

An Intelligent Computer Vision-Based Multi-User Gym Monitoring Systems for Trainer Assistance Using -AI.

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ABSTACT

The rapid growth of digital technologies and artificial intelligence has significantly transformed various aspects of healthcare, wellness, and fitness management. In recent years, advancements in AI, computer vision, machine learning, and data analytics have created new opportunities for developing intelligent systems capable of assisting individuals in maintaining healthier lifestyles. Traditional fitness training methods, such as manual supervision by personal trainers or the use of conventional workout applications, often lack real-time monitoring, personalized guidance, and accurate posture correction. Most existing fitness applications primarily depend on user input and provide only generic exercise recommendations, making it difficult to ensure proper exercise execution. As a result, users may perform exercises incorrectly, leading to inefficient workouts, reduced motivation, slower progress toward fitness goals, and an increased risk of physical injuries. Furthermore, the availability of professional trainers may be limited due to factors such as cost, location, and scheduling constraints. These challenges highlight the need for an intelligent fitness assistance system capable of providing automated guidance and continuous monitoring. To address these limitations, this project presents an AI Fitness Trainer System that combines computer vision, machine learning, and web technologies to provide an intelligent, interactive, and user-friendly fitness platform capable of delivering personalized fitness assistance.

The proposed system is designed to monitor and improve user fitness through real-time exercise detection, posture analysis, automatic repetition counting, and personalized workout recommendations. Unlike traditional fitness applications that depend heavily on manual data entry and self-reporting, the system utilizes a webcam to capture live video input and analyze body movements using advanced pose estimation techniques. This approach enables the system to continuously monitor user performance during workout sessions and provide immediate feedback. The AI module is developed using Python along with OpenCV and MediaPipe libraries, which enable accurate body landmark detection, skeletal tracking, and posture analysis. By identifying key body joints and monitoring their movement patterns, the system can evaluate exercise execution with high precision. The system evaluates user movements in real time and provides immediate visual or audio feedback whenever incorrect posture, improper alignment, or unsafe movement is detected. This feature assists users in correcting mistakes instantly, thereby improving workout effectiveness while minimizing the chances of injury. Through continuous monitoring and intelligent feedback mechanisms, the system creates an experience similar to having a virtual fitness trainer available at all times.

The platform also includes several additional features designed to enhance fitness management and user engagement. These features include workout tracking, calorie monitoring, progress visualization, and fitness goal management. Users can maintain detailed records of their daily workout activities and monitor the number of exercises performed, repetitions completed, and calories burned. An interactive dashboard provides graphical representations of workout performance, allowing users to visualize progress over time and identify trends in their fitness journey. The system also enables users to set short-term and long-term fitness goals, helping them stay focused and motivated. Users can view their workout history, monitor consistency, evaluate exercise performance, and analyze progress through detailed reports and visual analytics.

To further improve motivation and long-term user engagement, the system incorporates gamification elements such as streaks, achievements, reward badges, leaderboards, and fitness challenges. These features encourage users to maintain regular workout habits and provide a sense of accomplishment when milestones are achieved. Gamification has been widely recognized as an effective strategy for increasing user participation and sustaining motivation in fitness applications. Additionally, an AI-based recommendation engine suggests suitable workout routines and diet plans according to the user's fitness level, goals, physical activity patterns, and historical performance data. The recommendation system continuously adapts its suggestions based on user progress and workout history, ensuring that recommendations remain relevant and effective. The system is designed to support users of different experience levels, ranging from beginners who require basic guidance and posture correction to advanced users seeking detailed workout analytics and performance optimization.

The web-based interface of the system is developed using PHP and MySQL, ensuring efficient database management, scalability, and smooth interaction between users and administrators. The platform is designed with a responsive user interface that can be accessed through desktops, laptops, tablets, and smartphones. This flexibility allows users to conveniently access fitness services from different devices and locations. The admin module provides functionalities for managing user accounts, monitoring workout logs, tracking membership payments, handling user complaints, and generating system reports. Data related to members, workout activities, fees, progress records, and complaints are securely stored in the MySQL database for efficient retrieval and management. Basic authentication, authorization, and session management techniques are implemented to ensure secure access and proper handling of user information. Furthermore, the system prioritizes user privacy by avoiding the permanent storage of sensitive biometric information and ensuring that personal fitness data is handled responsibly.

