Insightful Fitness: Shaping the Exercises of Tomorrow using Mediapipe

Abstract: In this project, The fusion of Computer vision and machine learning was used to analyze bicep curls, so that one can check the accuracy of a bicep curl in real time and provide insights into the bicep curl. The proposed setup efficiently examines input videos, recording and calculating the angles formed by the left and right arms in the video during bicep exercises using Opencv and Mediapipe features. The use of a Logistic Regression model expands the project's potential by enabling the prediction of bicep curl accuracy based on right and left arm data. This combination of computer vision and machine learning is a useful tool for fitness enthusiasts, offering an integrated approach to exercise monitoring and improvement. The study not only advances the understanding of bicep curl exercise but also paves the path for the use of automated assessments, contributing to the developing field of technology-assisted exercise analysis. This research not only examines blending computer vision and machine learning for bicep curls, but also proposes an additional use of this technology for overall activity monitoring. The goal is to expand the scope beyond bicep curls to enhance the methods for predicting and sustaining exercise accuracy through a variety of exercises. This approach attempts to lay the groundwork for a comprehensive application-based system that maintains accuracy criteria across a wide range of exercises.
Keywords: Opencv, Mediapipe, Machine Learning, Human Pose Detection, Logistic Regression

INTRODUCTION

Physical exercise is crucial for leading a healthier and more active lifestyle as it enhances physical and mental wellness. Among all of the exercises that contribute to a person's general wellness, the bicep curl comes up as a simple yet beneficial strength training activity. The bicep curl, which focuses and strengthens the bicep muscles, is a fitness staple that helps people shape their arms and build upper-body strength. As technology improves, novel techniques are being developed to improve the workout experience and provide valuable insights into performance data. A common instance of technological advancement is the addition of computer vision into technologies like Mediapipe. Mediapipe is an extensible system that examines streamed video to provide real-time awareness of body movements and gestures. Mediapipe's keypoint recognition and monitoring algorithms allow for an accurate and complete understanding of human position and motion. In the context of the bicep curls project, Mediapipe comes to be a useful tool for accurately capturing and evaluating all aspects of the workout, generating valuable data for future research.

Machine learning, a form of artificial intelligence, enables users to analyze workout patterns and performance. Logistic Regression, a strong machine learning algorithm, is useful in classifying and predicting outcomes based on input data. In this study, Logistic Regression has been used for evaluating data from Mediapipe, allowing users to find patterns and trends in bicep curl execution. This combination of cutting-edge technology and powerful analytical methodologies promises to transform the way one approaches and maximizes physical activities. To explore the complex intersection of physical activity, computer vision, and machine learning, this research aims not just to enhance the execution of the bicep curl but also to gain a better understanding of how to use technology for individualized fitness routines.

LITERATURE REVIEW

Nath [1] indicates that in today's world, the majority of personal gym trainers utilize AI for tailored exercises, dietary planning, and progress tracking. This AI trainer is considerably more affordable than personal trainers and can potentially utilized at any time. Monitoring multiple exercises performed by a variety of people, this AI trainer serves as a game changer. However, some people are afraid to use this due to the low level of human interaction and the substantial quantity of AI use, although these ideas totally change the area of fitness in terms of economics and precision. Every researcher understands that a proper posture is essential for an activity to target a certain portion of the body. The movement of joints throughout a bicep curl is captured in order to show the effectiveness of the media pipe in identifying the left and right arm elbow angles and determining exercise accuracy. This method diminished the use of COCO models in performance and prediction techniques across several datasets. Using these methods, one can readily demonstrate and assess correctness while performing an activity in a short period of time. Bhamidipati et al. [2] proposed that considering Robust Intelligent Posture Estimation as a crucial element of an AI Gym Trainer, it becomes clear how important it is for fitness enthusiasts to improve their training methods and reduce the likelihood of injury. This paper presents a method for achieving accurate posture estimation using Mediapipe and OpenCV. Although the research focuses on the particular use case of bicep curl repetitions, it suggests that the suggested approach can be expanded to include lunges, squats, and push-ups. Based on the video input, the system analyzes, detects, and outputs using picture recognition and reading. With its positioning as an AI gym trainer, this system may be tested and implemented to provide fitness freaks with a tool to improve their form and technique while reducing the risk of injury.

