AI-BASED WORKOUT ASSISTANT AND FITNESS GUIDE

A PROJECT REPORT

Submitted by

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DEPARTMENT OF COMPUTER APPLICATIONS

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DECLARATION

I undersigned hereby declare that the project report on **AI-BASED WORKOUT ASSIS-TANT AND FITNESS GUIDE**, submitted for partial fulfillment of the requirements for the award of degree of Master of Computer Applications of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Prof. Natheera Beevi M. This submission represents my ideas in my own words and where ideas or words of others have been included,I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in our submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University..

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CERTIFICATE

This is to certify that the report entitled **AI-BASED WORKOUT ASSISTANT AND FITNESS GUIDE** submitted by **S CHANDRAKANTH** (TKM21MCA-2015) to the APJ Abdul Kalam Technological University in partial fulfillment of the Masters degree in Computer Applications is a bonafide record of the project work carried out by him under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

Internal Supervisor   Head of the Department   External Examiner

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ABSTRACT

AI-BASED WORKOUT ASSISTANT AND FITNESS GUIDE, is an innovative application that uses artificial intelligence (AI) to assist individuals in achieving their fitness goals. Health and Fitness play a vital role in our day-today life.This can be attained in many ways of which exercising is one. Performing exercise can help us maintain very good health, only if carried out properly and in a defined manner, else the repercussions may have adverse effects on our body. To tackle this issue, we have created a system that keeps track of body movements and provides us with the number of repetitions performed, if performed within the foundation of the model. In our work, we introduce BEFIT, an application that detects the user's exercise pose counts the specified exercise repetitions and provides personalized, detailed recommendations on how the user can improve their form. Training without a trainer often leads to serious internal and external injuries if a specific workout is not properly done. Our project offers multiple features that can benefit the users to attain their ideal body by providing them with a personalized trainer with a personalized workout and a customized diet plan. The application uses the MediaPipe to detect a person's pose, and afterwards analyses the geometry of the pose from the real-time video and counts the repetitions of the particular exercise.

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Chapter 1

Introduction

AI-BASED WORKOUT ASSISTANT AND FITNESS GUIDE, is an innovative application that uses artificial intelligence (AI) to assist individuals in achieving their fitness goals. This is an AI-based Workout Assistant and Fitness guide to guide people who don't have access to the gym but are still willing to work out at home to maintain their physique and fitness and keep their body in good shape.To help them perform the exercises correctly and prevent them from injuries.

It also provides a personalised health guide and diet plan along with a personalised daily workout calorie count.Most gyms have a wide variety of exercise equipment and also have trainers who guide us about the exercise and its correct posture. But the unavailability of the above equipment and trainers can be an important reason that can stop us from doing exercise at home.

We aim to build an AI-based trainer that would help you exercise more efficiently in your own homes.The AI-based fitness guide is designed to provide users with customized workout plans that are tailored to their specific needs and goals. By collecting data on users' fitness levels, exercise history, and health status, the guide can create personalized recommendations for exercises, workouts, and training regimens. The guide can also provide real-time feedback on exercise performance, enabling users to optimize their workouts and achieve their fitness goals more efficiently.

1.1 Problem Statements

The AI-based workout assistant and fitness guide seeks to address several key problem statements in the fitness industry, including:

- Safety Concerns: Incorrect form and technique during exercise can lead to injury. Existing workout assistants do not always provide adequate guidance on form and technique, which can pose a safety risk to users.

- Lack of personalized guidance: Many individuals struggle to achieve their fitness goals because they lack access to personalized guidance that is tailored to their specific needs and goals. The AI-based fitness guide aims to address this problem by providing customized workout recommendations and real-time feedback that is optimized for each user.

- Inefficient workouts: Another common problem in the fitness industry is the inefficiency of workouts, which can lead to frustration and discouragement. The AI-based fitness guide aims to optimize workouts by providing real-time feedback on exercise performance and recommending exercises that are most effective for each individual.

- Lack of flexibility in workout plans: Many workout plans are rigid and inflexible, which can make it difficult for individuals to adapt to changes in their schedule or fitness needs. The AI-based fitness guide aims to provide more flexibility by continuously learning and adapting to users' needs over time.

- Limited Accessibility: Many fitness programs and workout routines require specialized equipment and gym memberships, which may not be accessible or affordable for all users. An AI-based workout assistant and fitness guide should offer customizable workout plans that can be done from home with minimal equipment.

1.2 Objective

The objectives of the AI-based workout assistant and fitness guide are as follows:

1.2.1   Personalized workout recommendations

The primary objective of the AI-based fitness guide is to provide personalized workout recommendations that are tailored to the specific needs and goals of each user. By collecting data on users' fitness levels, exercise history, and health status, the guide can create customized workout plans that are optimized for each individual.

1.2.2   Real-time feedback

The fitness guide also aims to provide real-time feedback on exercise performance, enabling users to optimize their workouts and achieve their fitness goals more efficiently. The guide can provide feedback on technique, form, and other factors that can impact the effectiveness of exercises and workouts.

1.2.3   Continuous learning and adaptation

Another objective of the AI-based fitness guide is to continuously learn and adapt to users' needs over time. By analyzing workout data and user feedback, the guide can identify areas where users are excelling and areas where they need more support, enabling it to provide targeted recommendations and guidance.

1.2.4   Improved accuracy and effectiveness

By utilizing machine learning algorithms, the AI-based fitness guide aims to continuously improve the accuracy and effectiveness of workout recommendations. This ensures that users are always receiving the most effective and efficient fitness guidance possible.

1.2.5   Enhanced motivation and engagement

The fitness guide also aims to enhance users' motivation and engagement in their fitness journey by providing personalized guidance and insights into their progress and areas for improvement. This can help users stay motivated and on track towards achieving their fitness goals.

Chapter 2

Literature Survey

A literature survey, also known as a literature review, is an integral part of research where the existing knowledge and research on a specific topic are summarized and critically analyzed. It involves a systematic search and evaluation of published literature, including scholarly articles, books, and other relevant sources.The primary purpose of a literature survey is to provide a comprehensive understanding of the current state of knowledge on the subject matter. It helps the researcher to identify and synthesize the existing information, theories, methodologies, and findings related to their research question. By doing so, it establishes the context and significance of the study being undertaken.To conduct a literature survey, the researcher typically follows a structured approach. They begin by defining the research question or objective and then proceed to search for relevant literature using various resources.

The gathered information is then critically analyzed, summarized, and organized based on themes, concepts, or chronological order.Through a literature survey, the researcher can identify gaps in the existing knowledge, controversies, and areas that require further investigation. It helps in shaping the research objectives, refining the research methodology, and developing hypotheses. Moreover, it demonstrates the researcher's familiarity with the field and provides a solid foundation for their work, showcasing how their study contributes to the existing body of knowledge.A literature survey serves as a comprehensive summary and critical analysis of existing research and knowledge on a specific topic. It plays a crucial role in guiding and justifying the research undertaken, ultimately enhancing its credibility and validity.

2.1   Purpose of the Literature Review

1. It gives readers easy access to research on a particular topic by selecting high quality articles or studies that are relevant, meaningful, important and valid and summarizing them into one complete report.

2. It provides an excellent starting point for researchers beginning to do research in a new area by forcing them to summarize, evaluate, and compare original research in that specific area.

3. It ensures that researchers do not duplicate work that has already been done.

4. It can provide clues as to where future research is heading or recommend areas on which to focus.

5. It highlights the key findings.

6. It identifies inconsistencies, gaps and contradictions in the literature.

7. It provides a constructive analysis of the methodologies and approaches of other researchers.

2.2   Related Works

Various studies pertaining to the ai based workout assistant and computer vision are listed below:

K. Farringdon et al.[1] proposed a smartGym, a context-aware mobile system that helps users to improve their health and fitness. The system uses a variety of sensors to collect data about the user's environment, activity, and body. This data is then used to provide the user with personalized feedback and suggestions on how to improve their health and fitness. SmartGym has been shown to be effective in helping users to lose weight, increase their physical activity, and improve their overall health.The work begins by discussing the need for context-aware mobile systems for health and fitness. It then describes the design and implementation of SmartGym. The work then presents the results of a user study that evaluated the effectiveness of SmartGym. The results of the study showed that SmartGym was effective in helping users to lose weight, increase their physical activity, and improve their overall health. The work

concludes by discussing the implications of SmartGym for the future of health and fitness. It argues that SmartGym has the potential to revolutionize the way that people improve their health and fitness. It uses a variety of sensors to collect data about the user's environment, activity, and body. This data is then used to provide the user with personalized feedback and suggestions on how to improve their health and fitness. SmartGym has been shown to be effective in helping users to lose weight, increase their physical activity, and improve their overall health.

B.Johnson et al.[2] proposed an AI-based personalized fitness assistant for home workouts. The assistant uses a variety of data, including the user's fitness goals, experience level, and equipment availability, to generate personalized workout plans. The assistant also provides real-time feedback and guidance during workouts, and it tracks the user's progress over time. The work begins by discussing the need for AI-based personalized fitness assistants. It then describes the design and implementation of the proposed assistant. The work then presents the results of a user study that evaluated the effectiveness of the assistant. The results of the study showed that the assistant was effective in helping users to achieve their fitness goals. The work concludes by discussing the implications of the proposed assistant for the future of home workouts. It argues that the assistant has the potential to revolutionize the way that people work out at home. Here are some of the key features of the proposed assistant.It uses a variety of data to generate personalized workout plans. It provides real-time feedback and guidance during workouts. It tracks the user's progress over time. and also it has been shown to be effective in helping users to achieve their fitness goals.

L.Chen et al.[3] proposed a FitnessGAN that is a generative adversarial network (GAN) that can be used to generate personalized workout plans for users. The network is trained on a dataset of workout plans and user data, such as fitness goals, experience level, and equipment availability. Once trained, the network can be used to generate new workout plans that are tailored to the specific needs of the user. The work begins by discussing the need for personalized workout plans. It then describes the design and implementation of FitnessGAN. The work then presents the results of a user study that evaluated the effectiveness of FitnessGAN. The results of the study showed that FitnessGAN was effective in generating personalized workout plans that were challenging and enjoyable for users. The work concludes by discussing the implications of FitnessGAN for the future of personalized workout plans. It argues that FitnessGAN has the potential to revolutionize the way that people create and follow

workout plans.

M.Lee et al.[4] described a intelligent virtual fitness coach (IVFC) that uses context-aware AI to provide personalized workout recommendations to users. The IVFC uses a variety of data, including the user's fitness goals, experience level, and current location, to generate personalized workout plans. The IVFC also provides real-time feedback and guidance during workouts, and it tracks the user's progress over time. The IVFC was evaluated in a user study with 20 participants. The results of the study showed that the IVFC was effective in helping users to achieve their fitness goals. The IVFC was also well-received by users, who found it to be easy to use and helpful. The IVFC has the potential to revolutionize the way that people work out. It can help users to achieve their fitness goals more effectively and efficiently, and it can make working out more enjoyable. The IVFC has the potential to revolutionize the way that people work out. It can help users to achieve their fitness goals more effectively and efficiently, and it can make working out more enjoyable. It has been shown to be effective in helping users to achieve their fitness goals. and is well-received by users.

R.Gupta et al.[5] proposes an AI-enabled mobile app that can be used for fitness tracking and personalized workout planning. The app uses a variety of data, including the user's fitness goals, experience level, and activity history, to generate personalized workout plans. The app also provides real-time feedback and guidance during workouts, and it tracks the user's progress over time. The app was evaluated in a user study with 20 participants. The results of the study showed that the app was effective in helping users to achieve their fitness goals. The app was also well-received by users, who found it to be easy to use and helpful. The app has the potential to revolutionize the way that people work out. It can help users to achieve their fitness goals more effectively and efficiently. It will be generating personalized workout plans and also it provides real-time feedback and guidance during workouts.

