JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Human Pose Estimation for Exercise Tracker

Vaibhav Mane , Ganesh Sahu , Vaibhav Patil ,Siddhesh Nate, M. R. Gorbal
[1]Department of Information Technology, SSJCOE, India
[2]Department of Information Technology, SSJCOE, India
[3]Department of Information Technology, SSJCOE, India
[4]Department of Information Technology, SSJCOE, India

Abstract : Human Posture Estimation is one of the foremost essential errands within the field of computer vision that empowers the localization and the discovery of key body points and can advantage the areas like gaming, excitement, sports investigation and numerous more. Capturing human developments, analysing them and giving feedback on execution can profoundly advantage from the Human Posture Estimation and it's dependable location. The later progressions within the field of profound learning have presently made it conceivable to create real-time frameworks that contain the capability to precisely recognize and analyse human postures in realtime.

IndexTerms **:- Mediapipe, Pose detection with MediaPipe, Keypoint detection, OpenCV.**

I. Introduction:

In today's fast-paced world, maintaining a healthy lifestyle is more important than ever. Human pose estimation, a cutting-edge technology in computer vision, offers a revolutionary way to monitor and improve physical fitness by accurately tracking body movements. When combined with MediaPipe, a versatile framework developed by Google, this technology becomes even more accessible and powerful, enabling the creation of sophisticated exercise trackers that can revolutionize how we approach fitness routines. Human pose estimation involves the precise identification and localization of key points on the human body, such as joints and extremities, from images or video streams. By reconstructing these key points, pose estimation algorithms can infer the posture and movements of individuals in real-time. MediaPipe provides a robust platform for implementing pose estimation models efficiently, making it ideal for developing exercise tracking applications.

1.1 Key Features:

1. **Real-time Pose Estimation**: Utilizing MediaPipe's pose estimation capabilities, the tracker accurately detects and tracks key points on the human body in real-time. This includes joints such as shoulders, elbows, hips, knees, and ankles, allowing for precise analysis of body movements during exercises.

2. **Exercise Recognition**: The tracker can recognize various exercises performed by the user, including common strength training exercises like squats, lunges, push-ups, and yoga poses. This enables the system to provide tailored feedback and guidance for each specific exercise.

3. **Form Analysis** : By analyzing the user's body posture and movements, the tracker can identify errors in exercise technique and provide real-time feedback to correct them. This feedback may include visual cues, audio prompts, or haptic feedback to guide the user towards proper form and alignment.

II. LITERATURE REVIEW AND OBJECTIVE:

2.1 Literature Review:

Lu Meng and Hengshang Gao in paper [1] introduced 3D human pose estimation is more and more widely used in the real world, such as sports guidance, limb rehabilitation training, augmented reality, and intelligent security. Most existing human pose estimation methods are designed based on an RGB image obtained by one optical sensor, such as a digital camera. There is some prior knowledge, such as bone proportion and angle limitation of joint hinge motion.

Alexander Toshev and Christian Szegedy in paper [2] proposed a method for human pose estimation based on Deep Neural Networks (DNNs). The pose estimation is formulated as a DNN-based regression problem towards body joints. We present a cascade of such DNN regressors which results in high precision pose estimates. The approach has the advantage of reasoning about pose in a holistic fashion and has a simple but yet powerful formulation which capitalizes on recent advances in Deep Learning. We present a detailed empirical analysis with state-of art or better performance on four academic benchmarks of diverse real-world images.

The authers in paper [3] proposed a method posture recognition system that can be applied for medical surveillance. The proposed method estimates human posture using mobilenetV2 and long short-term memory (LSTM) to extract the important features of an image. The output of the system was a fully estimated skeleton. We used seven human indoor postures, including lying, sitting, crouching, standing, walking, fighting, and falling, and classified them. The output results are the extraction of the human skeleton and the corresponding labels for the poses.

Abhay Gupta et al. in paper [4] introduced a Human Activity Recognition is becoming a popular field of research in the last two decades. Understanding human behavior in images gives useful information for a large number of computer vision problems and has many applications like scene recognition and pose estimation. There are various methods present for activity recognition; every technique has its advantages and disadvantages.

2.2 Objectives:

1. Real-time Feedback: To provide users with immediate feedback on their exercise form and technique, allowing them to make adjustments in real-time for better performance and injury prevention.

2. Accurate Pose Estimation: To accurately detect and track key points on the human body during exercises, enabling precise analysis of body movements and postures.

3. Exercise Recognition: To recognize a wide range of exercises performed by the user, including strength training exercises, yoga poses, and aerobic activities.

4. Form Analysis and Correction: To analyze the user's body posture and movements during exercises and provide feedback to correct errors in form and technique.

