MINI PROJECT REPORT

ON

"AI-BASED FITNESS MENTOR"

SUBMITTED IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS OF DEGREE OF

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Certificate

This is to certify that the Mini Project-2B entitled "**AI-BASED FITNESS MENTOR"** is a bonafide work of **Sarthak Hasbe, Prajwal Halle, Smitesh Gajakosh, Prathmesh Chaudhari** submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of **"Undergraduate"** in **"Computer Engineering".**

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Declaration

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included. We have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will because for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Fitness, it is a journey, whether it is about strength, endurance, flexibility, or overall health, but it needs to be guided in a systematic, personalized way to achieve optimal results. In general, every individual has unique fitness needs, and without proper guidance, one may struggle to meet their goals. The pursuit of optimal fitness is a uniquely individual journey, often hindered by the lack of personalized guidance and adaptive training strategies. The accessibility and scalability of such a system can democratize expert-level fitness guidance, making it available to a wider audience and empowering individuals to take proactive steps towards a healthier future.

Keywords: Posture Correction, Adaptive Training, Motivation, Fitness Safety

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Chapter 1

Introduction

1. Introduction

1.1 Background

The fitness industry has seen significant growth over the past decade, with more individuals becoming increasingly conscious of their health and well-being. However, despite the availability of various fitness resources, many people still struggle to maintain consistency, progress, and achieve their desired fitness goals. Traditional methods, such as gym trainers or fitness classes, often come with limitations in terms of accessibility, cost, and personalization. Additionally, many individuals lack the expertise to perform exercises with proper form and technique, which can lead to injuries or inefficient workouts. This project addresses the growing demand for individualized fitness plans while making health and fitness guidance more affordable and accessible to a broader audience. This initiative seeks to bridge the gap between the desire for a healthier lifestyle and the practical challenges of achieving it, fostering long-term consistency and ultimately helping individuals reach their unique fitness aspirations.

1.2 Motivation

In today's fast-paced world, maintaining a healthy lifestyle has become more challenging than ever. With busy schedules, lack of motivation, and limited access to professional fitness trainers, many individuals struggle to stay consistent with their fitness routines and meet their health goals. Traditional fitness methods, while effective, often lack the personalization and adaptability required for optimal results. Additionally, the risk of injury due to improper exercise form or overexertion remains a significant concern. This empowers individuals to take control of their health, maintain consistency, and achieve their fitness goals at their own pace and convenience, making fitness an inclusive journey for everyone.

Chapter 2

Literature Survey

2.1 Basic Terminologies

1. **Progress Tracking**: Monitoring of users' physical progress over including metrics such as Reps , Posture and flexibility.
2. **Exercise Library**: A database of various exercises and workout routines, each powered by AI to recommend the best exercises for users.
3. **Posture Correction**: Computer vision or sensor-based technology integrated with AI that detects and corrects users' posture during exercises in real-time.
4. **Data Privacy Compliance**: Ensuring that users' health and personal data are securely handled and protected, in compliance with privacy regulations and standards.
5**.Multi-Platform Accessibility**: Seamless integration with various platforms (mobile, desktop) to ensure that users can access their fitness journey and track progress anytime, anywhere.
6. **Rep Counting:** Monitor the number of reps completed for each set and track progression over time**.**

2.2 Existing system

Several AI-powered fitness applications and systems are already transforming the fitness industry by providing personalized guidance, tracking performance, and offering adaptive workout plans. Freeletics, for instance, utilizes AI to create customized workout plans based on a user’s goals, fitness levels, and real-time feedback, adjusting the routines as users progress. Peloton offers a connected fitness system that combines live and on-demand classes, using AI to track user performance, provide feedback, and suggest personalized workouts based on data from wearable devices. Similarly, Mirror is an interactive fitness platform that uses AI-driven real-time coaching to correct users' form and optimize their exercises, while Tonal focuses on strength training, adjusting the weight resistance dynamically based on the user’s performance and progress.

