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DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Advanced Kinetic Activity and Personalized Physiotherapy Monitoring System using CV with Gemini, Exercise DB and Rapid API

PRESENTED BY : BATCH.NO: 12

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INTRODUCTION

- The Exercise Monitoring & AI Chat System is an intelligent fitness assistant that combines real-time exercise tracking with AI-powered fitness guidance.
- This project integrates computer vision for detecting workout movements and AI-driven chatbot assistance to provide exercise insights, equipment recommendations, and personalized workout suggestions.
- By leveraging multiple APIs, users can access comprehensive exercise details, view relevant images, and watch high-quality YouTube tutorials for correct workout execution.

OBJECTIVE

Monitoring and Feedback: Create a unified system using computer vision to monitor, evaluate, and provide exercise feedback. This system caters to all users, including:

- General fitness users who need guidance on daily exercise routines.
- Individuals with specific needs, such as those with bone fractures, body wounds, or in recovery from paralysis, where exercises target specific body parts or full-body movements as needed.
- The system offers real-time feedback and performance monitoring, enhancing the effectiveness and safety of both general exercise and physiotherapy routines.

Additional Feature: Exercise Prediction by Text Input:

- Users can type the name of an exercise to receive predictions and guidance on correct execution. This feature allows for easy exercise selection and personalized recommendations.

LITERATURE REVIEW

S.NO	Title of the Paper	Author	Year	Limitations	Methodology
1	Assessment Technology for Physiotherapy Practices using Deep Learning	Nandhini Vineeth Darshan PM Deepu K Arihant Daragaj Ananth G Prabu	2024	The limitations of this paper include potential inaccuracies in key point detection, dependence on webcam quality, and challenges in adapting the system for diverse body types and complex physiotherapy exercises	Deep learning CNNs
2	A Video-based Physiotherapy Exercise Dataset	Khawja Redwanul Islam Md.Sagir Ahmed Anik Ahamad Kaniz Fatima Thameena Akter Popy Byungyong Ryu	2023	A relatively small dataset, potential biases due to specific lighting and camera conditions, and the need for more diverse subjects to improve generalizability across broader populations and The dataset consists of 1237 video clips	Video-based method CNNs

LITERATURE REVIEW

S.NO	Title of the Paper	Author	Year	Limitations	Methodology
3	Physiotherapy-based human activity recognition using deep learning	Madhushi Verma P.Suresh Neeraj Kumar	2023	The data quality variability, limited generalizability, high computational demands, or the need for extensive labeled data.	RNNs and LSTM
4	Automatic Evaluation of Physiotherapy Activities Using Deep Learning Techniques	Xavier Arequipa Bryan Hernandez	2023	The limitations include reliance on large datasets, high computational costs, potential generalization issues, and real-time performance challenges.	CNNs
5	HDL-PSR: Modelling Spatio-Temporal Features Using Hybrid Deep Learning Approach for Post-Stroke Rehabilitation	Vishwanath Bijalwan Vijay Bhaskar Semwal Tapan Kumar Manda	2023	HDL-PSR system include potential overfitting on small datasets, dependency on high-quality sensor data (e.g., Kinect), and challenges in adapting to varied patient movements and environments	CNN-GRU hybrid model

LITERATURE REVIEW

S.NO	Title of the Paper	Author	Year	Limitations	Methodology
6	Computer Vision-Based Unobtrusive Physical Activity Monitoring in Schools	Hans Horak	2022	The study explores using computer vision to unobtrusively monitor physical activity in schools, promoting a healthier lifestyle for students.	Computer vision
7	Real-Time Posture Correction in Gym Exercises: A Computer Vision Based Approach	Hitesh Kotte Milos Kravcik Nghia Duong-Trung	2021	This research presents a system that uses computer vision to correct real-time posture during gym exercises to prevent injuries.	Pose Estimation using Deep Learning
8	An Automatic Vision-Based Monitoring System for Accurate Vojta Therapy	Muhammad Hassan Khan Julien Helsper Cong Yang Marcin Grzegozek	2020	This paper introduces a vision-based system to accurately monitor and evaluate Vojta-therapy exercises, enhancing physiotherapy treatment.	LSTM and RNNs

Summary of Literature Review

From the above Literature review we inferred that

- The papers are focused on the Deep learning for accurate physiotherapy posture assessment and feedback.
- They used various advanced Deep learning algorithms Convolutional Neural Networks (CNNs)
- The accuracy and the desired output of each paper is varying on a minute difference with an average accuracy of 80%
- Overall Latency of the base papers are not up to the mark which downgrades the real time usage of the model

