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AI-Driven Workout Guide

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Undergraduate Research Paper, Department of Computer Engineering, Smt. Kashibai Navale College of Engineering, Pune, India[1,2,3,4]

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Abstract: For the previous years, thousands of gym goers are looking for the solution to having an efficient and customized workout. Currently, the majority of users go through a poor posture while doing some exercises that leads to pain or decreased result. To fight this issue, the "AI-Based Workout Guide" is a technology solution which utilizes computer vision and AI to provide real-time posture correction and rep counting.

The project utilizes AI and machine learning algorithms to determine users' body motion while performing a workout. Recorded by means of a camera or phone, the system will then compare this posture with the most common model ones for the optimal methods of performing the exercises. In case of a wrong posture, it will always provide immediate feedback regarding what one needs to change. Another aspect of the system is that the repetitions are automatically counted, and therefore no manual counting is needed and even greater focus on correct form by the user.

The model has been trained on the database of different exercise poses, like squats, push-ups, and lunges. OpenPose or Mediapipe computer vision libraries are utilized to detect important landmarks, i.e., joint angles and alignment. In real-time, the system checks these milestones in order to give a correct posture analysis and rep count. Eventually, this would assist the users in becoming more efficient in their workouts, minimizing the possibility of injury, and achieving fitness objectives better.

It's a readable, scalable AI-driven workout manual, from which it follows that it can be easily converted into any web or mobile application. Its usability reaches to beginners and intermediate fitness enthusiasts. This project demonstrates how technology can revolutionize personal training in fitness: the marriage of cutting-edge AI methods with a pragmatic solution for the implementation of fitness.

Real-Time Feedback for Ongoing Improvement: The real-time feedback allows users to correct immediately, and therefore maintain ongoing improvement in workout performance. This instant advice discourages poor habits from developing, important to ongoing fitness gains.

Increased Precision: The system takes advantage of leading machine learning methodologies, such as deep learning methodologies, to analyze and suggest precise posture adjustments against a huge dataset of correct postures during workouts. Precision is guaranteed while following complicated movements, and it's even able to modify the fit according to distinct users' variance in form.

Keywords: AI, Computer Vision, Workout Guide, Pose Estimation, MediaPipe, OpenCV, Exercise Form Correction.

I. INTRODUCTION

There is increasing consciousness about fitness today, and people are doing exercises more frequently, either in the gym or at home. Certainly, this trend promotes physical health and wellness, but accompanying this trend is a challenge: ensuring that one maintains proper posture when exercising. Bad posture forms particularly when one performs such strength-oriented or repetitive movements like squats, push-ups, or lunges, causing strains and injuries and subpar workouts. Furthermore, rep counting habitually diverts attention from form to sustaining the required pace. It decreases the likelihood of moving ahead and elevates the chances of mistakes. For all these reasons, technology forms the core of personal fitness to overcome the issues mentioned above with artificial intelligence (AI) as a major weapon to help users in real time.

This will lead to a smart workout guide that not only identifies workout posture but also corrects it and has a count of repetitions done. The AI system would make use of computer vision, with it monitoring the user's body movement and analyzing it in real time for varying exercises. With previously trained models of flawless posture, the system would

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determine whether the user is exercising or not. It will notify the user immediately concerning bad posture and thus provide them with a chance to rectify it. Further, it monitors repeats without encumbering the user such that he is not required to count repeats himself but can concentrate on correct posture and maximize workout efficacy.
The importance of proper posture during exercise cannot be overemphasized. Not only does poor form reduce the effectiveness of a workout, but a poor posture in stress or strength training can cause serious physical damage. Some minor error, like rounding the back in squats or failing to pay attention to overall alignment in a pushup, for a normal person, goes unnoticed. This is where AI technology enters the picture. AI monitors the postures in real-time through sophisticated machine learning algorithms and computer vision technologies and inputs from multiple sources, which even pick up on tiny deviations in the ideal form and can trigger the user to adjust accordingly. OpenPose or Mediapipe are the key technologies for a system of this type, well-known libraries for the detection of human body landmarks, i.e., joints, angles, etc.