5. Progress Tracking: To track the user's progress over time, recording metrics such as repetitions, sets, duration, and intensity of workouts.

III. System Architecture:

Input Data Acquisition: The system starts by acquiring input data, which could be either video streams from cameras placed in the gym or individual image frames.These input frames serve as the basis for detecting and tracking human poses.

Preprocessing: Preprocessing steps may include resizing, normalization, or any other required transformations to prepare the input data for pose estimation.In some cases, noise reduction techniques may also be applied to improve the accuracy of pose estimation.

Pose Estimation: This is the core component of the system where human poses are detected in each frame.MediaPipe offers pre-trained deep learning models for human pose estimation, such as PoseNet or BlazePose, which can be used to detect key points corresponding to different body parts.These models typically use convolutional neural networks (CNNs) or similar architectures to extract features from input images and predict the locations of keypoints.

Post-processing: After obtaining the keypoint locations from the pose estimation model, post-processing steps may be applied to refine the detected poses.Techniques such as filtering, smoothing, or temporal consistency checks can be used to improve the accuracy and stability of the detected poses, especially in video sequences where poses may change rapidly from frame to frame.

Visualization and Analysis: The final step involves visualizing the detected poses overlaid on the input frames, which can provide valuable feedback for gym trainers or users.Additionally, the system may analyze the detected poses to extract useful information such as exercise repetitions, form evaluation, or movement patterns. Visualization tools or user interfaces can be developed to present this information in a user-friendly manner.

Integration with Gym Tracking System: The pose estimation system may need to be integrated with other components of a gym tracking system, such as activity recognition modules, user tracking systems, or data logging systems. Integration ensures that the detected poses can be used effectively for various applications such as fitness tracking, automated feedback generation, or personalized workout recommendations

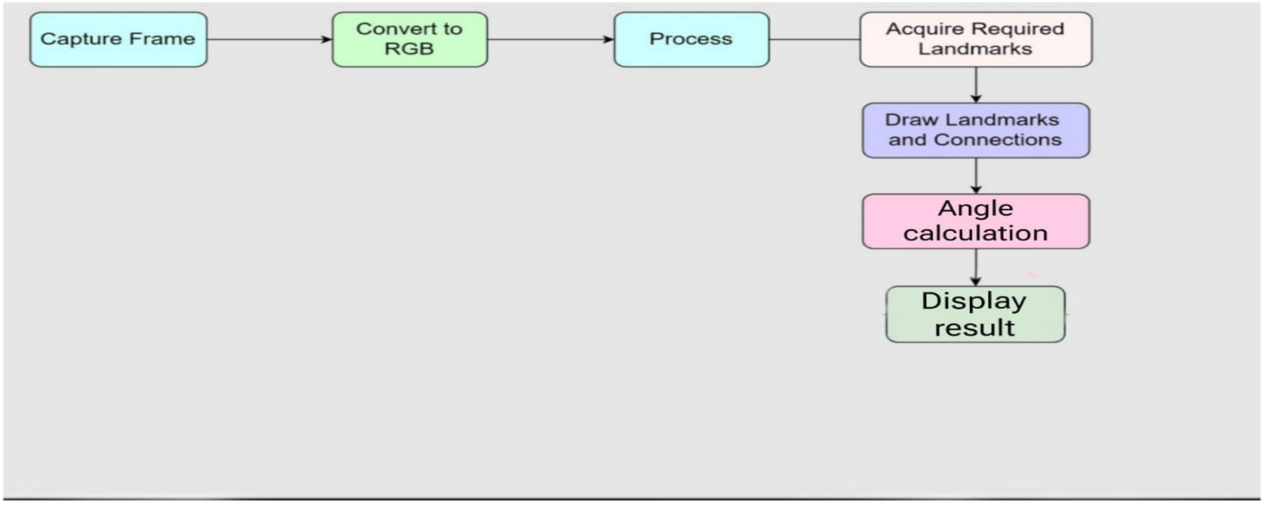

Figure 1 : System Architecture

3.1 System Specifications:

3.1.1 Hardware specification:

- Windows 7 or above
- Processor: Intel core i3 or avove
- RAM: 8GB or higher.
- Storage: At least 16GB of available storage space.

3.1.2 Software specification:

- For desktop/laptop computers: Windows 10, macOS, or Linux.
- .IDE: Jyputer notebook
- Language: Python

IV. RESULTS:

Users are likely to spend more time interacting with the Web app due to its immersive 3D and AR experiences, leading to higher engagement metrics such as session duration and page views. The ability to visualize furniture items in 3D and AR helps users make more informed purchasing decisions, leading to greater satisfaction and confidence in their choices.