Jaiswal et al. [3] present a study in which a system that assesses exercise methods in real time and offers recommendations for correction is introduced. It tracks exercise movements using a physics simulator and counts repetitions and poses using MediaPipe. The system diagnoses variations from the recommended workout motions using this technology. In this research, Interaction Network (IN), a physics simulator that understands object relationships via Graph Networks was introduced. This study uses bodily landmarks and their relationships to represent human biomechanical signals, taking advantage of IN's capabilities. It assists with correcting workout postures by using IN's functions to forecast future dynamics based on these relationships. For exercise analysis, the Interaction Network (IN) uses position and velocity data from certain landmarks and reference points. The relation-centric model (fR) and the object-centric model (fO), which were trained over 2500 epochs, are the two neural networks used by IN. After hyperparameter tuning, the resultant error signatures are classified using a Random Forest classifier to determine if exercise repetitions are correct or incorrect. This shows consistency across different exercises. Chen and Liu [4] present a blossoming field of research focusing on visual-based human pose detection that has emerged in recent years due to the rapid advancements in artificial intelligence and computer vision technology. With applications ranging from motion-sensing games for HCI to activity prediction and medical rehabilitation, this field has enormous practical value. The application of human stance detection for fitness movement counts is the particular focus of this study. The main goal of the system is to accurately detect skeletal key points in the image of each body part, creating a skeleton of the human position. This skeleton allows the tracking of numerous postures to create movement trajectories and is essential for capturing human motion characteristics in video data. The technology evaluates trajectory and angle changes to determine whether fitness activities are right and helps users become more effective. The suggested fitness movement detection and counting system uses a lightweight MediaPipe model to improve accuracy and recognition speed in response to issues with current models such as OpenPose. The study highlights three main contributions: establishing an acceptable network structure for skeletal point detection, using trials to determine the right skeletal shape for fitness movements, and putting in place a Qt interface for HCI. Mukundan et al. [5] state that an exercise like squat is a movement in which a standing person descends to a posture with their torso vertical and their knees firmly bent, then returns to their original upright position. Each person's squat is distinct, with varying limb lengths causing their form to change when observed. It has been observed that the mobility of various joints and muscular strength have a role in this. This paper presents a method for classifying squat types and recommending the right squat version. Multiple methods, such as the Hidden Markov Model (HMM), Bayesian learning, NNs, SVM, etc., have been used to perform HAR. Multiple algorithms such as OpenPose, MediaPipe Pose, BlaisePose, You Only Look Once v7 (YOLOv7) pose, VoxelPose, etc., are used to provide the pose data in a 3D coordinate format for multiple points on the body. The method proposed for human pose recognition based on Deep Neural Network (DNN) was executed by training 4000 training and 1000 testing images using a DNN-based regression model that performed better results on pose estimation as compared to generic CNNs, which were initially designed for classification. Each process is analyzed with its advantages and disadvantages. Six squat analysis algorithms are considered to examine both quantitatively and qualitatively.

Sharma et al. [6] describe that Artificial intelligence is becoming more and more popular among developers, which may be ascribed to its many uses. One field that stands out in particular is Human Pose Estimation. In modern study, the estimate of human postures has gained prominence. Here, a system with a trained model is used to recognize the joints in the body of a person who is in front of it. Applications for this technology can be found in many different fields, such as determining an athlete's level of fitness or confirming that exercises are performed correctly. The artificial intelligence modelling of a gym tracker is the main topic of this article. The way the system works is that it counts the number of reps for four different exercises: pull-ups, curls, push-ups, and squats. This cutting-edge application demonstrates how versatile artificial intelligence can be when it comes to tracking fitness and analyzing human movement. Samhitha et al. [7] say that there is a well-known proverb "Exercise not only changes our body but also our mind, attitude, and mood" perfectly captures the current fitness craze. The quest for health, attractiveness, and fitness has become popular in the modern period. But the pandemic's obstacles have made it harder to access typical gym settings or personal trainers. In this study, an inclusive solution—an AI Trainer model that can be used by people of various ages and health conditions—is presented. The model makes use of Human Pose Estimation, a well-liked method for figuring out where the human body is in relation to other bodies. In order to do this, important body points must be generated, creating a virtual 2D skeleton. The AI Trainer records landmarks or important places on the human body using live video from a person's webcam as input. It provides feedback and corrections while guiding users on the number and length of exercises. This work presents a methodology that uses pose estimation, which runs on the CPU and computes gestures and curls (biceps) depending on important locations. The suggested method makes use of OpenCV to accomplish human pose estimation, which adds to the availability of artificial intelligence-based fitness recommendations. Srivatsa et al. [8] proposed a study whose main aim is to obtain a simple and efficient method for human pose estimation in the domain of sports and physical fitness. Human pose estimation(HPE) is the process in which from a single image, the configuration of a human body pose is identified. 2D Human Pose. Estimation calculates the 2-dimensional spatial location