II. PROBLEM STATEMENT

Most individuals can easily injure themselves or diminish the effectiveness of their exercise if they fail to hold correct posture. Additionally, counting repetitions manually while exercising would distract a user's focus to shape. Lack of real-time feedback during exercise, with most exercise being conducted at home or unsupervised, presents a need for a smart solution that would be able to correct posture and count repetitions automatically. This planned project would create an AI-based workout guide for which a live detection and correction of exercise posture using computer vision with accurate rep counting was utilized, thereby making the exercise improved and reducing the risk of injury.

III. PROPOSED WORK

1. Overview

The suggested system is a computer vision-based gym trainer utilizing machine learning that offers real-time feedback on exercises of users without needing a human trainer. The intention is to increase the accuracy of fitness training, minimize risks of injury, and tailor workout sessions to individuals based on their exercise needs.

2. System Architecture

The system has the following key modules:
- Exercise Selection Interface: It allows users to select from a set of exercises that are supported.
- Video Input Module: Records live video from the user's webcam.
- Pose Detection (MediaPipe/OpenPose): Detects body key points to determine user posture and movements.
- Joint Angle Calculator: Calculates angles between joints to assess form accuracy.
- Repetition Counter & Form Evaluation: Detects full or half reps and grades form via threshold-based inspection or ML classifiers.
- ML-based Form Classification: Applies trained models to detect correct or incorrect form.
- Personalized Feedback Engine: Offers immediate audio/visual feedback and improvement tips.
- Performance Dashboard: Shows metrics such as total reps, accuracy, calories burned, and progress trends.

3. Key Innovations

- Real-time AI-based posture correction and feedback.
- Personalized difficulty adjustment and form analysis.
- Integration of user feedback and goals to create customized sessions.
- Gamified features and multilingual feedback for broader accessibility.

IV. LITERATURE REVIEW

A literature survey is as follows:
In "Deep Learning: Methods and Applications," some of the efforts in the development and deep learning algorithms towards numerous applications including pose detection and human movement tracking are presented by Deng and Yu (2016).

Their publication is the core basis of the original methods employed in AI models used to identify patterns of human movement and posture. This paper builds the foundation of designing systems that would estimate human poses in real-

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time on the topic presented, that of neural networks, which would have immense usability to AI-powered workout guides where accurate pose estimation is a crucial element.

Islam et al. (2020) in their work, "Correction and Estimation of Workout Postures with Pose Estimation using AI," demonstrate how pose estimation methods based on AI can even identify improper workout postures. In this work, the research has delved into how deep learning models can be used to examine human movement and feed back real-time into users while working out. This research helps establish intelligence.

Park et al. presented "Virtual Gym Tracker: AI Pose Estimation" in 2021. The system is described as one that leverages sophisticated deep-learning methods for tracking users' movements within an exercise setting.

The system offers real-time analyses and feedback to the users thus improving the efficacy of their exercise through an instant change in the shape of users. This study is useful for fitness systems based on AI since it showcases the manner in which instant feedback boosts the motivation of users participating in exercises as well as performance. The second study contributed to this body is the paper authored by Ranganathan et al. in 2021. In this article, the work talks about employing AI for following the exercise posture and repeating them in real-time.

It applies pose estimation methods to commonly performed gym exercises like squats and lunges. In return, it offers a solution that enhances the accuracy of performance and ensures the users are in the right form. In summary, the paper enables readers to comprehend the way in which AI could be integrated into fitness routines and the potential for such integration to enhance the user experience during real-time exercise. Li et al. (2022) in "Robust Intelligent Posture Estimation for an AI Gym Trainer" recognizes a posture estimation system using AI methods, such as Mediapipe and OpenCV, to be used for offering real-time feedback during gym exercise.

This work is strongly applicable due to the ability to monitor and correct form in real-time in the context of AI fitness guidance. This also shows that intelligent posture estimation has the potential to make fitness more personal without eliminating the absence of round-the-clock oversight from human fitness trainers. Chaudhary et al. (2022): In their paper, "AI-Enhanced Fitness Coaches for Personalized Workout Plans," Chaudhary et al. discuss the integration of AI-powered posture monitoring systems with personalized workout training coaching.

They pinpoint how AI can adapt to an individual's specific body mechanics and fitness objectives, giving personalized instructions and real-time cues during exercise. Their study indicates that AI could easily replace conventional personal trainers, not just monitoring movements but also giving a personalized fitness experience to each individual.

