MIND MUSCLE CONNECTION IN PYTHON

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ABSTRACT:

This paper presents Mind Muscle Connection (MMC), an AI-based workout assistant that uses computer vision techniques to detect a user's exercise pose and count the repetitions of a specified exercise. The system offers personalized recommendations for improving exercise form and uses the MediaPipe framework for pose detection. It analyzes the geometry of the pose using both a dataset and real-time video feed, resulting in accurate repetition counting. Its purpose is to enhance the effectiveness of workout routines by providing users with real-time feedback and guidance. The results of the study demonstrate the potential of AI-based workout assistants to revolutionize the fitness industry, promoting healthy habits and improving physical well-being.

KEYWORDS: Mind Muscle Connection, AI-based workout assistant, computer vision, personalized recommendations, real-time feedback, MediaPipe, exercise form improvement, effectiveness, physical wellbeing, fitness industry.

I. INTRODUCTION

In recent years, the fitness industry has significantly transformed with the introduction of AI gym trainers. Artificial intelligence and machine learning algorithms are utilized by these systems to provide customized training programs and guidance to individuals, leveraging the advancements in technology such as computer vision, natural language processing, and sensors.

The first AI gym trainers emerged in the early 2000s with the introduction of interactive fitness machines. These machines incorporated sensors and advanced algorithms to create customized workouts based on a person's fitness level, body composition, and exercise preferences. This approach to training provided a unique opportunity for individuals to receive personalized training programs that could help them achieve their health goals.

Over the years, AI gym trainers have become more sophisticated with the inclusion of machine learning algorithms and natural language processing. This has enabled these systems to create more personalized and engaging experiences for individuals. Some AI gym trainers use computer vision to track a person's

movements and provide real-time feedback on their form, while others use voice recognition technology to provide verbal cues and encouragement.

Virtual personal trainers are one of the most popular types of AI gym trainers. These trainers provide individuals with customized workout programs that are tailored to their unique needs and abilities. They use machine learning algorithms to create programs that take into account a person's fitness level, body composition, and exercise preferences. This ensures that individuals receive workouts that are challenging but not too difficult, allowing them to make steady progress toward their health goals.

Another type of AI gym trainer is the fitness chatbot. They can answer questions about workouts, diet, and health goals, providing individuals with a comprehensive approach to their fitness journey.

Interactive fitness apps are also becoming more popular, with many incorporating AI technology to provide individuals with personalized workout programs. These apps use sensors to track a person's movements and provide real-time feedback on their form. They can also adjust the difficulty of workouts based on a person's fitness level, ensuring that individuals are always challenged but not overwhelmed.

One of key benefits of AI gym trainers is their ability to help individuals stay motivated and on track with their fitness goals. These systems can provide individuals with regular feedback and encouragement, making it easier for them to stick to their workout routines.

A. Relevant Contemporary Issues:-

While AI gym trainers are designed to provide personalized workout programs, there is a concern that they may not be as effective as working with a human personal trainer. This is because AI gym trainers may not be able to pick up on subtle cues and individual preferences that a human trainer would be able to. Moreover, many users don’t know the technique for that particular exercise.

B. Identification of Problem:-

Despite the fact that AI gym trainers are designed to provide customized workout programs, there is a legitimate concern that they may not be as effective as working with a human personal trainer. This is because AI gym trainers may not be able to pick up on subtle cues and individual preferences that a human trainer would be able to identify. Additionally, many users lack the technical knowledge required to perform certain exercises, which further reduces the effectiveness of AI gym trainers. As a result, individuals who rely solely on AI gym trainers may not receive the same level of personalized attention and guidance that a human trainer can provide, which could negatively impact their fitness outcomes.

C. Identification of Task:-

The task in the above problem is to communicate the concern that AI gym trainers may not be as effective as working with a human personal trainer in a professional manner. This involves discussing the limitations of AI gym trainers, such as their inability to pick on subtle cues and individual preferences, as well as the fact that users lack the technical knowledge required to perform exercises.