of human body key points from input visuals such as images or videos, which can be used to evaluate human body pose. key points are usually located for the given objects. The key points above allow one to compare various movements and postures and draw conclusions. Augmented reality, animation, games, and robotics are all fields where pose estimation is used. This project is made with the culmination of the Classical 2D Human Pose Estimation Approach, Media Pipe, Blazepose, Architecture, and Human Pose Estimation Pipeline. The main mechanism implemented is a combination of human pose estimation and user-defined constraints and functions to calculate angles.
Gayatri et al. [9] investigated that the $90 billion fitness and healthcare industry employs 200 million people, so performing exercises correctly is critical. With worries about global health and a desire to stay away from crowded places, it is even more important to make sure you are in proper workout posture. Despite continuous technological breakthroughs, the situation is made worse by the proliferation of false information regarding posture. In this context, artificial intelligence appears to be a workable answer to some problems. Physiotherapy is a popular choice for treating injuries, and exercises are essential for enhancing posture. However, it can be difficult to ensure proper execution when patients complete exercises at home. To help people practice at home, this project suggests an application that uses a deep learning object detection model in the backend to correct exercise posture in real-time. Vedangi et al. [10] proposed that as people place a higher priority on preserving their physical and emotional well-being, the COVID-19 pandemic has led to a spike in the adoption of yoga and exercise regimens. Since internet approaches were the favoured option during the period of total lockdown, yoga has been a popular habit for maintaining health and fitness. To meet this increasing demand, the Play Store offers a wide variety of yoga applications. Yoga fans are beginning to feel the impact of artificial intelligence (AI), as its incorporation into the fitness sector continues to gather momentum. This covers smart wearables, AI-powered gym equipment, and fitness trainers. This study investigates how different yoga mobile apps use artificial intelligence (AI) to provide positive feedback and individualised experiences. It also presents the idea of an AI-powered yoga trainer, which is intended to assist, direct, remember, and inspire users as they practice yoga.

METHODOLOGY

This study aims to create a model that can predict the accuracy of a person performing bicep curls utilizing a video or live recording. In this research, A gym activity has been examined, namely the bicep curl, and the major goal of this project is to determine whether a person performing a bicep curl using a barbell rod or a standard dumbbell exercise is doing it accurately or not. For this task, Mediapipe is being considered. Mediapipe's primary focus is on the Mediapipe pose marker. The MediaPipe Pose Landmarker job can be used to recognize human body landmarks in images or videos. This exercise can be utilized to classify movements, analyze posture, and identify key body parts. This attempt makes use of machine learning (ML) models that work on individual pictures or videos. The job outputs body position landmarks in both picture and three-dimensional world coordinates. In this research, the angle between a person's elbow and bicep is utilized to assess the precision of their workout. To determine the angle between the elbow and the bicep, three locations were designated for various body sections (a, b, and c). Where points a, b, and c indicate the shoulder, elbow, and wrist, respectively. To complete and visualize the assignment, computer vision is used. To improve model speed and reduce computational load, the "Rescale Frame" is utilized. This function contributes significantly to increased processing efficiency. The primary objective is to dynamically resize video frames while maintaining a balance between computational load and posture detection accuracy. The function requires two parameters: frame and percentage. The frame represents a single video frame taken from the input video stream with OpenCV. a percentage sets the proportion by which the original frame dimensions will be scaled. By default, it is set to 75%. After that, a video was used as input for pose detection and angle calculation. The code then calculates the bicep curl employing variables such as the curl's current stage (stage), the total number of curls (counter), and lists containing minimal angles for both the left and right arms (angle_min_left and angle_min_right). All of this information will be saved in a CSV file and applied subsequently for training purposes. The Mediapipe mp_pose module was used to identify and process posture landmarks in each frame. This enables the precise identification of important locations such as the shoulders, elbows, and wrists, which are required for determining bicep curl angles. Pose landmarks are retrieved from the pose detection outcomes. These landmarks include the left and right shoulders, elbows, and wrists, which serve as the foundation for angle calculation and analysis. The code uses the extracted landmark coordinates to determine the left and right angles created during a bicep curl. These angles are then appended to CSV files, which contain data. The algorithm creates a logical framework for counting bicep curls based on identified angles. The curl stages are determined, and the counter is incremented when both the left and right arm angles meet specific criteria.