Research Papers:

Sr No.	Name of Paper	Author Name	Methodology	Research Gap
1.	AI-Fitness Trainer	Samiksha Katkar, Akanksha Mohite, Swarangi Patil, Akshay Agrawal, Sanketi Raut	The AI fitness trainer, built with Flutter, MoveNet, and transfer learning, personalizes workouts and diet plans using user data, offering real-time posture correction, performance tracking, and adaptive recommendations for effective digital fitness coaching.	Maintenance Challenges, Modifying the final layer for specific task.
2.	AI-Driven Fitness Coach: Webcam-based Form Correction and Rep Counting for Optimized Workouts	Bharath Kumar. V, Anitha Julian	The AI fitness trainer, built with Flutter, MoveNet, and transfer learning, tracks posture by computing joint angles, sending AI alerts, and optimizing models for a seamless and effective fitness experience.	Lacks intensity tracker, Object detection accuracy
3.	AI Fitness Trainer	Ahsan Ashraf, Areebul Haq, Kantesh Kumar, Muhammad Moiz Alam, Talha Shahid	The AI Workout Assistant uses MoveNet for real-time tracking, providing feedback, corrections, and personalized workouts with enhanced model customization.	Personalization Challenges, Data Dependency
4.	AI Fitness Model using Deep Learning	B Adibasava, Gowtham R, Dr Asha K H	The AI Fitness Model uses YOLOv5, OpenCV, and MediaPipe for real-time pose detection, personalized feedback, and adaptive routines, revolutionizing workout tracking with deep learning-based movement analysis and fitness optimization.	Responsive and seamless user experience, Performance concerns

5.	"Associative embedding: End-to-end learning for joint detection and grouping"	Newell A, Deng J	The model enhances multiperson pose estimation by detecting joints independently, optimizing for specific exercises, and improving accuracy through training, ensuring precise feedback and personalized fitness experiences.	AI trainer application have latency problems, particularly when it is used on devices with limited resources, Complex AI algorithms
6.	Human pose estimation via convolutional part heatmap regression	Adrian Bulat and Georgios Tzimiropoulos	The paper introduces a cascaded CNN using heatmap regression for accurate human pose estimation, even with occlusions, demonstrating adaptability across CNN backbones and achieving state-of-the-art benchmark results.	Complex Backgrounds and Lighting Conditions, Uncommon Poses and Activities
7.	2d human pose estimation	A Newell, K Yang, and J Deng	The MPII Human Pose Dataset is a large-scale benchmark with accurate joint annotations, addressing limitations of previous datasets and tackling challenges like pose diversity, occlusions, and inter-person interactions in realistic scenarios.	Severe Occlusion and Pose Articulations, Limited Focus on Multi-Person Pose Estimation

2.3 Problem Statement

Many individuals struggle to achieve their fitness goals due to a lack of personalized guidance, ineffective workout routines, and improper exercise form. This leads to:

- ***Injury Risk***: Incorrect technique and posture during exercises can lead to injuries, especially for beginners.
- ***Lack of Progress:*** Generic workout plans fail to adapt to the unique needs and progress of individuals, resulting in frustration and slow results.
- ***Limited Accessibility:*** Professional trainers are often expensive and not always available, making personalized coaching inaccessible for many people.
- ***Lack of Accountability and Support***: Without a structured program and personalized support, individuals may struggle with accountability and maintaining consistency.
- ***Difficulty Tracking Progress Effectively***: Many individuals lack the tools and knowledge to accurately track their progress beyond basic metrics like reps and posture.

Chapter 3

Requirement Gathering

3.1 Software and Hardware Requirements

Here we will discuss everything we will need in order to execute. Below we list the necessary hardware and software requirements.

1. **Software Requirements:**

- Operating System: Windows
- Python versions:2.7.X,3.6.X
- OpenCV, TensorFlow/PyTorch
- APIs or libraries for extracting and processing video content, such as YouTube Data API.
- Local servers for hosting the application and processing video summaries

2. **Hardware Requirements:**

- Processor: Multi-core CPU
- RAM: Minimum 8GB
- Resolution: Minimum 1920x1080
- Webcam

Chapter 4

Plan of Project

4.1 System Architecture

The system architecture described is designed to automatically count exercise repetitions using a webcam. It begins by capturing video from the webcam, which is then processed frame-by-frame by the Video Capture Module. These processed frames are fed into a Pose Detection Module, which identifies and locates key body landmarks using computer vision techniques. The coordinates of these landmarks are then used by the Joint Angle Calculation Module to determine the angles between relevant joints, providing insight into the body's pose.. The Repetition Counting Module uses the sequence of identified exercise stages to count the number of repetitions performed, likely employing a state machine to detect transitions between stages.. This architecture leverages computer vision and pose estimation techniques to create a system that can automatically track and count exercise repetitions, making it applicable in fitness tracking, virtual training, rehabilitation, and interactive entertainment.