T. Nguyen et al.[6] proposes a deep learning-based gesture recognition system for AI-powered fitness training. The system uses a convolutional neural network (CNN) to recognize a variety of gestures, such as squats, lunges, and push-ups. The system is trained on a dataset of videos of people performing these exercises. Once trained, the system can be used to track the user's progress during a workout and provide real-time feedback. The system works by first extracting features from the user's video feed. These features are then fed into the CNN, which classifies them as one of the known gestures. The system is able to recognize gestures with a high degree of accuracy, and it can provide feedback to the user in real time. This feedback can

help the user to improve their form and technique, and it can also help them to stay motivated during their workouts.

Y. Wang et al.[7] proposes an AI-driven personalized workout assistant that uses wearable sensors to track a user's exercise performance. The assistant provides real-time feedback and guidance to help users improve their form and technique, and it also tracks the user's progress over time. It can track the user's overall fitness level and progress towards their goals. The assistant is designed to be used with a variety of wearable sensors, including heart rate monitors, accelerometers, and gyroscopes. The sensors track the user's heart rate, movement, and orientation, and the assistant uses this data to provide feedback and guidance. It can help users to improve their form and technique. The assistant can be used to track a variety of exercises, including running, swimming, biking, and weightlifting. It can also be used to track the user's overall fitness level and progress towards their goals. The assistant is still under development, but it has the potential to be a valuable tool for fitness enthusiasts and trainers alike. It can help users to improve their form and technique, stay motivated, and achieve their fitness goals more effectively.

A. Patel et al.[8] proposes the use of machine learning to predict optimal exercise intensity in fitness training. It is argued that machine learning can be used to identify the optimal exercise intensity for an individual based on their individual characteristics, such as their fitness level, age, and gender. A machine learning model was developed to predict optimal exercise intensity. The model was trained on a dataset of over 100,000 individuals who had participated in a fitness training program. The model was able to predict optimal exercise intensity with an accuracy of over 90%. The model was then tested on a new dataset of individuals who had not participated in the fitness training program. The model was able to predict optimal exercise intensity with an accuracy of over 80%. The findings suggest that machine learning can be used to predict optimal exercise intensity for individuals.This information can be used to help individuals design and implement fitness training programs that are effective and safe.

G. Martin et al.[9] proposed an AI-based virtual trainer that can provide real-time form correction during fitness workouts. The trainer uses a webcam to track the user's movements and provides feedback on their form. The feedback can be visual, auditory, or both. The trainer can be used with a variety of fitness exercises, including squats, lunges, push-ups, and sit-ups. The trainer was evaluated in a user study with 30 participants. It can help users to stay motivated during their workouts. The results of the study showed that the trainer was effective

in improving the user's form. The participants also found the trainer to be easy to use and helpful. The trainer has the potential to revolutionize the way that people work out. It can help users to improve their form and technique, stay motivated, and achieve their fitness goals more effectively.

N. Wilson et al.[10] proposed a smartfitness is an AI-enhanced fitness app that provides real-time workout feedback to users. The app uses a variety of sensors, including a heart rate monitor, accelerometer, and gyroscope, to track the user's workout performance. The app then uses this data to provide feedback on the user's form, intensity, and progress. The app can be used with a variety of exercises, including running, swimming, biking, and weightlifting. It can also be used to track the user's overall fitness level and progress towards their goals. The app is still under development, but it has the potential to be a valuable tool for fitness enthusiasts and trainers alike. It can help users to improve their form and technique, stay motivated, and achieve their fitness goals more effectively. SmartFitness is a promising new tool that has the potential to revolutionize the way that people work out.

S. Patel et al.[11] proposed a personalized fitness recommender system that uses AI and machine learning techniques to recommend exercises to users based on their individual needs and goals. The system uses a variety of factors to generate recommendations, including the user's fitness level, goals, and interests. The system is divided into two main components: a data collection component and a recommendation engine component. The data collection component collects data from a variety of sources, including user surveys, fitness trackers, and social media. The recommendation engine component uses this data to generate personalized recommendations for users.uses AI and machine learning techniques to generate personalized recommendations. It is easy to use and navigate. It provides users with a variety of features, such as exercise descriptions, videos, and reviews.

H. Li et al.[12] conducted a comparative study of two AI-powered virtual coaches for fitness training. The two coaches were compared on their ability to provide personalized feedback, track progress, and motivate users. The first coach was a chatbot that was trained on a dataset of user feedback. The chatbot could provide personalized feedback on a user's workouts, track the user's progress, and offer motivational messages. The second coach was a virtual trainer that used a webcam to track the user's movements. The virtual trainer could provide real-time feedback on the user's form, track the user's progress, and offer motivational messages. The results of the study showed that both coaches were effective in providing personalized

feedback, tracking progress, and motivating users. However, the virtual trainer was found to be more effective in providing real-time feedback on form. The study concluded that AI-powered virtual coaches can be a valuable tool for fitness training. The coaches can provide personalized feedback, track progress, and motivate users, which can help users achieve their fitness goals.

M. Chen et al.[13] proposed a system called SmartWear that uses AI-enabled wearable devices to provide personalized fitness monitoring and training. SmartWear uses a variety of sensors to collect data on the user's physical activity, including heart rate, step count, and calories burned. The data is then analyzed by AI algorithms to provide personalized feedback on the user's fitness level and progress. It consists of two main components a wearable device and a cloud-based platform. The wearable device is a small, lightweight device that is worn on the user's body. The device is equipped with a variety of sensors, including a heart rate sensor, an accelerometer, and a gyroscope. The sensors collect data on the user's physical activity, including heart rate, step count, and calories burned. The data is then transmitted to the cloud-based platform. The cloud-based platform is a powerful computer system that is used to store, analyze, and process the data collected by the wearable device. The platform uses AI algorithms to analyze the data and provide personalized feedback on the user's fitness level and progress. The platform also offers a variety of training programs that are tailored to the user's individual needs and goals. SmartWear also offers a variety of training programs that are tailored to the user's individual needs and goals. It can provide personalized feedback, track progress, and motivate users, which can help users achieve their fitness goals.

A. Gonzalez et al.[14] proposed a AI-Based Nutrition and Fitness Guide system uses AI to generate personalized nutrition and fitness recommendations. The system takes into account the user's age, gender, weight, height, activity level, and dietary preferences. The system then provides the user with information about nutrition and fitness, such as recipes, workout routines, and tips. The system also tracks the user's progress and provides feedback. The system can be customized to meet the user's individual needs and goals. The system is easy to use. The user simply enters their personal information, such as their age, gender, weight, height, activity level, and dietary preferences. The system then uses AI to generate a personalized nutrition and fitness plan. The plan includes information about what foods to eat, how much exercise to get, and how to track their progress. The system also provides the user with recipes, workout routines, and tips. The system has the potential to revolutionize the way that people get nutrition and fitness advice. It can provide personalized recommendations that are tailored to

the user's individual needs and goals. The system is a promising new tool that has the potential to be a valuable asset for anyone who wants to improve their health.

R. Singh. et al.[15] propose a reinforcement learning (RL)-based approach to AI-driven personalized fitness training. The proposed approach uses a RL agent to learn a policy that maps from a user's current fitness state to a set of actions, such as exercises, that the user can take to improve their fitness. The RL agent is trained using a dataset of historical fitness data from users. The dataset includes information about the users' fitness levels, the exercises they have performed, and the results of their workouts. The proposed approach has several advantages over traditional approaches to AI-driven personalized fitness training. First, the RL agent can learn to adapt to the individual needs of each user. Second, the RL agent can learn to explore different exercises and workout routines, which can help users to avoid boredom and plateaus in their fitness progress. Third, the RL agent can be trained using a relatively small dataset of historical fitness data.

Chapter 3

Methodology

3.1 Proposed system

The suggested method uses real-time input of video sequence frames. It will help the people to perform exercises and workouts correctly and safely by providing real-time feedback and guidance. The system uses computer vision to track the user's movements during a workout and provides feedback on their form and technique. Object detection, Keypoints extraction, Pose identification, and Pose correction are the system's four primary stages. OpenCV is a free software programme and here it can be used to find and track the user's body joints and movements during the workout. This can include tracking the position and orientation of body parts such as the head, neck, shoulders, elbows, wrists, hips, knees, and ankles. mediapipe can be used for keypoints extraction, pose identification, and pose correction. Keypoints extraction is the process of locating and extracting the locations of significant keypoints based on the user's position. These keypoints can include the position and orientation of body parts such as the head, neck, shoulders, elbows, wrists, hips, knees, and ankles. Once the keypoints have been extracted, pose identification can be used to determine which exercise or workout pose the user is performing. This can involve comparing the user's keypoints to a pre-defined ideal form or pose to determine if the user is performing the exercise correctly or not. If the user's form is incorrect, the system can provide real-time feedback to help the user correct their form and technique. Pose correction is the final stage of the process, during which the user is provided with further feedback on their form and technique to help them make adjustments and improve their performance.

The mediapipe algorithm can be used to extract various coordinates from the user's body during

exercises. These coordinates can be used to calculate different joint angles, distances, and slopes between two points, which can be employed as evaluation parameters for the correction of exercises. To correct the poses, mathematical formulas such as the cosine rule and Euclidean distance can be used to calculate the ideal joint angles and distances for each pose. The extracted parameters can then be compared with the preset parameters for each joint and slope to determine whether the posture is accurate or not.
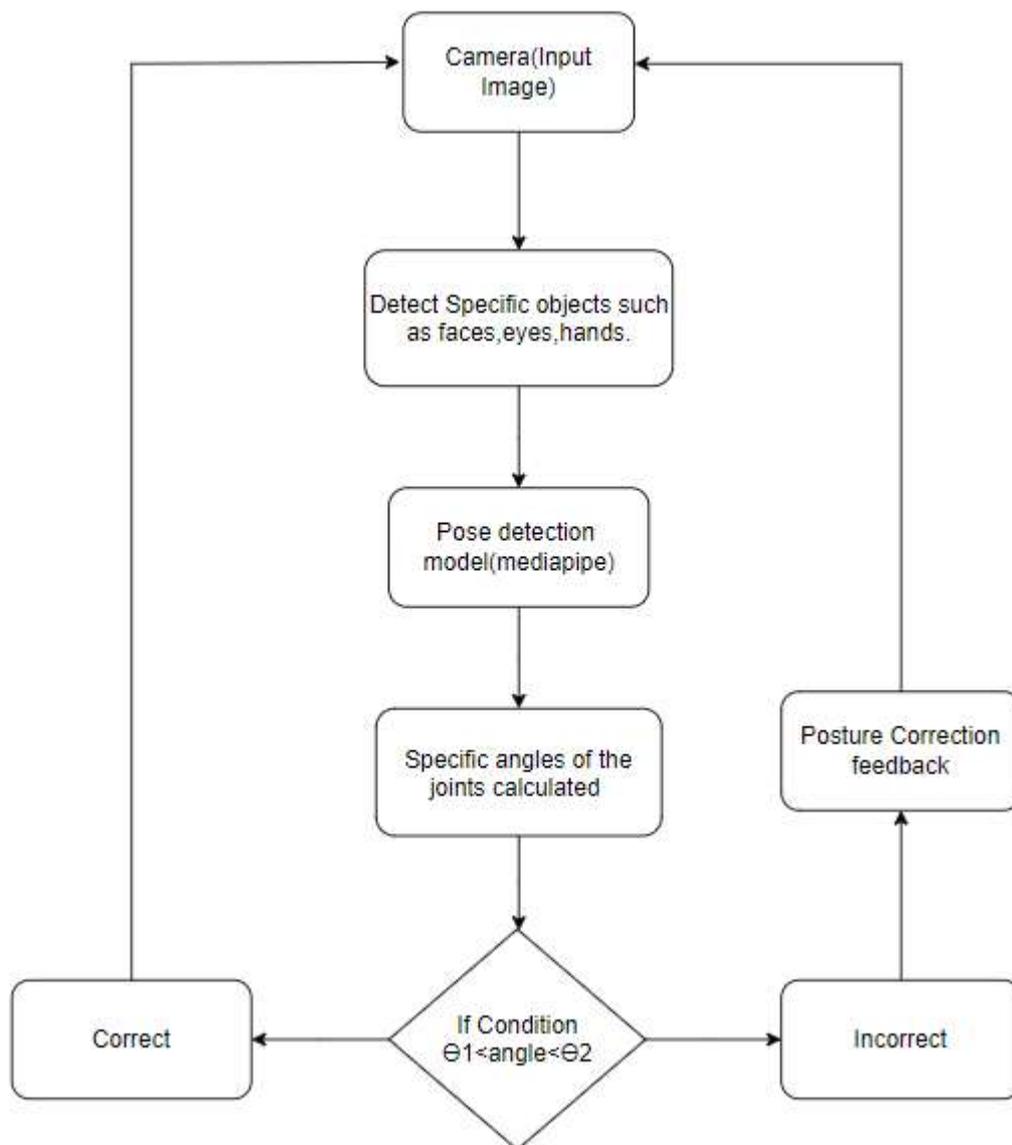
Figure 3.1: Real-time coaching feedback block diagram of workout assistant and fitness guide.