V. TECHNOLOGIES USED

We have employed numerous libraries in our implementation such as OpenCV and MediaPipe that employ machine learning along with a great deal of arithmetic operations and algorithms. We are employing CPU capability for posture estimation to obtain the exact positions and angles. With these angles known, we can identify special activities such as the number of bicep curls and so on. We can find the angle between any three points with a single line of code.

[1] OpenCV
OpenCV is a computer vision library that is open-source and intended primarily for use in real-time applications. It was originally designed by Intel but is now supported by Willow Garage and Itseez. OpenCV is a cross-platform library that is available under the BSD license, thus making it open-source and very accessible.

[2] Python
Python is a general-purpose, high-level, easy-to-read, and easy-to-understand language. Python includes dynamic type checking along with auto-garbage collection, offering support for varied programming paradigms such as procedural object-oriented and functional styles of programming. Though not highest on the web development list, it is the best for use in machine learning applications, data analysis, as well as in GUI development. Its frameworks and libraries are largely utilized in work done in data science. Those include the analysis of big datasets, visualization of data, and prototyping. Among other industries, it has become more popular with data scientists than the recent trend for web development.

[3]Artificial Intelligence
Artificial intelligence is the computer science discipline that builds systems that can replicate human-based judgment, comprehension, and intelligent behavior in order to resolve intricate tasks performed by humans. It encompasses voice

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recognition, decision-making, and translation. Fundamentally, an AI system essentially seeks to simulate human behavior and decision patterns.

[4]MediaPipe

MediaPipe makes it easier to build live applications, such as 3D human pose estimation, by providing efficient neural network inference directly on the device. Its pose estimation function operates on 33 body key points that it can recognize and predict based on a dataset. MediaPipe uses the BlazePose tool, fueled by machine learning, to detect poses in real-time from a camera feed or RGB video. This process applies a two-stage pipeline of machine learning to enhance its accuracy. In the former, it first identifies the region of interest in the video; then the latter identifies key points within the region of interest. The tracker only operates when the model is at the beginning of the process or is not able to detect key points.

VI. SYSTEM ARCHITECTURE

One of its main strengths is providing real-time feedback to the users. It allows them to correct their posture and then always maintain proper form during their workout, which is critical for avoiding injuries as well as maximizing the effectiveness of any exercise. To avoid such deviations in posture, the system establishes threshold values and can subsequently detect such deviations immediately, providing instant alerts to the user in real time. This also ensures that they receive instant feedback so that while the users exercise, they can correct their form and increase their performance. The proposed system is carefully engineered to provide real-time support for exercisers in various exercises. It features a pose recognition model combined with geometric analysis of posture to detect and correct it, ensuring the proper performance of the exercises. The system processes information coming from a live webcam feed or a video data set, providing subjects with real-time feedback, including progress tracking and repetition counting. Below is a flowchart that represents the architecture of our system:

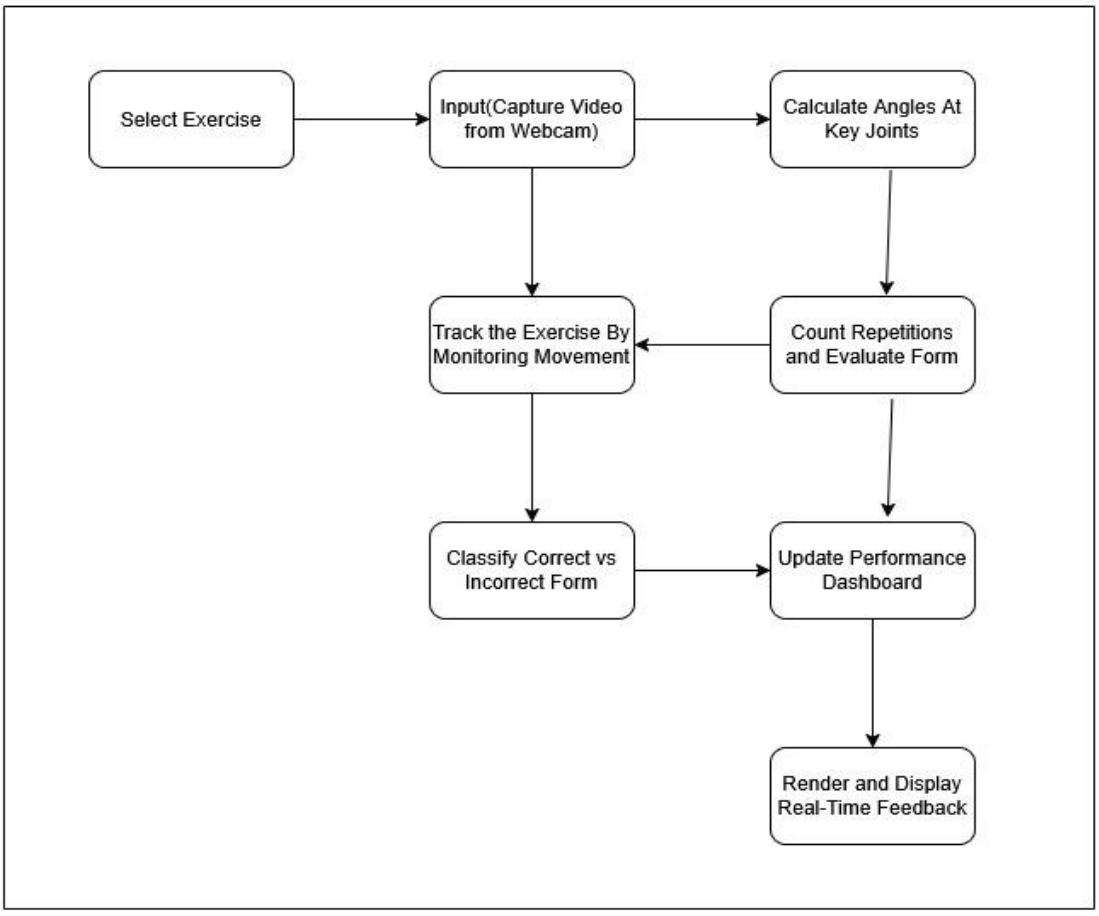

Fig 1. System Architecture

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Input and Output:

Input: Real-time video feed

Output: Repetition Counter, Posture Feedback

Flow of Data :

Captures video from webcam.

Process each frame to detect the human pose using Mediapipe.

Calculate angles at specific joints.

Track the exercise by monitoring arm movement and back posture.

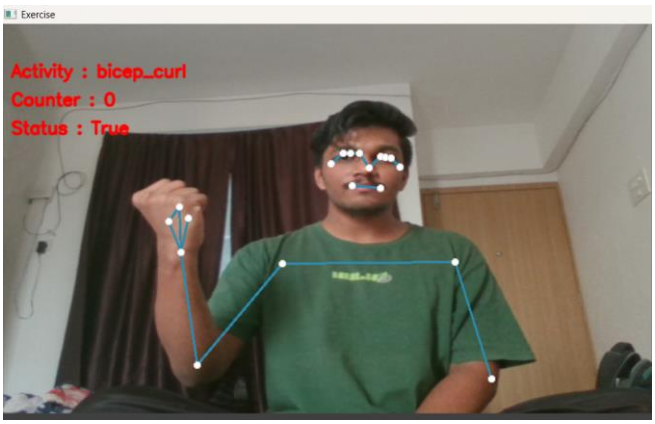
Count Repetitions and access forms based on angles.

Render and Display Results such as count, form evaluation, and pose landmarks on the screen.

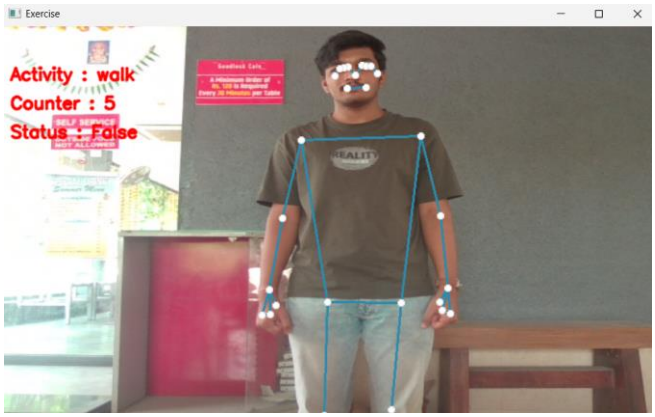
Exit when the user chooses to do so.

