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Fitness Assistant

Rutu Khatal
Student
Dept.of Artificial Intelligence and Data Science
Savitribai Phule Pune University
Nashik, India
rutuk.aids_ioe@bkc.met.edu

Neha Sardar
Student
Dept.of Artificial Intelligence and Data Science
Savitribai Phule Pune University
Nashik, India
nehas.aids_ioe@bkc.met.edu

Samiksha Bakare
Student
Dept.of Artificial Intelligence and Data Science
Savitribai Phule Pune University
Nashik, India
samikshab.aids_ioe@bkc.met.edu

Rutuja Pawar
Student
Dept.of Artificial Intelligence and Data Science
Savitribai Phule Pune University
Nashik, India
rutujap.aids_ioe@bkc.met.edu

Prof. S. R. Bedse
Assistant Professor
Dept.of Artificial Intelligence and Data Science
Savitribai Phule Pune University
Nashik, India
shitalb_ioe@bkc.met.edu

Abstract: The Fitness Assistant is an advanced Android application developed to revolutionize the way people engage with home workouts. The system provides real-time posture correction, repetition counting, and feedback , enhancing workout effectiveness and reducing injury risks. By integrating multiple technologies like MediaPipe for landmark detection, OpenCV for image analysis, and K-Nearest Neighbors (KNN) for posture classification, the system ensures a personalized fitness experience. MediaPipe identifies body landmarks and tracks movement, while OpenCV processes the image data to calculate joint angles. KNN classifies poses by comparing real-time data to a trained model, thereby determining if the user's form is correct.The system dynamically adapts to users' progress by analyzing real-time feedback and making necessary corrections. As users continue their workout journey, the Fitness Assistant fine-tunes its recommendations, ensuring consistent progress. This research discusses the application of KNN in pose classification, evaluates the system's performance, and highlights potential improvements, including integration with wearable devices and the incorporation of more advanced machine learning models to increase efficiency.
***Keywords* -** Android app, exercise tracking, pose estimation, MediaPipe, OpenCV, real-time feedback , home fitness.

1.0
INTRODUCTION:

Navigating through physical fitness challenges, especially in home environments, presents unique obstacles. Traditional fitness solutions often rely on rigid, one size-fits-all workout plans that fail to account for the individual differences in goals, preferences, and physical capabilities. These methods often struggle to adapt to the varying needs of users, leading to issues such as lack of engagement, injuries, or suboptimal progress [5]. Furthermore, users face difficulties in staying motivated due to a lack of real-time feedback and personalized guidance.

In this context,fitness assistants have emerged as a transformative solution. These assistants utilize advanced technologies to provide customized workout plans, monitor user performance, and offer real-time feedback. By leveraging user data, such as exercise habits, progress, and health metrics, AI systems can create tailored fitness journeys that align with personal goals and ensure optimal results [6]. The primary focus of this project is to develop an AI-powered home fitness assistant that can provide personalized workout routines, real-time feedback, and motivation. The system will use advanced ML algorithms to analyze user data, adapting the workouts dynamically based on progress, physical capacity, and preferences. Furthermore, it will incorporate wearable devices or smartphone sensors to track performance and provide immediate corrective feedback, helping users optimize their routines.

By utilizing AI, the fitness assistant aims to enhance user experience, improve workout effectiveness, and increase adherence to fitness plans. The system will also be capable of learning from user feedback to continually refine its recommendations, ensuring a highly personalized and engaging fitness journey. This technological advancement offers numerous practical applications, ranging from individual fitness goals to promoting a healthier lifestyle across diverse populations.

A. Motivation and Objectives

Motivation:The rapid rise in demand for home fitness solutions, especially in the wake of the COVID-19 pandemic, has highlighted the need for personalized, adaptable, and engaging workout systems [6]. Traditional fitness approaches often fail to meet individual needs, and there is a growing desire for technology that can offer smarter, data-driven fitness experiences [5].

- Develop an fitness assistant capable of generating personalized workout plans based on user goals, physical condition, and progress.

- Integrate real-time performance tracking and feedback mechanisms using wearable devices or smartphone sensors to ensure correct posture and movement.

- Enhance motivation by providing adaptive coaching, reminders, and rewards based on user performance and consistency.

- Ensure that the system is adaptable to various fitness levels and capable of evolving over time to accommodate user’s changing needs.

- Foster a culture of wellness by offering a flexible and accessible solution that users can incorporate into their daily lives, regardless of location or schedule.

2.0LITERATURE REVIEW

Studies and research conducted to understand advancements in fitness tracking technologies, the role of artificial intelligence in fitness monitoring and the impact of real-time feedback on exercise form and injury prevention. We explore attempts to leverage mobile applications for at home fitness and analyze the effectiveness of pose estimation techniques in guiding workout routines.

2.1Pose Estimation and Virtual Gym Assistant using MediaPipe and Machine Learning:

The paper introduces a virtual fitness trainer using Google's MediaPipe for posture estimation and rep counting. By detecting body landmarks and calculating angles, the system provides feedback on exercise form. Machine learning models including SVM [4], Logistic Regression, Naive Bayes and Decision Tree classify postures and improve accuracy [3, 5]. While effective MediaPipe may struggle in crowded settings due to occlusions. Enhancements like depth sensors or contextual data are suggested for better performance. The system is tested on exercises like bicep curls, demonstrating reliable, personalized feedback to enhance workout efficiency and safety [6].