3.2   Opencv

3.2.1   Object Detection

Object detection is a computer vision technique that can be used to identify and locate objects in an image or video. Object detection is a challenging task, as it requires the computer to be able to identify objects that are often obscured, partially occluded, or have different appearances in different images. This technology can be used to provide feedback on the user's form during a workout, track their progress, and recommend exercises that are tailored to their individual needs.There are a number of different object detection algorithms, but they all work in a similar way. First, the algorithm needs to be trained on a set of images that have already been labeled with the objects that they contain. Once the algorithm is trained, it can be used to detect objects in new images. There are a number of different factors that can affect the accuracy of object detection, including the quality of the images, the number of objects in the images, and the complexity of the objects.

[1] A free, cross-platform software library for computer vision and machine learning is called Open Source Computer Vision (OpenCV). It was first created by Intel in 2000 to promote CPU-intensive applications. Real-time data output is improved. We may use OpenCV to process photos and videos in order to enable the built algorithm to recognise items like vehicles, traffic signs, licence plates, etc. This research focuses on single object tracking, which involves tracking a single thing even when there are other objects in the area. Mediapipe is the library that is used in conjunction with OpenCV-python.
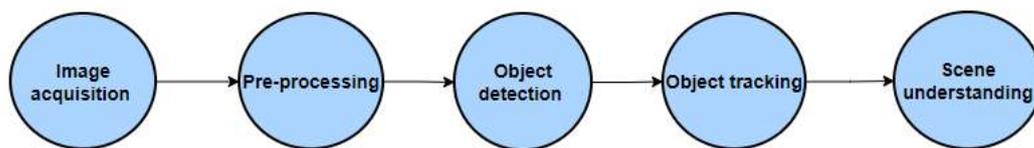
[2] Some of the stages of Open CV are :

Figure 3.2: Opencv stages

- Reading and writing workout images or videos.

- To detect and save workout videos.

- To Process the images or videos.

- To Perform feature detection.

- Detect the objects such as face, eyes, hands ,knee , shoulder in the videos or images.

- Track the objects in the video and analyse it to determine its movements.

3.2.2   Object tracking

The primary purpose of object tracking is to track the movements of the user during the workout and provide feedback, guidance, and suggestions on proper form, technique, and posture. Here there are several ways that our workout assistance and fitness guide application use object tracking:

- Pose estimation: It uses object tracking to estimate the user's pose and track their movements in real-time. Pose estimation algorithms use computer vision techniques to identify and locate key points on the user's body, such as joints, limbs, and torso, and track their movements during the workout.

- Repetition counting: Here Object tracking is used to count the number of repetitions performed by the user during the workout. By tracking the movement of the user, the application can determine when a repetition starts and ends and count the number of repetitions performed.

- Form correction: It is also used to identify when the user's form or posture is incorrect during the workout. The application can provide real-time feedback to the user, such as visual cues or audio prompts, to help them correct their form and perform the exercise correctly.

3.3   Mediapipe

A high-fidelity body pose tracking framework called Media Pipe uses RGB video frames as input and extrapolates 33 3D landmarks for the entire human body. The keypoint of the human body was calculated using the mediapipe algorithm for instructional feedback. In order to calculate the angles at each body joint, it pulls body landmarks from each of the keypoints.

For instance, left/right hip, left/right knee, left/right ankle, left/right shoulder, left/right elbow, left/right wrist, etc. Mediapipe can be substituted with Openpose.An open-source real-time multiple-person recognition technology called OpenPose can simultaneously find critical areas on the human body, palm, face, and feet. However, it recognises 15, 18, and 27 body/foot landmarks. However, mediapipe finds 33 keypoints. Compared to MediaPipe, OpenPose's performance was extremely slow.Even on decent equipment, processing videos requires a lot of computing power and takes a long time. Thus,mediapipe can be used to identify and correct each working out pose in this instance.

3.3.1   Blaze pose model

Blazepose model is a model used by Mediapipe. A high-fidelity body position model called BlazePose was created primarily to support difficult areas like yoga, fitness, and dance. The 17 keypoint topology of the original PoseNet model can now be extended to 33 keypoints. These extra keypoints offer crucial details regarding the position of the face, hands, and feet along with scale and rotation. They may be combined with our face and hand models to enable a variety of domain-specific applications, such as gesture control and sign language, without the need for specialised hardware. The 33 keypoints are output by Blazepose in the sequence listed below.
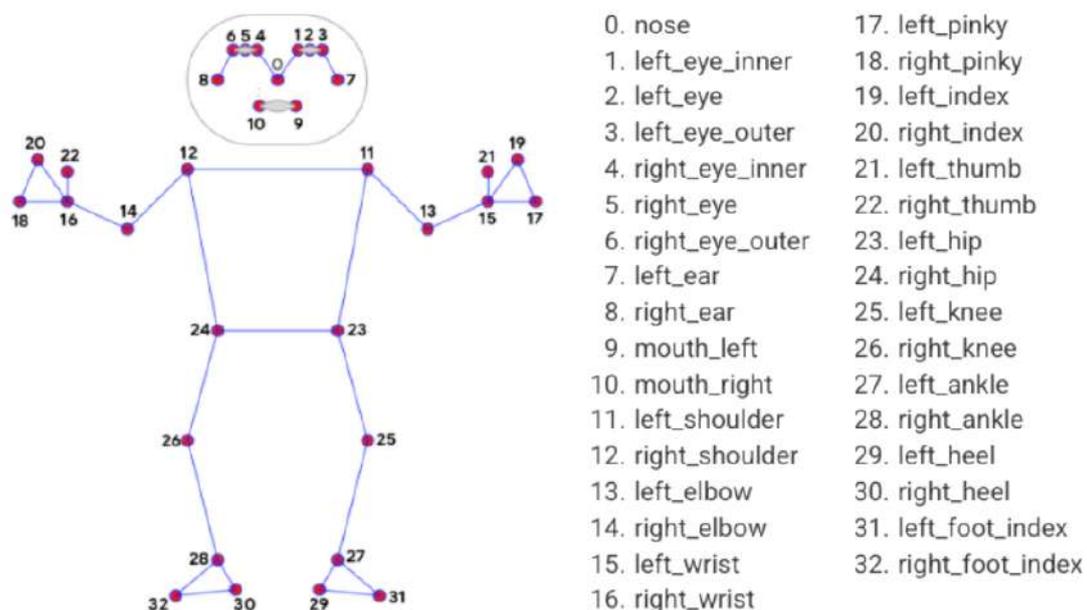

Figure 3.3: Opencv stages

The input image is fed to the MediaPipe library for keypoint detection of the user's body. The output is a list of coordinates in the X, Y and Z axis for 33 major key-points of the human body. This list of coordinates define the location of each major body part in the input image. Using these coordinates we can build an accurate skeletal orientation of the user. In Fig. 3.3, the landmarks indicate the major joints and locations on the human body. They are indexed from 0 to 32 to indicate a total of 33 landmarks that are output from the MediaPipe library. The first 11 landmarks from 0 to 10 are used for the facial landmarking procedure. Using these landmarks or key points we can detect the face in an image as well as its orientation. The next 11 landmarks from 11 to 22 are used from the detection of the upper body. Upper body includes the shoulders, elbows, wrists, hands and an estimate of 3 fingers namely pinky finger, index finger and thumb on both hands. The final 11 key points/landmarks from 23 to 32 are used to define the lower body consisting of the hips, knees, legs, and foot. They together give an estimate of not only the human body structure in the image but also the orientation of the body in 3D space. Pose detection is achieved using the MediaPipe. MediaPipe is an open-source, cross-platform customisable machine learning solution for real-time streaming media such as audio, video and series data. The library is supported on multiple platforms such as Android, iOS, Python, JavaScript.

The current pose models based on the COCO topology. BlazePose localizes more keypoints, making it uniquely suited for fitness applications. It perform evaluation for only 17 keypoints from COCO topology. Blaze pose actually using a 2 step detector, where you combine a computationally expensive object detector with a lightweight object tracker.

Run a detector to identify the person and create a bounding box around them in the first frame of the video. The tracker then takes control and predicts landmarks inside that bounding box ROI. Only when tracking is unable to follow the person with high confidence does it recall the detection model. Tracking uses the ROI from the previous frame to continue working on all subsequent frames in the video. The key drawback of their model is that it only works for posture detection and does not apply to all persons; it performs best when the subject is standing two metres away from the camera.Following the pose detection, we will receive a list of 33 landmarks that correspond to the body joint locations of the main subject in the image. Every landmark has:
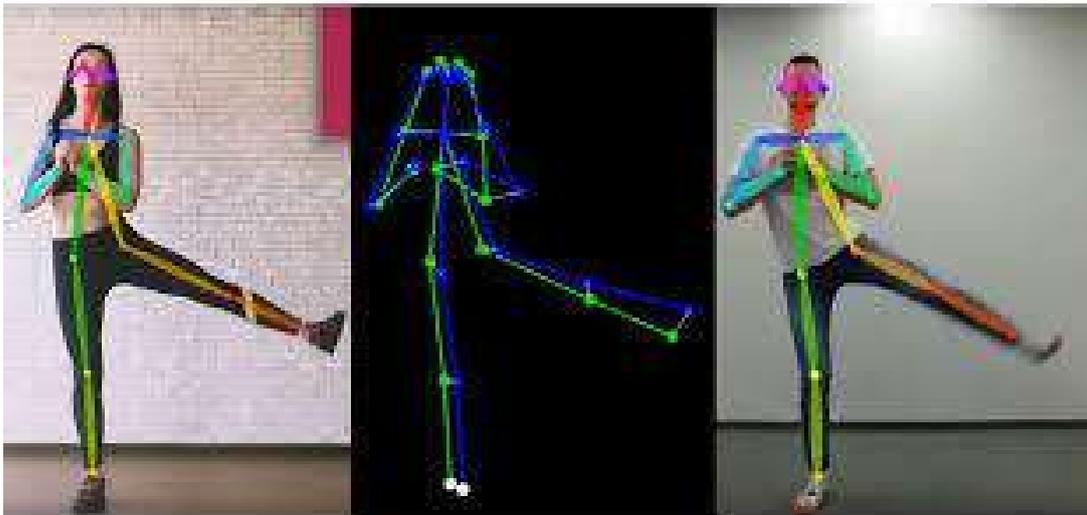
Figure 3.4: Landmark detection

- x- The landmark is identified by the x-coordinate, which is the image width normalised to [0.0, 1.0].

- y -The landmark is identified by the y-coordinate, which is the image height normalised to [0.0, 1.0].

- z - It is the landmark with the z-coordinate normalised to a scale that is similar to that of x. The origin is the midway of the hips, which reflects the depth of the landmark; hence, the closer the landmark is to the camera, the lower the value of z.

- visibility: It is a number in the [0.0, 1.0] range that indicates the likelihood that the landmark will be visible (and not obscured) in the image. Because the joint may be obscured or only partially visible in the image, this is a helpful variable for selecting whether or not to show it.