This ensures precise tracking of all bicep curl repetitions. The video frames, annotated with pose landmarks and angle information, are shown in Fig. 1,2, and 3 in real-time by OpenCV.

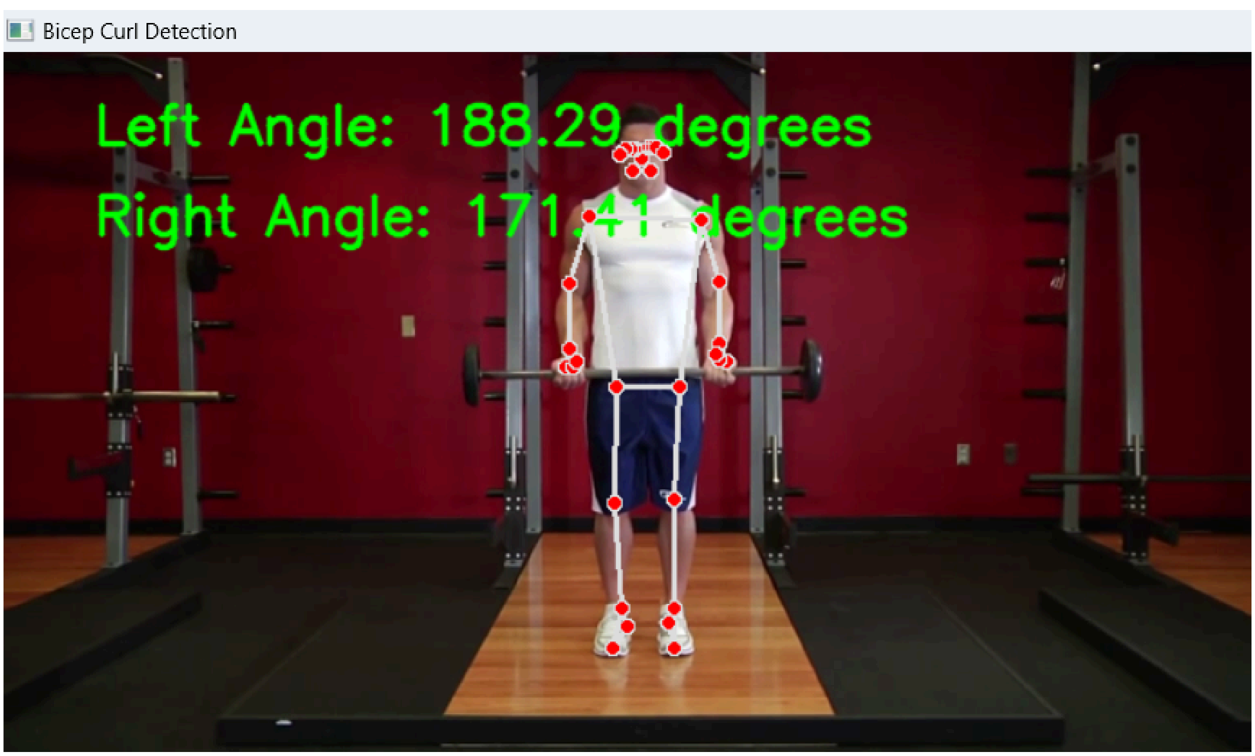

Fig 1. First Curl Left and Right Angle Calculation in Input Video

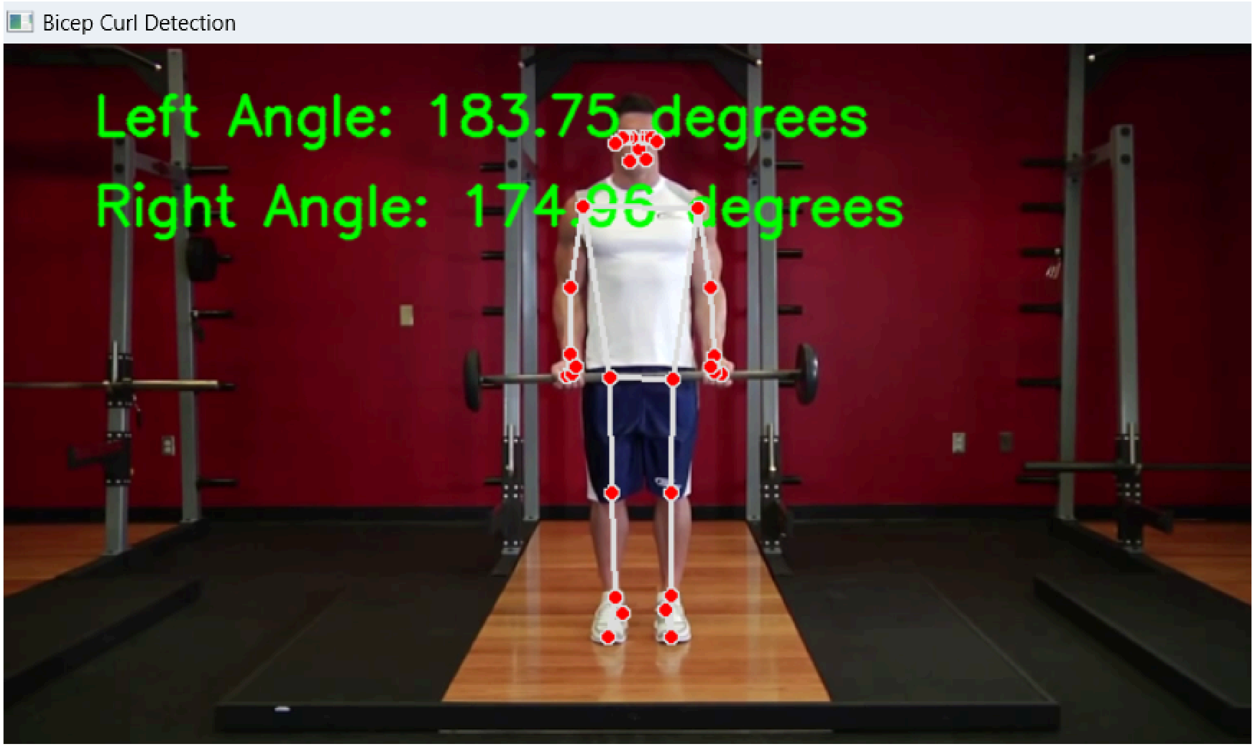

Fig 2. Second Curl Left and Right Angle Calculation in Input Video

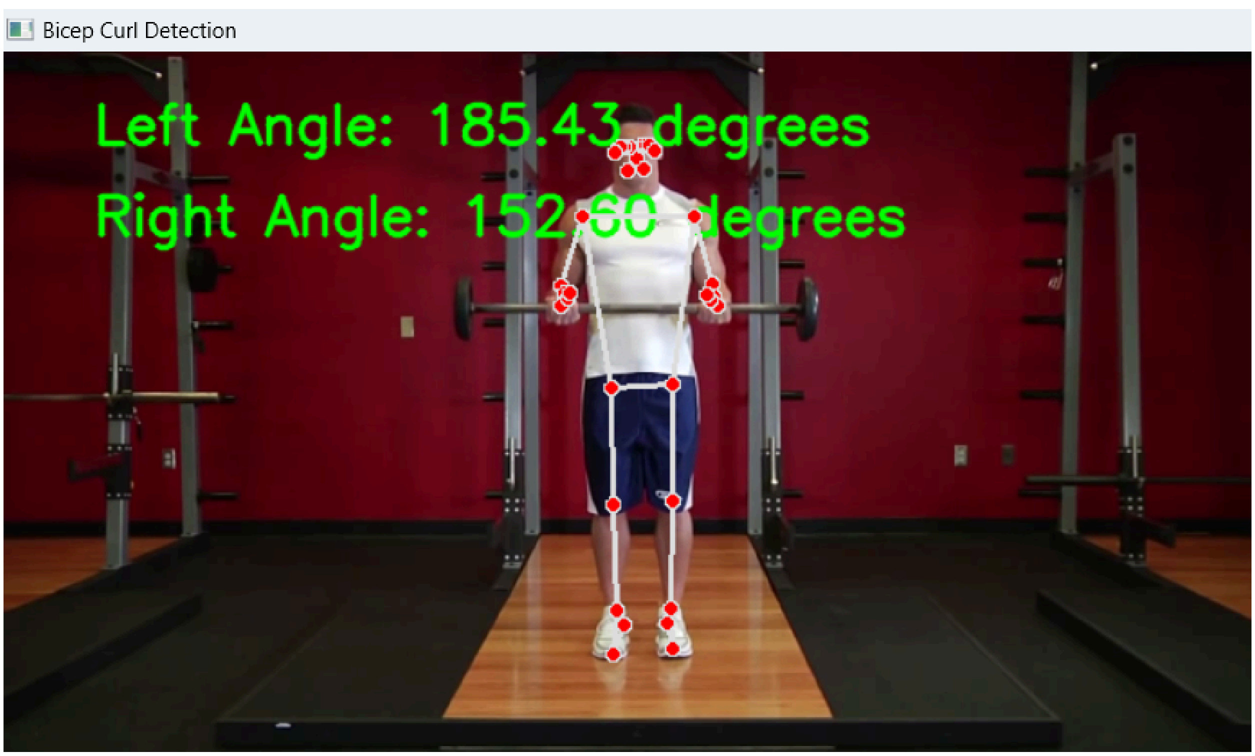

Fig 3. Second Curl Left and Right Angle Calculation in Input Video

After the code determines the human body posture and counts bicep curl, left angle, and right angle and saves the data in a CSV file, a second file was created to hold all three variables in a CSV file with 250 rows. The training method included dividing the dataset into training and testing sets, fitting the model, and assessing its performance. A logistic regression model is trained to determine the accuracy of bicep curls achieving an accuracy of 84%.

RESULT

