YOGA POSE DETECTION AND CORRECTION

A PROJECT REPORT

Submitted by

RASIKA V V (TKM20MCA-2029)

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In partial fulfillment of the requirements for the award of the Degree of

MASTER OF COMPUTER APPLICATIONS

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Kerala

DEPARTMENT OF COMPUTER APPLICATIONS

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DECLARATION

I undersigned hereby declare that the project report YOGA POSE DETECTION AND CORRECTION, 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 my 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.

Place: Kollam

Date: 26-07-22

RASIKA V V

DEPARTMENT OF COMPUTER APPLICATIONS

TKM COLLEGE OF ENGINEERING

C E R T I F I C A T E

This is to certify that, the project report entitled **"YOGA POSE DETECTION AND CORRECTION"** is submitted by **RASIKA V V (TKM20MCA-2029)** to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the degree of Master of Computer Applications,is a bonafide record of the project work carried out by her 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

Today, many people practise yoga on a regular basis. Yoga pose identification uses technology to assist with exercises and sports. Self-learning is a crucial component of yoga, however poor posture while practising yoga can seriously injure the body's muscles and ligaments. So, in order to avoid this, I describe a machine learning-based intuitive approach to correcting the practitioner's position while executing different yoga asanas.

The suggested method aims to give the practitioner clear feedback so they can do yoga poses correctly, help them recognise the erroneous postures, and offer a suitable feedback for improvement in order to prevent injuries and develop their understanding of a certain yoga position. A entire yoga class ambience may be produced at the user's home using such a setup, and the mediapipe algorithm is used to automatically detect and correct the yoga stance.In order to calculate the angles of each body joint and give the user the guidance they need to correct the yoga stance, it collects body landmarks from each of the keypoints. So that the appropriate directions may be given to them in a very practical way, enabling them to alter their positions and discover their mistakes in real time. In order to help practitioners learn more about various yoga poses, increase their knowledge of them, and prevent injuries that can happen during the learning process, there is an increasing demand for the creation of computer-assisted training systems.

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Chapter 1

INTRODUCTION

Yoga, a kind of healthful exercise with Indian roots, promotes physical and mental equilibrium. One of the world's oldest sciences is known for its capacity to develop and sustain healthy physical, mental, and spiritual health. Yoga practise has been shown to improve muscular tone, flexibility, energy, and sleep, as well as strength, cardiovascular and circulatory health, sports performance, injury prevention, and reduce chronic pain. Yoga is more effective than therapeutic exercise in treating chronic lower back pain and psychiatric problems. 89.4percent of poll participants believed that Yoga helps to relieve headaches, depression, and joint and muscle discomfort.Yoga injuries caused by misalignment pose a risk to all practitioners. Misalignment-related injuries include fracture, strain and sprain, joint dislocation, bone spurs, sciatic nerve injury, and stroke. Many of these practitioners are injured as a result of poor practise.So there is a need for developing a yoga coaching system to help learner's to do yoga perfectly.

The recognition of human activities is a well-known computer vision issue that has presented numerous difficulties over time. Finding keypoints and a human body's posture using sensor data is the issue at hand. Numerous fields, including as biometrics, video surveillance, human-computer interface, assisted living, sports arbitrage, in-home health monitoring, etc. can benefit from activity recognition. With the use of activity recognition and monitoring, the health condition of an individual can be assessed and forecasted. Recognizing yoga postures is a more recent use. Yoga must be done in the proper forms and postures, just like any other kind of exercise, in order to get its advantages. Ineffective outcomes can be produced by incorrect postures to the point of having poisonous repercussions. This makes it necessary for a yoga instructor to get each person into the right position. Yoga is an expensive endeavour as there aren't many yoga instructors available. Yoga outreach is challenging due to overall cost and resource availability, necessitating the use of technology-based support.

In this project, I suggest a system that employs several deep learning approaches to recognise and correct yoga positions in real-time. A entire yoga class ambience may be produced at the user's home using such a setup, and the mediapipe algorithm is used to automatically detect and correct the yoga stance. A machine learning (ML) method called MediaPipe uses RGB video frames to infer 33 3D landmarks and a background segmentation mask on the entire body for high-fidelity body posture tracking. It might be challenging to locate a yoga class that is both cheap and compatible with one's schedule.This initiative seeks to meet the need for on-demand yoga sessions by providing real-time feedback on the asana practise.This software is just like an instructor. Whenever it is required to join any classes or hire an instructor, how the instructor helps. This will be the same as instructor oral guidance to perform any pose. If the postures are wrong, an entity must correct them, and the particular person will perform the correct postures.

1.1 Problem Definition

Yoga includes self-learning as a key component. To get the most out of a given pose, the practitioner must follow specific instructions, and failing to do so frequently might result in serious injury from wrong postures. If these bad habits are maintained for a long time, the joint may experience chronic discomfort.This became the impetus for the development of a yoga self-training system that allows practitioners to exercise independently using a web-based application, allowing for the delivery of proper instructions in a very convenient manner, allowing them to adjust their poses and learn about their incorrectness in real time. Furthermore, there is a rising need from practitioners for the development of computer-assisted training systems to aid them in their training.

1.2 Objective

The project's major purpose is to:

- A variety of yoga poses were captured on video, and learners were asked to do each pose.
- It can assess pose quality; By examining stance characteristics, it can differentiate between various movements.
- As a result, the mediapipe algorithm automatically assesses yoga positions and offers recommendations to alert learners.

Chapter 2

LITERATURE SURVEY

A literature review is a summary of the earlier written works on a certain subject. The phrase can be used to describe an entire academic paper or a specific piece of an academic work, like a book or an essay.It provides a thorough summary of earlier research on a subject. The review of the literature lists books, scholarly articles, and other sources pertinent to a particular field of study. The analysis should list, describe, sum up, critically assess, and explain this prior research.The literature review acknowledges the earlier researchers' work, which guarantees the reader that your writing has been thoughtfully crafted.When a previous study in the subject is mentioned, it is assumed that the author has read, assessed, and incorporated that study into the current work. A literature review gives the reader a complete grasp of the developments in the subject by providing a ”landscape” for them. The reader may tell from this landscape that the author has really incorporated all (or the vast majority) of earlier, important works in the topic into their own work.

2.1 Purpose of the Literature Review

1. By choosing high quality research papers or studies that are pertinent, significant, important, and valid and compiling them into a single comprehensive report, it makes it simple for readers to get information on a certain issue.

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 makes sure that previous work is not repeated by researchers.

4. It can suggest topics to focus on or give hints about the direction that future study should take.

5. It emphasises the important findings.

6. It points up gaps, discrepancies, and inconsistencies in the literature.

7. The literature's discrepancies, gaps, and inconsistencies are noted.

2.2 Related Works

L Rupasinghe et al. [1] developed a Yoga coaching application that is able to detect user movements using the webcam. The system consists of two main parts, a pose detection part which identify 25 keypoints using Openpose, They used the BODY25 dataset for landmark extraction. And a pose detection part which consists of a Deep Learning model, that uses Long Short Term Memory and SoftMax regression in order to analyze and predict learner's pose . This part was trained to differentiate 6 yoga poses and the model which uses OpenPose for pose detection,which produce an accuracy of 99.91percent.

Agarwal et al. [2] included 5500 photos of 10 different yoga positions. Pose identification algorithms have been shown to help people to practise yoga more accurately by helping them to recognise the postures. Due of the scarcity of datasets and the difficulty of real-time posture detection, posture recognition is a difficult undertaking. To solve this issue, a sizable dataset with at least 5500 photos of 10 various yoga poses was compiled using a real-time human body skeleton drawing algorithm called the tf-pose estimation Algorithm.80 percent of the dataset was utilised for training, while 20 percent was used for testing. This dataset is examined using various machine learning classification models, and a Random Forest Classifier has an accuracy of 99.04 percent.

Anilkumar et al. [3] proposed a method in which the mediapipe library performs the geometric analysis based on the frames collected from the camera whenever a stance is made by the user in front of his camera. The study of techniques and systems that restore the stance of an articulated body is known as ”articulated pose estimation” in computer vision. The procedure of determining the location of human body joints and parts in a given image is described in the study as articulated body posture estimate.Building a yoga monitoring system, which analyses and tracks user movements and postures for mistakes during the yoga programme, is the major goal of this paper. The user is then informed of their incorrect posture via a wireless speaker or a display screen. The user’s incorrect body stance can be pointed out in real-time so that the user can correct it.

With the help of Kinect, Chen et al. [4] developed a computer-assisted self-training system that recognised the tree pose, warrior 3 pose, and downward dog asanas while also extracting the user’s body contour and star skeleton. They conducted their studies with only an overall accuracy of 82.84 percent.

Kadbhane et al[5] .’s use of Microsoft Kinect allowed them to record video data. A skeletal tracking tool for Kinect can recognise up to twenty body joints. For practising yoga, we’d want adequate instruction as well as a trainer who will watch over body alignment and movement. Therefore, Microsoft Kinect was set up to identify various locations on the human body in real-time and compute various angles from these mutual lengths to live the correctness of certain yoga poses for a user in order to increase popularity accuracy with shorter training sessions.They calculated using the ten joint positions they had set. By accumulating information about the joint sites from human posture, they developed the reference framework for each yoga pose.They calculated vector cosine similarity by computing the angles between all vectors connecting any two joint points.

For Android apps, Girija Gireesh et al.[6] offer AI-based yoga position estimate. Yoga is valued widely, and the ancient sages’ teachings about its health advantages have held true over time. Although yoga is gaining popularity, there are still many obstacles to overcome when practising it, including poor form, pricey lessons, and a lack of time due to our hectic schedules. Promising ways for estimating human posture have been found using computer vision techniques.There are no particular records or initiatives specified concerning yoga, and these methods are hardly ever used in the sphere of fitness or health. This article discusses several posture assessment systems and offers recommendations for the top usability-based approach for Android applications. The approach for implementing yoga posture estimation using an Android application is then discussed, along with how the programme is designed and each component's behaviour is described.

Nagalakshmi et al. [7] proposed detecting three-dimensional landmarks from a single picture. They employed a skinned multi-person linear (SMPL) and an encoded classification model architecture. KNN, SVM, and other deep learning models such as AlexNet, VggNet, and ResNet were among those used. Each model was built using a dataset that included 13 distinct yoga positions. A half-camel stance, a standing half-forward bend pose, a butterfly pose, a cobra pose, a bridge pose, a seated pose, a standing forward bend pose, a kid pose, a corpse pose, a mountain pose, a tree pose, a triangle pose, and a twisted pose are all included in the dataset. The categorization analysis received an accuracy value of 83percent.