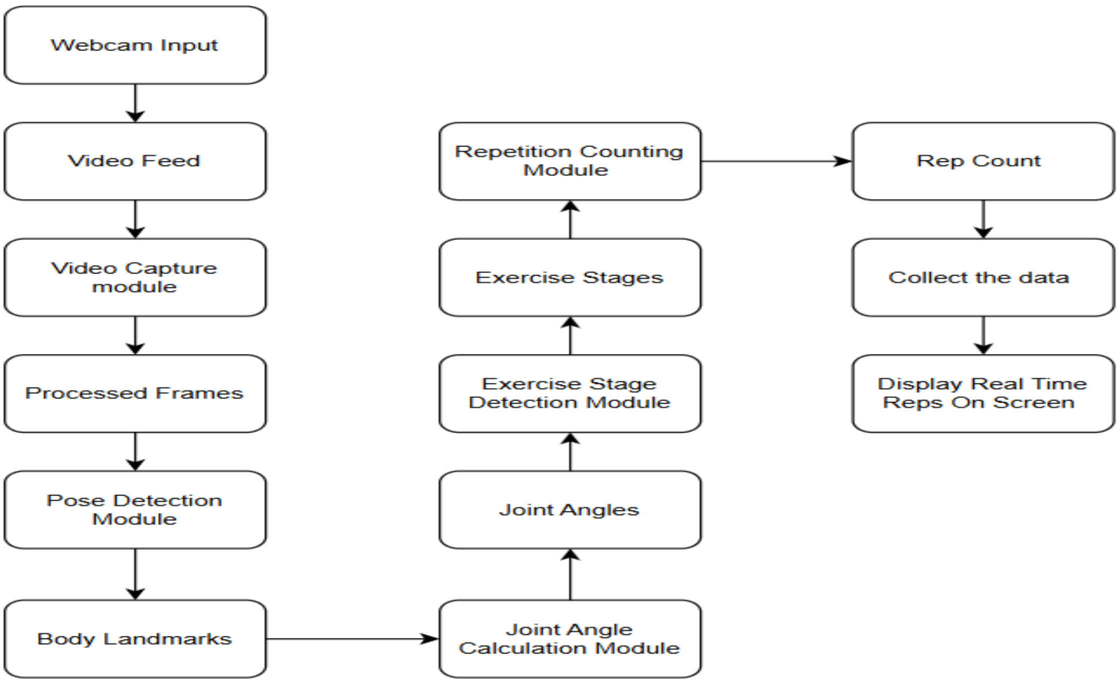

Figure 4.1: System Architecture

4.2 Methodology

1. Data Acquisition and Preprocessing:

- **Webcam Input:** Capture video using a standard webcam.
- **Frame Extraction:** Extract individual frames from the video stream using a library like OpenCV in Python.

2.Pose Detection:

- **Choose a Pose Estimation Model:** Select a suitable pose estimation model (e.g., MediaPipe Pose, OpenPose). Consider factors like accuracy, speed, and compatibility with your hardware.
- **Model Integration:** Integrate the chosen model into your system using its respective API or library.

3.Joint Angle Calculation:

- **Define Relevant Joints:** Determine the specific joints required for the target exercise (e.g., elbow, shoulder, knee).
- **Store Angles:** Store the calculated angles for each frame.

4.Repetition Counting:

- **Define Repetition Criteria:** Determine the specific sequence of exercise stages that constitute a complete repetition (e.g., "fully extended" -> "fully flexed" -> "fully extended").
- **Implement Counting Logic:** Use a state machine or similar logic to track the exercise stages and increment the repetition count when a complete repetition is detected.

5. Testing and Refinement:

- **Test with Diverse Data:** Test the system with various users, lighting conditions, and exercise variations to ensure robustness.
- **Fine-Tune Thresholds:** Adjust the joint angle thresholds based on testing results to improve accuracy

Chapter 5

Result Analysis

5.1 Results and Discussion

1. Interface of System

Figure 5.1: Interface

The image displays a user interface for an application. It presents a list of common exercises, each with a corresponding button labeled "Start [Exercise Name]". These exercises include Biceps Curl, Shoulder Press, Squat, Deadlift, Push-Ups, and Lunges. The user interface appears to be designed for initiating the tracking of repetitions for each specific exercise.