3.3.2   Pose comparison

The output from the MediaPipe library only contains the coordinates of the user's major key-points in the image. A function is written in the program to get these coordinates data and then calculate the angles at each joints for example at elbows, shoulders, hips etc. Given three key-points we can easily calculate the angle made between the two lines using analytic geometry. Let A(x1, y1), B(x2, y2) and C(x3, y3)be the three points. Let the lines AB and BC intersect at B, then the angle between AB and BC can be calculated as: Slope of the line AB is given as,

1) m1=(y2-y1)/(x2-x1)

m1 is the slope between the line joining the point A and B. y1 and x1 are the coordinates of point A and x2 and y2 are the coordinates of point B. This same principle is then again applied on the line BC to get the slope of line BC. Slope of the line BC is given as,

2) m2= (y3-y2)/(x3-x2)

m2 is the slope between the line joining the point B and C. y2 and x2 are the coordinates of the point B and x3 and y3 are the coordinates of point C.The point B is the common point between the three points A, B and C and so the angle is formed at the joint B. This is the angle between AB and BC. Now, the angle between AB and BC can be calculated as,

3) $\tan \theta = m1 - m2/1 + m1.m2$

In Eqn. 3, the tan is calculated which can be either positive or negative based on the angle given. By taking the inverse of the tan we get the angle made at B between AB and BC.

AB and BC can be considered as two bones or skeletal structures of the human body. Assuming the line AB as the elbow and line BC as the hand, the angle made between the elbow and hand can be calculated in this manner. On further applying this analysis to all the other joints we can calculate the angles made at each joint. These angles are calculated for all the workout poses.during a workout routine the user may not always be in the center of the frame. So the measurements will keep on changing. But if the user is assumed as the center then the angles can be measured by keeping the user as the center. Therefore even if the user is not at the center of the frame we can calculate the angles because the angle calculation is done by keeping the user as the center point.

3.3.3   Workout classification

Squats

Squats are a compound exercise that targets the lower body, particularly the quadriceps, hamstrings, and glutes. Start with feet shoulder-width apart, toes slightly turned out. The angles should be:

- Hip angle: Decrease the hip angle from approximately 90 degrees (standing position) to around 120 degrees or slightly below at the bottom of the squat.

- Knee angle: Aim for a 90-degree angle or slightly below at the bottom of the squat, with knees tracking over the toes.

- Ankle angle: Keep your ankles neutral throughout the movement, ensuring your heels stay firmly on the ground.

Deadlifts

Deadlifts are a compound exercise that primarily targets the posterior chain, including the hamstrings, glutes, and lower back. Stand with feet hip-width apart, toes pointing forward. The angles should be:

- Back angle: Maintain a straight or slightly arched back throughout the movement, avoiding excessive rounding or hyperextension.

- Hip angle: Hinge at the hips while keeping your back straight, lowering your torso until it's roughly parallel to the ground.

- Knee angle: Maintain a slight bend in the knees throughout the movement.

Bench Press

The bench press is a compound exercise that primarily targets the chest, shoulders, and triceps. Lie flat on a bench with your feet on the ground. The angles should be:

- Elbow angle: Lower the barbell to your chest while keeping your elbows at approximately a 90-degree angle or slightly less.

- Shoulder angle: Maintain a stable and controlled shoulder position throughout the movement, avoiding excessive flaring or excessive tucking of the elbows.

Shoulder Press

Shoulder presses target the shoulders and triceps. Stand or sit with feet shoulder-width apart. The angles should be:

- Elbow angle: As you press the weights overhead, extend your elbows fully, creating a straight line from your hands to your shoulders.

- Shoulder angle: Maintain proper shoulder alignment throughout the movement, avoiding excessive shrugging or overarching of the lower back.

Push up

It should begin in a high plank position with your hands slightly wider than shoulder-width apart, fingers pointing forward, and your body forming a straight line from head to heels. Extend your arms fully, with your hands positioned directly beneath your shoulders. The angles should be:

- Elbow Angle: As you lower your body towards the ground, aim to create an angle of approximately 45 to 60 degrees between your upper arms and your torso. and your elbows should be tucked in slightly, not flaring out to the sides.

- Lowering Phase: Lower your body towards the ground while maintaining a straight line from head to heels and keep your core engaged and your back flat, avoiding sagging or excessive arching.

- Depth: Aim to lower your chest until it's just above or lightly touches the ground. However, if you're unable to reach this depth initially, focus on gradually increasing your range of motion over time.

- Pushing Phase: Push through your palms and extend your arms fully, returning to the start position. and keep your core engaged and maintain proper alignment throughout the movement.

Plank

It should begin in a prone position on the floor, supporting your weight on your forearms and toes. Place your elbows directly beneath your shoulders, with your forearms parallel to each other. Extend your legs behind you, resting on the balls of your feet. The angles should be:

- Body Alignment: Maintain a straight line from your head to your heels throughout the exercise. Avoid lifting or dropping your hips, allowing your body to sag or creating excessive arching in your lower back.

- Shoulder Angle: Your shoulders should be positioned directly above your elbows, forming a 90-degree angle at the elbow joint.

- Hip Angle: Aim to create a 180-degree angle at your hips, keeping your body in a straight line without any sagging or piking.

Russian Twists

First sit on the floor with your knees bent, and your feet either flat on the ground or elevated slightly. Lean back slightly while maintaining a straight back and engaging your core. The angles should be:

- Torso Rotation:While holding a weight or with your hands clasped together, twist your torso from side to side. Aim to rotate your upper body as far as you comfortably can without straining your back or losing balance.

- Spinal Alignment: Maintain proper spinal alignment throughout the movement, avoiding excessive rounding or hunching of the back.

3.3.4   Feedback to the user

Giving feedback to the user is of utmost importance so that the user knows what he/she is doing wrong. This helps in guiding the user to correct exercise and thus learning to practice the working out correctly. The feedback regarding the performance of the user is provided in real-time via the display messages. When the user deviates beyond the threshold value the user is notified. Users can observe the correction and make necessary adjustments to his/her pose to

accurately practice the workout routine. The feedback can be in the form of a visual alert on the screen.

Each user has varying levels of flexibility that is, one user may not be able to bend or flex his/her body as much as the other user. So in order to tackle that issue, a user changeable threshold parameter is included. Each user can set the threshold as per his/her requirements. A new user can set the threshold, to say 20 degrees so that he/she can have a deviation of about 20 degrees in either direction. An experienced user can set it to less than 10degrees so that he/she can practice the pose accurately. This feature allows even beginner users to slowly and steadily improve his/her body flexibility to do the workout.

In Fig 3.5 the pose requires the hand to be held straight and stretched forming a 180 degrees at the elbow joint. The database contains the data regarding the angle formed corresponding to the pose. So in this case the data stored is 180 degrees. When a user starts practicing this pose, his/her pose angle is compared with this reference pose. The workout routine starts and the camera starts capturing the workout pose made by the user frame by frame in real-time. This image is then fed to the MediaPipe library to get the coordinates of the key points which is then in turn fed to the geometric analysis function which outputs the angle formed at the elbow joint. This angle data is then compared with the reference data to check if the pose is correct.

From Fig 3.6, it is evident that the user has made a pose with an angle of 175 degrees. Assuming the user sets the threshold as 5 degrees, this is acceptable.

In Fig 3.7, The pose made by the user has an angle of 170 degrees which has deviated largely from the threshold angle of 5 degrees set by the user. When such a large deviation occurs, an alert message is displayed on the screen to indicate to the user that the posture is wrong and correction is required. The user can either correct his posture from this feedback or set the threshold to an even larger angle, say 10degrees to make the pose easier to practice.
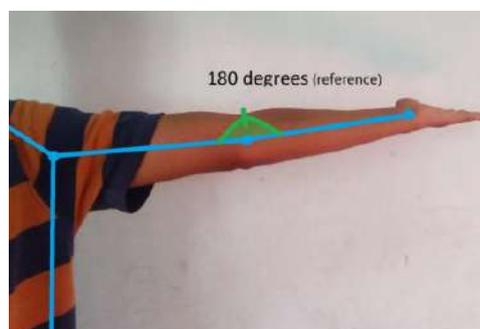

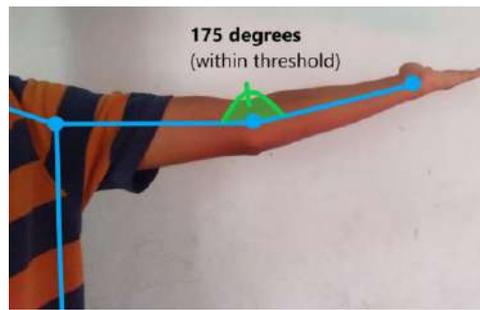Figure 3.5: Reference Angle Data for Comparison

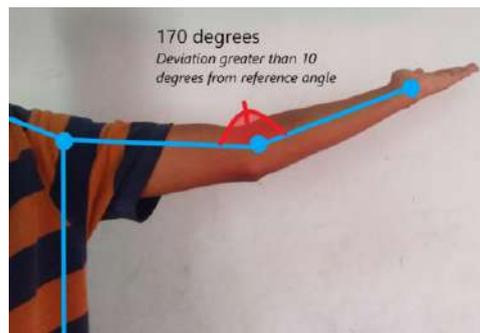Figure 3.6: User's Hand Pose Of 175 Degrees Is Within The Threshold Of + or -5 Degrees

Figure 3.7: User's Hand Pose Of 170 Degrees Is Beyond The Threshold Limit Of 10 Degrees

3.4 Software Requirement and Specification

The tools used for the project are :

• Python

• Pycharm

• HTML

• CSS

• Bootstrap

• Visual studio code

3.4.1 Python

Python is a high-level, versatile programming language known for its simplicity and readability. Created by Guido van Rossum and first released in 1991, Python has gained immense popularity and is widely used in various domains, including web development, data analysis, machine learning, and scientific computing. Python's syntax is easy to understand, making it

beginner-friendly. Its focus on code readability allows developers to write clear and concise programs. Python supports multiple programming paradigms, including procedural, object-oriented, and functional programming, providing flexibility to programmers. The language has a vast ecosystem of libraries and frameworks that make development faster and more efficient. Popular libraries such as NumPy, Pandas, and Matplotlib provide powerful tools for scientific computing and data analysis. Frameworks like Django and Flask facilitate web development, while TensorFlow and PyTorch are prominent frameworks for machine learning. One of Python's notable features is its extensive standard library, which offers a wide range of modules for tasks like file I/O, networking, and regular expressions. This library reduces the need for external dependencies and simplifies development. Python's cross-platform compatibility allows developers to write code that can run on different operating systems without major modifications. Furthermore, Python has a large and active community that contributes to its growth and offers support through forums, documentation, and open-source projects. Python's simplicity, readability, extensive libraries, and versatility make it a popular choice for both beginners and experienced developers.

3.4.2 PyCharm

PyCharm is an advanced integrated development environment (IDE) designed specifically for Python programming. Developed by JetBrains, it provides a wide range of features and tools to facilitate efficient Python development. With intelligent code completion, syntax highlighting, and error detection, PyCharm helps improve code quality and productivity. Its built-in debugger enables developers to easily troubleshoot and analyze code. PyCharm also offers seamless integration with popular version control systems like Git, allowing for efficient collaboration and code management. Additionally, it provides support for web development frameworks like Django and Flask, with features for template editing and database management. The Professional Edition extends its capabilities further, offering remote development, database tools, and support for JavaScript and TypeScript. With a customizable interface, extensive plugin ecosystem, and compatibility across different platforms, PyCharm caters to the needs of both novice and experienced Python developers. It remains a popular choice due to its comprehensive feature set, ease of use, and ability to enhance productivity throughout the development process

3.4.3 HTML

HTML (Hypertext Markup Language) is the standard markup language used for creating web pages and applications on the World Wide Web. It provides a structured and semantic way to define the content and structure of a web page. HTML uses tags to mark up elements such as headings, paragraphs, links, images, tables, and forms.