Manisha et al.[8] suggested classifying yoga poses using the Yoga-82 dataset. They used the DenseNet201 model to identify yoga postures on their Yoga-82 dataset and achieved the top-1 image detection performance score on 80 percent of the 82 multi-classes. The primary goal of this work was to develop a transfer learning-based yoga posture coaching system. 14 distinct yoga positions are collected using a camera, and CNN is then used to extract each stance in real time. If the learner's pose is incorrect, the system will provide the appropriate suggestions to enhance the learner's position.

Islam et al.'s[9] concept for a Yoga posture detection system uses Microsoft Kinect to locate human joints in real-time. Because of accidents and ageing, human musculoskeletal problems are increasing, which is quite concerning for the future of the planet. Exercises can aid in reducing this issue. Yoga is an excellent type of exercise. Yoga requires a trainer since they can monitor the precision of the various positions. This study proposed a system that can measure the mobility of various body parts and the accuracy of various postures in order to assist the user when practising yoga. Using Microsoft Kinect to recognise particular yoga positions for a person, it assessed how accurate each stance was.

Kumar Yadav et al.[10] developed a Yoga asanas tracking system using deep learning algorithms.Using 20 people (ten men and ten women) and an ordinary RGB webcam, a dataset of six yoga asanas—namely, Bhujangasana, Padmasana, Shavasana, Tadasana, Trikonasana, and Vrikshasana—was produced and made available to the public. The CNN layer is used to extract features from keypoints of each frame obtained from OpenPose and is followed by LSTM to give temporal predictions .After polling predictions on 45 frames from the videos, the algorithm obtains a test accuracy of 99.02 percent on single frames and 99.39 percent accuracy overall. A new group of 13 people (six men and seven women) were used to test the system in real time, and we were successful in 98.93percent accuracy.

Chapter 3

METHODOLOGY

3.1 Proposed system

The suggested method uses real-time input of video sequence frames. The anticipated yoga stance would be the output, along with any feedback for angle and pose modification. Object detection, Keypoints extraction, Pose identification, and Pose correction are the system's four primary stages. OpenCV is a free software programme that can identify particular objects in real-time including hands, faces, and eyes. Using mediapipe, the keypoints extraction phase locates and extracts the locations of significant keypoints based on the user's position. Pose identification determines which pose it is and whether or not it is appropriate. Pose correction is the last stage, during which the user is provided further feedback for pose adjustment.

The mediapipe algorithm is employed in this project to extract various coordinates. Different joint angles, distances, and slopes between two points have been retrieved using the coordinates and employed as an evaluation parameter for the correction of yoga poses. The correction has been made using a variety of mathematical formulas, including the cosine rule and the Euclidean distance. After the parameters were retrieved, a comparison was made between the extracted and preset parameters for each joint and slop in order to support the conclusion that the posture was accurate.

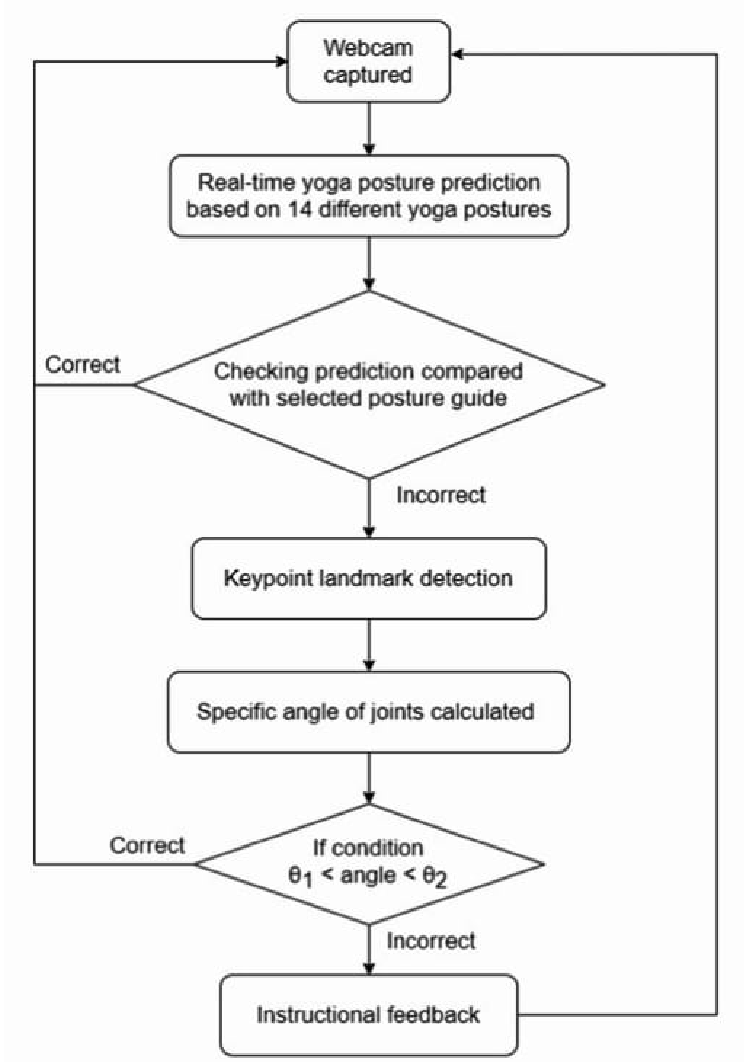

Figure 3.1: Real-time coaching feedback block diagram of yoga self-coaching system

3.2 Opencv

3.2.1 Object detection

An interdisciplinary scientific subject called computer vision is dedicated to the high-level analysis, modification, and interpretation of pictures. The computer vision system typically includes several processing stages, such as the use of simple filters, object extraction, data analysis from object extraction, data communication, and pattern comparison. There are numerous sub-domains of computer vision, such as object recognition, learning, indexing, and motion estimation. Visual object tracking is one of the core tasks in computer vision.

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.

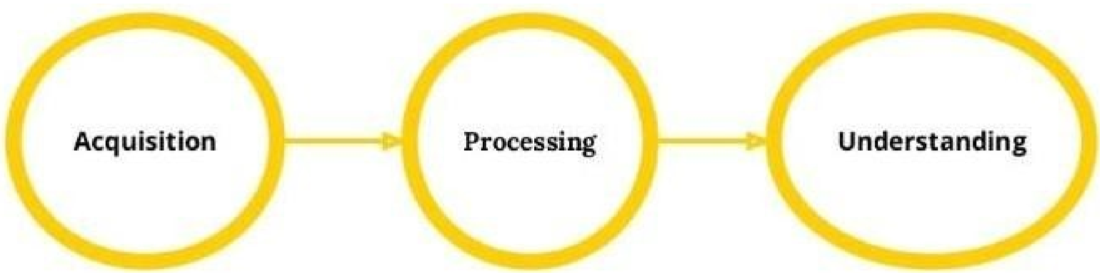

Figure 3.2: Opencv stages

- Reading and writing yoga images or videos
- detect and save yoga videos
- Process the images or videos
- Perform feature detection

- Detect the objects such as face, eyes, hand ,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

In general, there are a number of steps involved in tracking an object in a video, including: a) selecting the tracker; b) selecting the object (target) from the starting frame with the bounding box; c) initialising the tracker with information about the frame and bounding box; and d) reading the subsequent frames and determining the object's new bounding box. Typically, the last action is carried out within the loop.

3.3 Mediapipe

3.3.1 Pose estimation

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 yoga pose in this instance.

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.

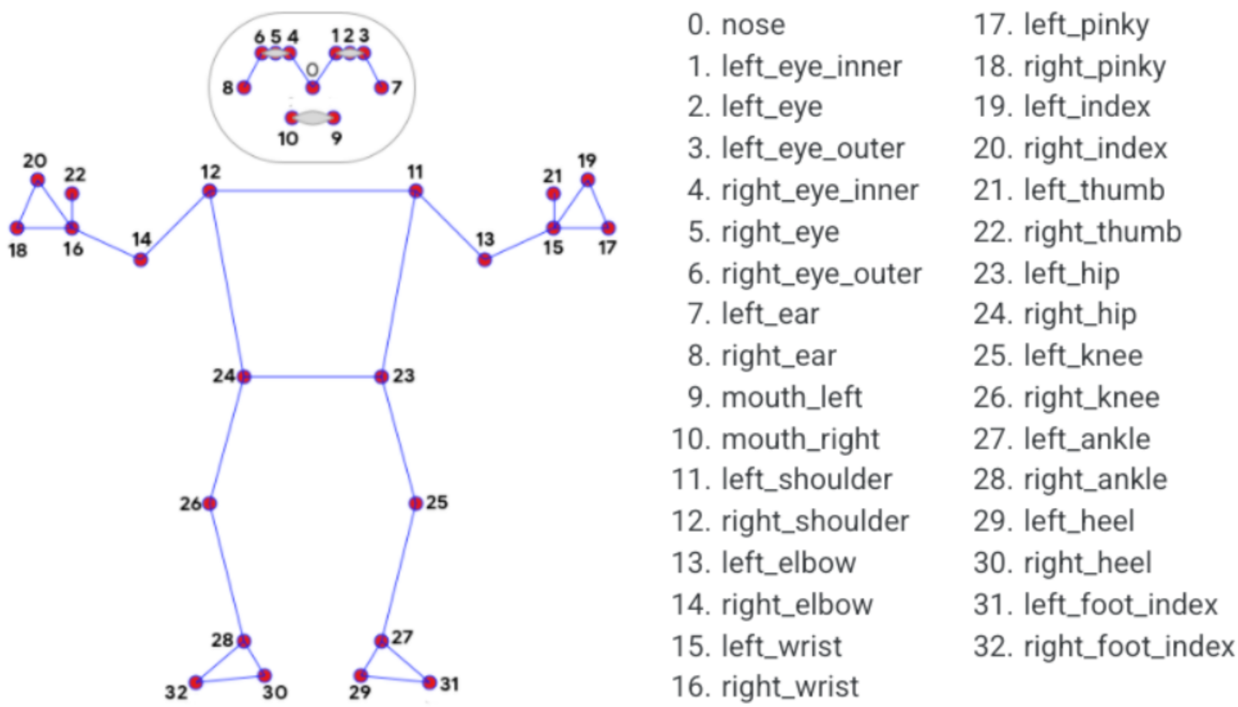

Figure 3.3: Blaze pose model

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.