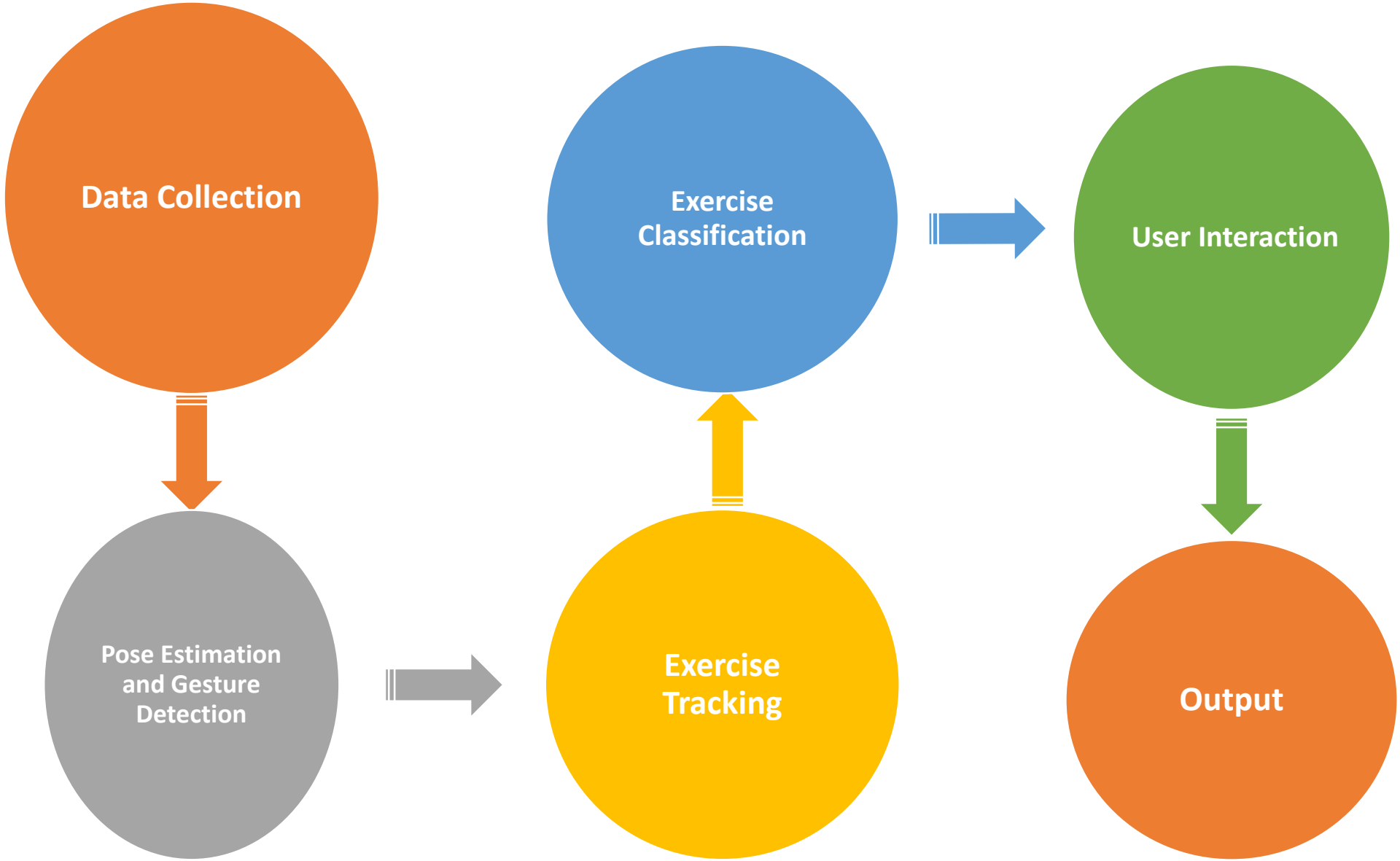
PROBLEM STATEMENT

- Incorrect Posture and Lack of Real-Time Feedback: Traditional workout applications fail to provide real-time posture correction, leading to improper form and potential injuries.
- Limited Personalized Guidance: Most fitness systems rely on predefined workout descriptions without interactive, AI-driven feedback tailored to individual users.
- Lack of Multi-Modal Exercise Insights: Existing solutions do not integrate diverse resources such as videos, images, and textual guidance for a comprehensive exercise learning experience.

METHODOLOGY TO SOLVE THE PROBLEM

- Real-Time Pose Estimation: The system utilizes MediaPipe Pose Estimation and OpenCV to track body movements and provide instant posture correction feedback.
- AI-Driven Chatbot Assistance: Integrating Google Gemini AI, the chatbot offers personalized workout guidance, answering user queries and suggesting improvements based on individual needs.
- Multi-Source Exercise Data Retrieval: APIs like YouTube and Pexels API provide dynamic workout tutorials and exercise images, ensuring an enriched user experience.

PROPOSED WORK



Data Collection: Capture a real-time video feed of the user's movements using a webcam for body tracking

- **Overview:** The real-time video feed is captured using a webcam, which is essential for tracking and analyzing the user's body movements.

- **Details:** The webcam records continuous frames of the user's movements during an exercise session. These frames are fed into a pose estimation model to analyze the user's posture and detect specific gestures or movements.

- **Importance:** Real-time video capture is crucial for continuous monitoring, enabling the system to give immediate feedback on exercises performed, ensuring accuracy and proper form.

Pose Estimation and Gesture Detection: Utilize Mediapipe to detect and track body landmarks and gestures in real time

- **Overview:** Pose estimation involves detecting key body landmarks such as joints and limbs to determine body posture. Mediapipe, a powerful real-time ML solution, is used for tracking human body landmarks.

- **Details:** Mediapipe's holistic model tracks multiple landmarks including hands, body, and face. It uses these landmarks to detect gestures and body positions in real time, enabling accurate recognition of exercises.

- **Importance:** Accurate pose estimation is the backbone of exercise detection and ensures that each movement is captured precisely. Gesture detection helps distinguish different exercises or actions, such as squats, push-ups, or stretches.

Exercise Prediction and Classification Real-Time Exercise Information Retrieval through API:

- **Overview**: The system allows users to type in the name of an exercise to retrieve detailed information about it, including target muscles, equipment, and body part focus. This feature leverages an external API to provide real-time exercise information, enhancing the user's ability to explore and understand various exercises.