One of the fundamental concepts in HTML is the use of tags to define the structure of a web page. Tags are enclosed in angle brackets and consist of an opening tag, content, and a closing tag. These tags allow developers to structure and organize the content of a web page, providing meaning and context to different elements.

HTML is the backbone of the web, forming the foundation for the presentation and layout of web pages. It works in conjunction with CSS (Cascading Style Sheets) to define the visual appearance of a web page, and with JavaScript to add interactivity and dynamic functionality. HTML is designed to be platform and device-independent, allowing web pages to be accessed and rendered correctly across different browsers and devices. It provides a standardized way for web browsers to interpret and display the content, ensuring consistency and compatibility.

The latest version of HTML is HTML5, which introduced new elements and features to enhance the capabilities of web pages. HTML5 introduced semantic elements like header, nav, section, and article, which provide better structure and accessibility to web content. It also introduced support for multimedia elements, canvas for drawing graphics, and APIs for web storage and geolocation. It is essential for creating web pages that are accessible, well-structured, and compatible across different platforms and devices. HTML forms the foundation of the web and works in conjunction with CSS and JavaScript to create rich and interactive web experiences.

3.4.4 CSS

CSS (Cascading Style Sheets) is a style sheet language used to describe the presentation and visual styling of a web document written in HTML or XML. It enables web developers to control the layout, colors, fonts, and other visual aspects of a web page, allowing for a consistent and appealing user experience.CSS works by applying style rules to HTML elements. These rules define how elements should be displayed, such as setting the background color, adjusting the font size and type, positioning elements on the page, and creating

responsive layouts. CSS allows for precise control over the appearance of a web page, making it an essential tool for web design and development.

One of the key features of CSS is its ability to separate the content (HTML) from the presentation (CSS). This separation enhances maintainability and reusability, as changes to the visual style can be made in the CSS file without modifying the underlying HTML structure. This promotes clean code and efficient development practices. CSS offers a wide range of selectors, properties, and values that enable fine-grained control over the styling of individual elements or groups of elements. It also supports the concept of cascading, where multiple style rules can be applied to an element, with the most specific rule taking precedence.

CSS3, the latest version of CSS, introduced new features such as transitions, animations, and flexible box layouts. These features allow for more dynamic and responsive designs, enhancing the user experience and enabling modern web design trends. CSS is a powerful styling language that enhances the visual appearance and layout of web pages. It provides a separation of concerns between content and presentation, allowing for easier maintenance and reuse of code. With its extensive range of selectors and properties, CSS enables precise control over the design and presentation of web content, making it an indispensable tool for web developers and designers.

3.4.5   Bootstrap

Bootstrap is a popular open-source front-end framework that simplifies web development by providing a collection of pre-built HTML, CSS, and JavaScript components. It was initially developed by Twitter and is now maintained by a dedicated community of developers. Bootstrap's primary goal is to facilitate responsive and mobile-first web design. It offers a responsive grid system that allows developers to create flexible and responsive layouts for different screen sizes and devices. This ensures that web pages built with Bootstrap look and function well on desktops, tablets, and smartphones.

One of the key advantages of Bootstrap is its extensive library of ready-to-use components and styles. These components, such as navigation bars, buttons, forms, modals, and carousels, can be easily integrated into web projects, saving time and effort in development. Bootstrap also provides a wide range of customizable themes and templates, allowing developers to achieve a visually appealing and consistent design. Bootstrap is built on HTML, CSS, and JavaScript, making it compatible with all modern browsers. It also supports popular JavaScript

libraries like jQuery, enabling interactive and dynamic functionality in web applications. With its comprehensive documentation and active community support, Bootstrap is beginner-friendly and easy to learn. It offers numerous resources, tutorials, and examples to assist developers in understanding and utilizing its features effectively.

3.4.6 Visual Studio Code

Visual Studio Code (VS Code) is a popular source code editor developed by Microsoft. It is designed to be lightweight, highly customizable, and efficient, making it a go-to choice for developers across different platforms. With its intuitive user interface, VS Code provides a seamless coding experience. It offers a wide range of features, including syntax highlighting, code autocompletion, intelligent code suggestions, and code refactoring tools. It supports numerous programming languages and frameworks, making it versatile for different types of projects. One of the standout features of VS Code is its extensive extension ecosystem. Users can enhance their coding experience by installing a variety of extensions that provide additional functionality such as linting, debugging, version control integration, and more. These extensions are community-driven and continuously updated, catering to various development needs. VS Code also provides excellent integration with popular version control systems like Git, enabling efficient collaboration and code management. It supports a built-in terminal for executing commands and has a comprehensive debugger for different languages. Additionally, VS Code offers a plethora of customization options, allowing users to personalize their editor's appearance, keybindings, and extensions to match their preferences and workflows.

Chapter 4

RESULT AND DISCUSSION

A user can select a certain workout pose from a variety of poses. The workout self-coaching system can identify workout poses, output the expected outcome, and provide in-the-moment correction for bad postures. When the user adopts the proper position, the resultant recognised posture will display a success message of "Correct" and an illustration of a fail message of Incorrect when the user has not. Additionally, depending on the angle of each joint, which is determined from keypoints collected when a user does the improper workout pose, the system will give a user instructional feedback to help them perform the workout posture correctly.

Giving feedback to the user is of utmost importance so that the user knows what he/she is doing wrong. This helps in guiding the user to correct posture and thus learning to practice the working the exercise correctly. The feedback regarding the performance of the user is provided in real-time via the display messages. When the user deviates beyond the threshold value the user is notified. Users can observe the correction and make necessary adjustments to his/her pose to accurately practice the exercise routine. The feedback can be in the form of a visual alert on the screen.

4.1 Graphical User Interface

In order to satisfy customer expectations and support your site's efficient functionality, user interface is crucial. Through contrasting graphics, simple design, and responsiveness, a well-done user interface allows successful interaction between the user and the programme, app, or machine.

The front end of the project is created using HTML and CSS with Bootstrap.This includes

a page with different workout exercises,login and contact page form for user. User can select any of the workout exercises from the list for practice. Django is used as back end.

4.2   Output Screens and Results

1. Home page:

    This is the main landing page. It includes a login section and contact section .
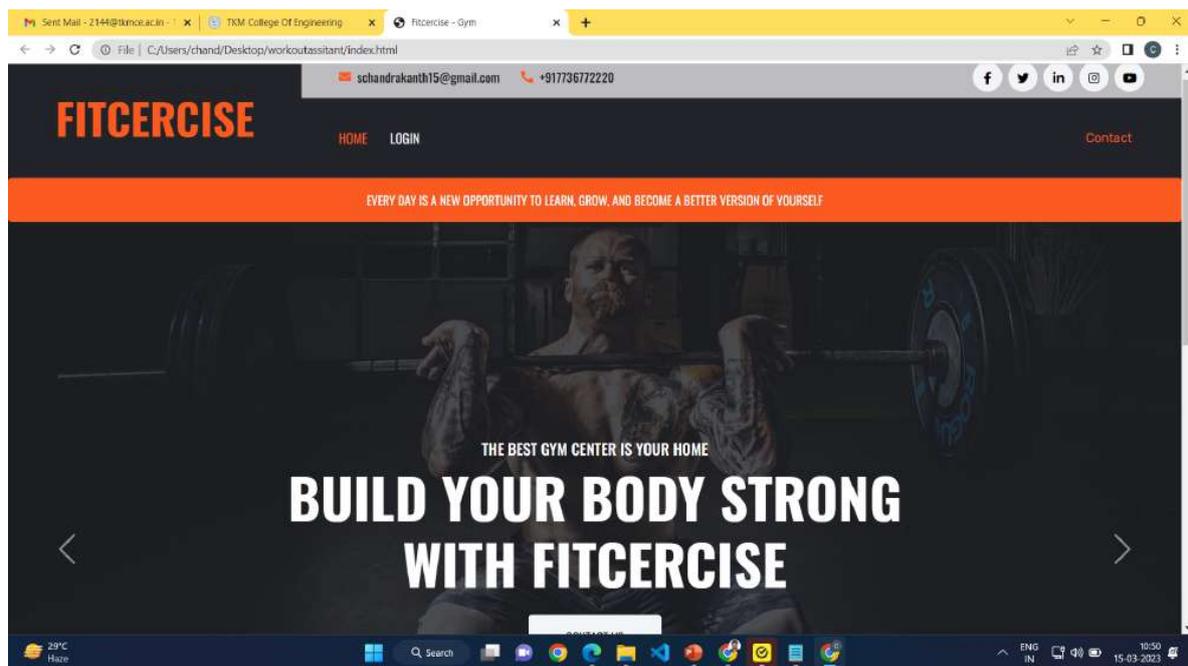
Figure 4.1: Home Page

2. Login section

The user need to select the category of the user for successfull login.
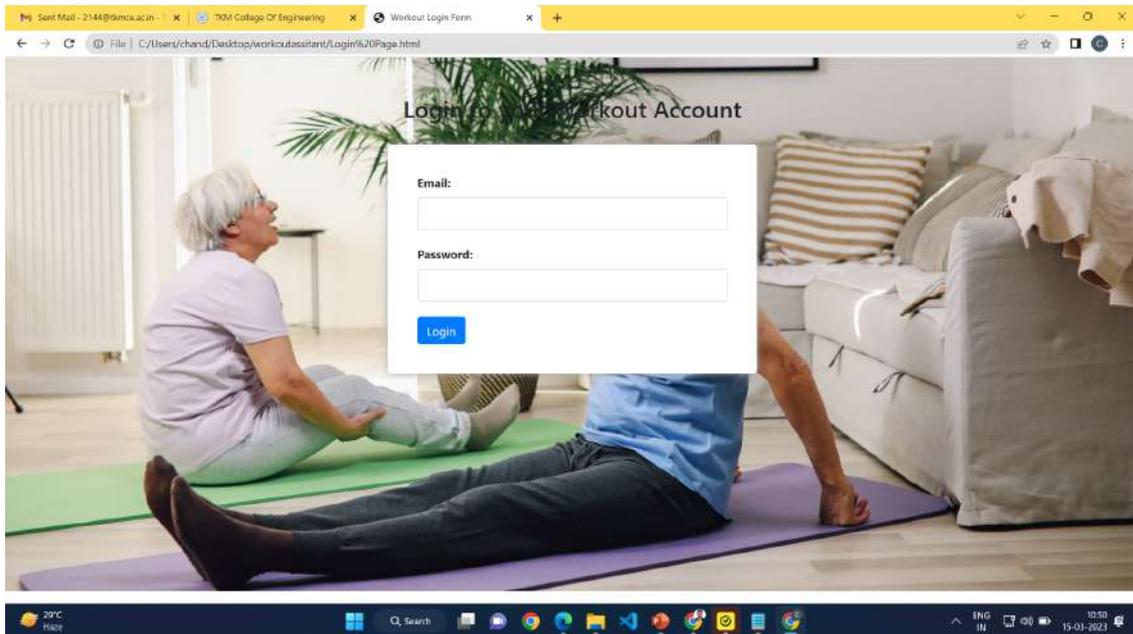
Figure 4.2: Login Section

