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Virtual Fitness Assistant Using Machine Learning

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Abstract— **Artificial Intelligence plays a major role in modern healthcare and fitness domain by improving and enhancing individual exercise habits, tracking health behaviour, and analyzing repetitive exercise pattern and subsequently use the data to guide in fitness improvement. The thesis proposes, develops and evaluate a smart and effective AI solution based virtual gym assistant in real-time streaming video using CNN.The predominant goal of the proposed task is to apprehend and explore the art of 3D Human Pose Estimation and applying them to different aspects of the task of posture correction in exercises.Over the time, Convolution neural networks (CNN) algorithms have shown significant improvement in the area of human pose estimation on real-time datasets .In this work, we have developed a production-ready application which not only helps people work out effectively at the comfort of their homes but also provides them with real-time feedback on their posture, and act as a personal virtual trainer that will help them to do their exercises in efficient manner.**
Firstly, we have explored different algorithms and deep learning framework for 3D human pose estimation that could help detect different postures by representing human joints using key-points. These key points help in analyzing the joint coordinates and calculating the angle between joints using mathematical formulation.
Finally, we have use these joints coordinates on evaluating pose made by a person on predefined workouts such as biceps, leg-raise, squats and push-ups.

Keywords— Image Processing, Human pose detection

I. INTRODUCTION

Maintaining proper posture during workouts is one of the simple and yet significantly important thing to consider, but sometimes failing to maintain a good body posture can often lead to injuries like muscle strains. Mistakes in exercises are made when the person does not form a proper body pose and is not aware of correct form during exercises. In these uncertain times of pandemic due to Covid-19, people had to avoid going to gym and stay indoors due to nationwide lockdown and hence exercising at home is an only way to maintain health and fitness. Due to these factors, people often tend to perform exercise in improper manner due to lack of proper guidance from gym instructor which can also lead to injuries.This project is an

attempt to solve this problem by creating a smart and yet affordable AI solution which not only helps people work out effectively at the comfort of their homes but also provides them with real-time feedback on their posture, and act as a personal virtual trainer that will help them to do their exercises in efficient manner.

II. OBJECTIVES

The objective of this paper is an attempt to solve this problem by creating a smart and yet affordable AI solution which not only helps people work out effectively at the comfort of their homes but also provides them with real-time feedback on their posture, and act as a personal virtual trainer that will help them to do their exercises in efficient manner.

III. REVIEW OF RELATED LITERATURE

Machine learning's use for estimating pose has been the subject of a lot of research in recent years. Using machine learning algorithms to analyse data from sensors, such as cameras or depth sensors, is one common technique for predicting the pose of a person or object. Particular body parts, such the head, arms, and legs, can be included in this data as well as their position and orientation.

The requirement for vast quantities of precise and varied training data is one of the main difficulties in posture estimation using machine learning. Particularly for more demanding poses or activities, this can be challenging to attain. Researchers have created a number of methods for creating training data that can be synthesised or generated, such as using computer graphics or motion capture devices. For instance, academics Kostas Bekris and Siddhartha Srinivasa (2008) propose a method for synthesising substantial amounts of training data for object recognition using computer graphics in their study "Synthesizing Training Data for Object Detection using Virtual Worlds."

IV. METHODS AND IMPLEMENTATION

Proposed method:

Long This system leverages the power of human pose estimation using Computer Vision and Deep Learning and aims to predict poses of individuals from videos and images data . It take in account of human activity by extracting key points which represent different joints of human body and using them to evaluate postures. It will help us in keeping track of repetitions , angle between joints and other important features related to different per-defined exercises and postures.The system will aim on providing instant real-time feedback on body form and alert user in case of any incorrect body posture.The application also aims in maintaining low latency output and use best deployment practise , thus giving a new dimension to physical fitness and personal training.The application also proposes different additional functionalities such as CLI access for development, voice based assistance for user-rich experience and exposed web API for HTML page demonstrating application dashboard .There are numerous other integration that can be made in this project where it can solve many health and fitness related real life problems, thus making an impact on the world and augmenting human capabilities in significant ways.

Methodology:

Our suggested system can leverage the power of computer vision and deep learning to read the data source, process and evaluate it , and output the results to the user in real time. OpenCV is a huge open-source library which will be used to process images and videos to identify objects, faces, and is used extensively in computer vision, machine learning, and image processing related applications.Using an appropriate pose detection framework such as OpenPose , MediaPipe , PoseNet, etc, the model will identify key points which is basically a set of coordinates for each human joint (arm, head, torso, etc.,). While OpenPose and PoseNet are able to provide real-time mutli pose estimations, MediaPipe only supports single person pose estimation.Considering all factors, we will harness the power of Blaze Pose (Mediapipe pose model framework), a fairly newly developed algorithm which allows us to infer 33 different 2D landmark key points of the human body in a single frame and hence it will help us to localize more body movements. It helps to give real-time feedback and subsequently run different machine learning models to provide state-of-the-art performance. The next step involves determining and assessing the joint coordinates and using mathematical computation to calculate the different joint angles in human pose At last, these angles are used to evaluate and analyze different body postures and provide real time feedback to users about this information.