- **Technology**: Using **Rapid API** integration with the **Exercise DB API**, the system fetches exercise details based on user input. When a user types an exercise name, the API provides relevant data, such as:
  - **Exercise Name**
  - **Target Muscle**
  - **Required Equipment**
  - **Body Part**

Exercise Tracking: Track and count the repetitions of each exercise using pose estimation data

- **Overview:** The system tracks the repetitions of each exercise performed by the user, using pose estimation data to analyze body movement and transitions.

- **Details:** By analyzing key points like the elbows, knees, and shoulders, the system detects when an exercise motion (like a push-up or squat) begins and ends. This helps track the number of repetitions completed.

- **Importance:** Accurate tracking of exercise repetitions ensures that users receive proper credit for their workout and allows for progress monitoring over time.

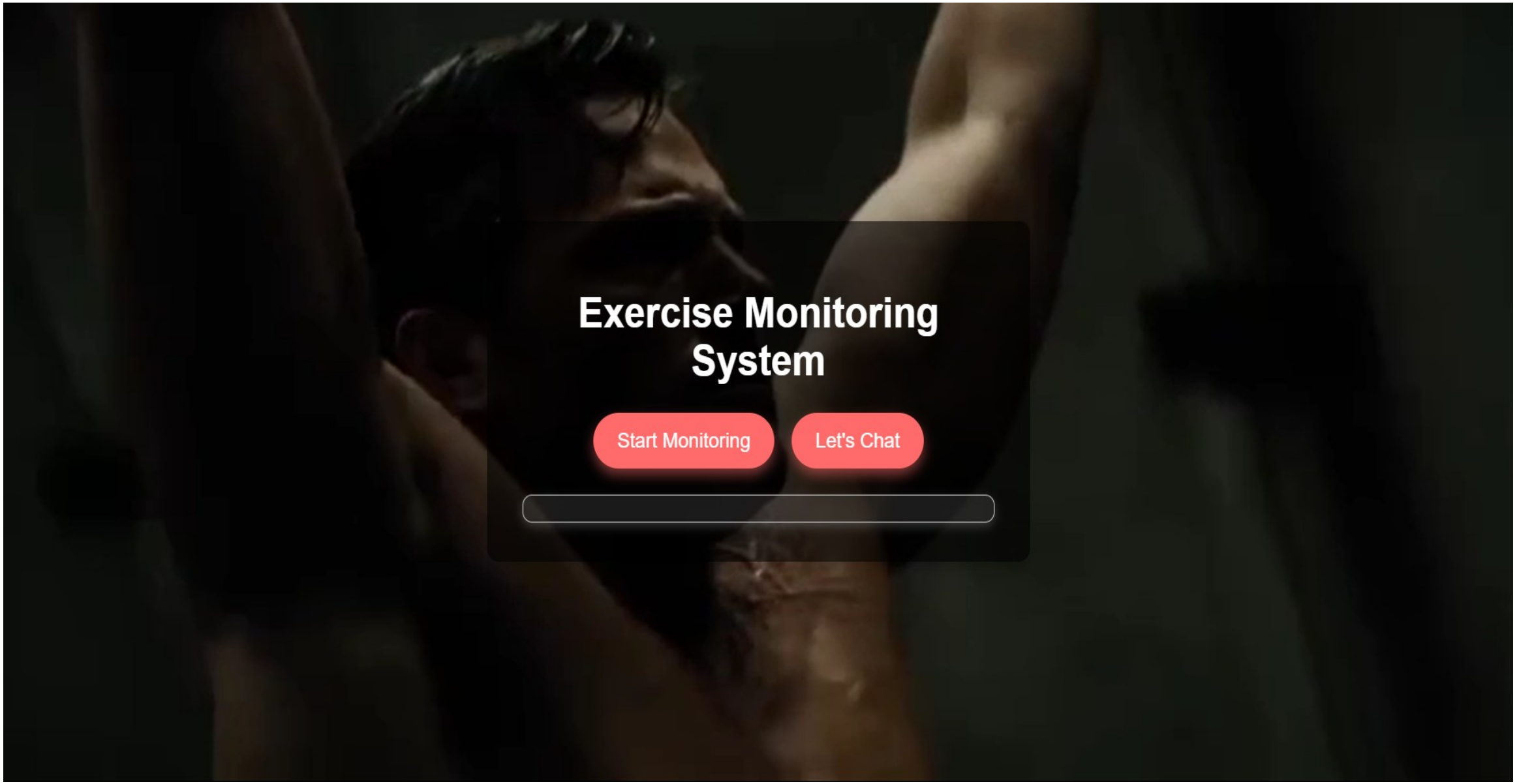
User Interaction: Provide real-time feedback and virtual prompts to guide users through the exercises

- **Overview:** The system gives real-time feedback on the user's performance and guides them through exercises using on-screen prompts and audio cues.