II. PROBLEM DESCRIPTION AND CONTRIBUTION

A new application has been developed that goes beyond just guiding users on which exercises to perform. It also offers real-time posture detection and counts repetitions using computer vision. This workout assistant provides personalized diet recommendations and can be used by individuals at home or expanded in scope to be used in gyms as a smart trainer. By reducing the need for human intervention, it offers a cost-effective solution for fitness enthusiasts. With its ability to detect correct posture and count reps accurately, users can ensure they are performing exercises safely and effectively, leading to better results and improved overall fitness.

A. Related Work:-

In a research article [1], the aim was to develop a method for estimating the pose of a user and real-time segmentation from images of a multi-person scenario, using a bottom-up approach. The proposed technique utilizes a convolutional neural network (CNN) that is trained to accurately detect and classify key points by analyzing their relative displacements and grouping them into different key point clusters to examine pose instances. The model achieved a COCO point accuracy of 0.665 with single-scale inference and 0.687 with multiple-level inference. The approach relies on key point level structure for training the real-time segmentation activity, which may be a limitation that can be addressed in the future.

In a research article [2], BlazePose, a lightweight convolutional neural network architecture optimized for predicting human posture, is introduced. The network generates 33 body key points for a single person during inference, operating at a rate of over 30 frames per second on a Pixel 2 phone. The researchers devised a robust method for estimating posture using Blazepose, which employs CNN and a dataset containing up to 25,000 photos with distinct body endpoints to improve accuracy. This model can operate in near real-time on a mobile CPU and super real-time on a mobile GPU. The algorithm for the 33 keypoint topology is efficient when combined with BlazeFace and BlazePalm. Nonetheless, the authors intend to integrate a solution that includes lower-body analysis of the pose.

In a research article [3], an effective solution for detecting poses when multiple people are present in real-time frames is proposed by the researchers. The model is trained to identify the user's points and classify them based on the relationship between different points in the frame, using a bottom-up approach. This approach is highly efficient in terms of accuracy and performance, regardless of the number of individuals in the frame. For a dataset consisting of 288 frame images, this method outperforms other discussed approaches by 8.5% in mean average precision (mAP). The approach achieves higher accuracy and precision in real-time. However, OpenPose, one of the earlier solutions, required redefining during the training stages. Additionally, OpenPose does not provide any depth data and necessitates high computational power, which can be considered as a disadvantage.

In a research article [4], the objective was to accurately locate points by utilizing a deep neural network. The researchers introduced DNN-based estimators, which increase the efficiency of predicting pose by improving precision.

In a recent research article [5], the goal was to provide pose detection and correction suggestions while also keeping a daily log of each user's calorie intake and suggesting exercises accordingly. Additionally, their approach could be employed to promote awareness about various government health schemes and disseminate information related to health insurance.

B. Objectives:

A lot of targets have been interested in reaping the goal:

- Exploring the potential of incorporating real-time posture detection and dietary recommendations into the AI gym trainer to further enhance users' fitness outcomes.
- Integrating personalized feedback mechanisms into the AI gym trainer to ensure users receive customized guidance based on their physical abilities and preferences.
- Establishing a scalable platform that can be used by individuals at home or expanded in scope to function as smart trainers in gyms, reducing the need for human intervention.
- Developing a cross-platform application with features such as health measurement.

C. Concept Generation:

Concept generation of an AI gym trainer with computer vision using MediaPipe involves leveraging its pre-built solutions and building blocks for developing an accurate and efficient system. The AI gym trainer would use the pre-built solutions for pose estimation and tracking provided by MediaPipe to analyze user movements in real time. The system would then use machine learning algorithms to compare these movements with a library of correct forms and provide personalized feedback on technique and form, allowing users to make real-time adjustments to their workouts.

D. Design Constraints:

★ *Feature Selection:-*

Feature selection is crucial for an AI gym trainer with Mediapipe to identify the relevant key points from video data for training a machine-learning model. Pearson correlation can be used to select the most informative features, leading to better exercise recognition and improved user experience.