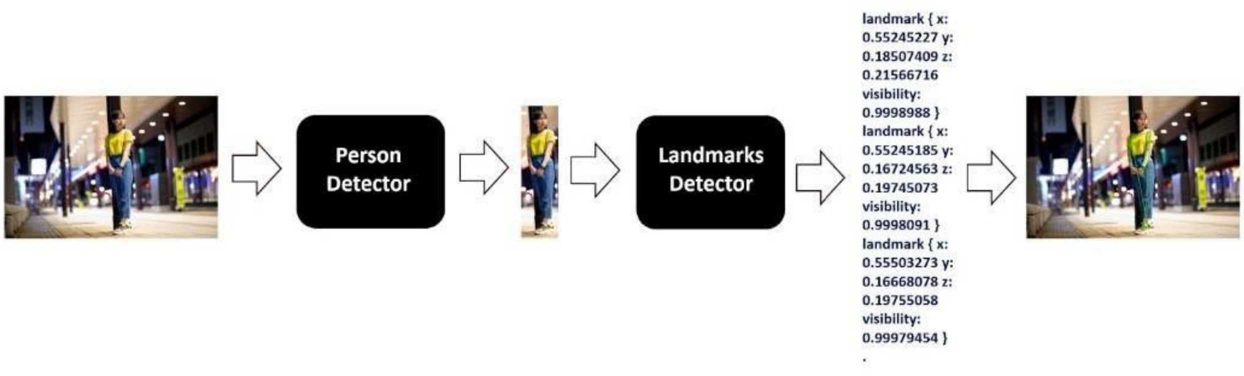

Figure 3.4: Landmark detection working

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:

- 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.

Figure 3.5: Landmark detection

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 eg. 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 6 yoga poses.during a yoga 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 Pose classification

Make a function that can categorise various yoga postures based on the calculated angles of various joints. The following yoga poses will be able to be recognised by the function:

Tree pose

Yoga position that requires keeping one leg straight and bending the other leg at the appropriate angle is called Tree Pose (also known as Vrikshasana). The following group of body component angles makes it simple to categorise the pose:

- One knee bent at around 180 degrees
- A 35° or 335° angle at the opposite knee, depending on which leg is bent.

T pose

T Pose (also known as a bind pose or reference pose), In order to do this position, one must stand up straight like a tree with both hands out like branches. To make this one, the following body part angles are necessary:

- 180° angle at both elbows
- 90° angle at both shoulders
- 180° angle at both knees

Mountain pose

Although Tadasana (Mountain Stance) may appear straightforward, it is actually a fundamental yoga pose. In this fundamental yoga position, the practitioner places their feet firmly on the floor while maintaining a straight, upright posture.

- 180°angle at both knees
- 20° angle at both shoulders

Goddess pose

It is said that the Goddess Posture, also known as Utkata Konasana, helps you connect to your energetic centre, which is the area just behind and beneath your navel. A squat is the goddess stance. Your lower body will tone up, particularly your thighs. Your inner thighs will receive a stretch and tone because your feet are turned out and you sit forward rather than back. Goddess pose also strengthens the back, chest, and core muscles as you maintain the position.

- 90°angle at both Shoulder
- 90°angle at both Elbow
- 100°angle at both Knees

Warrior-I pose

The chest, lungs, shoulders, neck, belly, and groyne are stretched during Warrior I. Additionally, it tones the muscles in your calves, ankles, and thighs as well as your shoulders, arms, and back. Keep your shoulders level and your upper body facing the front border of the mat. Right thigh and knee should be bent so that they are parallel to the ground. Keep your weight on your big toe and front heel. Lift from the inner arch of the back foot as you press it down.

Check if one leg is straight

- Knee around 170°

Check if the other leg is bended at the required angle

- Knee around 100°
- Shoulder around 220°
- Elbow around 180°

Warrior-II pose

Standing yoga stance known as Warrior II pose, or Virabhadrasana II in Sanskrit, strengthens the legs, torso, and spine while stretching the shoulder, chest, and groyne. One of the five additional warrior positions used in contemporary yoga is Warrior II. By combining the following body part angles, it can be categorised as follows:

- Around 180° at both elbows
- Around 90° angle at both shoulders
- Around 180° angle at one knee

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 posture and thus learning to practice the yoga pose 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 yoga 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 yoga.

In Fig 3.6 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 yoga routine starts and the camera starts capturing the 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 3.7, 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 3.8, 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.

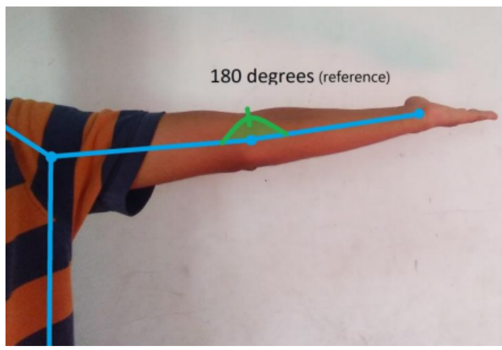

Figure 3.6: Reference Angle Data for Comparison

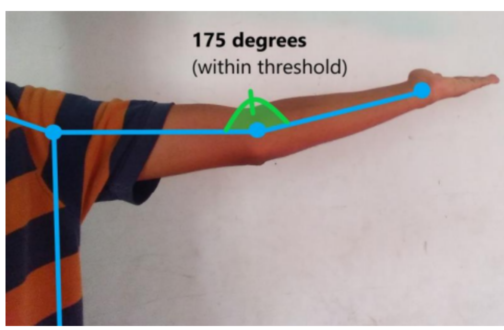

Figure 3.7: User's Hand Pose Of 175 Degrees Is Within The Threshold Of + or -5 Degrees

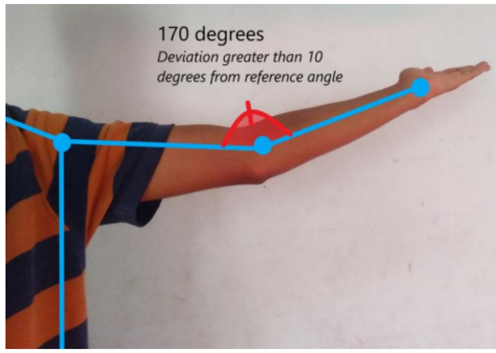

Figure 3.8: User's Hand Pose Of 170 Degrees Is Beyond The Threshold Limit Of 10 Degrees

3.4 Software Requirement and Specification

The tools used for the project are :

- Python
- Jupiter Notebook
- Django
- HTML
- CSS
- Bootstrap

3.4.1 Python

Python is an interpreted, general-purpose, dynamic, and high-level programming language. It allows the development of programmes using an object-oriented approach. It offers a large number of high-level data structures and is straightforward and simple to learn. Guido van Rossum created Python in 1991 at CWI in the Netherlands. In many different domains, including machine learning, artificial intelligence, web applications, etc., Python has a large variety of libraries and frameworks that are often utilised. Python has established itself as a standard in data science, allowing data analysts and other experts to utilise it to perform intricate statistical computations, design machine learning algorithms, handle and analyse data, among other activities.

The development of a website's or application's back end frequently uses Python. Python may be used in the building of websites to send and receive data, process data and interact with databases, route URLs, and maintain security. Python offers a number of web development frameworks. The most popular ones are Flask and Django. Since it is open source, anyone can use and distribute it without paying a fee—even for profit. It is simpler to read and understand because of its straightforward grammar, which mimics natural English. As a result, initiatives can be developed and improved more quickly. A sizable and engaged Python community adds to the language's family of modules and libraries and serves as a helpful resource for other programming languages. A sizable and vibrant community exists around Python that contributes to the language's family of modules and libraries and serves as a helpful resource for other programmers.

3.4.2 Jupyter Notebook

The most recent web-based interactive development environment for notebooks, code, and data is Jupyter Notebook. Users may create and arrange workflows in data science, scientific computing, computational journalism, and machine learning using the interface's flexibility. A modular design encourages additions to increase and improve usefulness.

The ideal method for installing Jupyter notebook is to use the Anaconda package. Jupyter Notebook and Jupyter Lab are already installed as part of the Anaconda package, so you don't need to install them. One of the requirements in this scenario is Python, 3.3 or later, or Python 2.7.Installing Python and the notebook programme using the Anaconda distribution is generally a good idea. An advantage of Anaconda is that you can easily install more than 720 packages.

3.4.3 Django

Python is a computer language used to create the web application framework known as Django. Model View Template (MVT) is the design pattern on which it is based. Due to its capability for quick evolution, the Django is quite demanding. After gathering client requirements, building an application takes less time. We can create web applications quickly by utilising Django. Django is built in such a way that it takes care of a lot of configuration tasks automatically, allowing us to concentrate solely on application development. Django was created and developed by Lawrence Journalworld in 2003, and it was made available to the public in July 2005 under a BSD licence.

Because Django takes security seriously, it assists developers in avoiding several security blunders, like SQL injection, cross-site scripting, cross-site request forgery, etc. To manage user accounts and passwords securely, it offers a user authentication mechanism.

Django is scalable and offers the flexibility to go from small to large size application projects with ease. To help with common Web development tasks, Django comes with a number of modules and libraries. User authentication, content management, site mapping, RSS feeds, and other issues are handled by Django. Django's adaptability makes it possible to create apps for a variety of different fields.These days, businesses use Django to create a wide range of applications, including content management systems, social networking websites, and platforms for scientific computing. An open source web application framework is called Django. It is freely accessible to the general public. It is available for download from the public repository with the source code. The overall cost of developing an application is lower with open source. It is among the most widely used web frameworks.

3.4.4 HTML

Hyper Text Markup Language, also known as HTML, is a programming language used to build websites and online applications. HTML offers many formatting tags, making it simple to create a presentation that is successful. Due to the fact that it is a markup language, it offers a versatile approach to create web pages in addition to the content.

