

Exercise Pose Estimation and AI Feedback System

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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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Abstract - Today's fast-paced world has made it increasingly important to stay physically fit. Many people workout at home with mobile applications and online tutorials. However, most of these platforms only provide guidance and do not ensure if exercises are performed correctly. This can cause bad posture, less effective workouts and a higher risk of injury. This project proposes an AI Based Exercise Pose Estimation and Feedback System that provides real time posture analysis. It uses computer vision techniques to capture real-time video from a webcam and then processes that video using machine learning models. In this implementation MediaPipe is used to find the body landmarks (joints and skeletal points) and OpenCV for image processing and handling video. These tools allow accurate tracking of human body movements. After detecting the body landmarks, the system calculates the angles between various joints like elbows, knees, and shoulders. The angles are matched with predetermined standard values to determine the correctness of exercise postures.

If the posture is incorrect, the system provides immediate feedback to the user so he/she can correct his/her movements in real time. This makes the system interactive and helps the user to improve his exercise performance in an effective way. The proposed system is cost-effective and reduces the dependence on personal trainers for fitness monitoring. It's easy to use and suitable for all levels of fitness. In addition, the system could be enhanced by increasing the number of exercises, adding voice feedback and developing mobile-based applications for better accessibility. In general, this project demonstrates the application of artificial intelligence in fitness and healthcare, promoting safe and effective workout routines.

Key Words: Exercise Pose Estimation, Artificial Intelligence, Computer Vision, Human Pose Detection, Real-time Feedback, Posture Correction, Machine Learning, Body Landmark Detection, Joint Angle Analysis, Fitness Monitoring.

1.INTRODUCTION

Today, physical fitness has become very important for healthy lifestyle in today's world. There are many mobile apps and online tutorials for exercising at home. But these platforms don't check that the exercises are being done correctly. Wrong position of an exercise can reduce the efficiency and even cause injuries. Trainers usually give proper guidance but not everyone has access to them. To overcome this problem, this project proposes an AI-based Exercise Pose Estimation and Feedback System. The system captures live video of the user through a webcam. It is a computer vision technique that uses MediaPipe and OpenCV to detect body landmarks. Based on these landmarks, the system calculates joint angles and analyzes. The posture is then compared with predefined correct values. If any mistake is detected, the system provides real-time feedback to the user. This helps users correct their posture instantly and perform exercises safely. The system is simple, cost-effective, and easy to use. Overall, it acts as a virtual trainer and improves workout efficiency.

1.Body of the Paper

A.Overview of the System

The Exercise Pose Estimation System is an AI-based application designed to analyze human body posture during physical exercises. The main goal of the system is to provide real-time feedback to users so that they can perform exercises correctly and safely. The system uses a webcam to capture live video and processes it using computer vision techniques. It detects body landmarks such as joints and skeletal points using MediaPipe. These landmarks help in tracking the movement of different body parts. The system then calculates angles between joints and compares them with standard values. Based on this comparison, it determines whether the posture is correct or incorrect and provides appropriate feedback.

B. Existing System

In the current scenario, most people depend on fitness applications, online videos, and gym trainers to perform exercises. While these resources provide useful instructions, they do not actively monitor the user's performance. Users are expected to follow along and assume that they are doing the exercises correctly. This approach has several drawbacks, especially for beginners who may not be aware of proper posture techniques. Without real-time feedback, users may continue performing exercises incorrectly, which can lead to poor results or even injuries. In gyms, trainers are available to correct posture, but this option may not be affordable or convenient for everyone. Moreover, during home workouts, users often have no way of checking their accuracy.

C. Proposed System

The proposed system offers a smart and effective solution to the problems faced in existing fitness methods. It uses artificial intelligence to track and analyze the user's body movements and provide instant feedback. The system captures live video using a webcam and processes it using OpenCV along with MediaPipe. It detects the position of various body parts and creates a digital representation of the user's posture. Once the body landmarks are identified, the system calculates the angles between joints and compares them with predefined standard values for correct exercise form. If the posture is correct, the system displays a positive message. If not, it alerts the user and helps them adjust their posture. This system works continuously, providing real-time feedback, which makes it highly effective for learning and improving exercise techniques. It reduces the need for a personal trainer and allows users to exercise confidently at home.

C. Methodology

The methodology of the proposed system is designed in a structured and step-by-step manner to ensure accurate detection of human posture and effective feedback generation. The system follows multiple stages, each responsible for a specific task.

1. Data Acquisition (Video Input)

The first step involves capturing live video using a webcam. The camera continuously records the user's movements during exercise. This real-time video acts as the primary input for the system.

2. Frame Extraction

The captured video is divided into individual frames. Each frame is processed separately to analyze body posture. This allows the system to perform continuous and real-time monitoring.

3. Pose Detection

In this stage, the system uses MediaPipe to detect human body landmarks. It identifies key points such as the head, shoulders, elbows, hips, knees, and ankles. These points form a skeletal structure of the human body.

4. Landmark Coordinate Extraction

After detecting the body keypoints, the system extracts their coordinates (x, y positions). These coordinates represent the exact location of each joint in the frame and are used for further calculations.

5. Angle Calculation

Using the extracted coordinates, the system calculates angles between different joints such as elbows, knees, and shoulders. These angles are important for determining whether the posture is correct.

6. Posture Analysis

The calculated angles are compared with predefined standard values for specific exercises. A threshold range is set to allow slight variations. Based on this comparison, the system determines if the posture is correct or incorrect.