★ *Feature Importance:-*

Feature importance is crucial in identifying the most informative features extracted from video data for an AI gym trainer using Mediapipe. By determining the importance of each feature, we can select the most relevant key points to train the machine learning model for exercise recognition. Using correlation-based techniques like Pearson correlation can aid in feature selection.

III. RESULT ANALYSIS AND VALIDATION

A. Particulars preprocessing:-

Preprocessing data for an AI gym trainer with Mediapipe involves collecting video data of people performing various gym exercises and using the Mediapipe library to extract key points from each frame of the video. The data is then normalized using techniques such as scaling or z-score normalization to make it more suitable for machine learning. The labeled data is typically divided into three sets: training, validation, and testing.

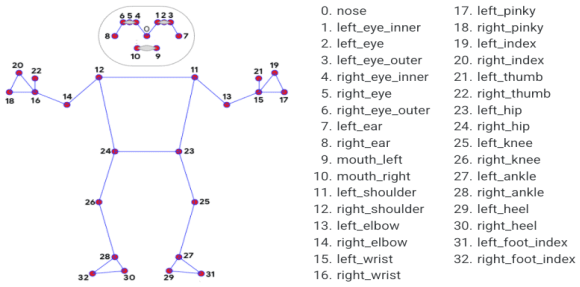

FIGURE 1: BLAZE POSE LANDMARK

B. Analysis:

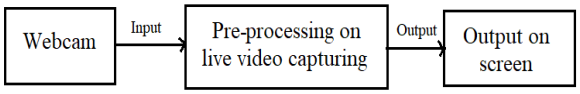

FIGURE-2: LEVEL 0 DFD SHOWING WORKING OF AI GYM MODULE

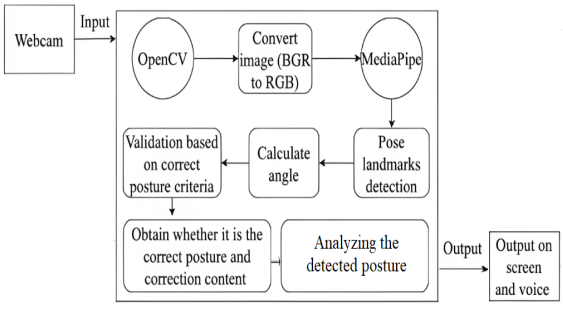

FIGURE-3: LEVEL 1 DFD SHOWING THE WORKING OF THE AI GYM MODULE

FIGURE-4: EXERCISE POSTURE RECOGNITION

C. Validation:

The professional approach to introducing more exercises to an AI-based workout assistant has several benefits. Firstly, it ensures that the added exercises are relevant to users' fitness goals and are popular in the fitness industry. This ensures that the AI-based workout assistant caters to a broader range of users with diverse fitness goals. Secondly, the use of accurate and reliable algorithms in developing pose detection and repetition counting models ensures that the system provides accurate results, enhancing the effectiveness of the workout routines.

FIGURE-5: ACCURACY VALIDATION

IV. CONCLUSION AND FUTURE WORK

A. Conclusion:

The MMC system presented in this paper demonstrates the potential of AI-based workout assistants to enhance the effectiveness of workout routines. The system provides real-time feedback and guidance to improve exercise form, enabling users to achieve their fitness goals more efficiently. The use of computer vision techniques and the MediaPipe framework ensures accurate pose detection and repetition counting, improving the overall effectiveness of the system.

B. Future Work:

- To improve the accuracy and precision of the Mind Muscle Connection (MMC) in detecting human movements and posture, the thesis aims to investigate various methods, such as developing more efficient neural network architectures and with an analysis model, more accuracy will be achieved.
- Use computer vision to help the user set realistic fitness goals based on their body composition, fitness level, and workout history. This can help the user stay motivated and focused on achieving their goals.
- Use computer vision to recognize the exercises that the user is performing and provide feedback and guidance based on the specific exercise. This can help ensure that the user is performing the exercises correctly and safely.

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