2.2Robust Intelligent Posture Estimation for an AI Gym Trainer :

This research introduces a system for accurate posture estimation to aid fitness enthusiasts in improving their workout techniques and preventing injuries. The approach uses Mediapipe for detecting human body landmarks and OpenCV for image processing and angle calculation. The system captures video, analyzes posture and provides real time feedback with corrective suggestions, tested primarily on bicep curls and applicable to exercises like squats and lunges. The model performs well under various lighting background conditions and has potential applications in physical therapy, sports training and workplace ergonomics. Ad ditionally, integration with wearable devices could enable real-time posture monitoring [6]. The study highlights the effectiveness of Mediapipe in this domain, suggesting its broader potential in AI-driven fitness and health tools.

2.3AI Fitness Trainer Using Human Pose Estimation.

This study explores the development of an AI-driven workout trainer that applies computer vision and machine learning techniques to analyze body movements. The system offers real-time feedback, enhancing home- based workout routines. By utilizing high-quality image capture through built-in or external cameras, the system supports both live video and recorded inputs.

A key component of this trainer is the BlazePose module from MediaPipe, which identifies 33 body landmarks in 3D coordinates, assigning a visibility score to each point to ensure accuracy. The system leverages MediaPipe's pose estimation capabilities to track body positioning and analyze exercise form. Continuous image capture throughout the workout session ensures precise feedback.

Tests conducted across different camera types have demonstrated the system's effectiveness, making it particularly useful for exercises such as push-ups, where maintaining proper form is essential to prevent injuries. Designed to be intuitive and user-friendly, this AI trainer is particularly valuable in scenarios where gym access is limited, such as during pandemic-related restrictions.

This research emphasizes the role of MediaPipe and OpenCV in real-time posture analysis, enabling the system to detect key body landmarks and provide corrective feedback. The primary objective is to create a system that supports safe and effective exercise routines, making fitness guidance more accessible and efficient for users.

3.0 METHODOLOGY

The methodology involves the following steps:

The AI-driven fitness assistant follows a structured pipeline consisting of two primary stages:

A. **Landmark Detection Stage**

Users position themselves in front of a camera, ensuring visibility of key regions of interest. MediaPipe is utilized to detect human body landmarks, identifying essential points required for movement analysis.

B. **Rep Counting Stage**

The system extracts key body landmarks from each frame and calculates angles between specified reference points. These angles are evaluated using a threshold function specific to each exercise type. When the calculated angle meets the predefined threshold, the repetition count is increased. Otherwise, it remains unchanged. To ensure accuracy, a machine learning model assesses the correctness of the exercise posture. If the confidence score surpasses 60%, the repetition is validated and counted. Otherwise, the system provides corrective feedback, and the rep count remains the same. Various machine learning and deep learning models are employed and compared to enhance classification accuracy.

C. **Pose Detection and Angle calculation**

Pose detection simplifies exercise monitoring by leveraging predefined landmarks, allowing precise identification of body positions and movement tracking.

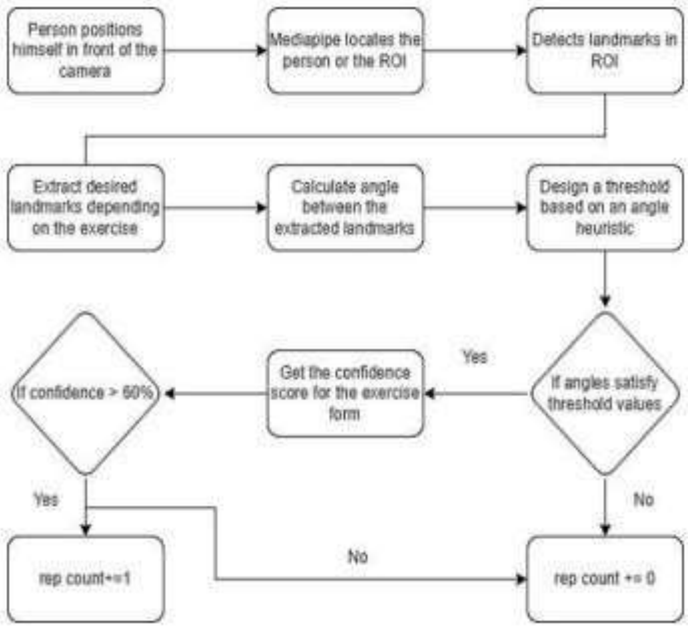


Fig 1. Pipeline Process

D. **Feedback Generation**

Machine learning models classify posture and assess exercise form. Real-time feedback algorithms provide alerts on proper form, rep counting, and posture corrections

E. **Ethical Considerations**

Data Privacy: User input and movement data are encrypted for security.

User Consent: Clear policies inform users about data collection and usage.

Accessibility: The system is design to support users of all fitness levels, ensuring inclusivity.

F. Justification of Methods

Precision: The use of pose estimation ensures highly accurate movement tracking.

Adaptability: Real-time integration of user feedback ensures a dynamic and personalized experience.

User-Centric Design: The interface is optimized for both tech-savvy users and beginners, ensuring a smooth user experience.

