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AI-FIT COACH - Revolutionizing Personal Fitness With Pose Detection, Correction and Smart Guidance

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***Abstract*--- In a fast paced world everyone is busy with their daily activities and works to lead a happy economic life by putting their health on the line. Its high time the human race understands the risk of health issues due to their stressed life. The panic created due to several ailments have now forced the people to workout daily. Study reveals that in India about 10% of the total population practice workouts on their own while the meager number rely on proper guidance from the trained persons. The proposed work has developed a Mobile Application which acts as the Artificial intelligence fitness coach for those who workout on their own to avoid injuries. Care will be taken on their body postures through this mobile application. The lack of proper guidance in the workout may definitely affect their muscles causing unavoidable sprains. The proposed work uses the technology of Pose Detection and Pose Correction using the Mediapipe library. Hitherto the workout has never been replayed to watchout for any improper postures. The proposed work has an option of uploading their saved workouts and ensuring the correctness of the workout postures at later stages for any corrections. This will motivate more people to do workouts on their own without risk of any injuries and can fetch good results without the help of Trainers. Voice assistance can also be included as a feature that keeps the user always alert with the correct postures. The user may not visit the screen for any information thereby keeping them in full concentration in their work outs.**

Keywords --- Deep learning, Image processing, Convolutional Neural Network, Tensor flow, Web Application.

I. INTRODUCTION

In our fast-paced world, where daily responsibilities often take precedence over health, the need for accessible and personalized fitness solutions is more apparent than ever. In India we learn from the statistics that only less number are attached to the professional trainers for workouts while a large number of candidates are on their own working out to stay healthy. These workouts may be sports of their interest at their younger ages. Any flaw in the postures may definitely cause the injury of the muscle or overload the muscle which may lead to muscle tear. In the world population only 2.4% people are going to the gym whereas 59% of the world population are doing their workouts on their own. To address this, we propose an AI fitness coach mobile application. This innovative platform, aimed at those who prefer to work out independently, uses advanced technologies such as Pose Detection and Pose Correction via the Mediapipe library to provide real-time feedback on exercise form, thereby reducing the risk of injury from unsupervised workouts.

Despite increased awareness of the benefits of physical activity, many people still lack access to structured fitness guidance, as reflected in low gym attendance rates. Our mobile application democratizes fitness coaching, empowering individuals to manage their own health and well-being. With features like real-time pose analysis and the capability to upload and assess saved workout routines, users can enhance their fitness journey with personalized support and accountability, even in the absence of direct supervision. Furthermore, the application goes beyond personal fitness to include sports performance analysis, especially in dynamic sports like tennis. By utilizing computer vision algorithms and gait analysis, we present a pioneering real-time shot prediction system. This feature not only improves training effectiveness by accurately predicting player movements and shot choices, but also offers invaluable insights for athletes looking to enhance their performance. Through this integrated approach, our mobile application aims to transform the interaction between technology and physical activity, promoting a holistic well-being culture and empowering individuals to lead healthier, more active lives.

II. LITERATURE SURVEY

"Pose Trainer: Correcting Exercise Posture using Pose Estimation (Steven Chen et al.)" In this study, Pose Trainer—an AI program that uses pose estimation to identify and adjust users' exercise postures—is introduced. The application uses OpenPose, a cutting-edge deep neural network for pose estimation, to infer users' stances. It uses machine learning and heuristic-based algorithms to assess workout posture. Performance of the deep learning-based evaluation, which uses dynamic temporal warping (DTW), is said to be susceptible to noise produced by OpenPose. "LAZIER: A Virtual Fitness Coach Based on AI Technology (Rani B1 et al.)" The study presents LAZIER,

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a virtual fitness instructor powered by AI designed for customized at-home exercises. By utilizing sophisticated methods including few-shot learning, contrastive learning, and real-time human pose estimation, it solves difficulties in online fitness environments. By using online video instruction to simulate offline fitness teachers, LAZIER offers personalized action demonstrations, tracks workouts, and assesses performance. While the dearth of different source videos and high-quality labeled data in online fitness settings presents obstacles for the algorithm, its performance is enhanced by technologies such as contrastive learning and human pose estimation.