Experimental evaluation of the system demonstrates effective performance in real-time workout monitoring and posture analysis. The AI posture detection module achieved approximately 80–90% accuracy under normal lighting conditions while maintaining processing speeds suitable for live workout sessions. The repetition counting mechanism produced reliable and consistent results with only minor deviations during highly dynamic or complex exercises. User testing indicated that real-time feedback significantly improved exercise accuracy and enhanced overall workout quality. However, certain challenges such as low-light environments, improper camera positioning, background interference, and highly complex exercise movements slightly affected detection accuracy. These limitations can be addressed in future versions through the integration of advanced deep learning models, multi-angle camera support, adaptive lighting compensation techniques, and enhanced motion filtering algorithms. Additional improvements may include support for a larger variety of exercises, voice-controlled interaction, wearable sensor integration, and cloud-based fitness analytics.

One of the major advantages of the proposed system is its accessibility and cost-effectiveness. Users can access the platform using standard laptops, desktop computers, tablets, or smartphones without requiring expensive fitness equipment, specialized hardware, or wearable devices. This significantly reduces the barrier to entry for individuals seeking professional-quality fitness guidance. The lightweight and responsive interface ensures smooth performance across different devices and operating environments, making intelligent fitness guidance available to a broader audience. By combining artificial intelligence, computer vision, and web technologies into a single integrated platform, the proposed AI Fitness Trainer System provides an effective, affordable, and scalable solution for modern fitness management while promoting healthier lifestyles and improved exercise practices.

1. INTRODUCTION

In recent years, the importance of maintaining physical fitness and a healthy lifestyle has increased significantly due to the growing awareness of health-related issues and sedentary living habits. Regular exercise and proper fitness management are essential for improving physical health, mental well-being, and overall quality of life. However, many individuals face difficulties in maintaining consistent workout routines due to lack of motivation, improper guidance, limited access to professional trainers, and the high cost associated with personal fitness coaching. Traditional fitness methods often rely heavily on manual supervision, prerecorded workout videos, or basic fitness applications that do not provide real-time monitoring or personalized feedback. As a result, users may perform exercises incorrectly, reducing workout effectiveness and increasing the risk of injuries.

With the advancement of artificial intelligence, computer vision, and machine learning technologies, modern fitness systems have evolved to become more intelligent and interactive. These technologies make it possible to analyze human body movements in real time, detect exercise posture, and provide immediate corrective feedback without requiring direct human supervision. The integration of AI into fitness applications offers opportunities to create smart systems that can guide users during workouts, monitor progress, and deliver personalized fitness recommendations.

The AI Fitness Trainer System proposed in this project aims to address the limitations of traditional fitness guidance methods by developing an intelligent, automated, and user-friendly platform for real-time workout assistance. The system uses computer vision techniques to detect and analyze body posture through a webcam, enabling users to perform exercises while receiving instant feedback on posture accuracy and movement correctness. By identifying incorrect postures and counting exercise repetitions automatically, the system helps users improve workout quality and reduce the chances of physical injuries.

The project integrates multiple technologies to achieve efficient and accurate performance. The AI-based pose detection module is developed using Python along with OpenCV and MediaPipe libraries, which are widely used for image processing and body landmark detection. MediaPipe enables the system to detect key body points and track movements in real time, while OpenCV processes video frames captured from the camera. The web interface and backend operations are implemented using PHP and MySQL, which provide efficient user management, data storage, and interaction between system components.

The system includes several important features designed to improve user engagement and overall fitness experience. Users can select exercises, receive real-time posture correction feedback, track workout history, and monitor their fitness progress through an interactive dashboard. The system also supports personalized workout and diet recommendations based on user goals, activity levels, and historical performance data. To motivate users and encourage consistency, gamification features such as achievements, streaks, and fitness challenges are incorporated into the platform.