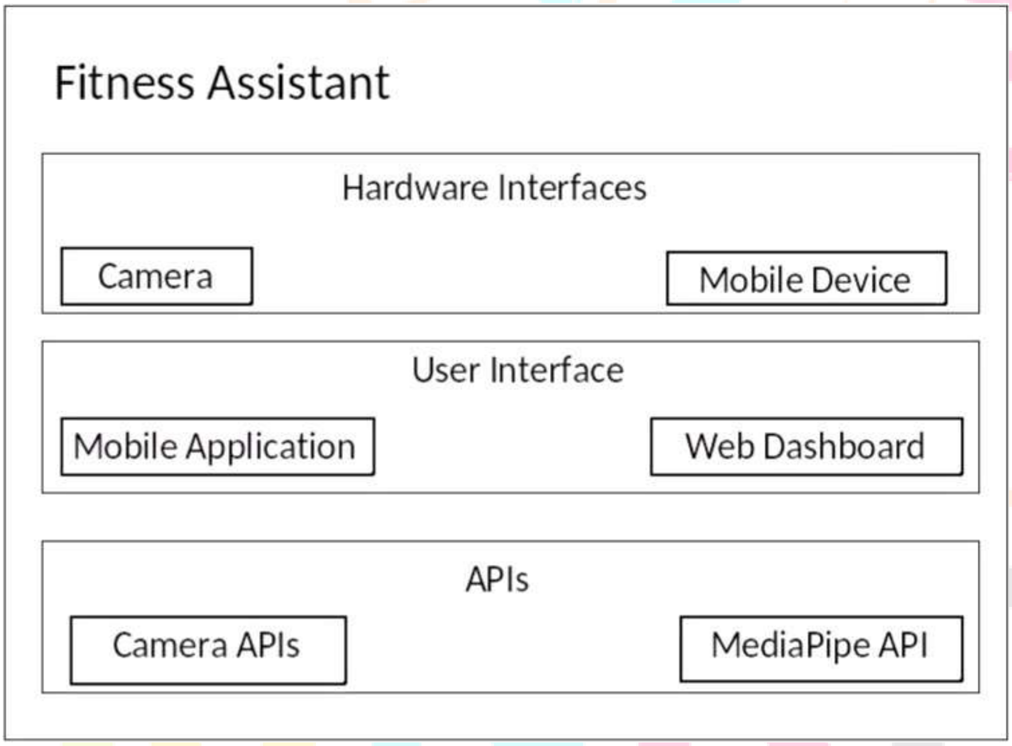


Fig. 2. System Architecture

4.0 RESULTS AND DISCUSSION:

A. Result

We successfully developed a secure and scalable home page with user authentication functionality for the Fitness Assistant app. The implementation focused on pose estimation, exercise tracking, and real-time feedback to enhance the workout experience [1, 7]. Key features developed include:

- User Authentication:

– A fully functional home page was developed using Firebase for user authentication. Secure sign-in and sign-out mechanisms were implemented to ensure user privacy and data protection.

– The user interface is designed for scalability,offering a seamless experience for logging in, registering, and interacting with the app.

– The user interface is simple yet robust, designed for scalability and easy integration of additional project functionalities.

- Pose Estimation and Feedback Generation:

– Utilizing the MediaPipe library for pose estimation, we implemented real-time exercise tracking and feedback mechanisms [5].

– The system detects key body landmarks and evaluates exercise posture for a range of exercises, including squats, bicep curls, and push-ups. Feedback on posture correction and repetition counting is provided during each session.

- Real-Time Feedback:

– Integrated machine learning models classify posture and form, delivering immediate feedback on exercise performance [7]. The feedback is visualized on the screen in realtime, highlighting areas that require correction and ensuring users maintain proper posture to reduce injury risk.

- Exercise Database and Monitoring:

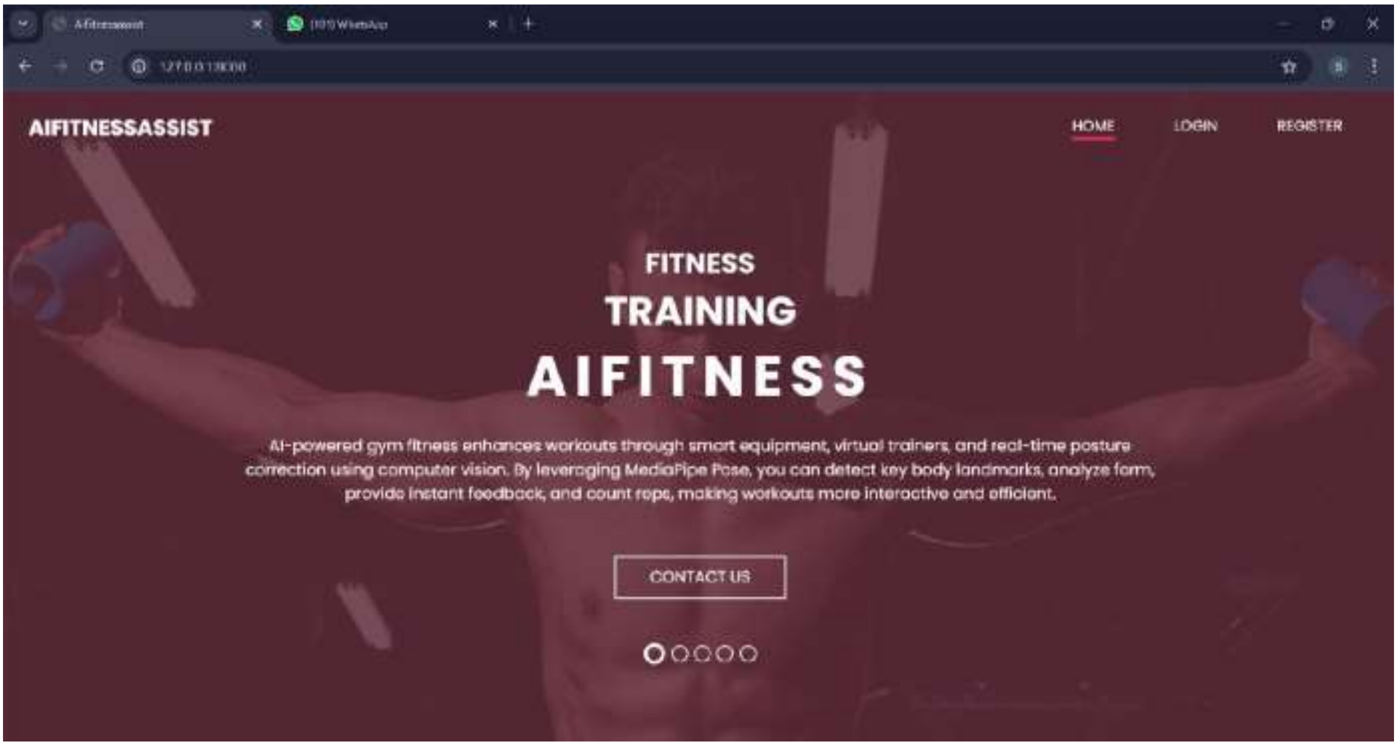
– The app includes a growing exercise database with various activities for users to choose from. Each exercise includes guidelines and suggestions for correct form. Additionally, realtime monitoring helps track user performance over time.