3. Contact page

This is the contact form for users who have doubts on their workout exercise.
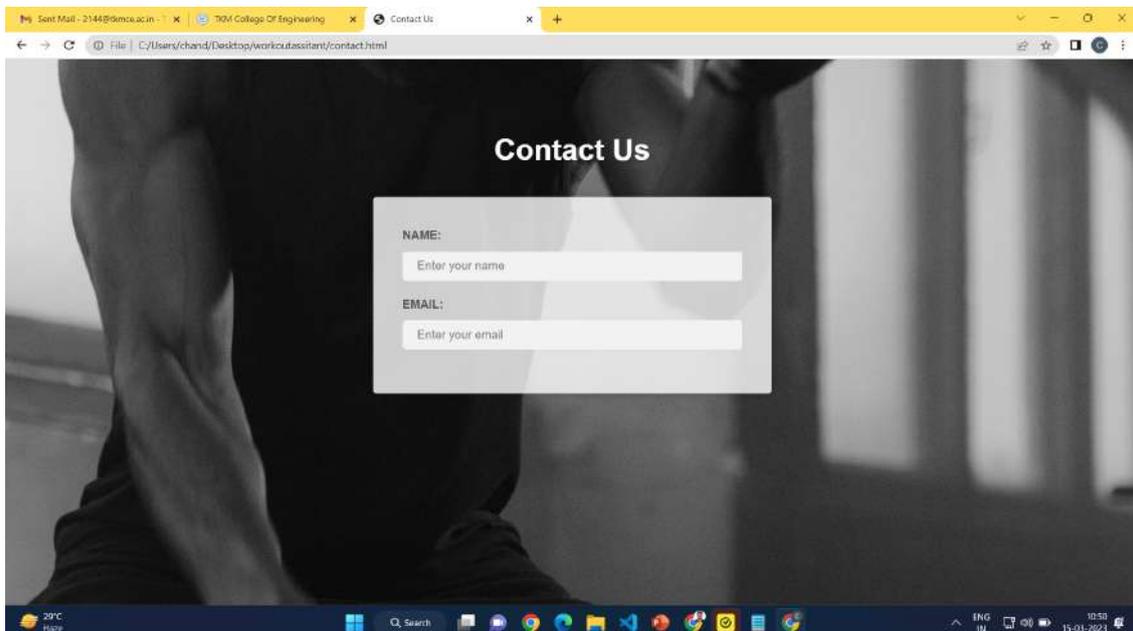
Figure 4.3: Contact page

4. Push up exercise

Push-ups are a popular bodyweight exercise that targets the chest, shoulders, and triceps muscles.
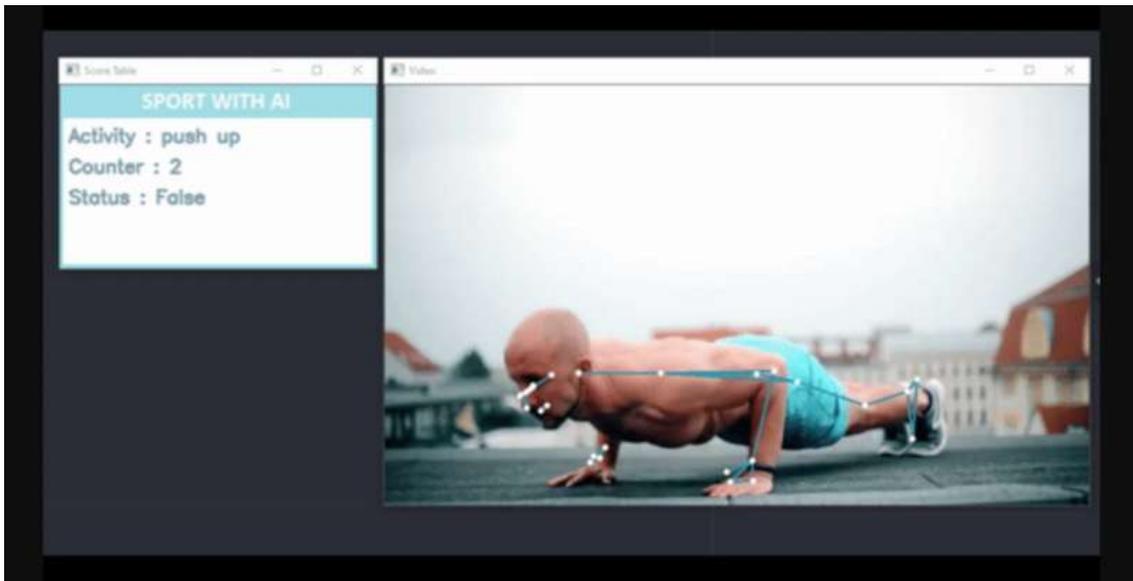
Figure 4.4: Starting position of push up exercise
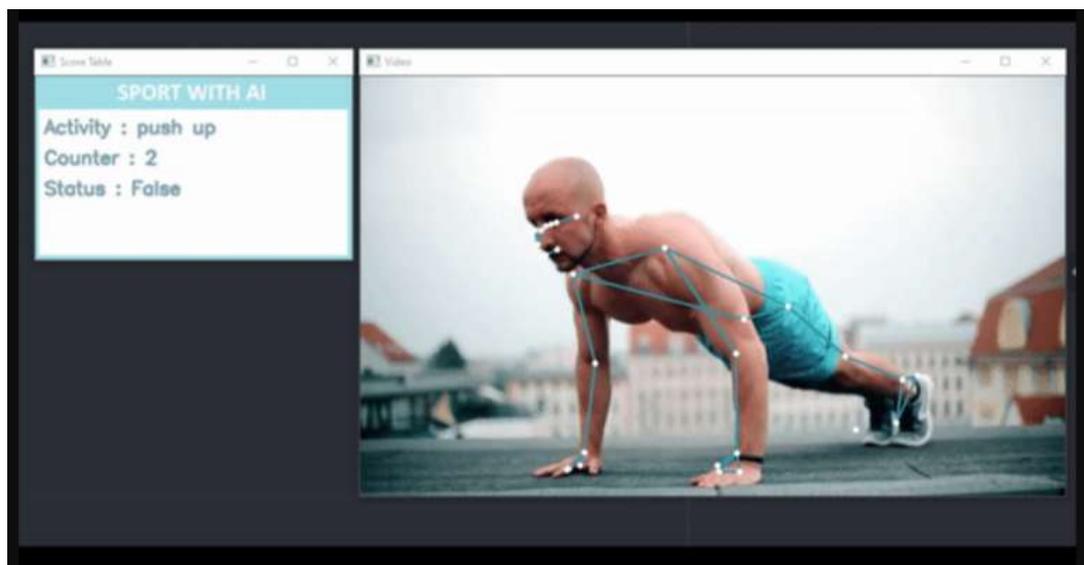
Figure 4.5: Full Extension phase of Push up exercise

5. Pull up exercise

Pull-ups are a challenging upper body exercise where you lift your body weight by pulling yourself up using an overhead bar, targeting the back, arms, and shoulders.
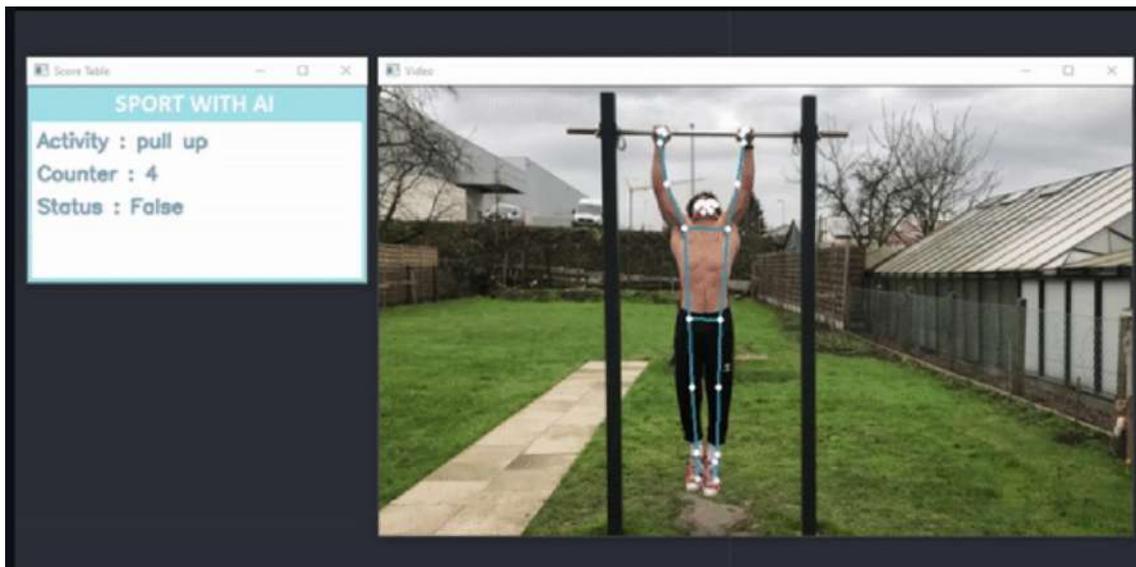
Figure 4.6: Starting position of pull up exercise
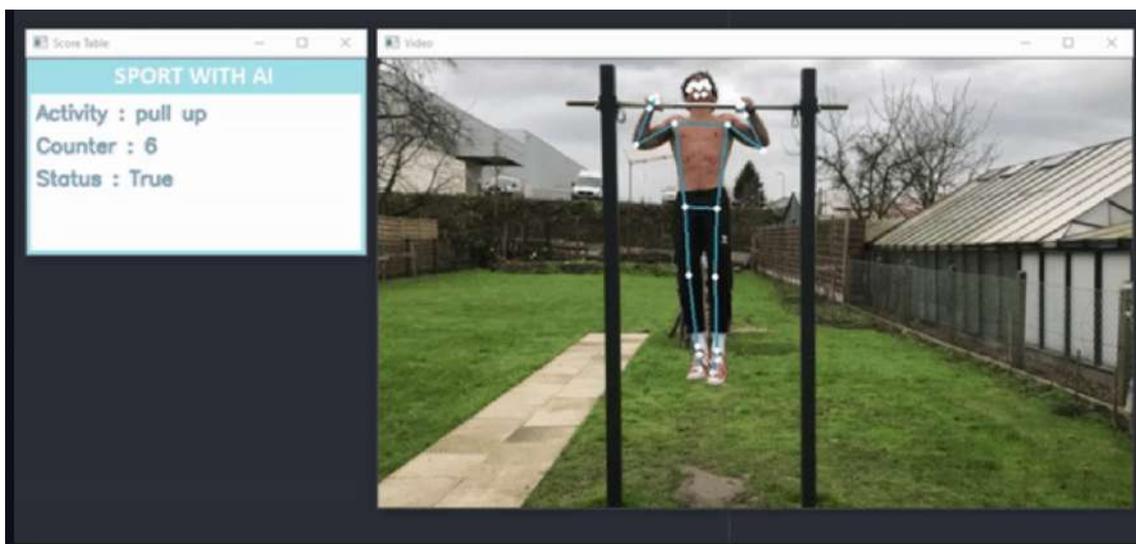
Figure 4.7: Top Position of Pull up exercise