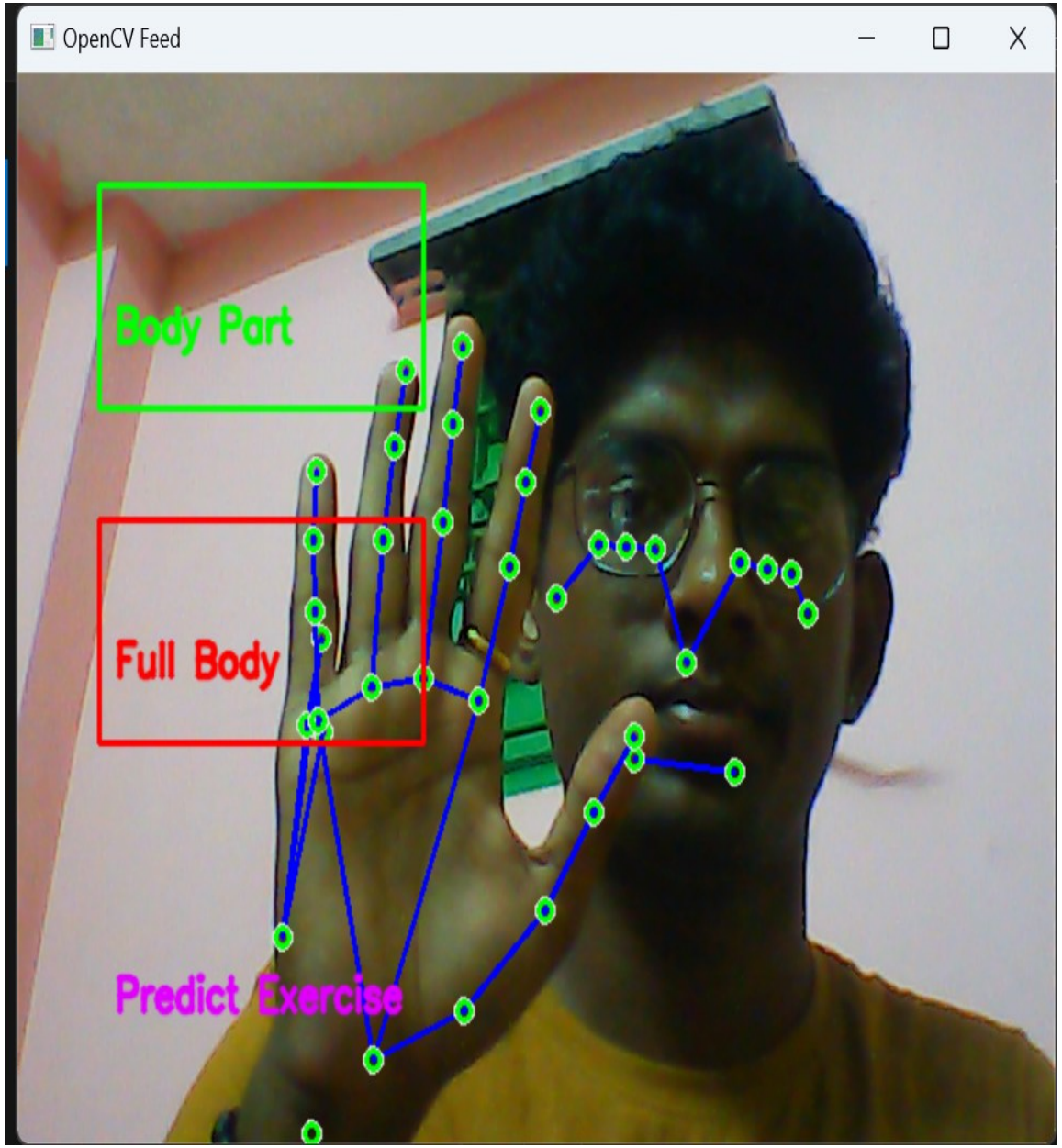
- **Details:**
  - Real-time feedback includes messages on form correction, repetition counts, and encouragement.
  - Virtual prompts help guide the user to the next exercise, ensuring that they follow a structured workout routine.
  - Examples include "Keep your back straight!" or "You've completed 10 reps!“.

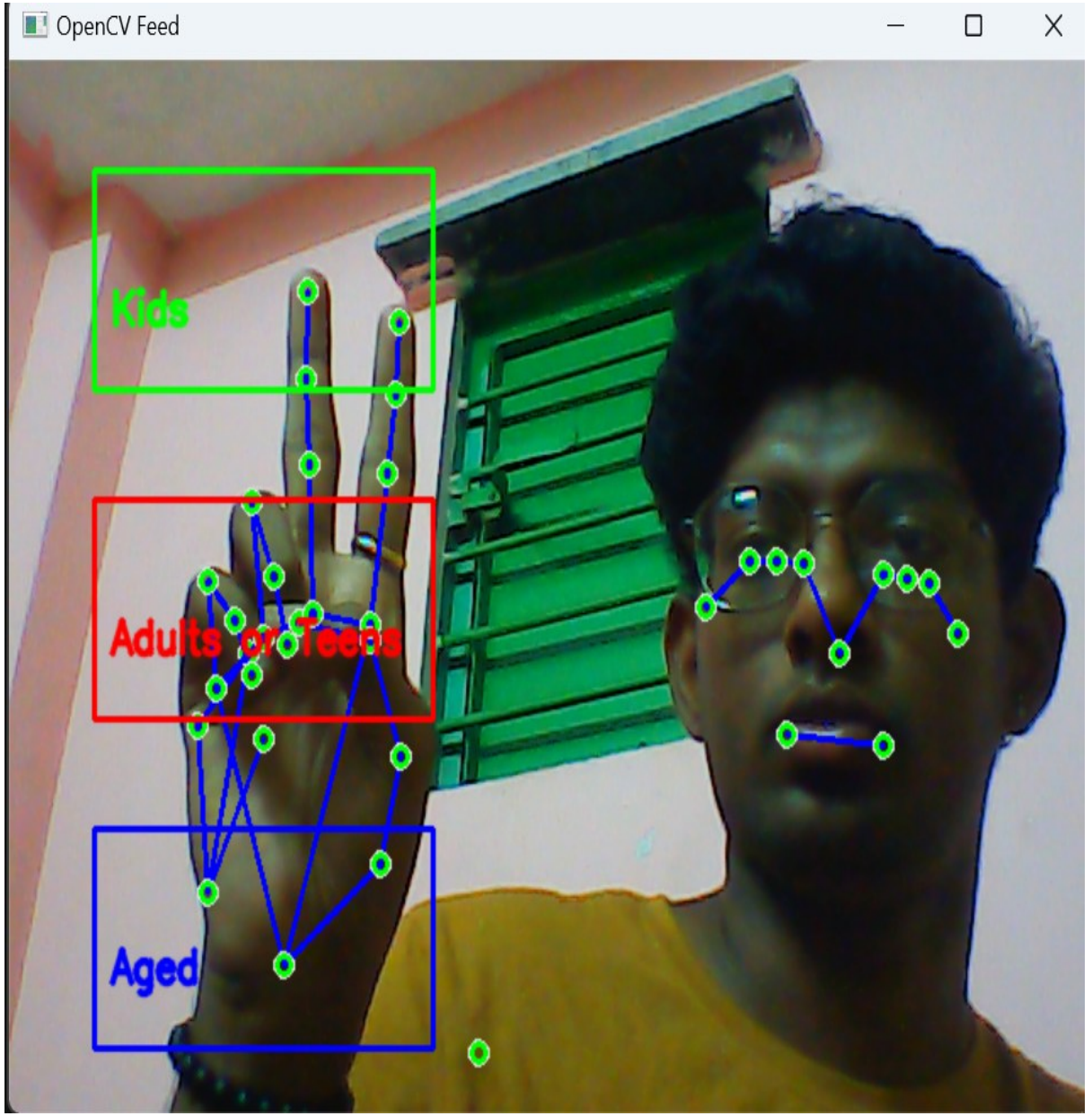
- **Importance:** Real-time feedback and interaction enhance the user experience by motivating users and helping them maintain correct form to avoid injuries.