By making it easier for programmers to create links to online pages, html anchor tags increase user interest in browsing. The core components of HTML pages are HTML elements. HTML structures can be used to embed images and other objects, such as interactive forms, in the produced page. By giving text elements like headers, paragraphs, lists, links, and other elements structural semantics, HTML makes it possible to create structured texts. It can be displayed on any platform, including Windows, Linux, Macintosh, and others, making it platform-independent.Because HTML is case-insensitive, we can use tags in both lowercase and uppercase. It makes it easier for the programmer to include Graphics, Videos, and Sound in the web pages, enhancing their appeal and interactivity.

3.4.5 CSS

CSS, or cascading style sheets, is an acronym. It is a language for creating style sheets that describe the layout and appearance of markup-language documents. It gives HTML an additional feature. Typically, it works with HTML to modify the look and feel of online pages and user interfaces. Since CSS style definitions are saved in external CSS files, altering a single file might alter the entire website.CSS offers more specific properties than plain HTML to define the website's look and feel. It helps you save lots of time. It simultaneously manages the layout of several web pages. It determines the page's background colour, font family, size, and colour. We can use it to add website animations or effects. We display animations with CSS, including animated backgrounds as well as animations for buttons, effects, loaders, or spinners.

3.4.6 Bootstrap

An HTML, CSS, and JS library called Bootstrap aims to make the creation of educational web pages as simple as possible. The main goal of adding it to a web project is to apply the colour, size, font, and layout options of Bootstrap to that project.All HTML components have basic style declarations once Bootstrap is introduced to a project.As a result, texts, tables, and form components appear consistently in all web browsers. In order to further personalise the appearance of their contents, developers can make use of the CSS classes defined in Bootstrap. For instance, Bootstrap includes support for page headings, bolder quotations, light and dark tables, and text with an underline.

Additionally, Bootstrap includes a number of JavaScript components that can be used independently of other frameworks like jQuery. They offer extra UI components like dialogue boxes, tooltips, progress bars, drop-down menus, and carousels. Each Bootstrap element is made up of an HTML framework, CSS declarations, and occasionally supplementary JavaScript code. Additionally, they increase the functionality of a few already-existing interface components, such as the auto-complete feature for input fields.

Chapter 4

RESULTS AND DISCUSSIONS

A user can select a certain yoga pose from a variety of poses. The yoga self-coaching system can identify yoga 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 yoga pose, the system will give a user instructional feedback to help them perform the 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 yoga pose 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 yoga 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 Bootstrap.This includes a page with different yoga poses,login and registration form for user.User can select any yoga pose from 6 poses for practice.Django is used as back end.