2. Biceps Curl

Figure 5.2: Biceps Curl

The movement involves bending the elbow to bring weight towards the shoulder and then lowering it back down with control.

3. Shoulder Press

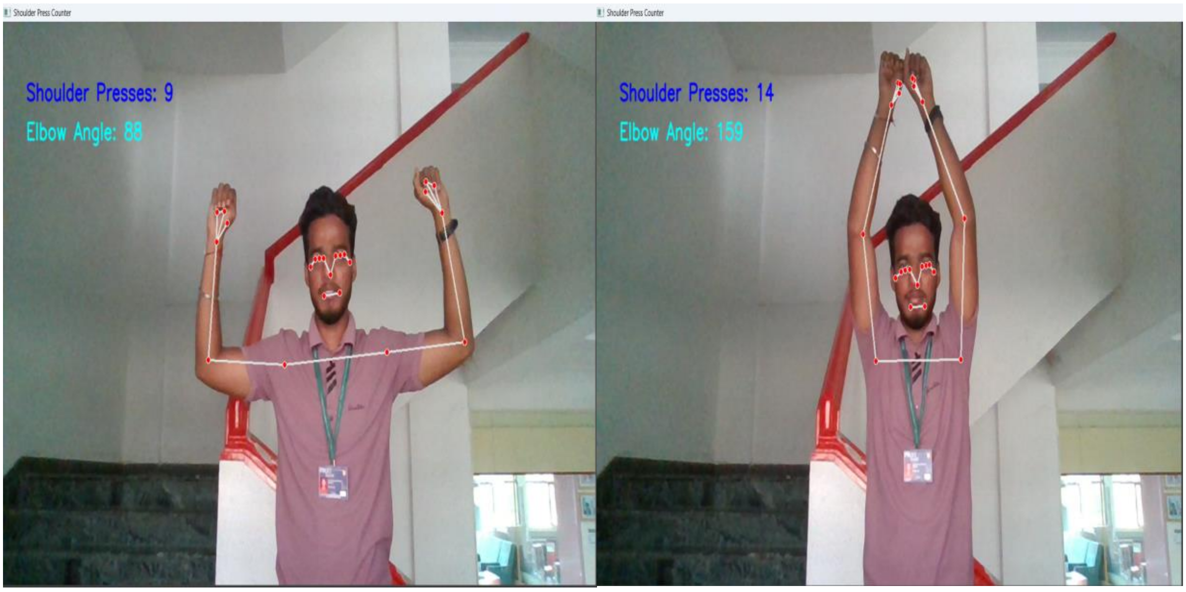

Figure 5.3: Shoulder Press

Shoulder press is a strength training exercise that primarily targets the deltoid muscles of the shoulder, responsible for lifting and rotating the arm. It also engages the triceps and upper chest muscles as secondary move.

4. Squats

Figure 5.4: Squats

Squats are a fundamental lower body strength training exercise that works multiple muscle groups simultaneously, including the quadriceps, hamstrings, glutes, and calves. The movement involves lowering the hips from a standing position as if sitting down in a chair, while keeping the back straight , chest up.

5. Pushups

Figure 5.5: Pushups

Starting in a plank position with hands shoulder-width apart, exercise involves lowering chest towards the ground by bending the elbows , then pushing back up to the starting position.

Chapter 6

Conclusion

Conclusion

An AI-based fitness mentor, leveraging insights from fundamental exercises like biceps curls, shoulder presses, squats, and push-ups, offers a personalized and accessible approach to physical training. By understanding the mechanics and benefits of these core movements – biceps curls for arm strength, shoulder presses for upper body power, squats for lower body strength and stability, and push-ups for chest, shoulder, and triceps development – the AI can design comprehensive workout routines tailored to individual fitness levels and goals. This technology has the potential to guide users through proper form, track progress, and adapt training plans dynamically, ultimately empowering individuals to achieve their fitness aspirations effectively and conveniently.

Future Scope

The AI Fitness Mentor can evolve into a full-fledged app with an enhanced GUI, real-time feedback, personalized workouts, and AI-driven diet plans. Its future holds tremendous promise, poised to revolutionize the fitness industry. AI technology will continue to create personalized workout plans tailored to individual goals, preferences, and progress. It will store user data, track progress, and adapt routines dynamically. Future improvements include wearable integration, gamification, social features, and cloud-based analytics, making it a comprehensive, interactive, and intelligent fitness assistant for users.

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