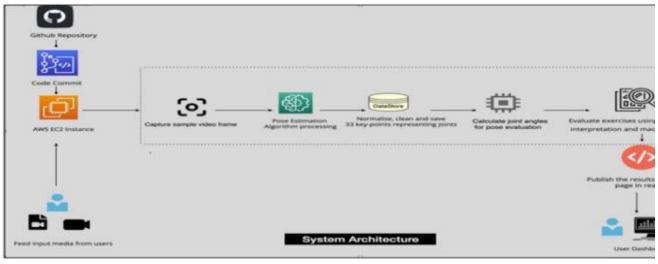

Fig 1 System Architecture

A. Video Acquisition:

Real-time media such as images or videos from webcam or media stored in working directory is given as input feed to the application using OpenCV.OpenCV performs the video processing by framing i.e. taking a single instance of frames at a given time.The default colour format in OpenCV is often referred to as RGB but it is actually BGR (the bytes are reversed), and hence we perform appropriate transformation of colour to pixels before analyzing the frame.

B. Pose Estimation:

We set up the mediapipe instance to perform pose detection on our captured frame of human body pose mediapipe provides state of the art solution for high quality and low latency real-time video feeds. As a result of pose detection we obtain a set of 33 key points which demonstrates the joint locations along with 3-d coordinates with visibility range

C. Angle Calculation:

These can also be shown on the frame using the mediapipe class methods for clear demonstration of keypoints these landmark coordinates are useful in calculating angles between joints using calculate angle function imported from evaluate module the function takes in the joint coordinates as input and returns the angle in degrees these joint angles are further used to count reps in exercises evaluate the exercise form and provide the correctness of exercise done by the user using custom pre-defined cases these cases vary and are based on gender of user exercise performed and the joint angle values in different exercises for instance in bicep exercise we have defined a use case where the application keeps track of the limb position I.e up or down and the counter to count the reps depending on the position change the feedback from the application is provided to the user in real-time on the screen itself so that he/she can adjust their pose accordingly and keep count of the calculated reps

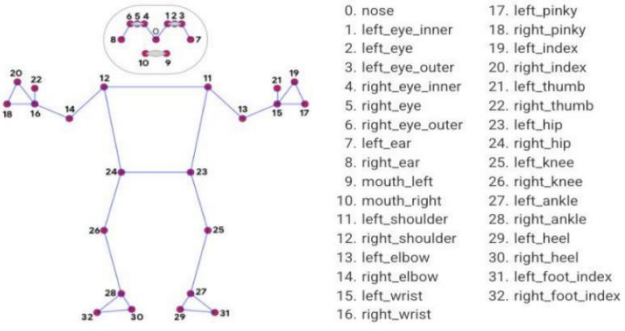

Fig 2 MediaPipe LandMark Points

V. UML DIAGRAMS

Use Case Diagram:

In this illustration the actor engages with the system to start the pose detection process the system then performs a number of operations on the data including preprocessing training a machine learning model testing the model analysing the findings and maybe improving the model within the broader perform pose detection use case each of these actions is shown as a distinct use case

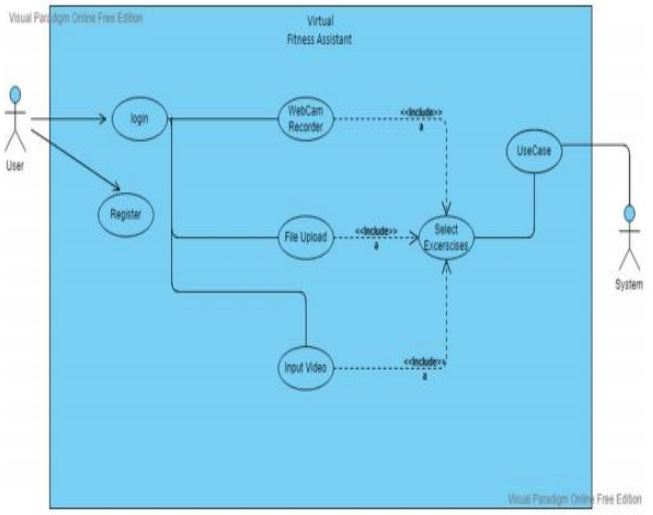

Fig 3 Use Case Diagram

Class Diagram:

Class diagrams are useful for representing the static structure of a system, and for understanding the relationships between the classes and their attributes and operations. They are also useful for identifying the interfaces and dependencies between the classes, and for specifying the attributes and operations of the classes in more detail.