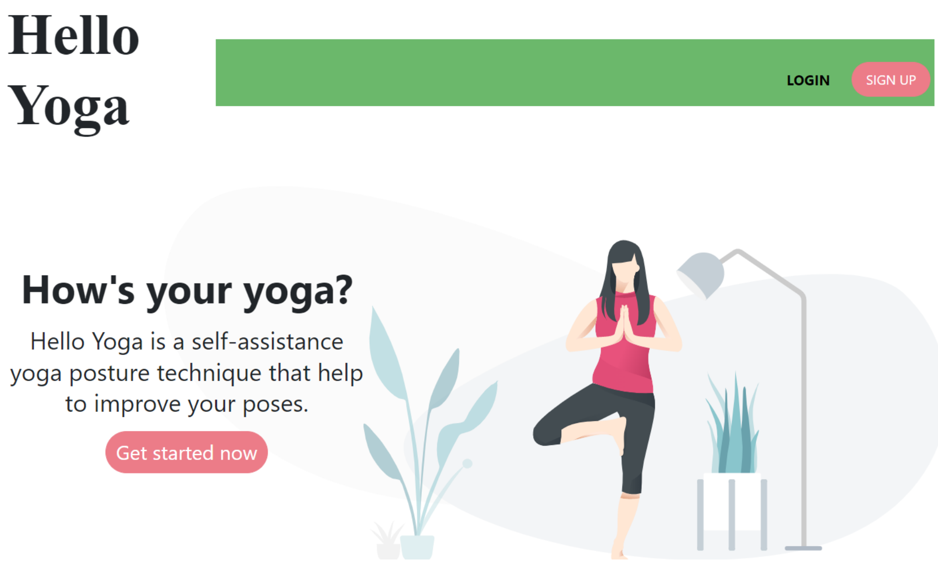

Figure 4.1: Yoga homepage

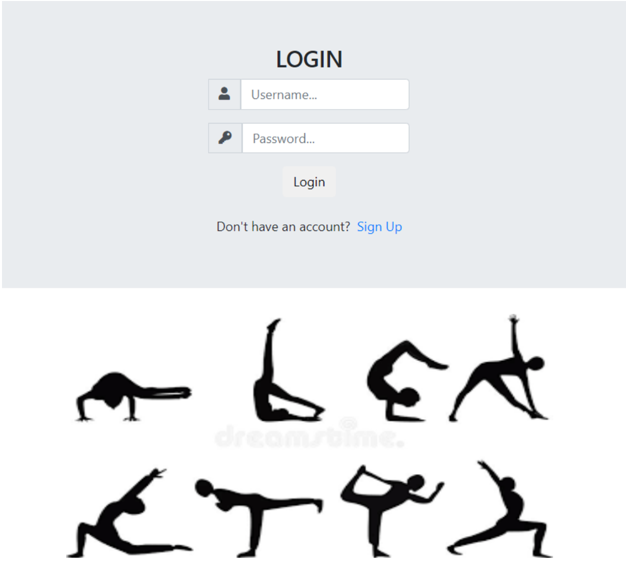

Figure 4.2: User login

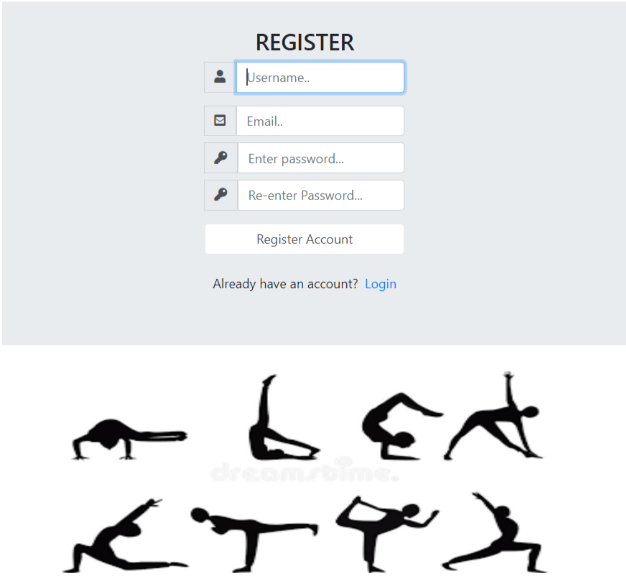

Figure 4.3: User registration

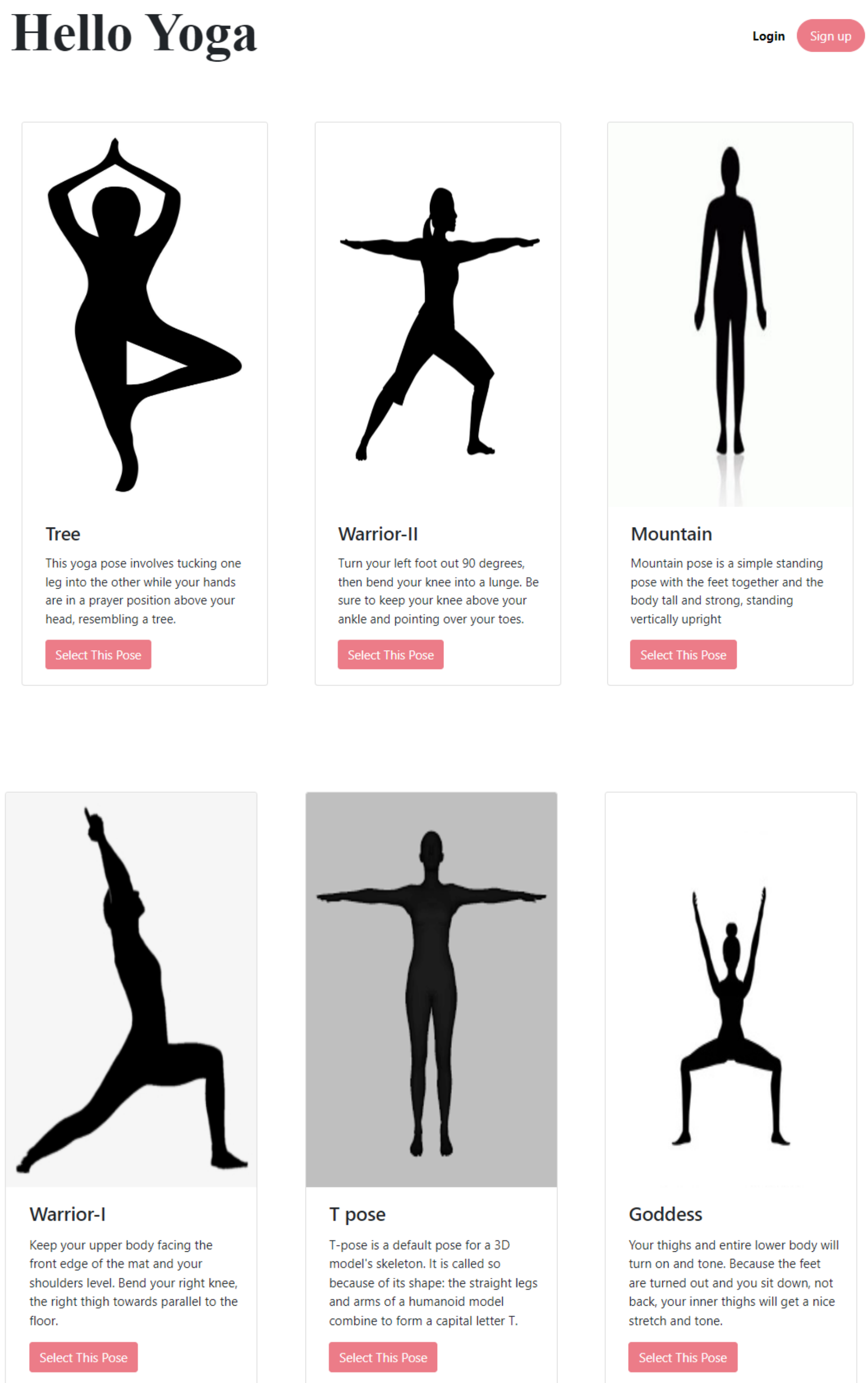

Figure 4.4: Different yoga poses

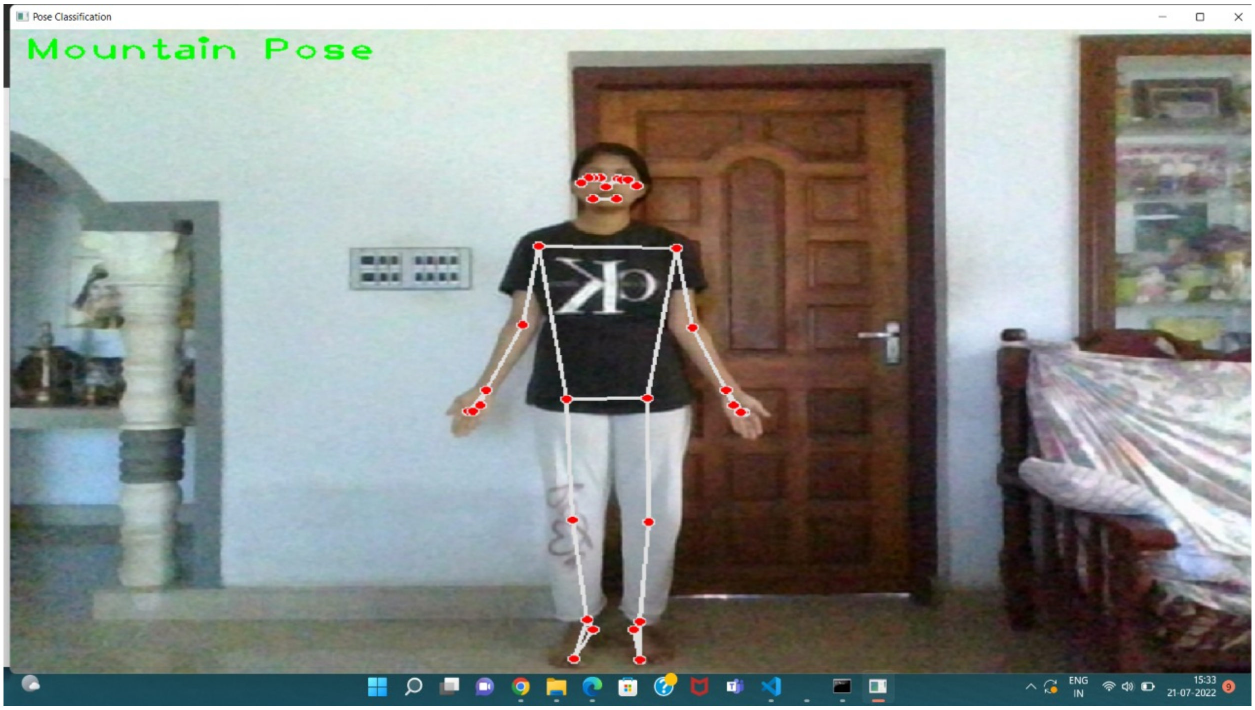

Figure 4.5: Mountain pose

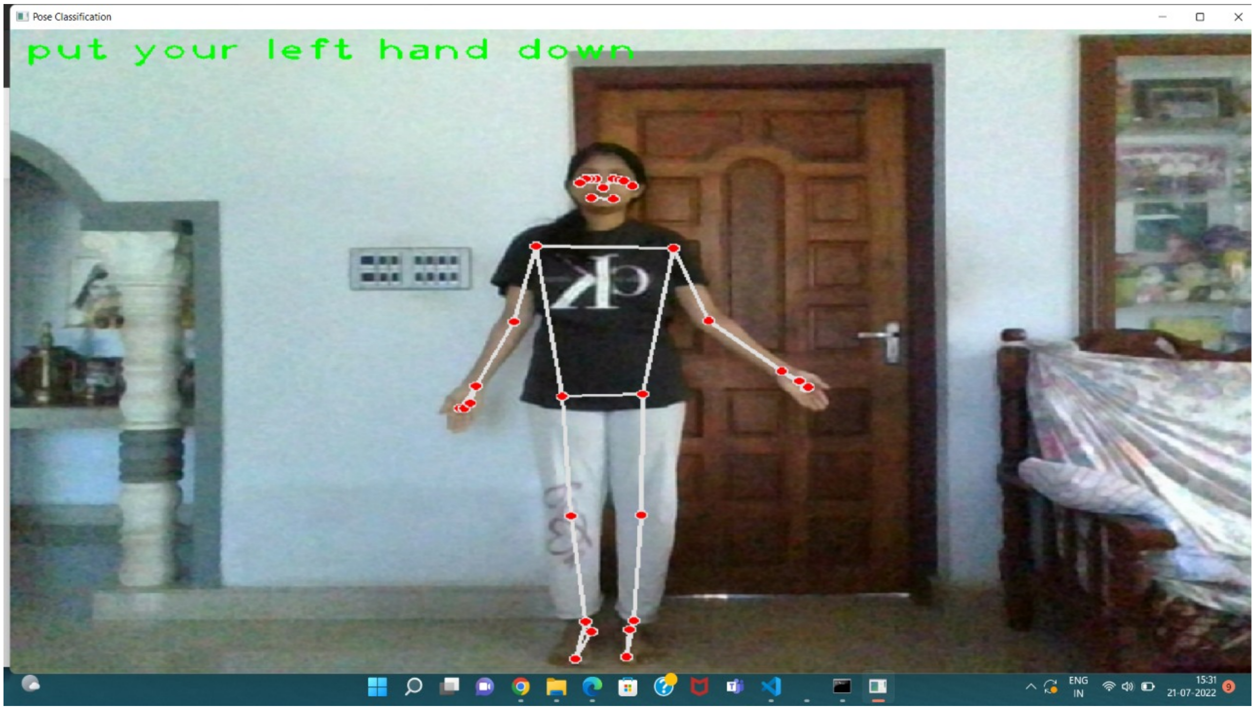

Figure 4.6: Mountain pose correction

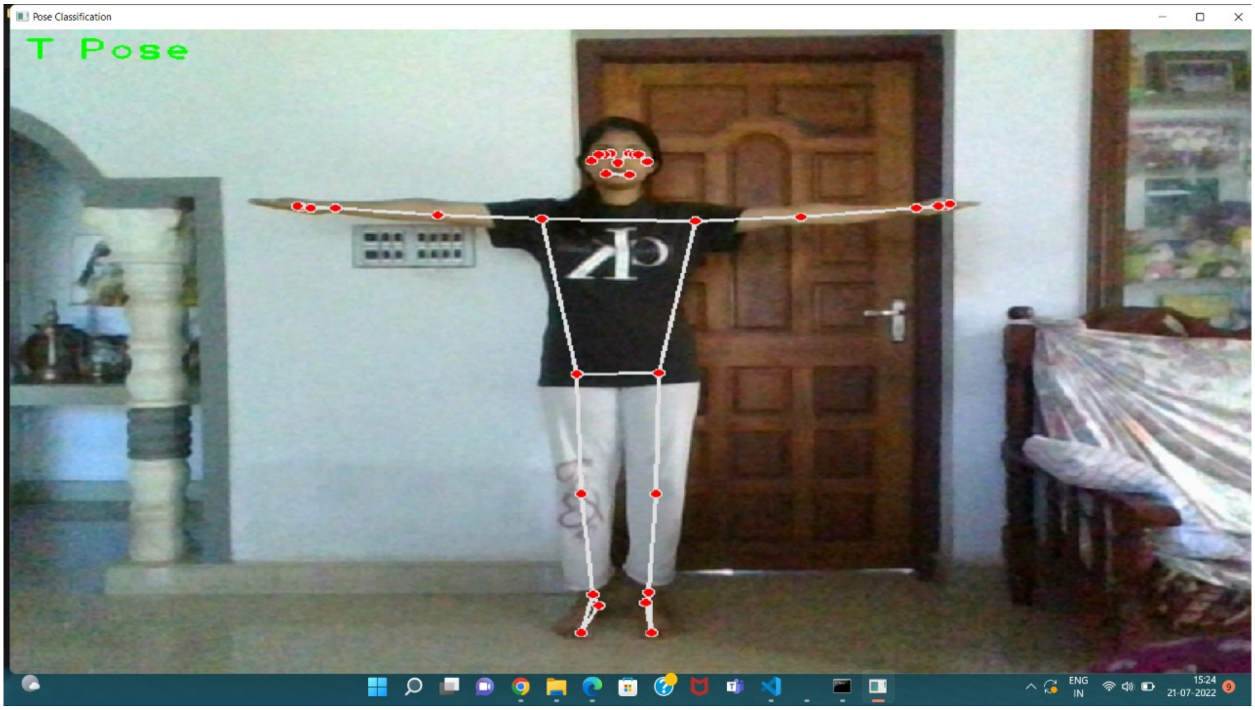

Figure 4.7: T pose

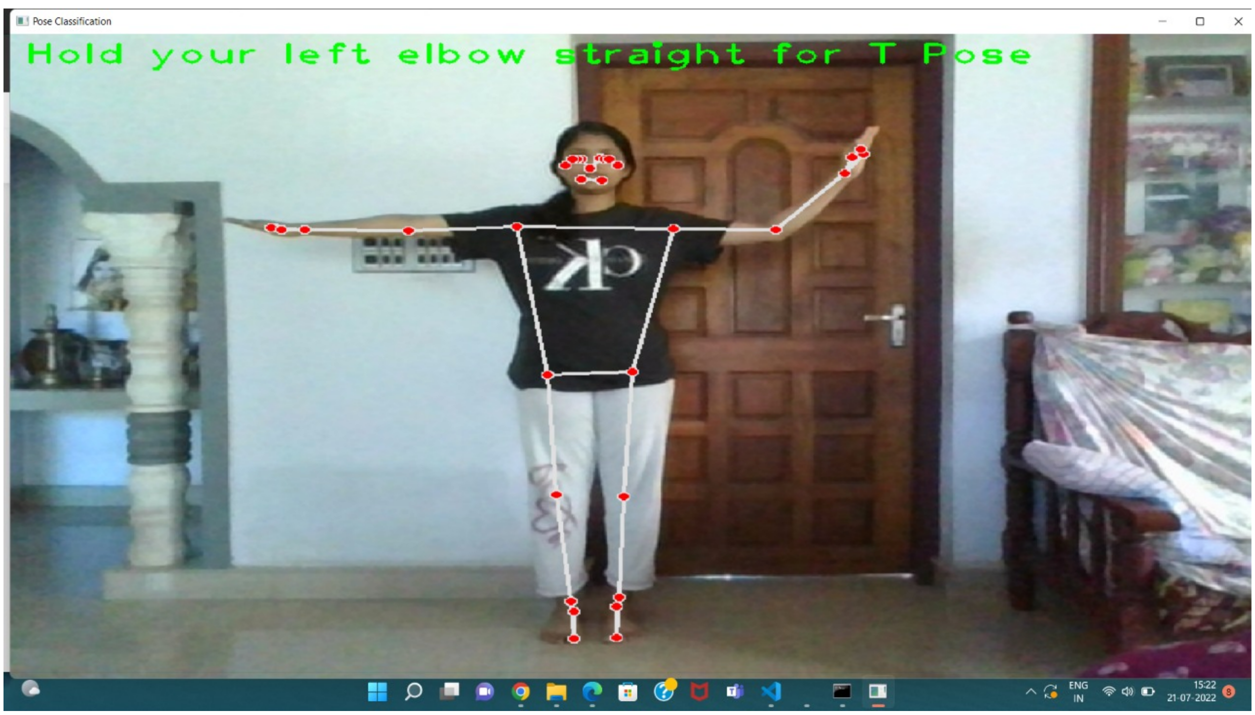

Figure 4.8: T pose correction

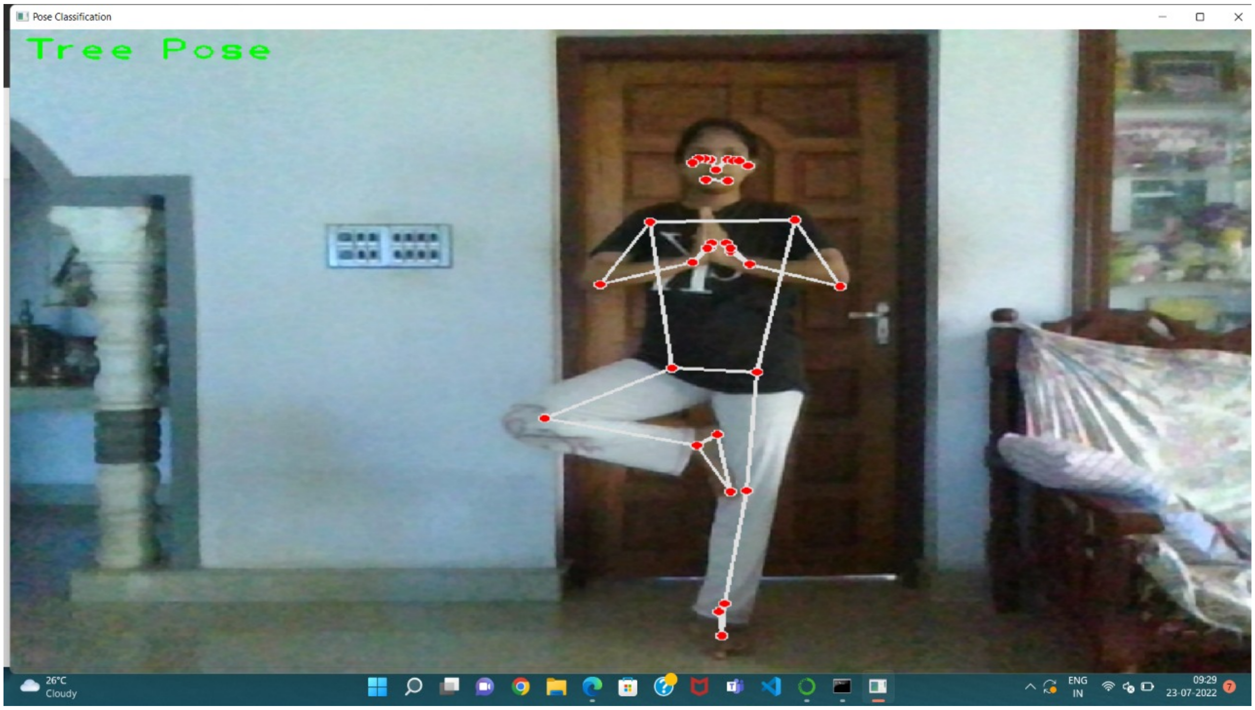

Figure 4.9: Tree pose

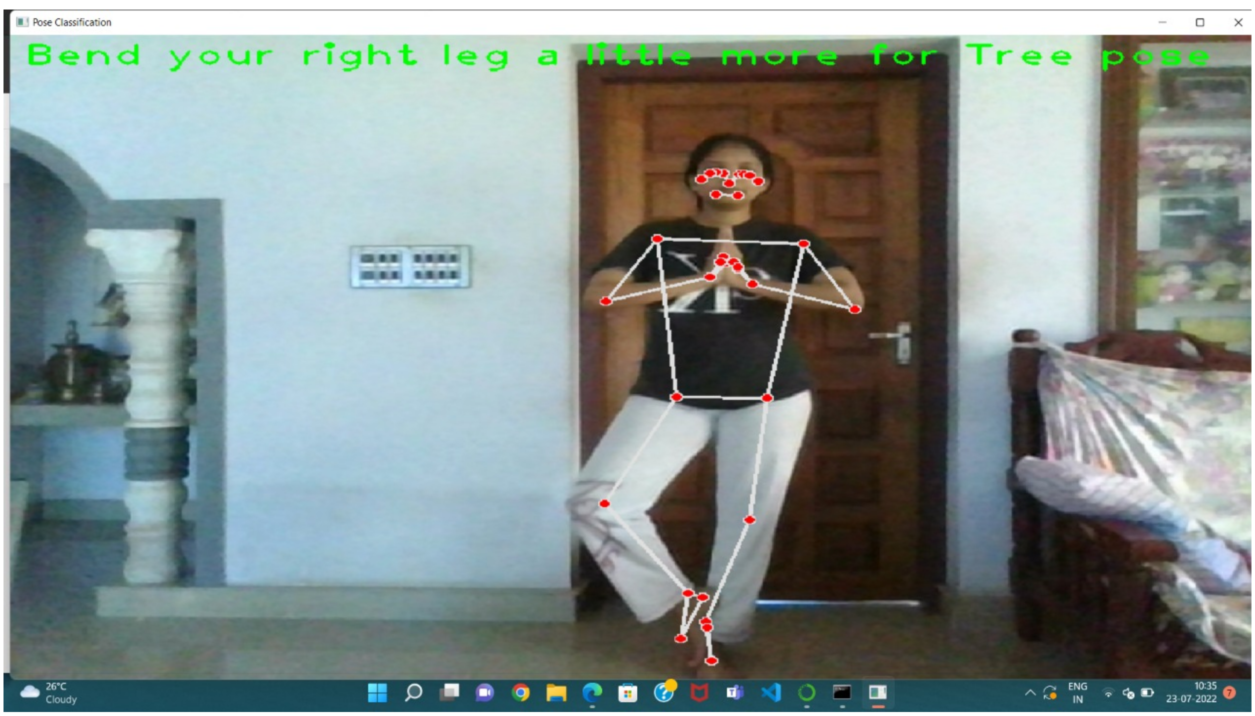

Figure 4.10: Tree pose

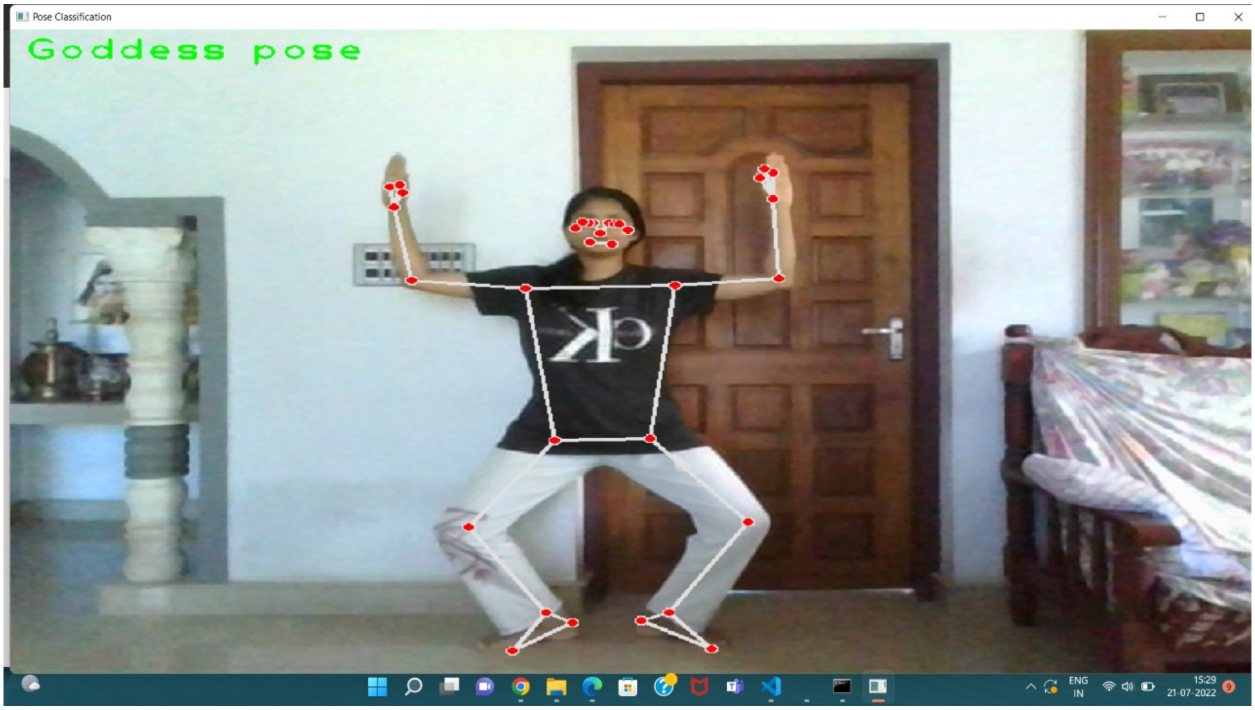

Figure 4.11: Goddess pose

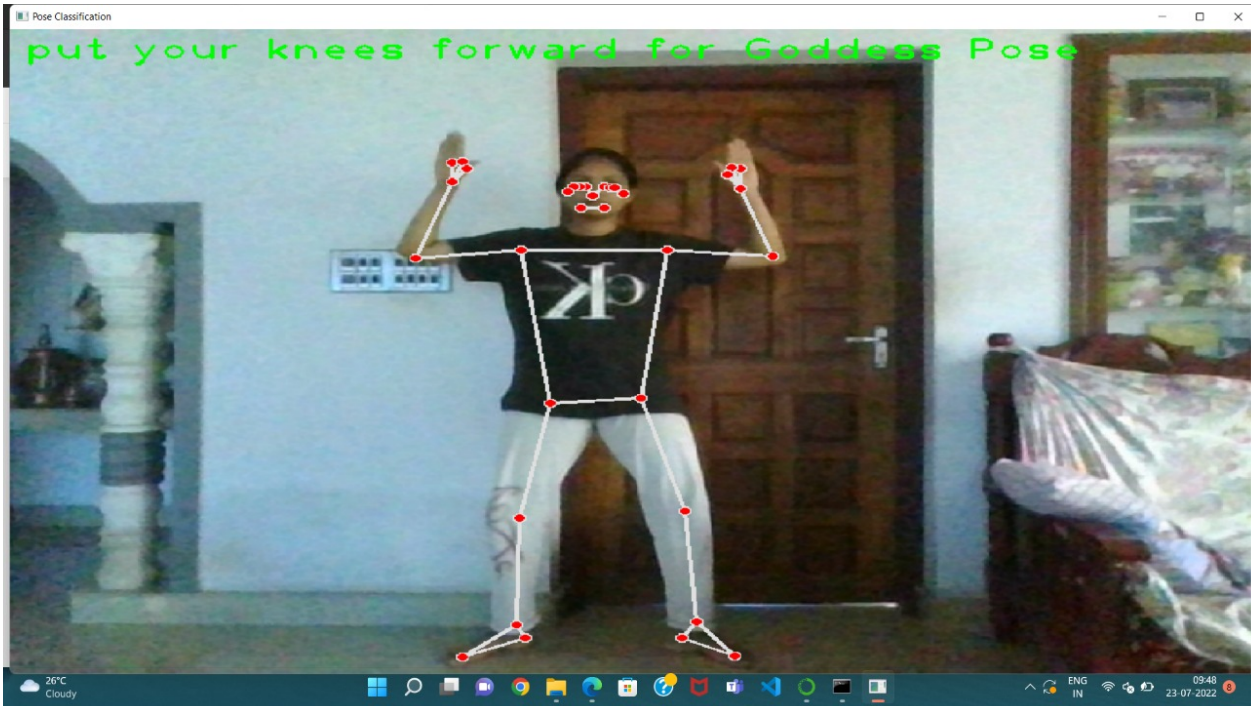

Figure 4.12: Goddess pose correction

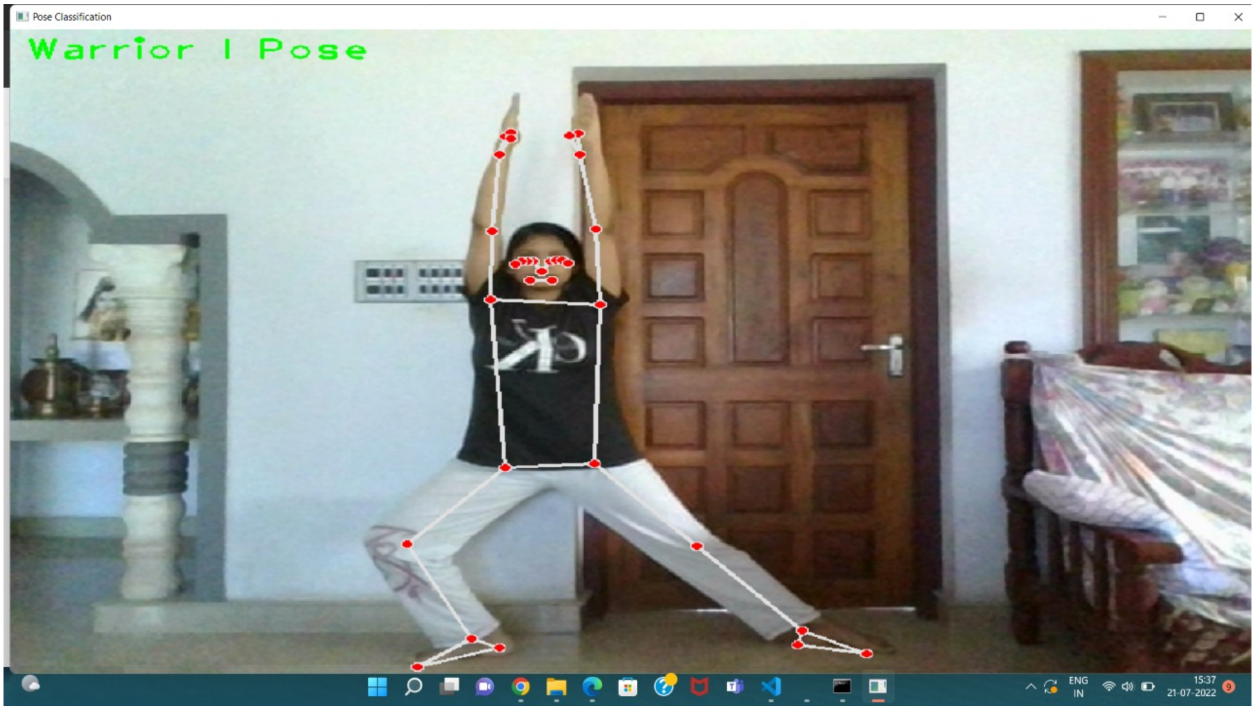

Figure 4.13: Warrior-I pose

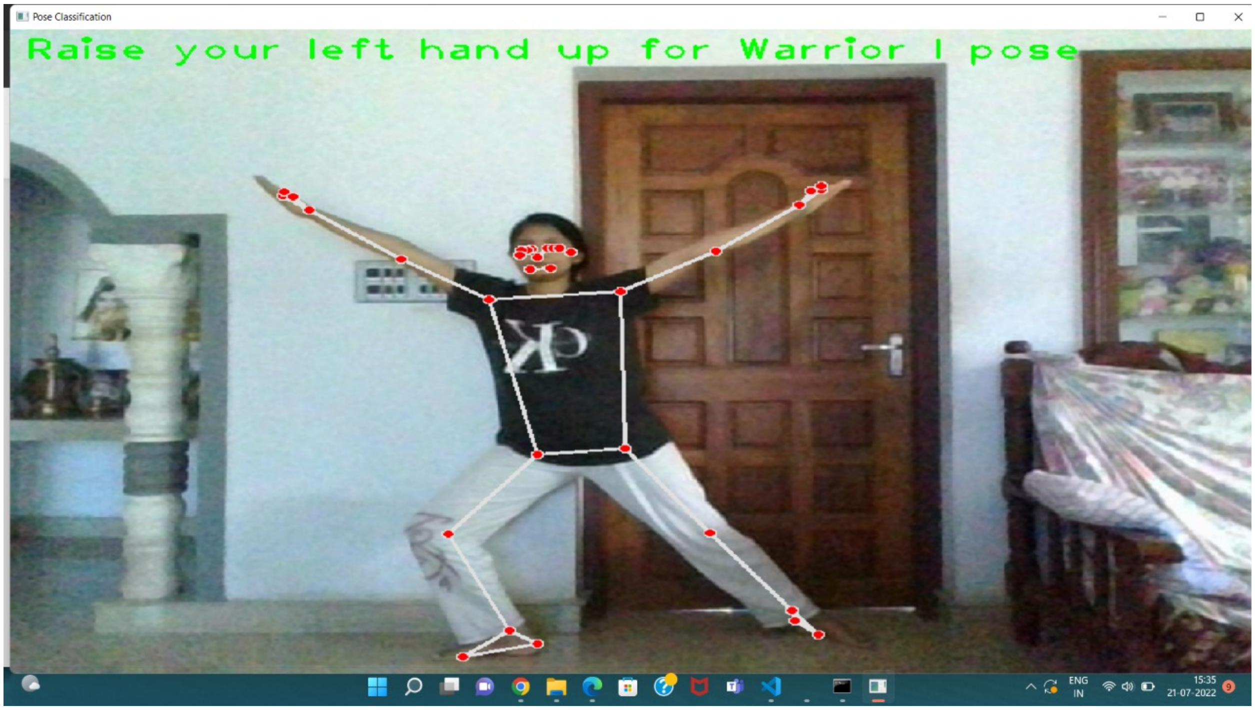

Figure 4.14: Warrior-I pose correction