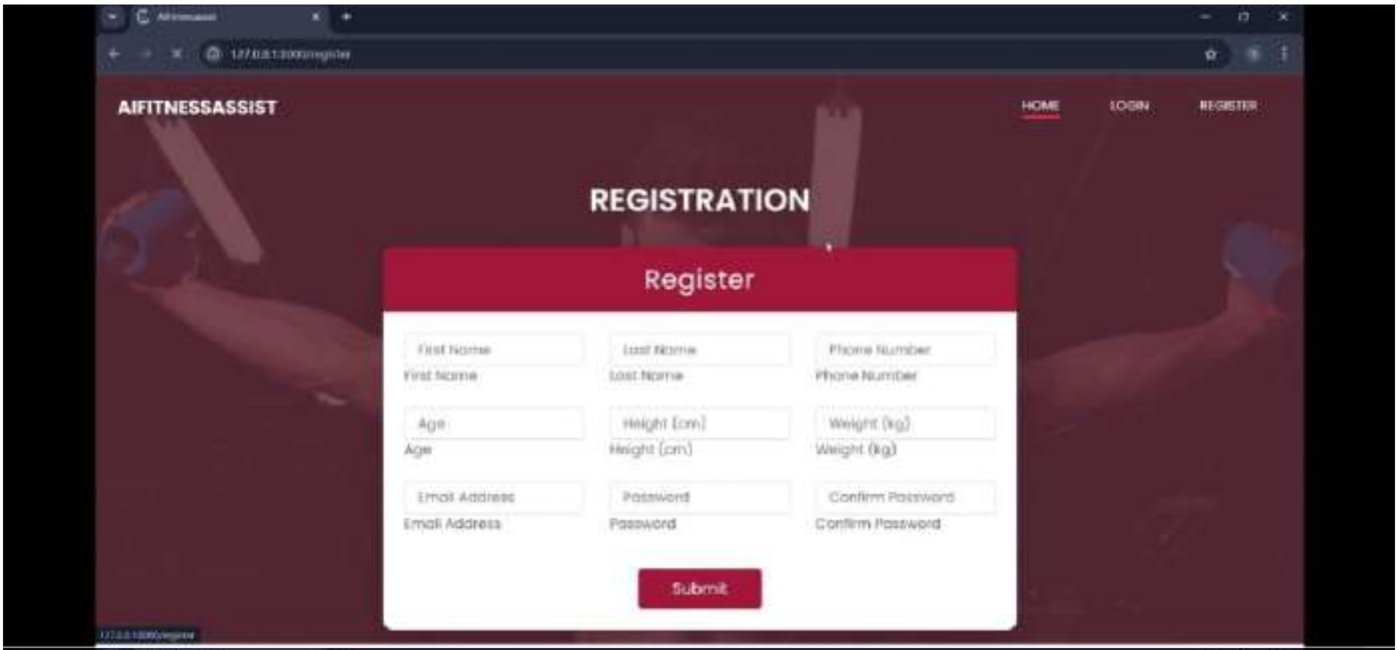
B. Table Results

Task	**Status**	**Description**	**Performance**
Data Gathering	Completed	Collecting relevant data for exercise tracking and feedback	Performance metrics
Designing & Planning	Completed	Planning system architecture and UI/UX	Performance metrics
Frontend Development	Completed	Developing the front-end UI of the app	Performance metrics
Pose Estimation Integration	Completed	Implementing MediaPipe for pose estimation and exercise tracking	Performance metrics

Repetition Counting	Completed	Implementing algorithm to count exercise repetitions	Performance metrics
Real-time Feedback System	Completed	Developing real-time feedback system based on body posture	Performance metrics
WEB Authentication by Firebase	Completed	Implementing secure authentication using Firebase	Performance metrics
Performance Monitoring	Completed	Monitoring user performance through data and sensor inputs	Performance metrics
Adaptive Feedback Mechanism	Completed	Integrating personalized feedback based on performance	Performance metrics
Backend Development	Completed	Developing backend APIs and database for user data management	Performance metrics
Security Implementation	Completed	Adding security features to the system (e.g., data encryption)	Performance metrics
Deployment	Pending	Deploying the app for public use	Performance metrics