6. Sit-ups exercise

Sit-ups are a core exercise where you lie on your back, bend your knees, and lift your upper body off the ground, engaging the abdominal muscles.
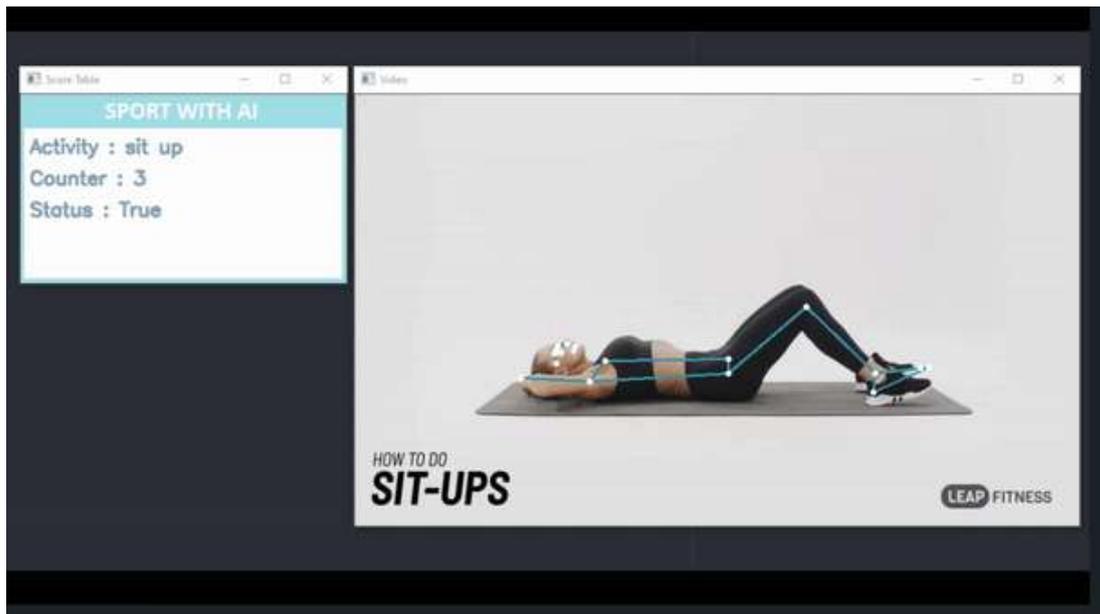
Figure 4.8: Starting position of sit-ups exercise
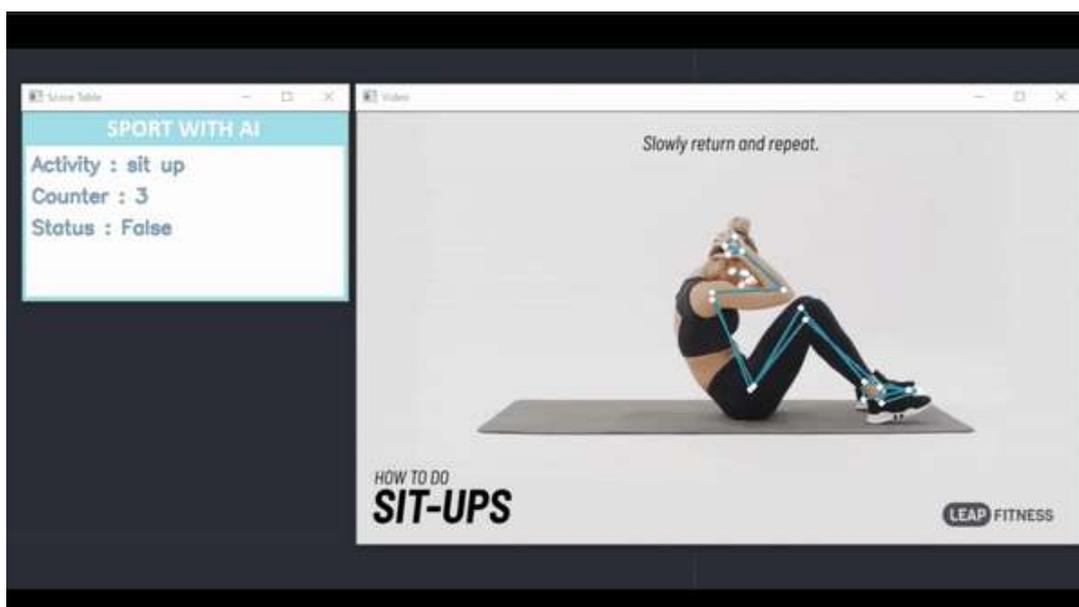
Figure 4.9: Upward Phase of Sit-ups exercise

7. Squats

Squats are a compound exercise where you bend your knees, lower your hips, and then rise back up, targeting the muscles of the thighs, hips, and glutes.
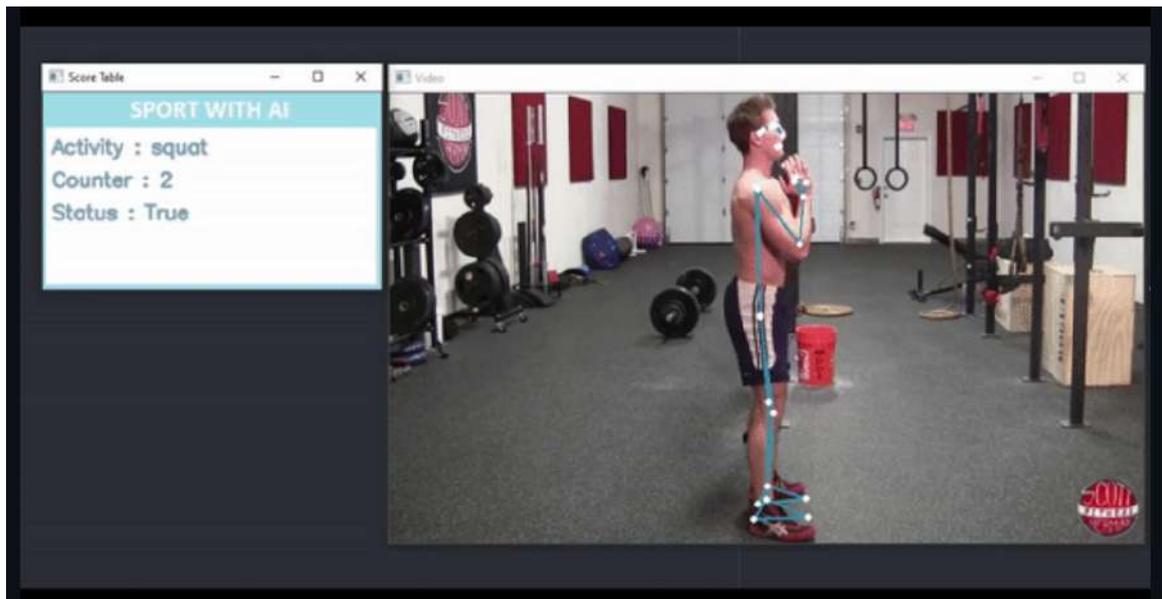
Figure 4.10: Starting position of Squats exercise
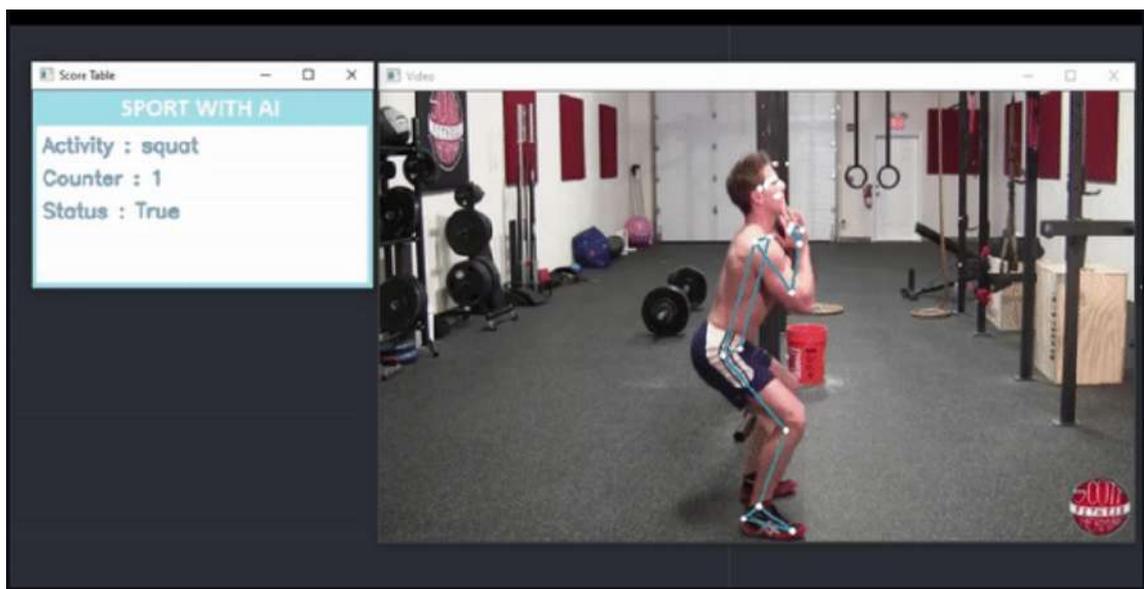
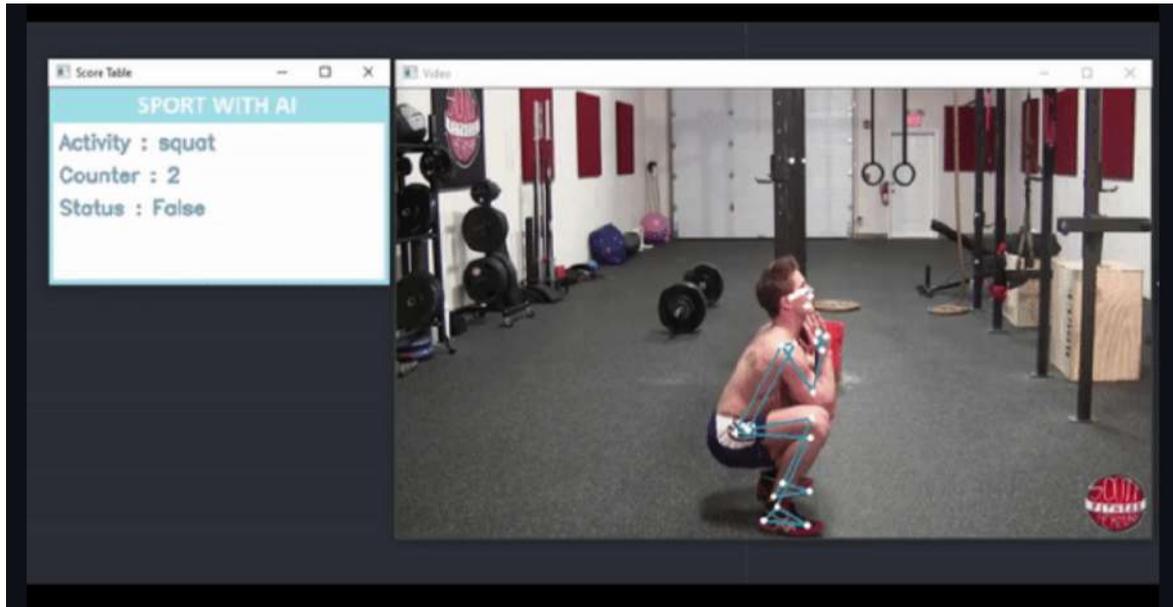Figure 4.11: Lowering Phase of Squats exercise

Figure 4.12: Squat Depth position

Chapter 5

CONCLUSION

AI-based workout assistance and fitness guide offer a number of potential benefits for users. These systems can provide real-time feedback on form, track progress over time, and even recommend personalized workout plans. As AI technology continues to develop, these systems are likely to become even more sophisticated and user-friendly, making them an even more valuable tool for people who are looking to get fit and healthy.

One of the most significant benefits of AI-based workout assistance and fitness guide is that they can provide real-time feedback on form. This can help users to avoid injuries and get the most out of their workouts. Additionally, AI systems can track users' progress over time, which can help them to stay motivated and see how far they have come. Finally, AI systems can recommend personalized workout plans based on users' individual goals and fitness levels. This can help users to get the most out of their workouts and achieve their fitness goals more quickly.

As technology continues to advance, we can expect further advancements in AI-based workout assistance, including more sophisticated virtual trainers, customized workout plans, and intelligent performance tracking. The future of fitness guidance lies in the seamless fusion of AI and human expertise, empowering individuals to optimize their fitness journey and achieve lasting results.

5.1   Future Enhancement

The system is designed in such a way that addition of new modules can be done without much difficulty. In order to make the system as versatile and user-friendly as possible, In

the future, I intend to include additional more exercises,Personalization which will reach new heights as AI algorithms leverage user data to provide tailored workout recommendations based on individual goals, preferences, and fitness levels. Advanced biometric tracking, including heart rate monitoring and sleep analysis, will provide a comprehensive understanding of users' overall health, enabling personalized recommendations.By embracing these enhancements, AI-based workout assistance and fitness guides will continue to empower individuals in achieving their fitness goals and promoting overall well-being.