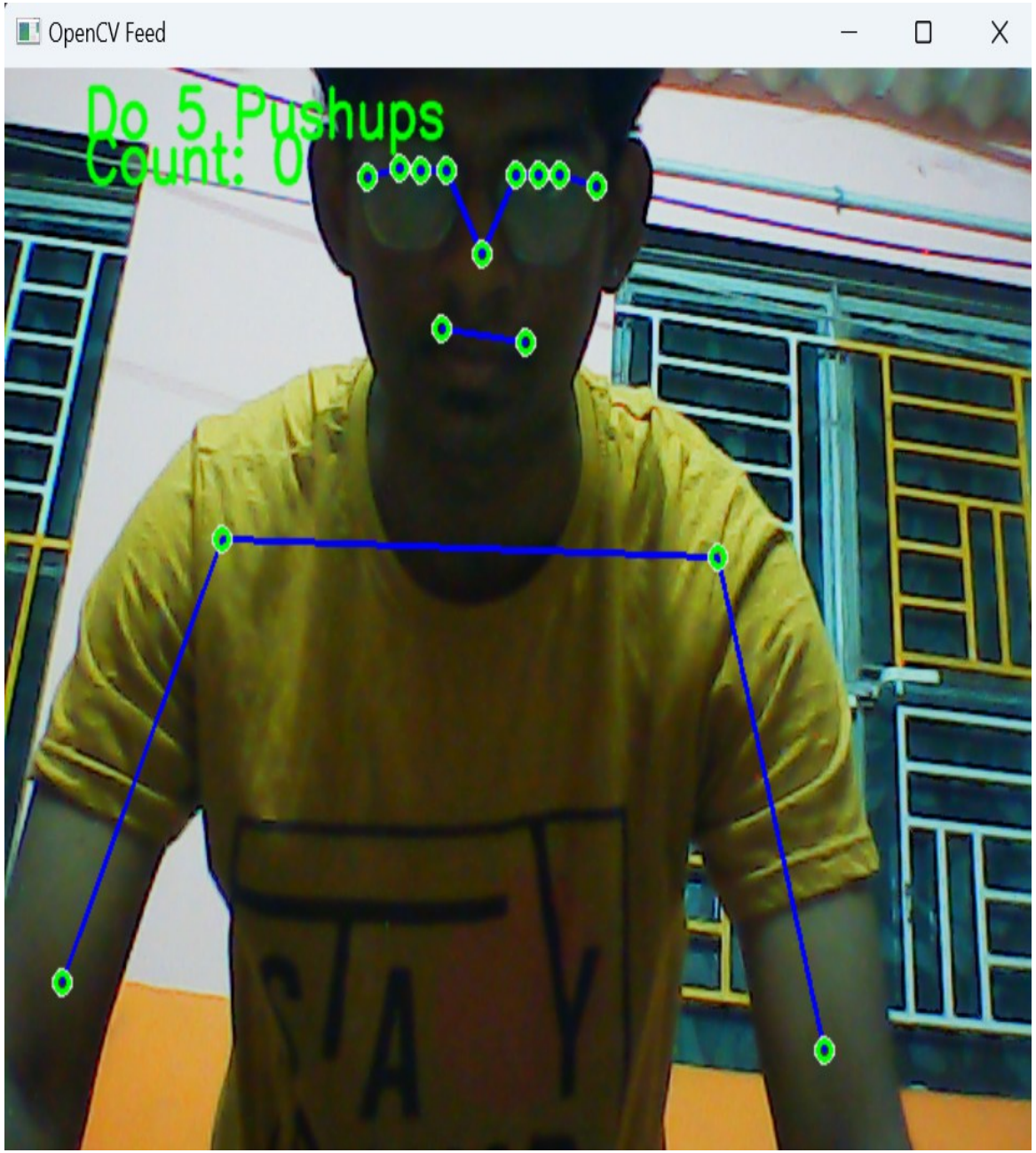
HOMEPAGE



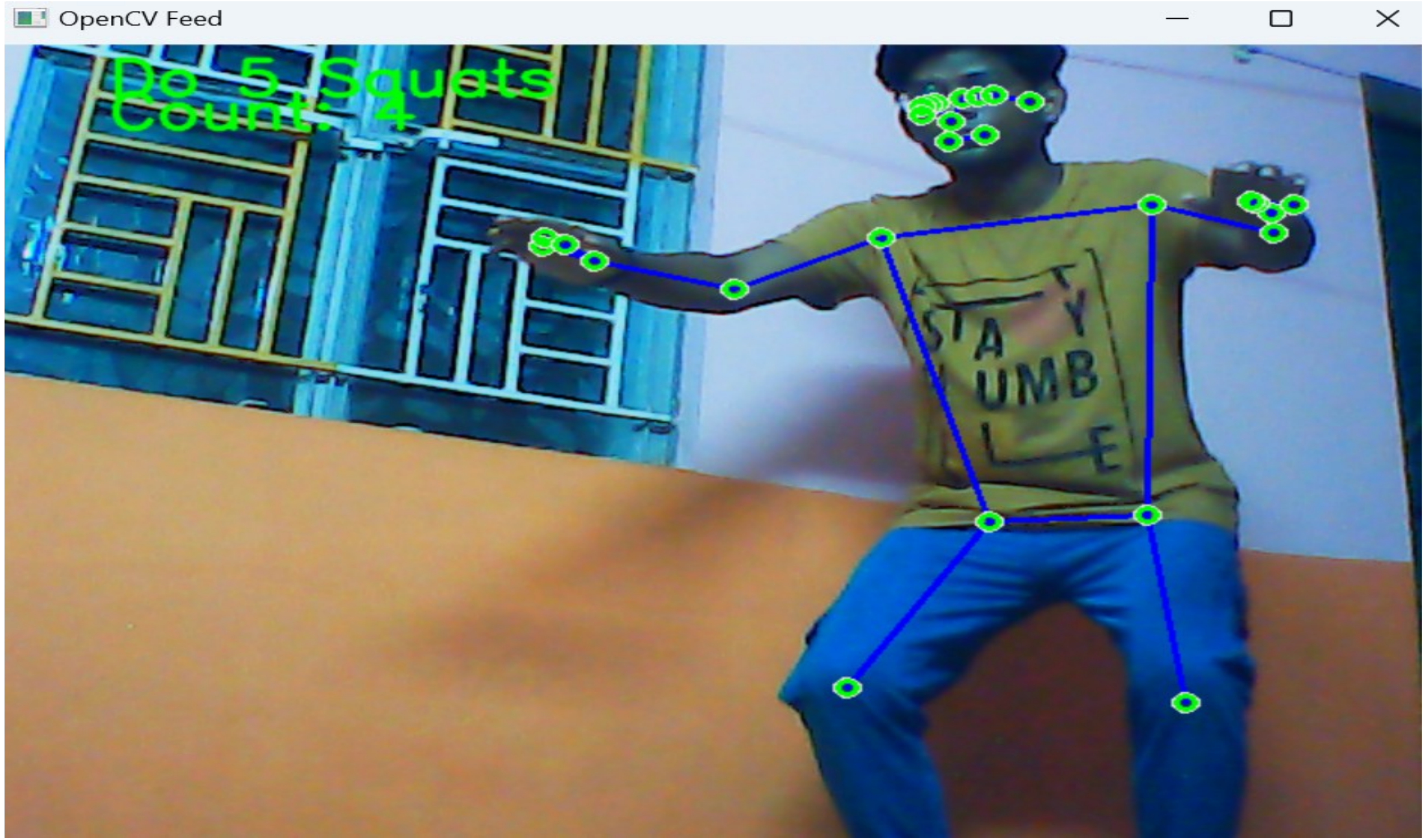
START MONITORING RESULTS



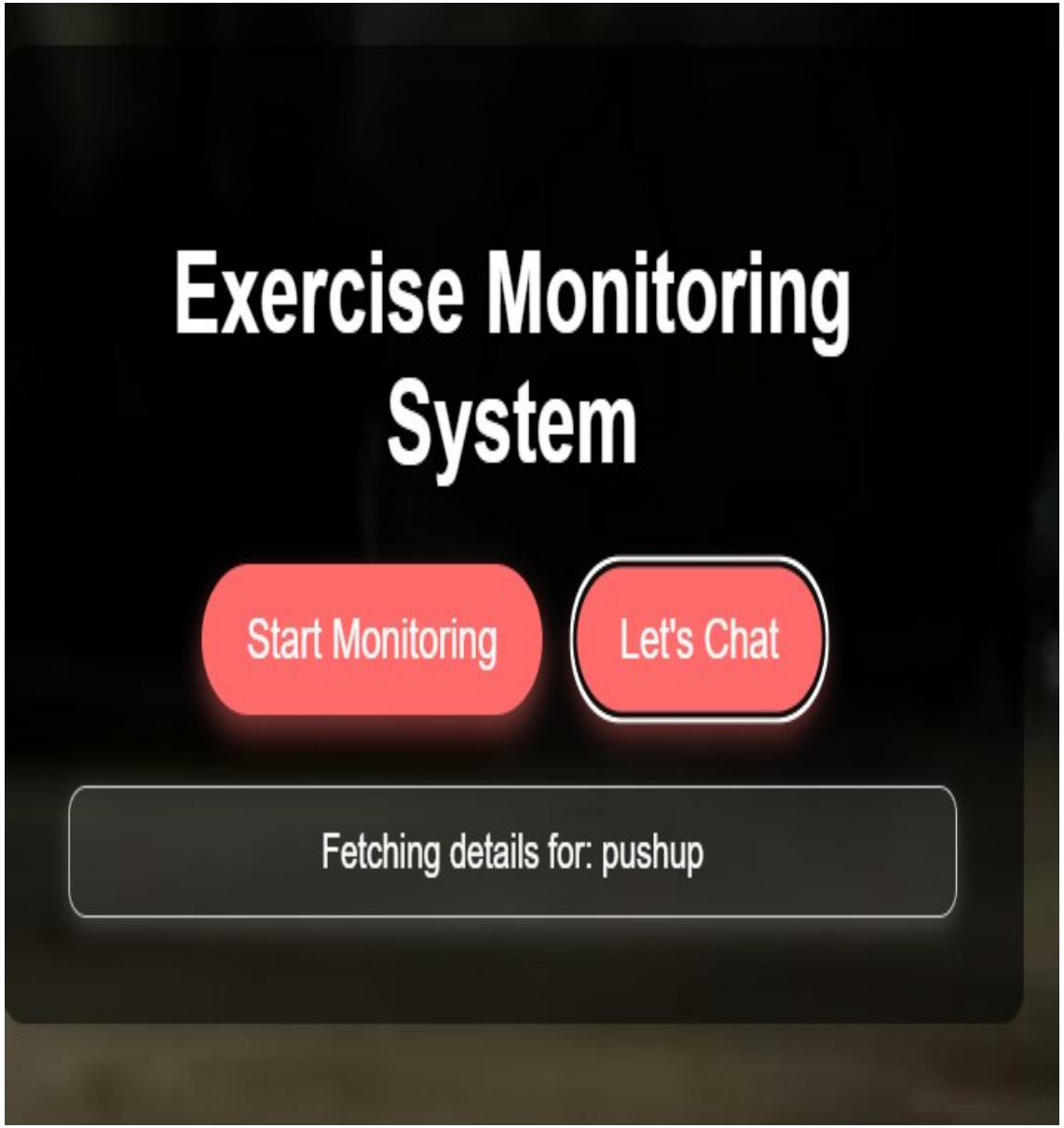


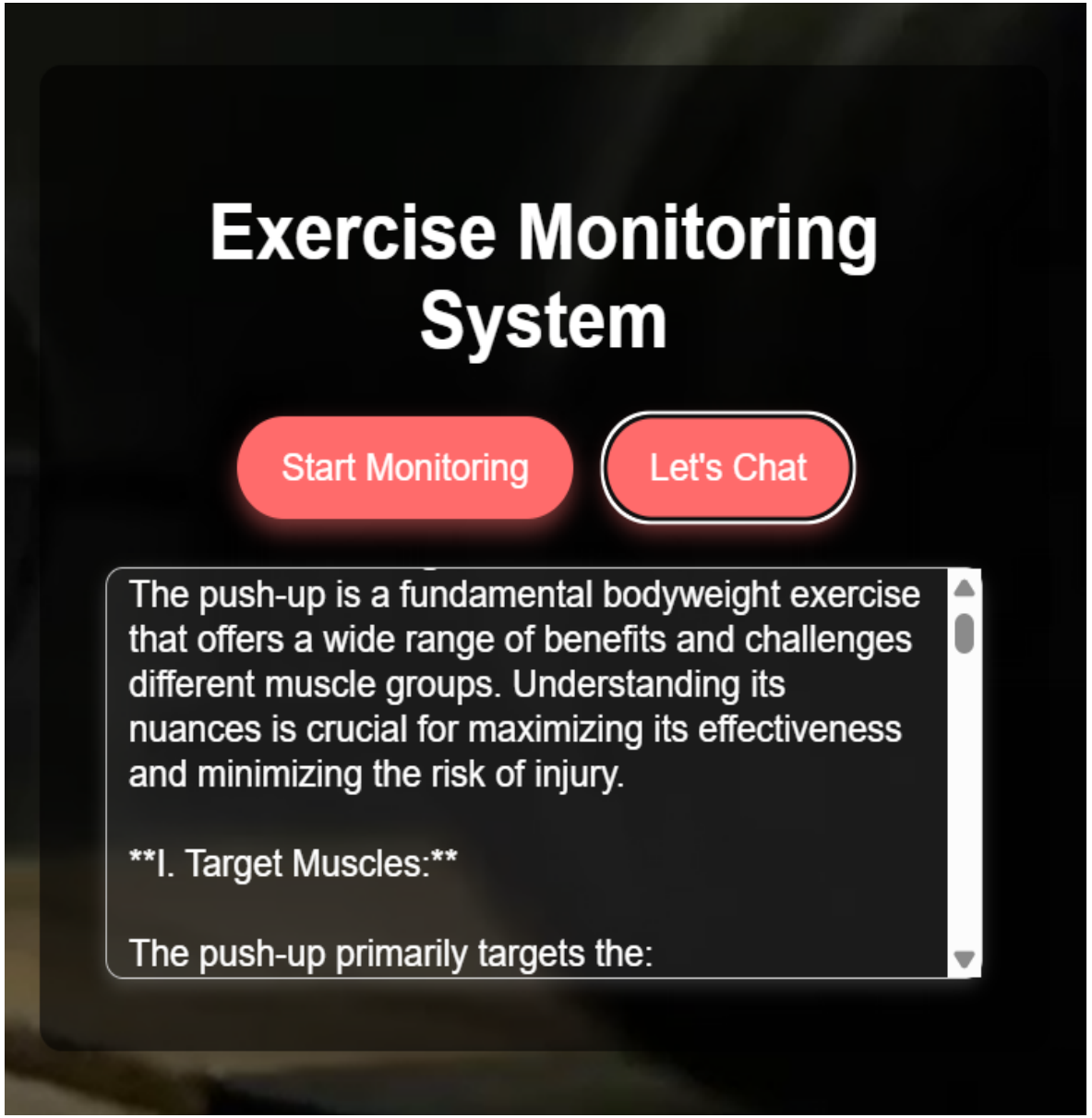

OpenCV Feed
Do 5 Pushups
Count: 0


OpenCV Feed
Kids
Adults or Teens
Aged


OpenCV Feed
Do 5 Squats
Count: 4

AI CHATBOT RESULTS





II. Benefits of Push-Ups:

* **Strength Building:** Push-ups are highly effective for building upper body strength, particularly in the chest, shoulders, and triceps.

* **Muscle Hypertrophy:** Consistent push-up training can lead to increased muscle size (hypertrophy).

* **Improved Endurance:** Performing multiple sets and repetitions enhances muscular endurance.

* **Increased Bone Density:** Weight-bearing exercises like push-ups contribute to stronger bones, reducing the risk of osteoporosis.

* **Enhanced Core Stability:** The need to maintain a stable core throughout the exercise strengthens abdominal and back muscles.

* **Improved Posture:** Strong core and shoulder muscles contribute to better posture and reduced risk of back pain.

* **Calorie Burning:** Push-ups, especially when performed in higher volume, contribute to overall calorie expenditure.

Proper form is paramount to maximize benefits and minimize injury risk. Here's a detailed breakdown:

1. **Starting Position:** Begin in a plank position with hands slightly wider than shoulder-width apart, fingers pointing forward or slightly outward. Your body should form a straight line from head to heels, engaging your core. Avoid sagging hips or arching your back.

2. **Lowering Phase:** Slowly bend your elbows, keeping them close to your body (not flared out). Lower your chest towards the floor, maintaining a straight line from head to heels. Aim for your chest to be a few inches from the floor.

3. **Pushing Phase:** Push back up to the starting position by extending your arms, maintaining core engagement and a straight body line. Avoid locking your elbows at the top.

4. **Breathing:** Inhale as you lower your body and exhale as you push back up.

5. **Controlled Movement:** Avoid bouncing or jerking movements. Each repetition should be controlled and deliberate.

6. **Hand Placement Variations:** Experiment with different hand placements to target different muscle groups:
* **Narrow Grip:** Emphasizes triceps.
* **Wide Grip:** Emphasizes chest.
* **Close Grip (Diamond Push-ups):** Focuses heavily on triceps.

PEXEL AND YOUTUBE API RESULT

Exercise Image:

YouTube Tutorial: Watch Here

Hardware Requirements

- **High-End GPU**: Required for accelerating the model inference, particularly for real-time exercise classification and pose estimation.
- **Multi-Core CPU**: Necessary for handling intensive video processing, real-time tracking, and managing multiple computational tasks efficiently.