B. Implementation Figure

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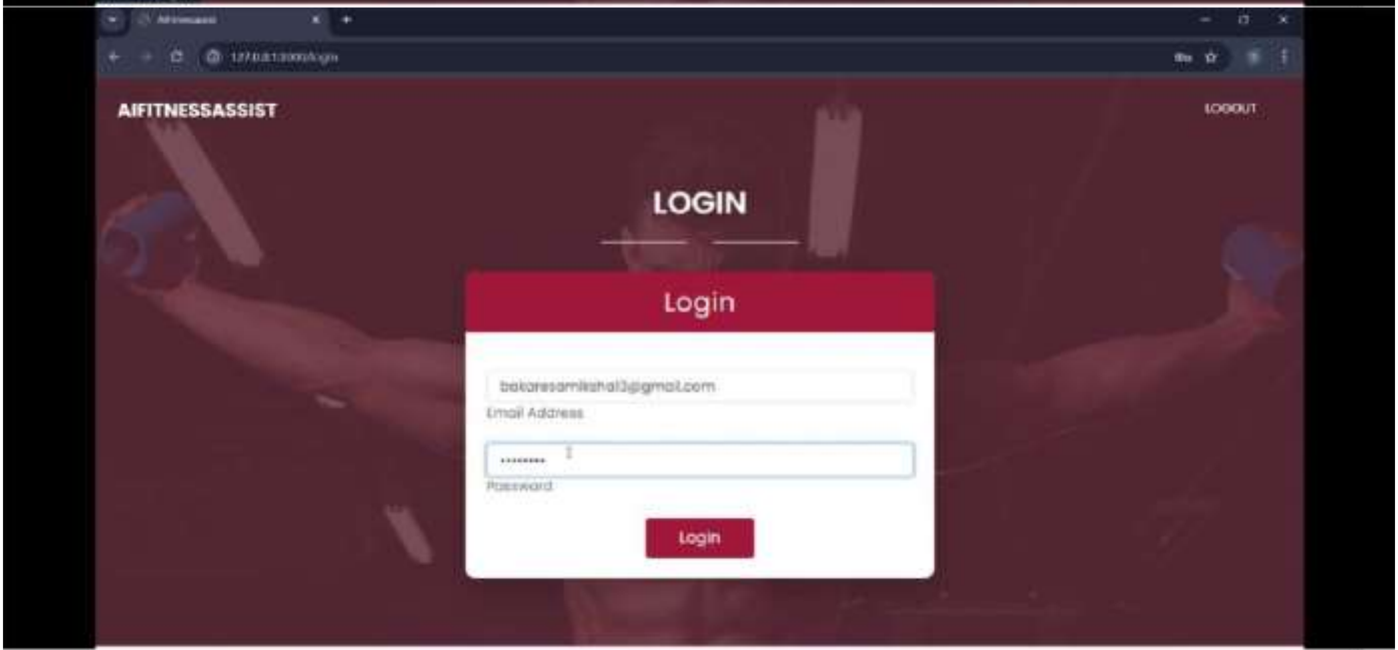
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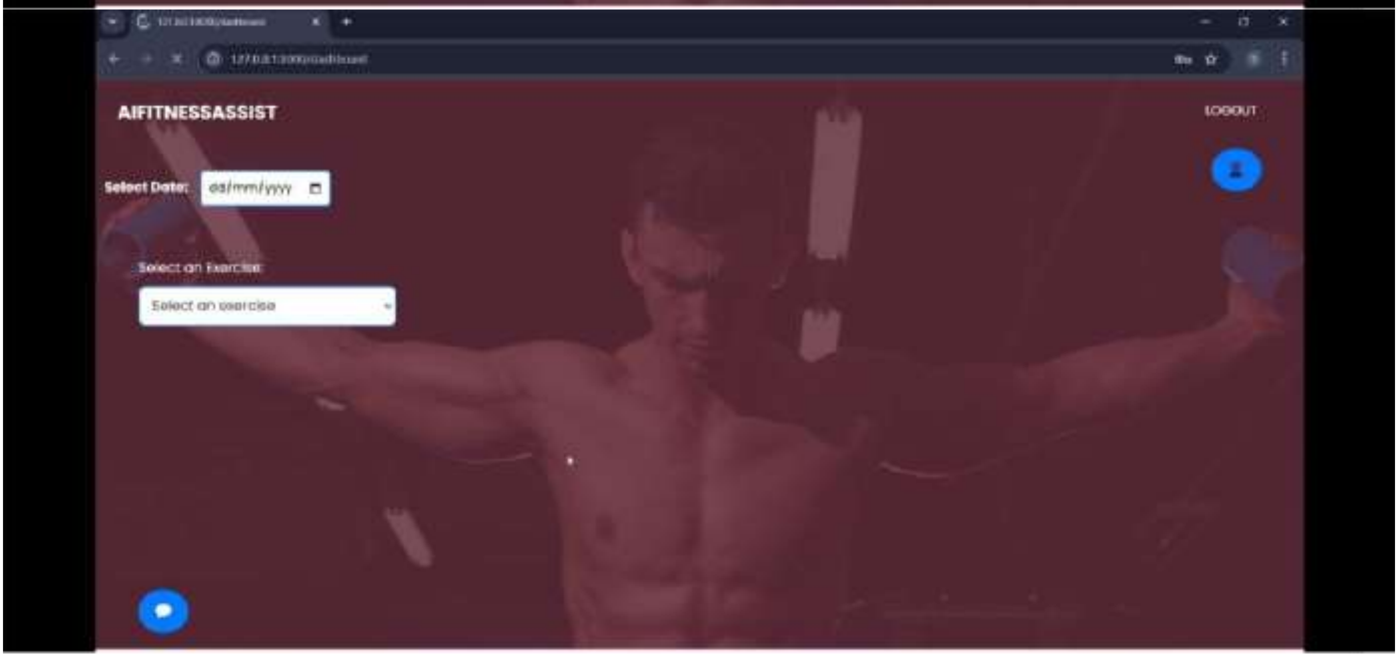