In the work of “Virtual Fitness Trainer using Artificial Intelligence (Neha D et al.)” The research describes how an AI fitness trainer with real-time feedback and tailored routines was created using Python and MediaPipe. The main technologies used are MediaPipe for computer vision to track and analyze user movements, and Python for machine learning and data processing. The reliance on camera-based tracking could be a disadvantage since it could limit accessibility in some settings where using cameras is prohibited and raise privacy issues for users.

The work “trAIner - An AI Fitness Coach Solution (Vaibhav Singh et al.)” The AI fitness coach solution "trAIner," AI is used in the technology, namely Mediapipe Pose for pose estimation, BlazePose for real-time body pose tracking, and a Random Forest Classifier for evaluating exercise form. The reliance on webcam-based motion data capture could be a disadvantage as it could reduce the precision of pose detection and form evaluation. The limitation of the work is that the system performance may be impacted by external variables, lighting, and webcam quality**.**

“AI FITNESS TRAINER (Kashish Jain et al.)” The work centers on an AI Fitness Trainer application by Dr. Yogita Maneet al uses BlazePose pose estimation to help users count repetitions and guide them in proper form during exercises, thereby promoting safe and efficient at-home workouts. The program makes use of MediaPipe's BlazePose, a computer vision technology, to detect poses in real time. OpenCV is also used to indicate key points and show the number of repetitions on the screen. For pose evaluation, the machine learning algorithm uses a Random Forest Classifier. Due to the difficulty of pose estimation, the application's supported exercises are limited, and its current desktop-only platform prevents it from capturing multiple users in real-time. Subsequent improvements might tackle these constraints, augmenting the application's range and practicality.

“Recommender System with Artificial Intelligence for Fitness Assistance SystemTin is the work of Trung Tran et al. The study presents a Recommender System (RS) for a Fitness Assistance System (FAS) that makes use of artificial intelligence. Specifically, it uses Soar architecture with reinforcement learning, Logistic Regression, and Artificial Neural Networks. With user data as its basis, the RS seeks to recommend tailored workouts. The effectiveness of the suggested system is shown by the results of the experiments. Future work will focus on enhancing workout recommendations and fine-tuning the Trainer Agent module. In order to provide individualized workout recommendations based on user data, the suggested fitness Recommender System (RS) combines technologies like artificial neural networks, logistic regression, and soar architecture with reinforcement learning. Experiments indicate that the system is effective; however, to improve system performance overall, it may be necessary to refine the Trainer Agent module and continuously improve the workout recommendations.

“AI-Based Fitness Trainer (Anuj Lamba et al.)” The paper introduces an AI-based fitness trainer, "Fitcercise," utilizing computer vision for real-time posture detection during workouts. It aims to enhance home exercise experiences by providing personalized feedback on form and repetition counting. The proposed system addresses challenges like lack of motivation and gym access, contributing to improved fitness routines. Fitcercise uses AI and computer vision to identify posture in real time and provide users with customized training feedback. Drawbacks include dependence on technology, a lack of variety in exercises, privacy concerns, expense concerns, and potential difficulties with adaptability, while offering

“Enhancing Fitness Training with AI (R. Gowtham Kannan et al.)” The study presents an AI personal trainer for at-home exercises that detects posture in real-time using MediaPipe and OpenCV. It was created with Flask and attempts to increase user involvement throughout the pandemic by providing individualized training plans. Using MediaPipe and OpenCV for movement analysis, the system integrates AI algorithms to provide individualized recommendations. Drawbacks include camera quality dependence, difficulties with user adaptation, limited in-person interaction, internet connectivity requirements, equipment accessibility issues, privacy concerns, differing motivational preferences, algorithm robustness issues, and scalability considerations, despite offering real-time feedback and adaptability. Sustained improvement is necessary for broad acceptance and effective execution.

“AI Personal Trainer Using Open CV and Media Pipe (Kriti Ohri et al.)” In order to enhance at-home exercises by providing customized exercise plans and encouraging relationships among users with similar fitness goals, the article presents an AI-based personal trainer that uses OpenCV and Media Pipe for real-time pose identification. The technology stack consists of ChatterBot, a user-query chatbot, Flask for web application development, and OpenCV and Media Pipe for pose identification. Nevertheless, a significant flaw in the paper is its failure to specifically address real-time user inquiry support and motivation for lone exercisers, nor does it include a comparative analysis with other models.