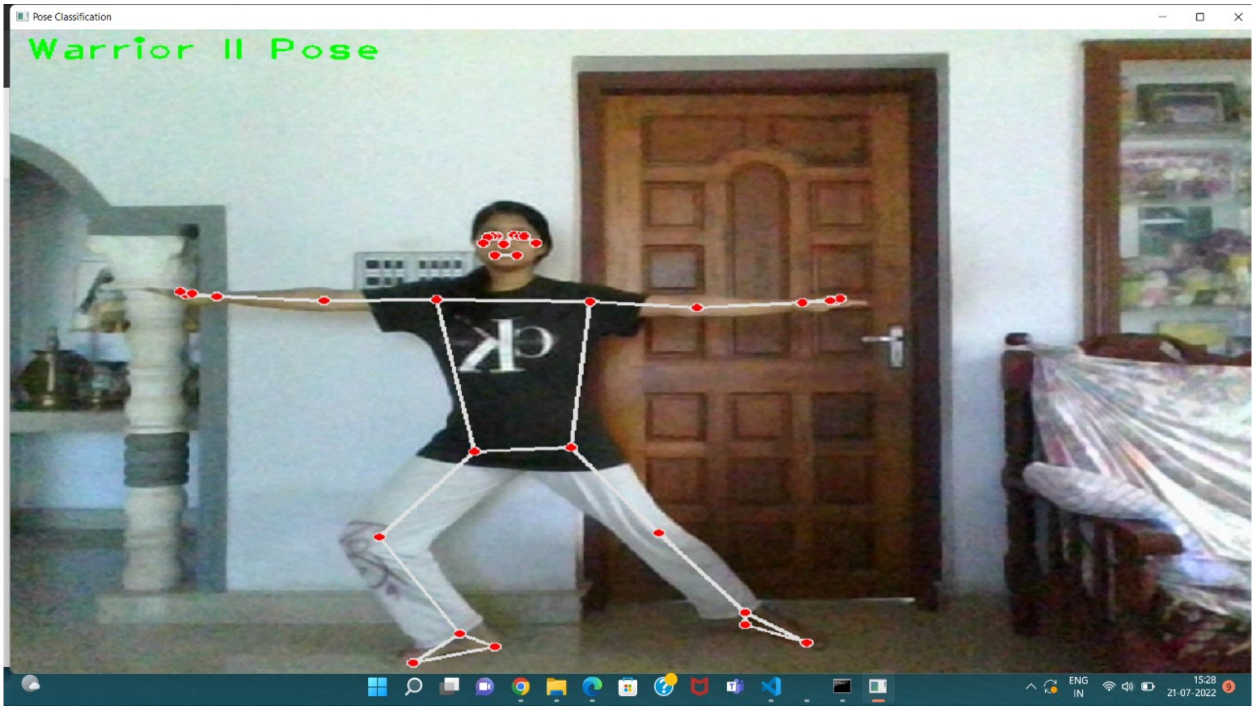

Figure 4.15: Warrior-II pose

Figure 4.16: Warrior-II pose correction

Chapter 5

CONCLUSION

Despite the fact that human poses appear to be complex, newly developed applications like yoga posture detection have made the adoption of the technology essential. A tool powered by artificial intelligence that teaches users how to perform yoga and other exercises properly could increase the appeal and advantages of these routines. People can prevent injuries and work out more effectively by utilising yoga posture estimation. Here, many yoga positions were captured on video, and learners had to adopt each yoga position. By examining the posture's properties, it can assess pose quality and differentiate between various movements. As a result, it uses the mediapipe algorithm to automatically evaluate yoga poses and offer suggestions to warn beginners.