In addition to fitness tracking, the system provides administrative functionalities for managing users, monitoring workout logs, tracking payments, and handling complaints. All workout activities and user information are securely stored in a MySQL database, ensuring proper organization and efficient retrieval of data. Basic authentication and session management techniques are implemented to maintain data security and controlled access to the platform.

One of the major advantages of the proposed system is its accessibility and cost-effectiveness. Unlike advanced fitness systems that require expensive wearable devices or specialized equipment, this system only requires a standard webcam or smartphone camera, making it affordable and accessible to a wide range of users. The lightweight and responsive design ensures smooth operation on most devices, enabling users to perform workouts conveniently from their homes or any location.

The AI Fitness Trainer System demonstrates how artificial intelligence and computer vision can be effectively combined with web technologies to create a smart fitness solution that enhances exercise accuracy, user motivation, and workout efficiency. By providing real-time guidance, automated monitoring, and personalized recommendations, the system contributes toward improving fitness experiences and promoting healthier lifestyles. Furthermore, the project establishes a strong foundation for future enhancements such as mobile application development, voice-assisted coaching, cloud deployment, wearable device integration, and advanced deep learning-based fitness analytics.

2. Literature Review

The application of Artificial Intelligence (AI) and computer vision in healthcare and fitness management has gained significant attention in recent years. With the increasing demand for personalized fitness solutions, researchers have developed various intelligent systems to monitor physical activities, analyze exercise performance, and provide real-time feedback. These technologies aim to overcome the limitations of traditional fitness training methods, which often depend on personal trainers, manual supervision, or basic workout applications.

Traditional fitness systems generally provide predefined workout plans and instructional videos without monitoring the user's actual performance. As a result, users may perform exercises incorrectly, reducing workout effectiveness and increasing the risk of injuries. Studies have shown that proper posture and movement play a crucial role in achieving fitness goals and preventing physical strain. This has led researchers to explore automated solutions capable of providing real-time exercise guidance and posture correction.

Computer vision has emerged as a key technology in modern fitness applications. It enables computers to analyze images and videos to identify human body movements. Earlier fitness monitoring systems relied on wearable devices such as accelerometers and motion sensors to track physical activities. Although these systems produced accurate results, they required additional hardware and were often inconvenient for users. Recent advancements in camera-based monitoring systems have eliminated the need for wearable devices by using pose estimation techniques to analyze body posture through video input.

Pose estimation frameworks such as MediaPipe, OpenPose, and PoseNet have become widely used for human movement analysis. Among these, MediaPipe has gained popularity because of its ability to detect body landmarks accurately while maintaining real-time performance. Researchers have successfully applied MediaPipe in fitness training, rehabilitation exercises, and posture correction systems. These studies demonstrate that pose estimation can effectively identify body positions and provide valuable feedback during exercise sessions.

Machine learning techniques have further improved the capabilities of fitness monitoring systems. Various algorithms have been developed to recognize exercise types, evaluate movement quality, and detect incorrect postures. AI-powered systems can compare user movements with predefined exercise models and generate corrective feedback when deviations occur. Research findings indicate that such systems can significantly improve exercise accuracy and reduce the likelihood of injuries.

Another important area of research is automatic repetition counting. Several studies have proposed methods that analyze body joint angles and movement patterns to count exercise repetitions automatically. These systems have shown good accuracy for exercises such as squats, push-ups, lunges, and bicep curls. Automated repetition counting helps users track workout performance without manual effort and enhances the overall fitness experience.

Researchers have also explored personalized fitness recommendation systems that generate customized workout and diet plans based on user preferences, fitness levels, and historical performance data. These systems improve user engagement by offering recommendations tailored to individual goals. Additionally, gamification features such as achievements, streaks, and fitness challenges have been integrated into many fitness applications to increase motivation and encourage regular exercise.