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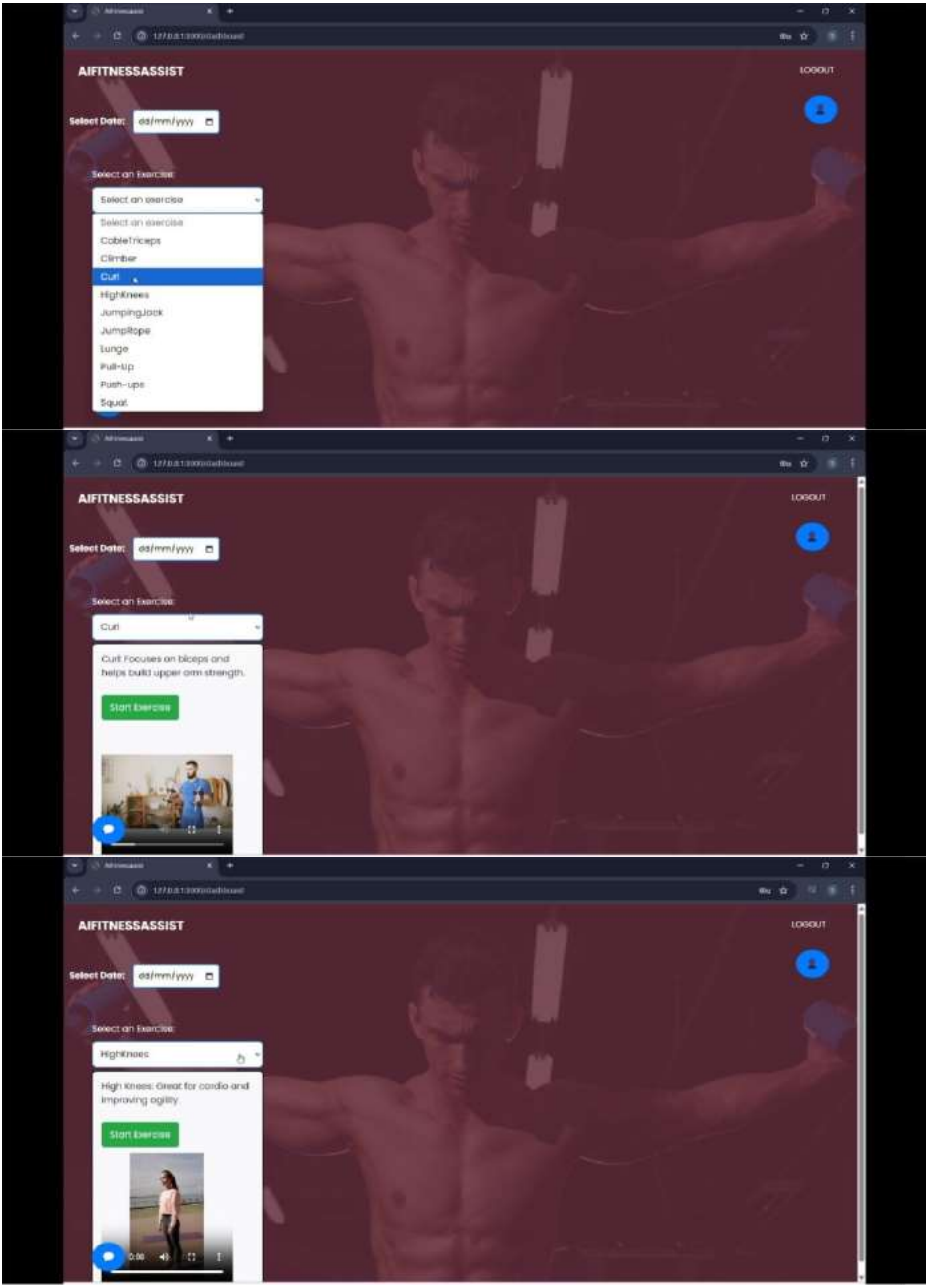
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JumpingJack
JumpRope
Lunge
Pull-up
Push-ups
Squat
Curl: Focuses on biceps and helps build upper arm strength.