This study focuses on evaluating bicep curls employing computer vision and machine learning methods. The given program evaluated the submitted video in real time, giving users quick feedback on their bicep curl accuracy. The calculated angles for both the left and right arms have been utilized, yielding an in-depth analysis of each frame's position along with the amount of bicep curls. The logistic regression approach obtained favourable outcomes, indicating its ability to determine the accuracy of bicep curl videos based on recorded position data. The introduction of machine learning into the project serves as an important advancement, establishing the groundwork for automated evaluation and input on exercise forms. The incorporation of imagery recognition for real-time monitoring and machine learning for predictive analysis strengthens the app's overall usefulness, offering users an extensive platform for optimizing their bicep curl routine. This dual strategy allows for the creation of a more advanced and efficient fitness monitoring system that fits into the changing landscape of technology-assisted exercise analysis and improvement.

CONCLUSION

The integration of continuous evaluation making use of image recognition and predictive analysis via machine learning strengthens the program's overall usability. Users now have a comprehensive tool for improving their bicep curl routines that works seamlessly into the evolving technology-assisted workout monitoring and improvement framework. This research not only enhances the understanding of bicep curl performance but also paves the way for future innovations in tailored fitness monitoring and automated form correction, therefore boosting the overall efficacy of training programs.

Acknowledgement

I would like to express my gratitude to the mentor Mr. Punit Kaushik of On My Own Technology Pvt. Ltd. for extending their help in carrying out this project.

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