VII. RESULT

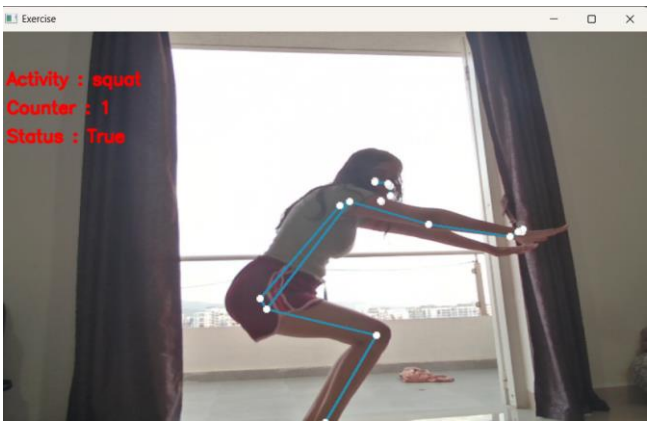
1. BICEP CURL



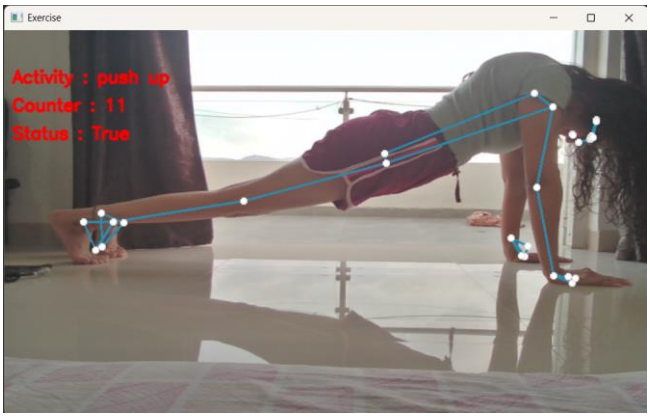
2. WALK



3. SQUATS



4. PUSH UPS



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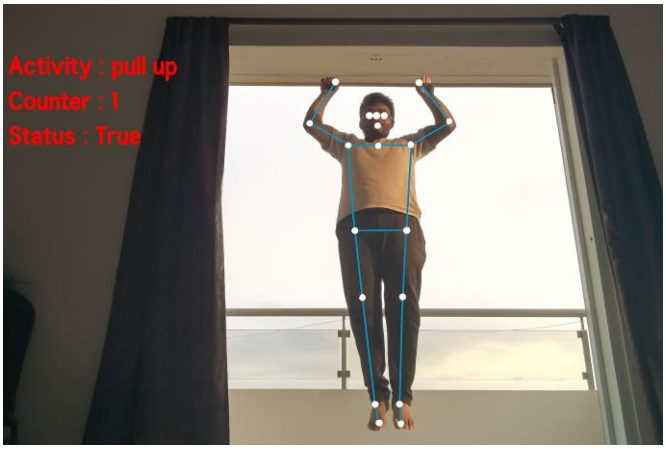
5. PULL UP



VIII. CONCLUSION

In this project, we have come up with an AI-based gym workout guide that not only supports the fitness journeys of the users through personalized training experiences but also has the capability to offer real-time posture correction and automated repetition counting using advanced computer vision methodologies. Since the guide is also a friendly and easily accessible workout option for a wide cross-section of fitness enthusiasts, it is an enabler toward healthier lifestyle choices. In a nutshell, this venture demonstrates the adaptability of artificial intelligence technology in revolutionizing personal fitness training and providing core benefits to users.

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IX. FUTURE SCOPE

Enhanced AI Algorithms: It shall improve the accuracy of posture detection and rep counting by including more advanced machine learning algorithms and through an expanded exercise dataset.

User Community Features: Social features allow users to connect, share how they're doing, and participate in challenges in order to build a healthy fitness community.

Incorporating wearable technology: Augment functionality through the integration of fitness trackers and smartwatches, thereby facilitating thorough health monitoring and tailored feedback.

Mobile App Development: Create a dedicated mobile application for better accessibility and user engagement, allowing users to access workouts and feedback on the go.

Advanced Analytics: Incorporate data analytics functionalities that provide users with insights regarding their performance trends, thereby facilitating the more effective establishment and attainment of fitness objectives.

Multilingual Support: Implement multilingual functionalities to accommodate a wider audience, thereby promoting inclusivity and enhancing user engagement across various regions.

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