Although existing studies have demonstrated the effectiveness of AI-based fitness solutions, challenges such as poor lighting conditions, camera positioning issues, and variations in body movements still affect system accuracy. Therefore, there is a need for a comprehensive and cost-effective platform that combines posture correction, exercise monitoring, repetition counting, progress tracking, and personalized recommendations. The proposed AI Fitness Trainer System addresses these requirements by integrating computer vision, machine learning, and web technologies to provide an intelligent and user-friendly fitness management solution.

3. PROJECT OVERVIEW

The AI Fitness Trainer System is a smart fitness application that helps users perform exercises correctly using Artificial Intelligence (AI) and Computer Vision. It uses a webcam or smartphone camera to monitor body movements, detect posture, count repetitions, and provide real-time feedback.

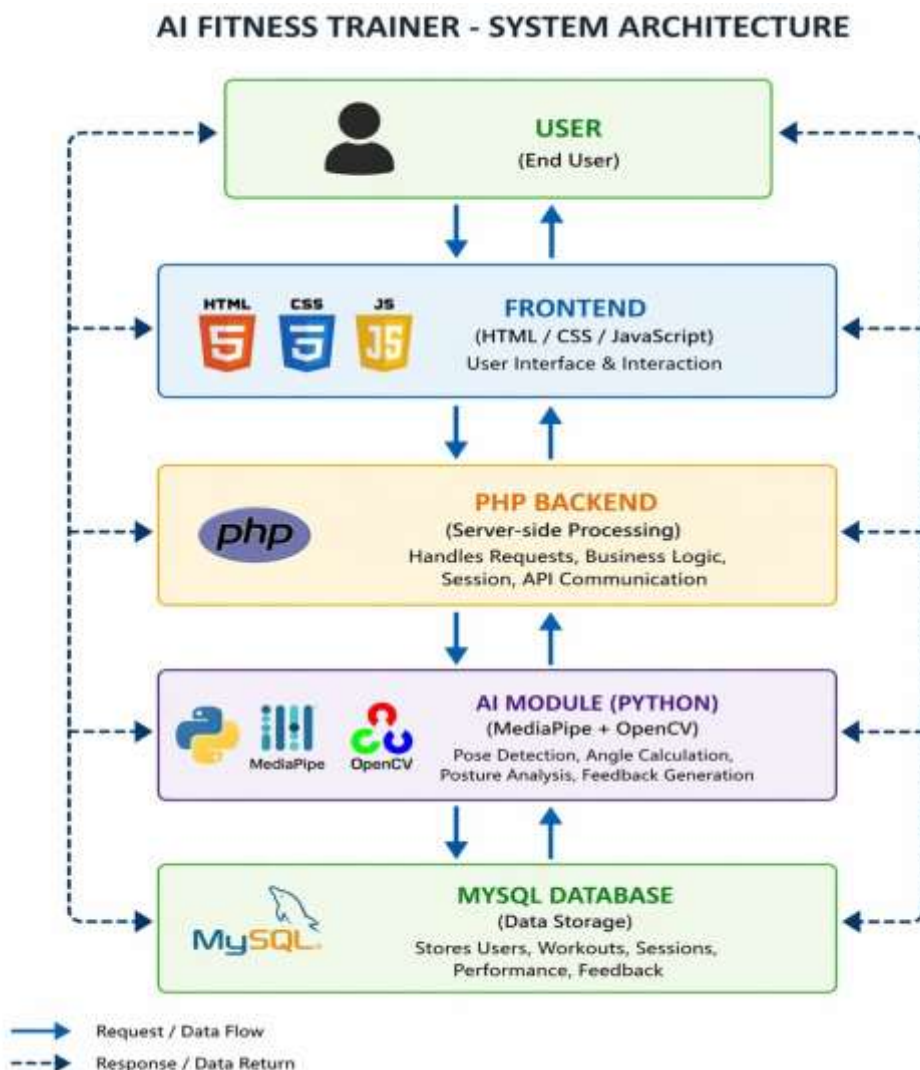
Unlike traditional workout methods that depend on trainers or videos, this system can automatically identify incorrect exercise postures and immediately guide users to correct them. This helps improve workout effectiveness and reduces the risk of injuries.