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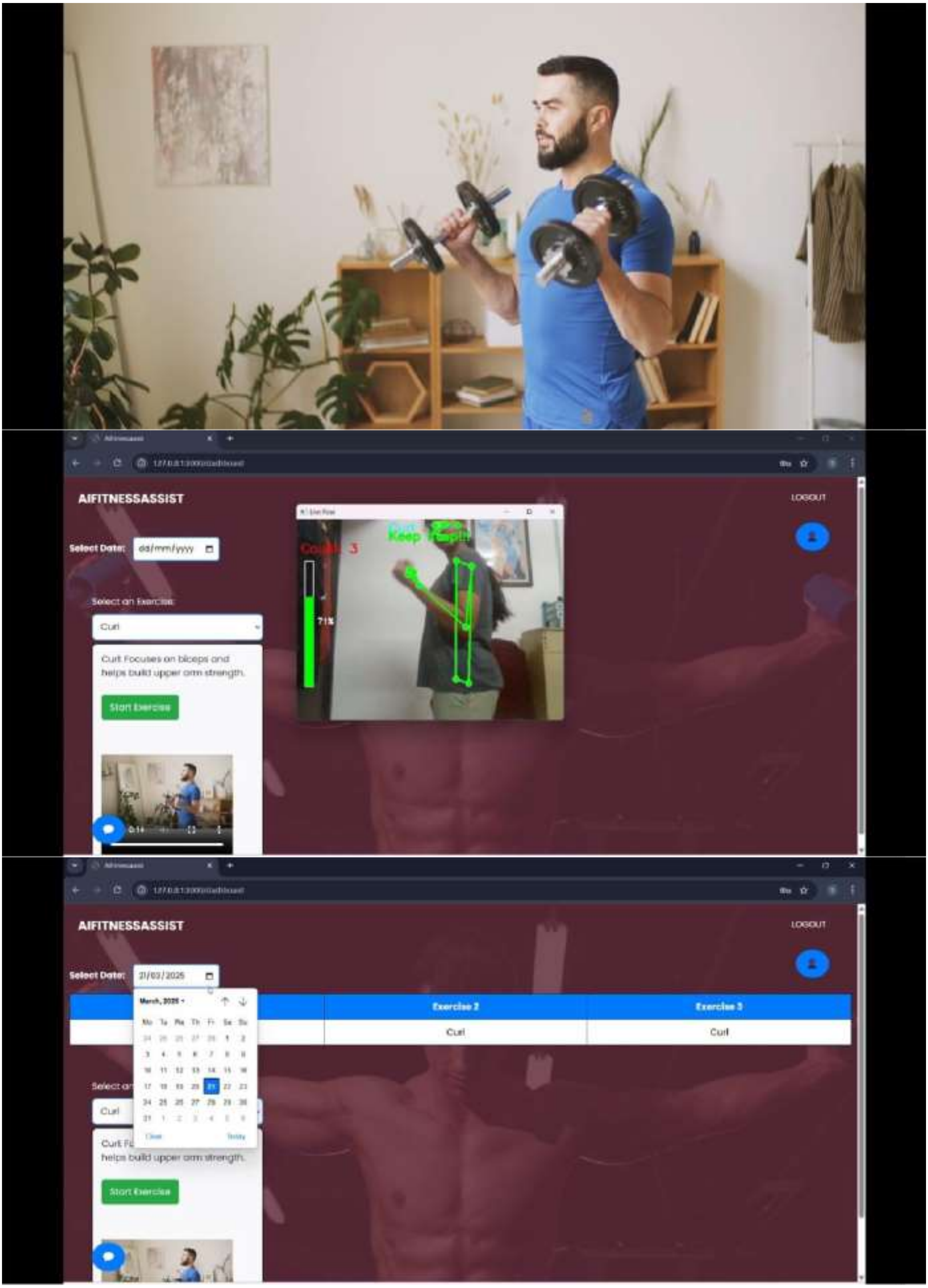
HighKnees
High Knees: Great for cardio and improving agility.
Start Exercise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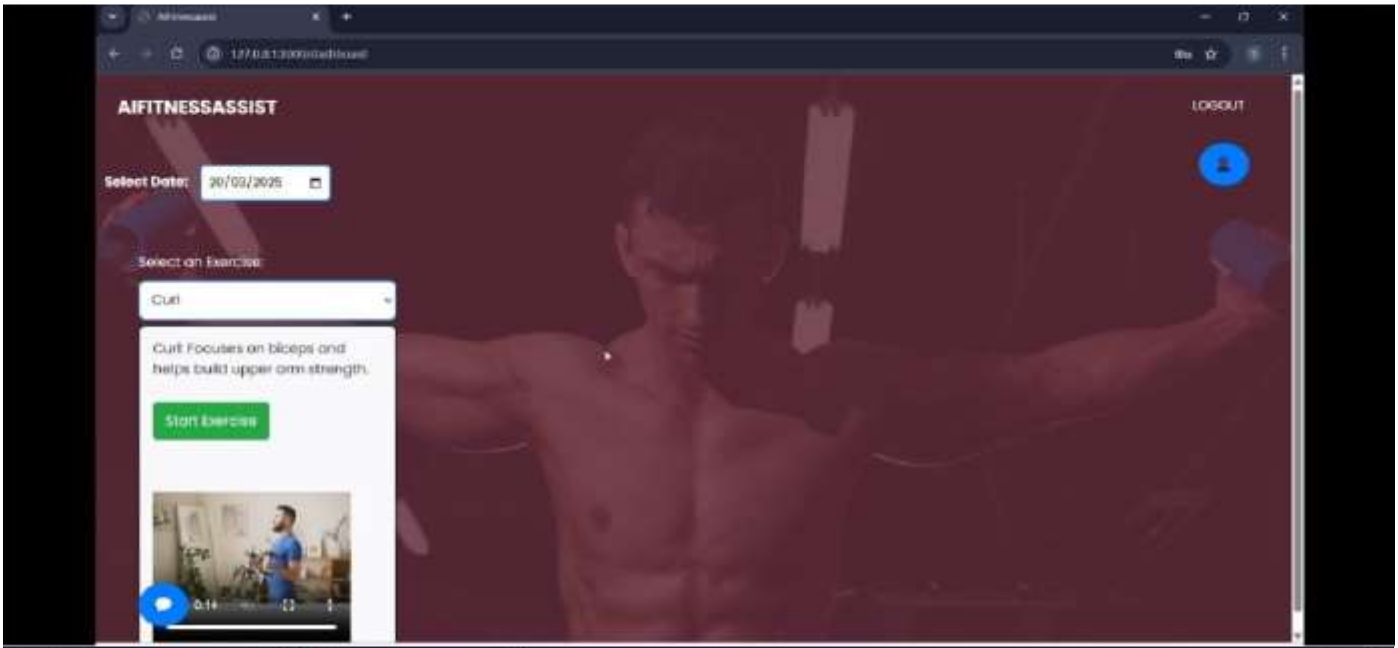