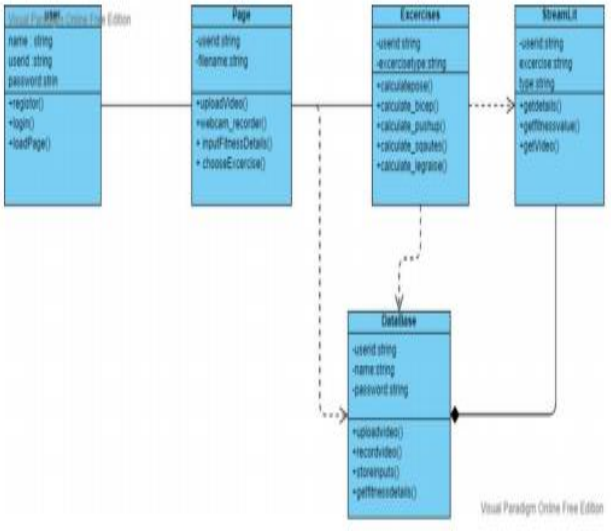

Fig 4 Class Diagram

VI. OUTPUT

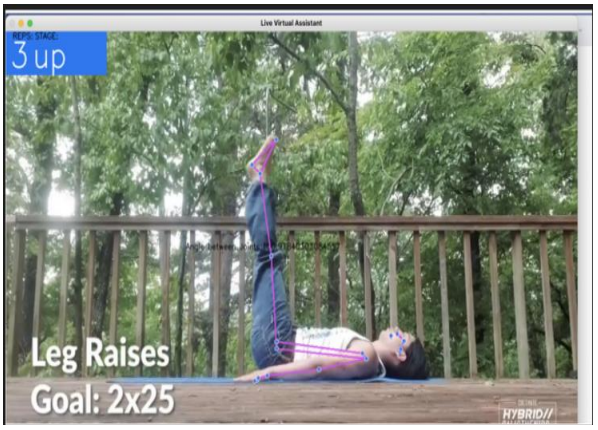

Fig 5 Working Demo Of Leg-Raise Exercise

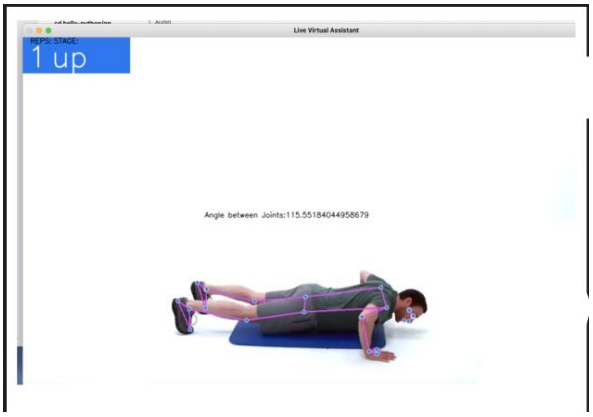

Fig 6 Working Demo Of Push-Ups Exercise

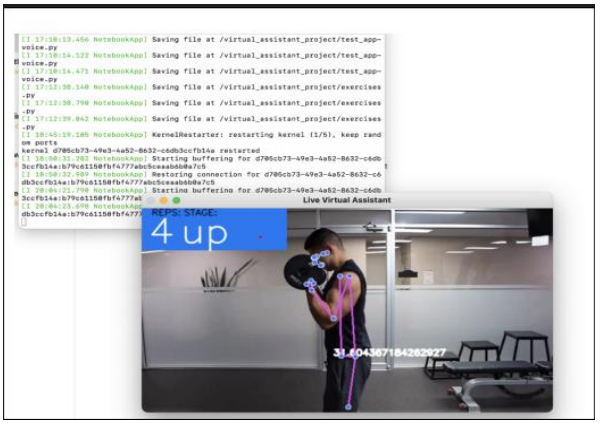

Fig 7 Working Demo Of Biceps Exercise

VII. CONCLUSION

since we rarely find the time in our busy schedules to stay healthy active and exercise every day various diseases and health difficulties have resulted artificial intelligence can be used to solve a variety of issues in the fitness industry our lives are made easier and our fitness path is made easier by the health-related software and technologies in this procedure we learned how to utilise the opencv library and package and how the use of machine learning may be helpful to people individuals can apply this application in their own exercises making them more efficient and less error-prone.

VIII. FUTURE SCOPE

This project has a lot of room for improvement, and it might be upgraded to include more exercises. The data gathered by the AI trainer can be retained and processed for the subsequent sessions. A user interface can also be provided to make it easier to go through the exercises, depending on your weight and body type. The trainer will recommend an exercise regimen and its intensity for convenience of use. this application might be extended into a full Android/IOS app.

IX.REFRENCES

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