The system is developed using Python, OpenCV, MediaPipe, PHP, MySQL, HTML, CSS, and JavaScript. It provides features such as exercise monitoring, repetition counting, progress tracking, personalized workout recommendations, and fitness analytics.

3.1MODULE DESCRIPTION

- ❖ User Module – User registration, login, and profile management.
- ❖ Pose Detection Module – Detects body posture and checks exercise form.
- ❖ Exercise Tracking Module – Counts repetitions and monitors workouts.
- ❖ Workout Management Module – Allows users to select and manage exercises.
- ❖ Progress Tracking Module – Shows workout history and performance reports.
- ❖ Recommendation Module – Suggests workouts and diet plans based on user progress.
- ❖ Admin Module – Manages users, payments, and system activities.
- ❖ Database Module – Stores user details and workout records securely.
- ❖ Gamification Module – Provides badges, rewards, and challenges to motivate users.
- ❖ Web Interface Module – Offers a user-friendly dashboard and responsive interface.

4.SYSTEM ARCHITECTURE



5.PROBLEM STATEMENT

Traditional fitness guidance systems and currently available fitness applications provide only limited support for users in maintaining proper workout routines and posture accuracy. Most existing systems rely heavily on manual supervision, prerecorded workout videos, or basic fitness tracking features that lack intelligence and real-time interaction. While these systems may help users follow exercise routines, they often fail to provide personalized guidance, automatic monitoring, and immediate corrective feedback.

Conventional gym training methods require the constant presence of professional trainers to monitor posture and exercise performance. This approach can be expensive, time-consuming, and inaccessible to many users. Similarly, online workout videos and standard fitness applications offer generalized instructions without analyzing whether the user is performing exercises correctly. As a result, users may unknowingly adopt improper postures, leading to reduced workout effectiveness and increased risk of injuries.

Most existing fitness tracking systems primarily focus on recording activities such as step counting, calories burned, or workout duration. However, they do not intelligently analyze body movements or provide real-time posture correction. In addition, many systems require manual data entry for workout logging and progress tracking, which can reduce user convenience and motivation. Some advanced fitness solutions depend on expensive wearable devices or specialized hardware, limiting accessibility for ordinary users.

Although modern fitness applications include certain motivational features, they often lack personalized recommendations and adaptive training mechanisms that can adjust according to the user's fitness level and performance. Existing systems also provide limited interaction and engagement, making it difficult for users to remain consistent with their fitness goals over long periods.

6.OBJECTIVES

The primary objective of the proposed AI Fitness Trainer System is to develop an intelligent and user-friendly fitness platform that utilizes artificial intelligence, computer vision, and machine learning technologies to provide real-time exercise monitoring and personalized fitness guidance. The system aims to accurately detect and recognize various physical exercises, analyze user posture, and provide immediate corrective feedback to ensure exercises are performed safely and effectively. Another important objective is to automate repetition counting and workout tracking, reducing the need for manual recording of fitness activities. The system is also designed to monitor user progress, calculate calories burned, and maintain detailed workout histories for performance analysis. Furthermore, it seeks to provide personalized workout routines and diet recommendations based on the user's fitness level, goals, and historical performance data. To improve motivation and long-term engagement, the platform incorporates gamification features such as achievements, streaks, and fitness challenges. The project also aims to develop a secure web-based environment for managing user accounts, workout records, payments, and complaints while ensuring data privacy and accessibility. By offering an affordable and accessible fitness solution that requires only a standard webcam or smartphone camera, the system strives to make professional fitness guidance available to a wider audience and promote healthier lifestyles through technology-driven fitness management.

7.PROPOSED SYSTEM

The proposed AI Fitness Trainer System is an intelligent and interactive fitness platform developed to overcome the limitations of traditional fitness guidance systems. The system integrates artificial intelligence, computer vision, and web technologies to provide real-time exercise monitoring, posture detection, workout tracking, and personalized fitness assistance. Unlike conventional fitness applications that depend on manual supervision or prerecorded workout videos, the proposed system automatically analyzes user movements through a webcam and provides immediate feedback on exercise posture and performance.