7. Feedback Generation

Once the posture is analyzed, the system generates feedback. If the posture is correct, it displays a

positive message. If incorrect, it provides suggestions to improve posture. This feedback is shown instantly on the screen.

8. Visualization

The system visually displays the detected body skeleton on the screen using OpenCV. This helps users clearly see their body alignment and understand mistakes better.

9. Continuous Monitoring

The entire process runs continuously for each frame of the video. This ensures real-time tracking and instant feedback throughout the exercise session.

10. Performance Evaluation (Optional Enhancement)

The system can also count repetitions and track performance over time. This helps users monitor their progress and improve consistency in workouts.

11. System Output

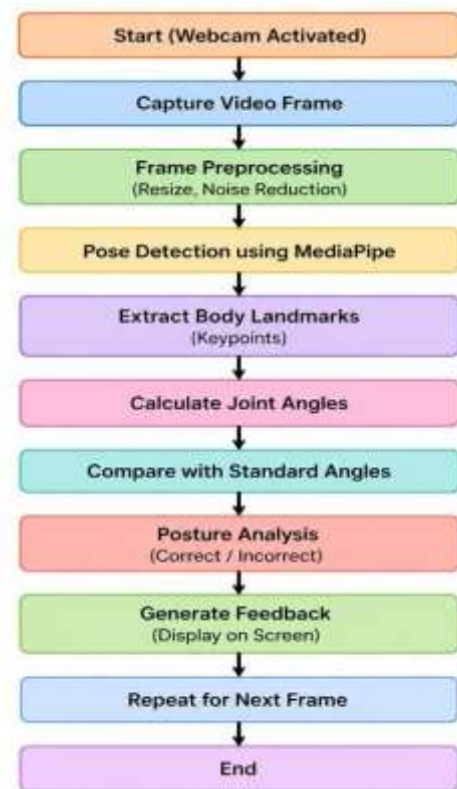
The final output includes:

- Correct/Incorrect posture indication
- Visual skeleton display
- Real-time feedback messages

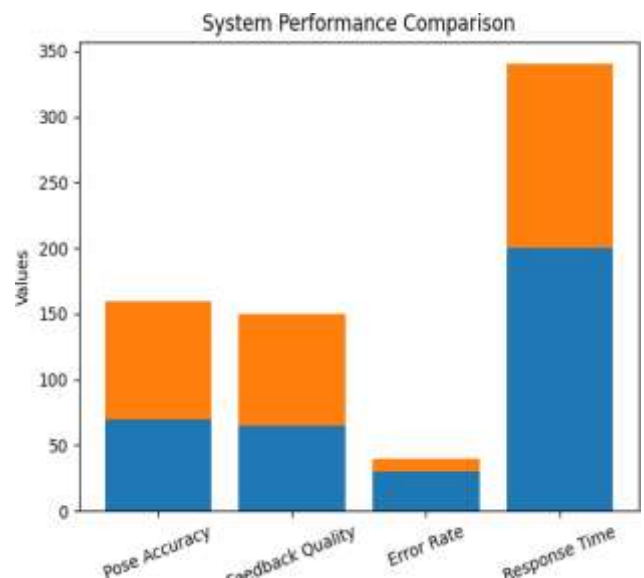
Table -1: Sample Table format

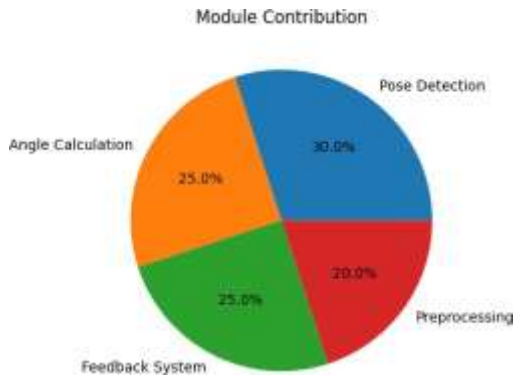
Evaluation Parameter	Existing System	Proposed System
Pose Detection Accuracy (%)	70%	90%
Pose Correction Feedback	Not Available	Available
Real Time Processing Speed (ms)	200 ms	140 ms
Joint Angle Calculation Accuracy	Moderate	High
Error Rate (%)	30 %	10 %
Robustness to Body Movement	Low	High

Fig -1: Figure



Charts





3. CONCLUSIONS

The Exercise Pose Estimation System successfully demonstrates how artificial intelligence and computer vision can be applied to improve fitness training. The system is capable of detecting human body posture in real time and analyzing it using pose estimation techniques. By calculating joint angles and comparing them with standard values, it accurately determines whether an exercise is performed correctly.

One of the key achievements of this project is the ability to provide immediate feedback to users. This real-time guidance helps individuals correct their posture instantly, improving the effectiveness of their workouts and reducing the risk of injuries. The system acts as a virtual trainer, making fitness training more accessible and convenient, especially for people who prefer exercising at home.

The use of technologies like MediaPipe and OpenCV ensures accurate detection of body movements and efficient processing of video input. The system is simple, cost-effective, and easy to use, making it suitable for users of all fitness levels.

Overall, this project highlights the potential of AI in the fitness and healthcare domain. It provides a smart and efficient solution for posture correction and promotes safe exercise practices. The results obtained show that the system is reliable and can be further enhanced for real-world applications.

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