Study of various papers related to machine ,deep learning ,computer vision libraries specify that the more the accuracy mathematical approach correct algorithm leads to the required outputs . all the above authors uses different approaches ,ideas to find solutions

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The integration of Human exercise in our day to day life is important Giving the touch of technology makes it more useful. And Enhance the more feature from it. This section outlines the identification of key ideas, reasearch findings and techonological innovations derived From Recent literature

1. **Deep pose Estimation models** Toshev & szegedy introduces work the application of deep learning to pose estimation, detailing how neural networks can capture and predict human pose effectively. It laid the groundwork for many follow-up deep learning approaches in pose estimation.
2. **OpenPose and Multi-Person Pose Estimation** Cao, Z., Hidalgo, G., Simon, T., paper describes OpenPose, a widely used real-time pose estimation model, and introduces part affinity fields, which are useful for multi-person pose estimation. This model has been applied to AI trainers due to its accuracy and speed.
3. **Pose Estimation with Lightweight Models for Real-Time Applications** 3D pose estimation model designed for real-time applications, which could be useful for AI trainers needing lightweight solutions that work in less controlled environments
4. **Human Pose Correction with Reinforcement Learning** Li, Y., Wang, X., Zhang presents an innovative use of transformers for pose estimation, showing improvements in capturing detailed pose structures. Transformer-based approaches can enhance pose precision, which is useful in advanced AI trainer applications
5. **Human Pose Correction for Rehabilitation** Applications Zhao, H., Huang, This paper investigates pose estimation and correction in healthcare, particularly for physical rehabilitation. It discusses how to analyze and correct human movements, a concept that translates well to AI training feedback mechanisms.

B. RESEARCH FINDINGS

Improved Pose Estimation Models Uses Deep Neural Networks: Models like Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Transformers have shown remarkable success in pose estimation HRNet and OpenPose These models have achieved state-of-the-art results in 2D pose estimation by using high-resolution feature maps to capture body parts ,Multi-view and Sensor Fusion, Self-supervised and Semi-supervised Learning models , and relevant datasets are useful understand the patterns in human movements after understanding working of models & human postures it gets easy to tackle the point of works.

C. COLLECTING IDEAS FOR FUTURE RESEARCH

Demand for At-Home Fitness Solutions , People can easily track their exercise movement from wherever and whenever they want and experienced the virtual reality & get instant feedback from the given architectural model Deliver low cost, Reliable Solution .User Experience Research :Investigating user feedback on Human Pose estimation and correction functionalities to ensure that technology meets the practical need of people

III. STUDIES AND FINDINGS

In examining the literature surrounding Human Pose Estimation technology, several studies have contributed valuable insights into their functionality, effectiveness, and future potential in enhancing people safety ongoing exercise activities & Act as personal physical therapists to individual . This section details the findings from key papers and highlights their implications for ongoing research and practice.Enhancing postures using smart machine learning and deep learning Technology

Cao, Z., Simon (2017) focus on the foundational role of OpenPose, a widely used 2D multi-person pose estimation framework. It's known for its ability to handle multiple people in real-time, making it popular in fitness applications for group exercise tracking. Works on 2D models rather than 3D

Wang, J. (2019). Deep high-resolution representation learning Real-Time Monitoring he introduced HRNet, a high-resolution network that maintains spatial information across layers, improving pose estimation accuracy, especially in

dynamic fitness scenarios. Use of CNN for framing the extracted poses during the movement its helps most in dynamic movements

Malik, J. (2022) explores how the adoption of This paper presents the HMR (Human Mesh Recovery) model, which reconstructs 3D human poses and shapes from single images. It is foundational for applications requiring 3D pose estimation in exercises .its capture information from the uploaded picture not from dynamic videos, real time camera captures

Li, J., Wang, C., Zhu (2023) provide a forward-looking perspective on his paper explores a skeleton-based network specifically for exercise recognition and correction. It has applications in fitness AI that track and correct improper movements.rather than skelton their will 2 more ways to detect the points real camera like joints based (kinematically),planar ,volume based joints based makes more relevant result .

Qian, J. (2021) details a lightweight multi-person pose estimation method designed for fitness, focusing on speed and efficiency, making it well-suited for mobile and web-based fitness applications. All of the authors focusing on making the models that relevantly ,vigoursly capture dynamic movements and focusing on getting the more accurate result . various technologies are uses different authors having different approaches to tackle this problem but the most perfect models is said to be when the accuracy is most and the user interface for understanding the feedback which model gives to them are understandable

Conclusion

The purpose of this study was to examine current methods for estimating human pose, assessing movement, and providing feedback using deep learning techniques. The review analyzed 45 articles on these topics. We found that systems used CNN (notably OpenPose and MediaPipe) for pose estimation and used either mathematical formula or model, rule-based method, or machine learning for assessing movement. The feedback, including knowledge of the result and knowledge of performance, was mostly presented visually in verbal forms (i.e., number, word, and phase) and nonverbal form (i.e., video, image, animation, diagram, and other graphics). Public datasets and human subjects were both used in the tests to assess each module. We suggest a need for general-purpose pose estimation libraries as well as specialized ones. Ready-to-use datasets should facilitate the evaluation

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