The system uses Python-based AI technologies such as OpenCV and MediaPipe for detecting body landmarks and analyzing posture accuracy during workouts. By processing live video input from the user's camera, the system can identify whether exercises are performed correctly and provide corrective suggestions in real time. This helps users improve workout quality, maintain proper posture, and reduce the risk of injuries.

The proposed system also includes automatic repetition counting, progress monitoring, personalized workout recommendations, and an interactive dashboard for viewing fitness activities and performance trends. The web interface developed using PHP and MySQL enables smooth interaction between users and administrators while securely managing workout data, user information, payments, and complaints.

To improve user engagement and motivation, the platform incorporates gamification features such as streak tracking, achievements, and fitness challenges. The system is designed to be lightweight, responsive, and accessible on standard laptops or smartphones without requiring expensive wearable devices or specialized hardware. This makes the platform affordable and suitable for users of different fitness levels.

The proposed AI Fitness Trainer System provides a smart, efficient, and user-friendly approach to fitness management by combining real-time AI-based analysis with personalized guidance and interactive features.

8.REQUIREMENT SPECIFICATIONS

8.1.HARDWARE REQUIREMENTS

Physical computing tools, also known as hardware, are the most basic set of specifications specified by the operating system and the software application. In these cases of operating systems, the hardware specification list is the often followed by the hardware configuration process. The below are the minimum hardware requirements:

HARDWARE REQUIREMENTS

COMPONENTS	SPECIFICATION
Processor	Pentium 4 or above
Hard Disk	320 GB or more
RAM	8 GB or more
Camera	Web Cam

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8.2.SOFTWARE REQUIREMENTS

Computer specifications are concerned with specifying the tools and prerequisites that must be implemented on a device in order for an application to work. These prerequisites must be installed before the app can be installed. The below are the minimum programme requirements:

Frontend	Backend	AI & ML Libraries
HTML5	Python	OpenCV
CSS3	Flask Framework	MediaPipe
JavaScript	PHP (for management modules)	DeepFace
jQuery		NLTK
Bootstrap		NumPy
Material UI		Pandas
SaaS		Scikit-learn

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9.SYSTEM IMPLEMENTATION

The implementation phase of the **AI Fitness Trainer System** is the process of converting the designed system into a fully functional working application. It involves coding, database creation, module integration, testing, and deployment in a controlled environment. The system is implemented using **Python, PHP, and MySQL**, along with frontend technologies such as **HTML, CSS, JavaScript, and Bootstrap**.

During implementation, each module such as **User Management, Admin Panel, AI Pose Detection, Workout Tracking, Progress Monitoring, and Recommendation System** is developed separately and then integrated to form a complete intelligent fitness platform. The implementation ensures that all functionalities such as real-time posture detection, repetition counting, workout logging, and progress tracking work efficiently.

The system is developed and tested on a local server environment using **XAMPP**, which provides Apache server and MySQL database support. Python runs separately for AI processing using OpenCV and MediaPipe, which captures and analyzes real-time webcam input.

9.1.IMPLEMENTATION PROCESS

1. System Setup

- Installation of Windows operating system
- Installation of XAMPP server (Apache and MySQL)
- Installation of Python (Anaconda / PyCharm / IDLE)
- Installation of required Python libraries (OpenCV, MediaPipe, NumPy, Pandas)
- Installation of Visual Studio Code for web development
- Setup of webcam for real-time pose detection
- Configuration of project folders in htdocs directory

2. Database Implementation

- Designing relational database structure in MySQL
- Creating database for fitness system
- Creating tables such as:
 - members
 - admin
 - gym_logs
 - workouts
 - fees (if included)
 - complaints
- Defining primary keys and relationships
- Ensuring data integrity and normalization
- Connecting MySQL database with PHP backend

3. Module Development

- Coding each module separately using PHP and Python
- Designing user interface using HTML, CSS, Bootstrap
- Implementing JavaScript for interactivity
- Developing AI module using Python (OpenCV + MediaPipe)
- Implementing real-time pose detection logic
- Developing repetition counting algorithm
- Implementing workout tracking and logging system
- Connecting frontend with backend and AI module