These works discussed above provide a foundation for understanding the methodologies, challenges, and successes in shot prediction and sports analytics using machine learning techniques, including TensorFlow. By analyzing and synthesizing the findings from these studies, one can gain a comprehensive understanding of the state-of-the-art in this field.

III. Proposed Work

The proposed methodology combines computer vision, gait analysis, and machine learning to develop a real-time AI Fitness coach app for those who cannot afford a personal trainer. The methodology followed is as given below

a. Data Collection

The video footage of a person who is doing the exercise is captured using a standard webcam with the best angle for correct analysis. The main challenge of the work lies in this phase of capturing the image as the angle variation decides the correctness of the analysis. This video serves as the primary data source for the system.

b. Pose Landmark Extraction

Utilizing the Media Pipe Pose model, we extract precise pose landmarks from each frame of the video. Using a streamlit framework helps us to create a website with live streams and also provides the option to upload the video. These landmarks consist of 33 key points representing various joints on the person's body, including shoulders, elbows, hips, knees, and more.

c. Gait Parameter Calculation

With the pose landmarks in hand, we compute essential gait parameters critical for shot type prediction. These include step length (the distance between successive steps) and cadence (the number of steps within a specified time interval). We calculate these parameters based on the changing positions of relevant body joints. Fig a shows the pose model

Fig a. Pose and Pivotal Points Marking

d. Machine Learning Model

A machine learning model is employed, specifically trained for correct motion of hands and other parts of the body while doing a particular exercise, to analyze the computed gait parameters. This model takes the gait parameters as input and provides the output of the accuracy of the posture of the exercise.

e. Machine Learning Algorithms

The Support Vector Machine(SVM), Random Forest, K-Nearest Neighbour and Recurrent Neural Networks are used for interpreting the GAIT parameter analysis of the datasets. OpenPose and PoseNet are used for the analysis of the pose of the person.

f. Training Data:

Proper data is collected on each type of workout from the experts and gym trainers in order to train the machine learning model.These base data set serves as the training sets and appropriate gait parameters are linked to each data point in the dataset.

g. Real-Time Prediction

The proposed model continually processes video frames while the person is doing the exercise in real time. It captures position markers from each frame and then calculates gait parameters. The calculated gait parameters are then fed into the machine learning model that has been trained. Fig b shows the flow of the work.

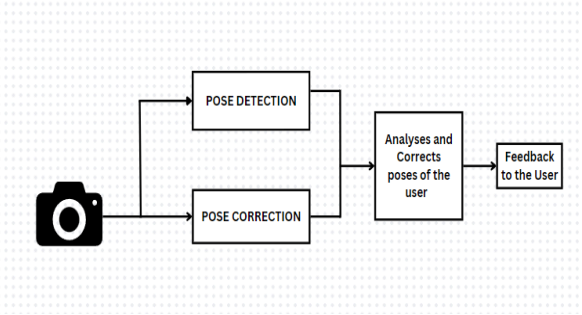

Fig. b Flow of Feedback generation

h. Visualization

The person may receive feedback on their exercise accuracy and posture since the anticipated posture is immediately superimposed into the live camera stream as shown in Fig c. Person may grasp the details and know how their gait factors affect the posture with the help of this visualization.

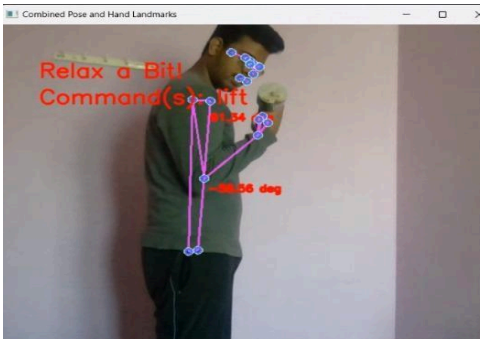

Fig c. Feedback of the Workout

The real time feedback plays an important role in immediate correction of any flaws in their postures.

i. Voice Assistance

The proposed work has an added feature of voice assistance. This feature is to eradicate the difficulty of the user to continuously look onto the screen for his feedback after each rep. The voice assistance gives the feedback audio which helps the user to rectify his posture by the command given.