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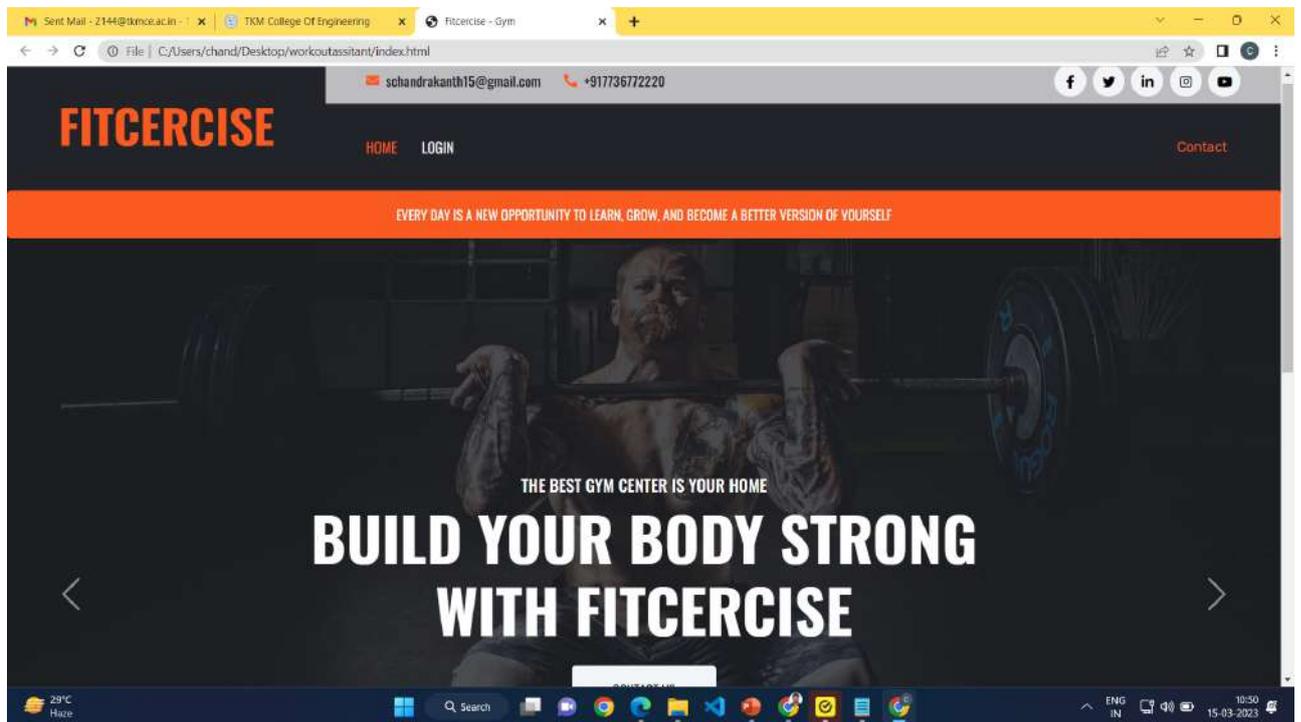
APPENDIX
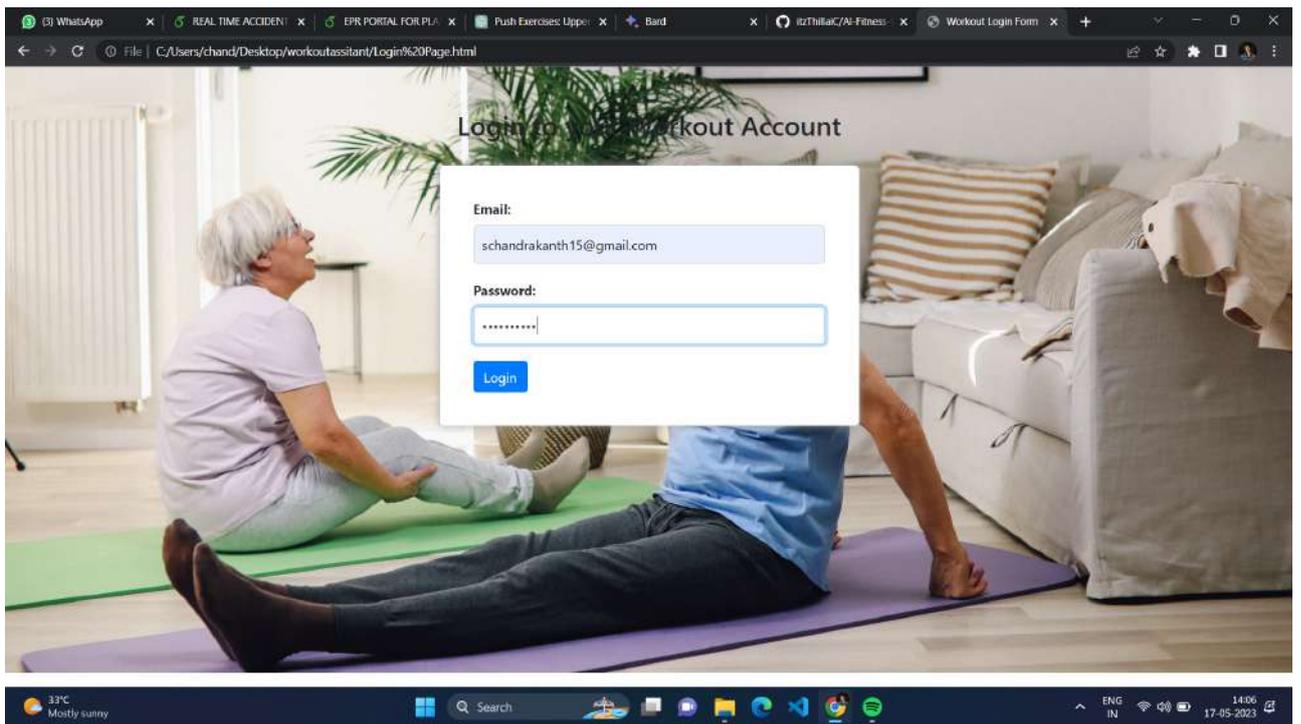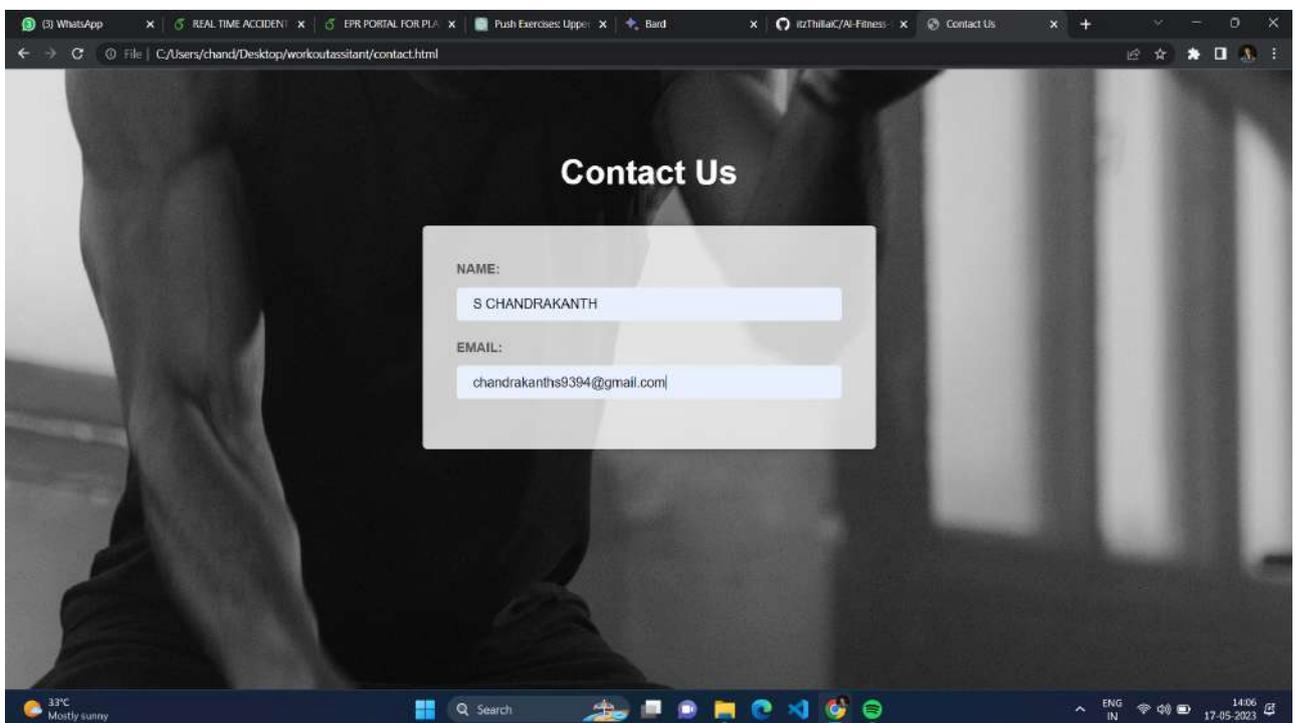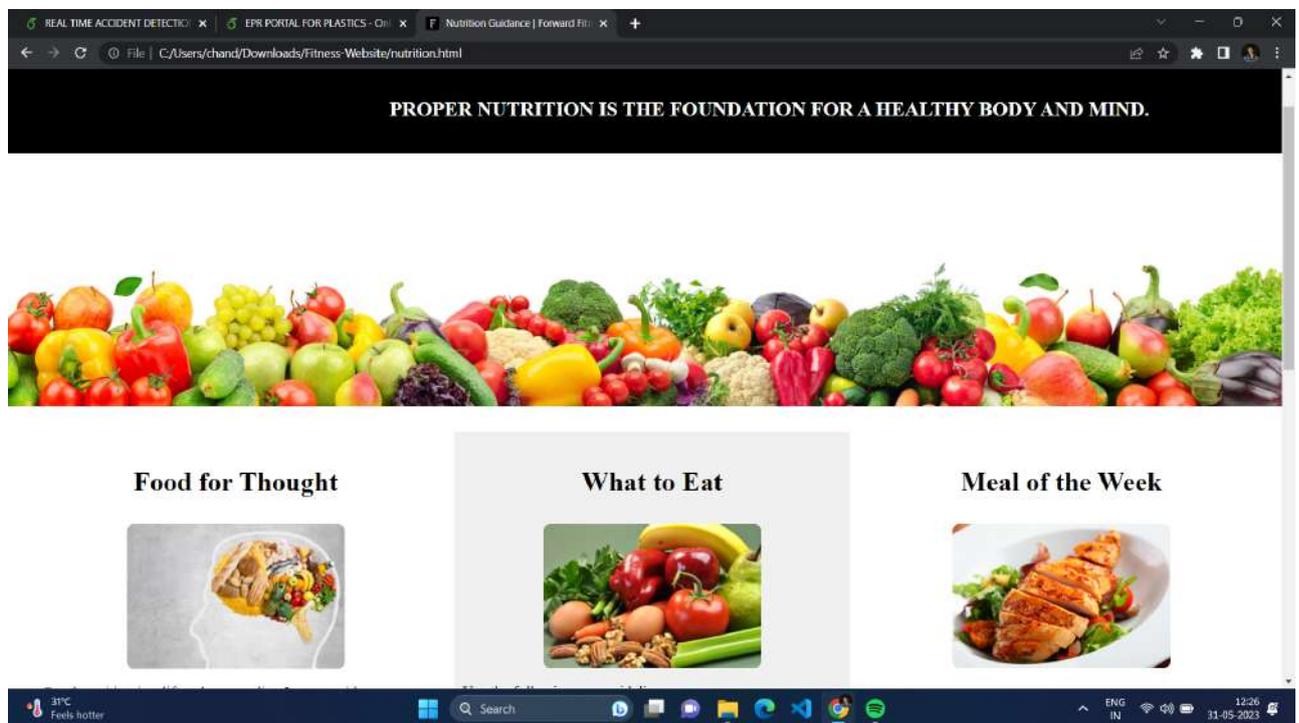
Screenshots

Figure A.1: Home page

Figure A.2: Login Section

Figure A.3: Contact page

Figure A.4: Nutrition page