4. Integration

- Combining AI module with web application
- Ensuring communication between Python and PHP backend
- Integrating MySQL database with all modules
- Linking user dashboard with workout tracking system
- Ensuring real-time data flow between webcam input and AI processing
- Resolving integration errors and synchronization issues

5. Testing and Debugging

- Performing unit testing for each module
- Conducting integration testing between AI and web system
- Debugging pose detection and repetition counting logic
- Fixing database connectivity issues
- Validating real-time feedback accuracy
- Improving system performance and reducing latency

6. Deployment (Local Server)

- Running PHP application on XAMPP local server
- Starting MySQL database server
- Executing Python AI module for real-time detection
- Connecting webcam for live workout tracking

- Accessing system via browser using localhost
- Testing full system functionality in real environment

10.FUTURE SCOPE

The AI Fitness Trainer System has significant potential for future development and enhancement. While the current system provides real-time posture detection, exercise tracking, repetition counting, and personalized recommendations, several advanced features can further improve its effectiveness and user experience.

One important future enhancement is the development of dedicated mobile applications for Android and iOS platforms. This will allow users to access fitness training services anytime and anywhere through their smartphones. Advanced artificial intelligence and deep learning algorithms can also be integrated to improve posture recognition accuracy and support a wider range of exercises.

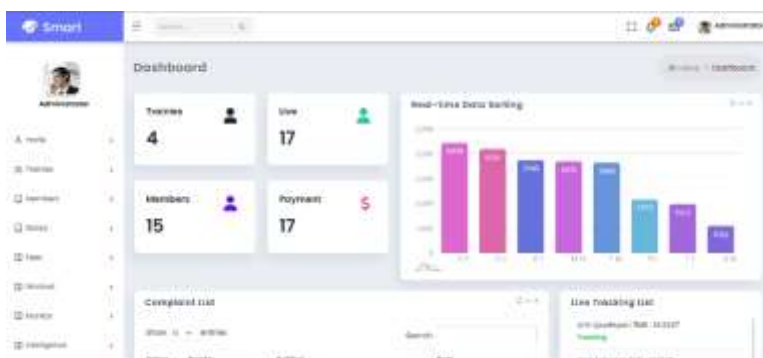
The system can be enhanced with voice-assisted coaching, enabling users to receive spoken workout instructions, motivational messages, and real-time posture correction. Integration with wearable devices such as smartwatches and fitness bands can provide additional health information, including heart rate, calories burned, oxygen levels, sleep quality, and daily activity tracking.