The interactive and personalized nature of the app may result in higher conversion rates, as users are more likely to proceed to purchase after experiencing the furniture items in AR and customizing them to their preferences. Users may provide positive feedback on the app's usability, design, and functionality, contributing to its reputation and encouraging others to use it. The success of the AR-based furniture web app may lead to increased brand awareness, customer loyalty, and ultimately, business growth as more users engage with and purchase furniture through the platform.

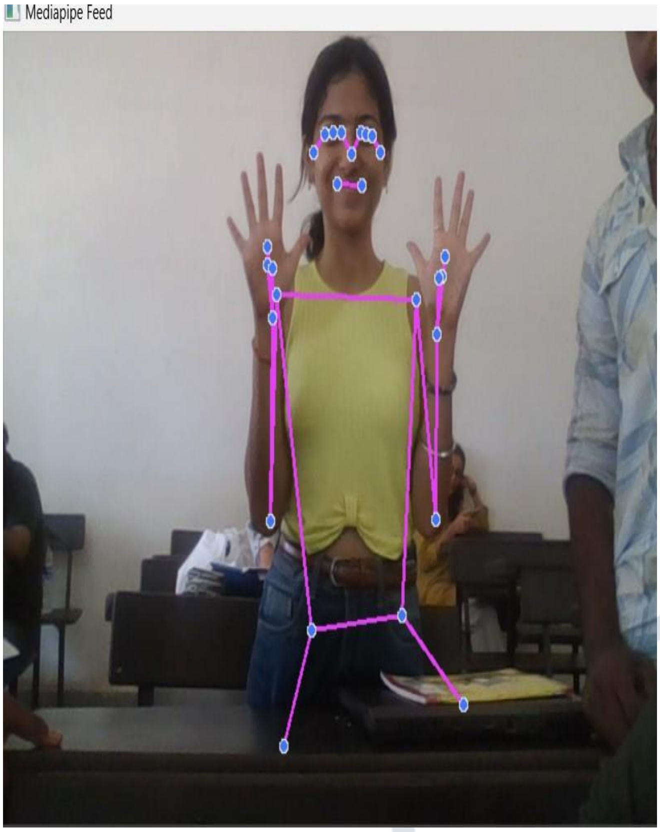

Figure 2: Determining Joints

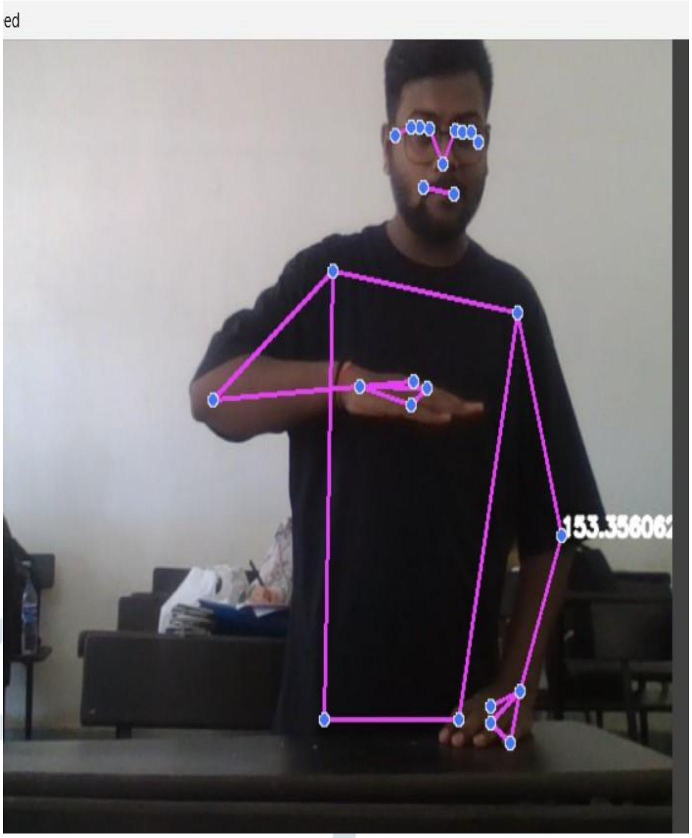

Figure 3: Angle Calculation

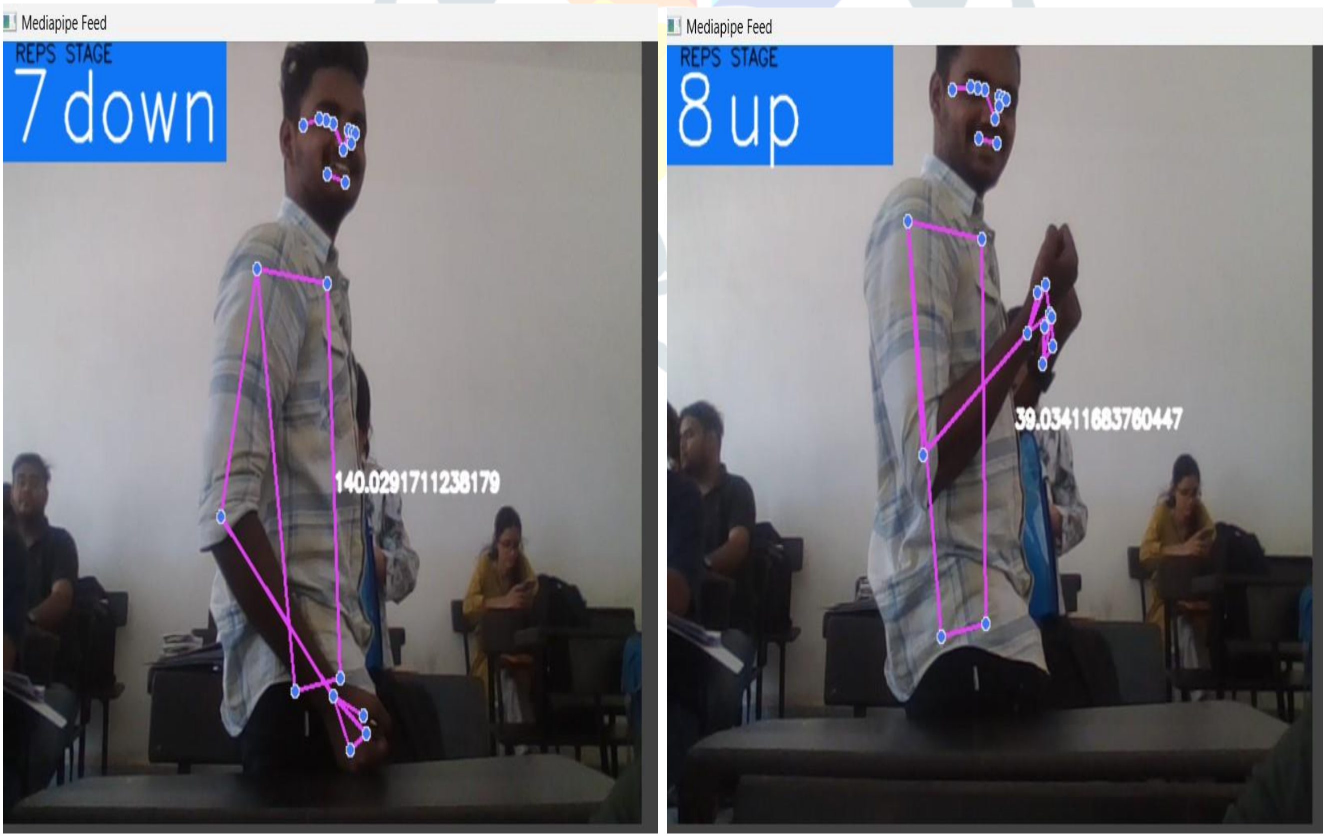

Figure 4 : Curl Counter

V. CONCLUSION:

This paper is only a humble venture to satisfy the needs in a made within a limited time frame at the beginning of the software paper and should be updated regularly as the paper progresses requirements of the organization. This project 'HUMAN POSE ESTIMATION' has been computed successfully. It is user friendly, and has required options, which can be used by user to perform desired operations. In this paper, we have developed a Gym Pose Detection system that utilizes the OpenPose library, a deep learning-based framework employing a convolutional neural network (CNN) architecture, to detect body keypoints. Additionally, we have used the MediaPipe Holistic module from the MediaPipe framework, which provides a comprehensive understanding of human pose, hand tracking, and face analysis in real-time. The MediaPipe Holistic module combines multiple machine learning-based models to estimate the key points (or landmarks) of the human body, hand, and face in a single integrated pipeline. Our system workflow is divided into two modules. The first module employs the MediaPipe Holistic model to detect the sequence of frames from the video inputted by the webcam. It leverages the extracted key points from the holistic model to recognize the hand gesture being performed. Based on the detected hand gesture, the system outputs the corresponding mapped or assigned exercise, which is determined through a pre-trained mapping of gestures to exercises. This exercise information is then passed to the second module for further analysis.

ACKNOWLEDGEMENTS :

The satisfaction that accompanies the successful completion of any task would be incomplete without the mention of people whose ceaseless cooperation made it possible, whose constant guidance and encouragement crown all efforts with success. We feel pleasure in expressing our heartfelt gratitude and vote of thanks to our guide, Prof. M. R. Gorbal, who guided us in difficult situations and helped us to enhance the concept of our project.

We would also like to extend our gratitude to our respected Principal, Dr. P. R. Rodge, and our Head of Department, Prof. Savita Sangam, for their support and encouragement throughout the development of this project.

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