The mediapipe method is employed in this project to extract various coordinates. Different joint angles, distances, and slopes between two points have been retrieved using the coordinates and employed as an assessment parameter for the correction of yoga postures. A growing number of practitioners are calling for the creation of computer-assisted training systems to assist them in bettering their knowledge and comprehension of various yoga postures and to safeguard them from harm that may come about while they are still learning. The approach suggested in this project can aid in the creation of applications and other tools that will make yoga and its advantages available to everyone.

5.1 Future Enhancement

The proposed paradigm currently divides yoga asanas into six groups. It is difficult to create a posture estimate model that is applicable to all yoga asanas because there are so many of them. Then, it can be expanded by including the necessary essential points for yoga poses. The technology can also be utilised to produce real-time predictions and do self-learning. Mediapipe's current evaluation, which may or may not be effective when there is overlap between people or across body parts, determines how the model is displayed. A single individual posture evaluation will not be sufficient in a number of real-life situations. It's difficult enough to include a variety of postures and to have the model perform a variety of poses.

In conclusion, I created a system for self-coaching yoga that can anticipate yoga position and instantly verify response from instruction. In the future, I intend to include additional challenging yoga asanas that are supported by AI. Since Covid-19 began, there has been an increase in home training, which, in our opinion, is supported by the method we built. The right yoga posture is identified using the yoga self-coaching system, which also provides on-the-fly guidance.

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APPENDIX

A Screenshots

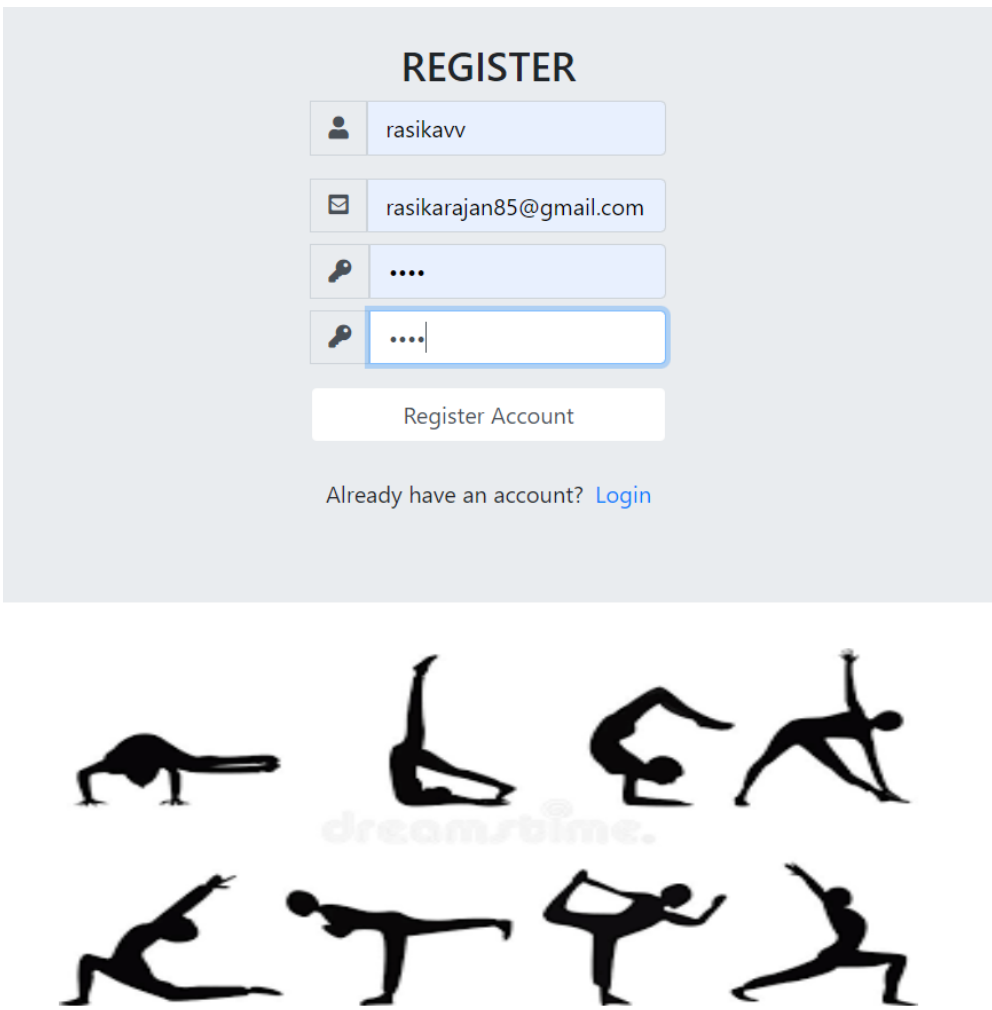

Figure A.1 : User registration

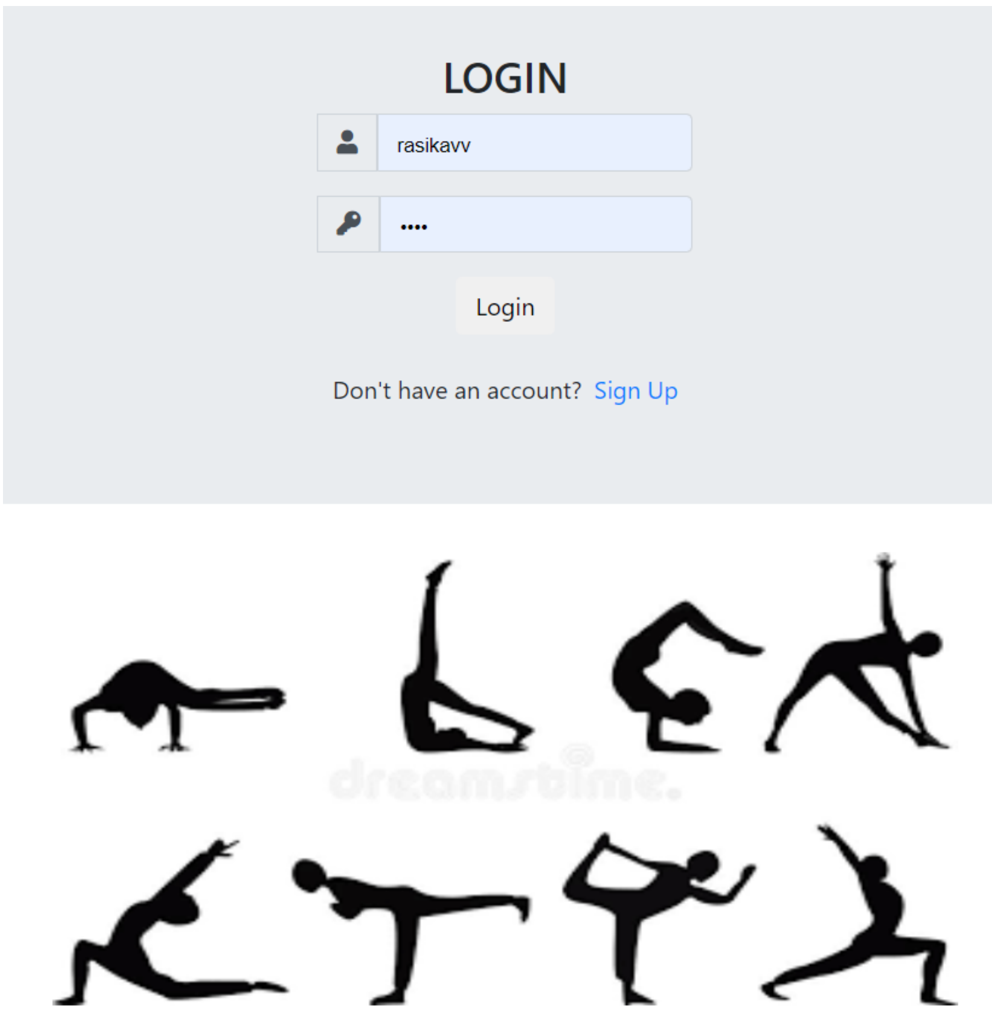

Figure A.2 : User login