- **16GB or Above RAM**: Ensures smooth performance during the real-time processing of video frames and exercise tracking, preventing memory bottlenecks.
- **HD Quality Camera**: Needed for capturing clear, high-resolution video for precise tracking of body movements and exercise classification.

Software Requirements

- **Frontend:** HTML, CSS, JavaScript
- **Backend:** Flask (Python)
- **Machine Learning:** Media Pipe, OpenCV
- **APIs Used:**
  - Exercise DB API (Exercise details: muscle group, equipment, body part)
  - Google Gemini AI (AI-generated exercise insights)
  - Pexels API (High-quality exercise images)
  - YouTube Data API v3 (Workout tutorial videos)
- **Deployment:** Flask for backend, Jupyter Notebook for AI processing

OUTCOME

- **Accuracy**: Tracks exercise accuracy by comparing the user's movements with the ideal exercise form, providing a performance score (e.g., 92% accuracy).
- **Exercise Count**: Automatically counts the number of repetitions for each exercise, including pushups, squats, and planks.
- **Feedback**: Provides real-time feedback on exercise form, suggesting improvements like "Keep your back straight during pushups" or "Knees should be aligned with your toes in squats."
- **Performance Analysis**: Offers a detailed report on the user's performance, tracking improvements and suggesting adjustments for more effective workouts.
- **Progress Monitoring**: Tracks the progress of the user over time, highlighting improvements in exercise count, accuracy, and consistency.
- **Final Output**: Provides a comprehensive report with key metrics such as accuracy percentage, total exercise count, and personalized feedback to enhance performance and prevent injury.

CONCLUSION

- This project successfully integrates computer vision and API's to provide real-time exercise tracking, classification, and feedback.

- By utilizing technologies like OpenCV, Mediapipe and API's like ExerciseDB, Google Gemini, Pexels, Youtube Data which helps the system for accurately monitors user movements, counts repetitions, and offers personalized feedback for performance improvement.

- The automated tracking and feedback system enhances exercise efficiency, ensures proper form, and assists in rehabilitation.

- Overall, this project demonstrates a practical application of AI in fitness and rehabilitation, offering an interactive and adaptive experience for users.

PUBLICATION DETAILS

- Journal paper has been accepted for the Publication in an International Conference on Computational Intelligence (ICCI) 2025 held on Trichy .
- Attended an International Conference on Computational Intelligence (ICCI) 2025 at K.Ramakrishnan College of Engineering, Trichy on March 22,2025.

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THANK YOU