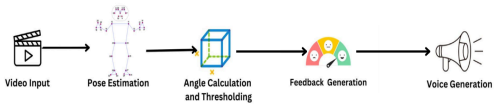

Fig. d Flow diagram of the Voice generation

IV. EXPERIMENTAL RESULT

The experimental findings for developing an AI-Fit coach is the pose detection and correction as this technology plays a vital part in tracking the movements of the user when doing the workouts. Mediapipe library helps in tracking pose for detection and correction in an accurate manner and along with this a Machine Learning Model is also developed along with Support vector machines (SVM), K-nearest neighbor, decision tree and RNN for Gait analysis. PoseNet and OpenPose(Deep Learning) are also used for pose detection and correction.

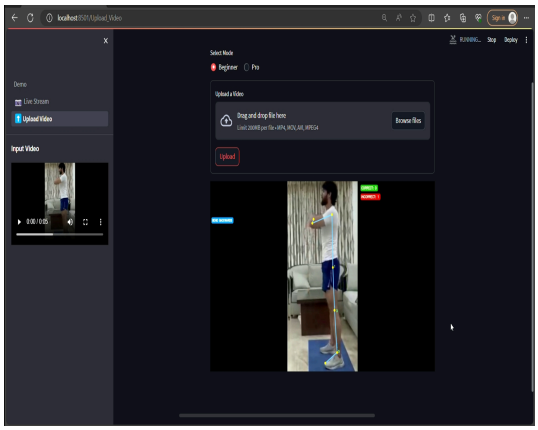

Fig. e Website Overview

Voice Assistance integration is also used as this is an application where the user does not need to look into the screen for his feedback which may disturb his rhythm while doing workouts. The voice assistance plays a major role in helping them as it gives the feedback to the users about their pose correction and other features after each reps. Fig e shows the website overview.

The application also contains a special feature where the user can upload the recorded videos for analysis and can get feedback about their posture and movements during their workouts. The same can even be sent in real time to the experts seeking further clarification.

V. FUTURE SCOPE

Future development may include personalized training programs created by coaches specially for their students that can help them follow their coaches' plans no matter where they are. Installing biometric sensors can be useful to monitor their health 24/7/365 days by their trainers. This feature helps the user from getting injured and can also suggest some modifications to prevent injuries.

Implementing Machine Learning algorithms that can adapt to the user's progress over time and can optimize the workout plans for the individuals. Implementing AR techniques improves the users experience as they can get real-time feedback. Nutritional guidance can also boost up the user's health and can be helpful for those who have no knowledge of balancing their nutrition in their body. Future developments in GAIT analysis and Computer vision technologies can boost up the accuracy level and can predict the posture for critical exercises in an easier way.

The main future scope of this system is the sports and games performance prediction where the user can check out their posture at which the performance is maximum. Later the same can be used to predict their performance for a particular posture during their training phases.The sports like javelin throws and shotput and all track events can make use of this model.

VI. CONCLUSION

The proposed model and its application helps individuals to get an instant feedback of their workouts and helps them to rectify the mistakes and helps them to have a better posture while they workout. This may help individuals to bring out their natural performance and also lowers danger of injury. The approach may be used by coaches to track the players' fitness who are on vacation, are at the rehabilitation center and monitor their developments over time and pinpoint areas where they need to improve their strength.

Using ML models will improve the accuracy of the prediction of how accurate a person is doing the workout and this application can be used by any individual who has a smartphone with a good quality camera and no need to hire a personal trainer to improve his health condition.

One of the major problems faced with this application is the camera angle. Some Android mobiles have wider camera angle but some don't have those features that may affect the detection of the correct pose required for the workout as the input fed wouldn't be good for the ML model to predict the pose.

This application also has an option to upload the recorded videos this helps the users to record the video of their workout and upload it in the application which analyzes the videos' each frame and provides feedback

of the workouts which they performed. This will be helpful for the users when they cannot live stream their workout session but can be analyzed later.

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