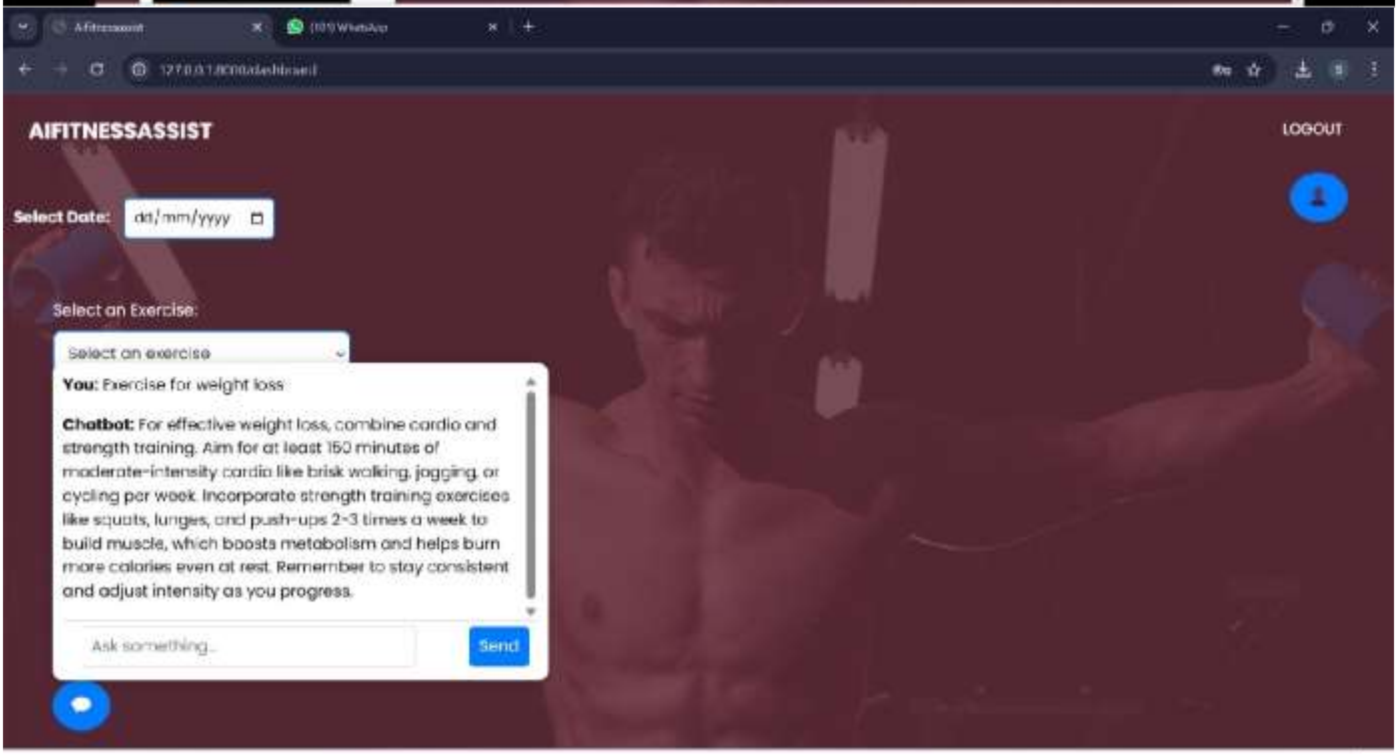

5.0CONCLUSIONS

The concept of mobile fitness assistance has evolved significantly over the past few years, yet there remains vast potential for growth and innovation. Our Fitness Assistant Application addresses the needs of users seeking personalized fitness and nutrition guidance in an increasingly digital world. By conducting thorough research and analysis, we have identified the essential requirements for creating an effective framework that empowers users on their fitness journeys. We have successfully developed a comprehensive Fitness Assistant Application that incorporates key features such as real-time feedback, video demonstrations and personalized workout plans. The application has been tested across various Android platforms, ensuring its accessibility and usability for a wide audience. The core objective of our project is to improve the health and fitness levels of individuals by providing a flexible, engaging and user-friendly platform. By creating a framework that simplifies the development of fitness applications, we aim to contribute to the growing field of mobile health and wellness solutions. As we look to the future, we are excited about the possibilities that lie ahead for enhancing the user experience and expanding the capabilities of the Fitness Assistant Application.

6.0ACKNOWLEDGMENT

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