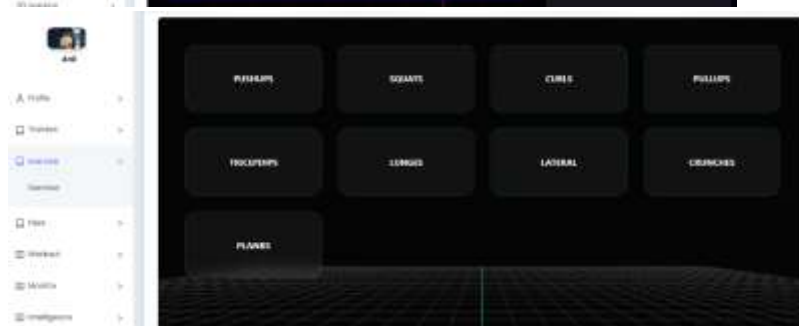
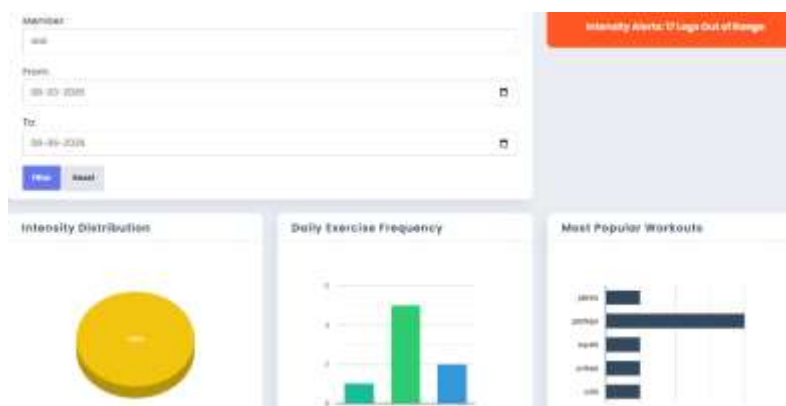
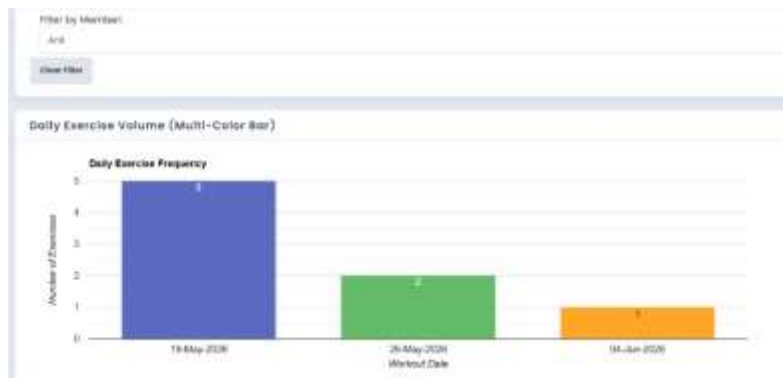
Cloud-based deployment can improve system scalability, accessibility, and data synchronization across multiple devices. Machine learning techniques can further strengthen the recommendation engine by generating highly personalized workout plans and diet suggestions based on user behavior and fitness goals.

Future versions may also include features such as diet management, hydration tracking, BMI analysis, stress monitoring, and mental wellness support, transforming the system into a complete health and wellness platform. Social features such as fitness challenges, achievement sharing, and trainer interaction can increase user motivation and engagement.

Additionally, the system can be expanded for rehabilitation exercises, physiotherapy support, educational institutions, gyms, and corporate wellness programs. With continuous advancements in AI, computer vision, and cloud technologies, the AI Fitness Trainer System can evolve into a comprehensive next-generation fitness and healthcare solution.

11.SAMPLE OUTPUTS





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12.CONCLUSION

The AI Fitness Trainer system developed in this project presents an effective solution to the limitations of traditional fitness guidance methods. Existing systems, such as manual training, pre-recorded workout applications, and basic fitness trackers, often lack real-time feedback, personalization, and intelligent assistance. These limitations result in inefficient workouts, incorrect posture, and increased risk of injuries. The proposed system overcomes these challenges by integrating artificial intelligence and computer vision techniques to provide a smart, interactive, and automated fitness experience.

The system successfully combines web technologies and AI-based processing into a unified platform. By integrating PHP for backend operations, MySQL for database management, and Python-based tools such as OpenCV and MediaPipe for pose detection, the system ensures smooth coordination between different components. The modular architecture allows seamless interaction between the frontend interface, backend logic, AI module, and database, resulting in a responsive and efficient system. Features such as user management, workout tracking, payment handling, and complaint management further enhance the completeness of the system.

One of the major contributions of this system is the implementation of real-time posture detection and feedback using AI. This significantly improves exercise accuracy and reduces dependency on physical trainers. Additionally, automatic repetition counting and workout logging through the `gym_logs` table help users track their performance over time. This promotes consistency, motivation, and better fitness outcomes. The system also improves user engagement by providing an interactive and user-friendly interface. Users can easily navigate through different modules, select workouts, and monitor their progress. Administrative functionalities such as managing members, tracking payments, and handling complaints ensure efficient system management.

Overall, the AI Fitness Trainer system demonstrates how the integration of artificial intelligence with web-based technologies can transform traditional fitness systems into a more intelligent, efficient, and user-centric solution. The system not only enhances workout effectiveness but also provides a scalable foundation for future advancements in smart fitness applications.

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