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Yoga Pose Detection and Correction System

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Abstract: ***Activity recognition is useful in many domains. These include biometrics, video -surveillance, human-computer interaction, assisted living, sports arbitration, in-home health monitoring, etc. The health status of an individual can be evaluated and predicted by monitoring and recognizing their activities. Yoga is one such domain that can be used to bring harmony to both body and mind with the help of asana, meditation, and various other breathing techniques. Nowadays in a fast-paced lifestyle, people do not have time to go to yoga classes. Hence, they prefer practicing yoga at home. However, there is a need for a tutor to assess their yoga poses. Hence, the system is presented where the user needs to do the yoga pose which is recognized in real-time video. Then, PoseNet is used to generate key points for the body parts. The identified pose is then compared with the target pose. Based on the comparison status generated by the function, verbal instructions are provided for the user to correct the yoga pose.***

Keywords: Real-time video; PoseNet; generation of key points; comparison with target pose; verbal instructions.

I. INTRODUCTION

The word yoga was gotten from the Sanskrit word Yuj which signifies 'to join' or 'to join together'. The union is not, merely, about our nose touching our knees as the user bend to touch our toes! The union referred to our mind with our body.

Several thousand years ago, on the banks of the lake Kantisarovar, Adiyogi poured his profound knowledge into the legendary Saptarishis or the "seven sages". The sages conveyed the incredible yogic science to various pieces of the world, including Asia, the Middle East, Northern Africa, and South America. Strangely, present day researchers have noted and wondered about the nearby equals found between antiquated societies across the globe. However, it was in India the yogic system was found its fullest expression. Agastya, the Saptarishi who traveled across the Indian subcontinent, crafted the culture around a core Yogic way of life.

Yoga includes different asanas which speak to actual static stances. The utilization of posture assessment for yoga is trying as it includes a complex setup of stances. Additionally, some top tier methodologies disregard to perform well when the asana incorporates even body act on the other hand when both the legs cover each other. Hence, the need to build up a strong model which can help advocate self-taught yoga frameworks. Human pose estimation is a well-established computer vision problem which has imposed several challenges over the years [1]. It is the problem of locating key points and the posture of a human body from the sensor data. Activity recognition is useful in many domains including biometrics, video surveillance, human-computer interaction, assisted living, sports arbitration, in-home health monitoring, etc. [2–4]. The fitness and health of an individual can be evaluated and predicted with the help of monitoring and recognizing their activities [5]. Yoga posture detection and correction is a relatively newer application. Yoga is an ancient science originated in India. According to the Bhagavad Gita, it is the remover of Misery and the destroyer of pain. Recently, Yoga is gaining fame across the globe due to its physical, mental, and spiritual benefits. In 2014, the General Assembly of United Nations has proclaimed 21st June as the 'Worldwide Day of Yoga' [6]. Over the last decade, Yoga is getting increasing importance in the medical research community, and numerous pieces of literature have been proposed for various medical applications including cardiac rehabilitation [6], positive self-perception intercession [7,8], dysfunctional behaviors [9], and so forth. Without the use of medicines, Yoga can almost completely cure many diseases [10]. Yoga practices support actual wellbeing just as help to purify the body, psyche, and soul [11]. It comprises many asanas and each of them denotes the static physical postures [12]. Yoga learning and self-instruction systems can popularize and spread Yoga while ensuring it is practiced correctly [13,14]. Humans are more likely to get musculoskeletal disorders with aging and accidents. To prevent some, form of physical exercise is needed. An application of pose estimation which has attracted many researchers in the field of exercise and fitness. One form of exercise with intricate postures is yoga which is an age-old exercise started in India, which is now famous worldwide because of its many spirituals, physical, and mental benefits [15]. Humans are prone to musculoskeletal disorders with aging and accidents [16]. Yoga, which is a physical and otherworldly exercise, has acquired gigantic importance locally of clinical scientists. Yoga can completely cure diseases without any medicines and improve physical and mental health A tremendous assortment of writing on the clinical utilizations of yoga has been produced which incorporates positive self-perception intercession, cardiovascular restoration, psychological sickness, and so forth. Yoga comprises various asanas which represent physical static postures.

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II. MATERIAL AND METHOD

A. Deep learning

Deep learning approaches help provide a more straightforward way of mapping the structure cancelling the need to deal with the dependencies between structures manually. [16] used deep learning to identify 5 exercise poses: pull up, swiss ball hamstring curl, push up, cycling, and walking. However, using the deep learning method for yoga poses is a relatively newer application [15].

One significant learning-based technique is profound realizing which is based upon Artificial Neural Networks (ANNs). An ANN is analogous to the human brain where the units in an ANN represent the neurons in the human brain, and weights represent the strength of the connection between neurons. Deep learning provides an end-to-end architecture will allow automatic learning of key information from images. One popular deep learning model which has been widely used for pose estimation is Convolutional Neural Network (CNN) which will be discussed later. [19] have contributed to the research by using CNNs and stacked auto-encoder algorithms (SAE) for identifying yoga poses and Indian classical dance forms. Nonetheless, their presentation assessment is done distinctly on pictures and not on recordings.

B. PoseNet

PoseNet is another deep learning framework similar to OpenPose which is used for the identification of human poses in images or video sequences by identifying joint locations in a human body. These joint locations or key points are indexed by "Part ID" which is a confidence score whose value lies in the range of 0.0 and 1.0 with 1.0 being the greatest. The performance of the PoseNet model varies depending on the device and output stride [14]. The PoseNet model is invariant to the size of the image, thus it can predict pose positions in the scale of the actual image irrespective of whether the image has been downscaled. In PoseNet, the SoftMax layer is replaced by a sequence of fully connected layers. A high-level architecture of PoseNet is shown in Fig. 1 [18]. The first component in the architecture is an encoder which is responsible for generating the encoding vector v, a 1024-dimensional vector is an encoded representation of the features of the input image. The second component is the localizer which generates vector u which denotes localization features. The last component is a regressor which consists of two connected layers are used to regress the final pose.

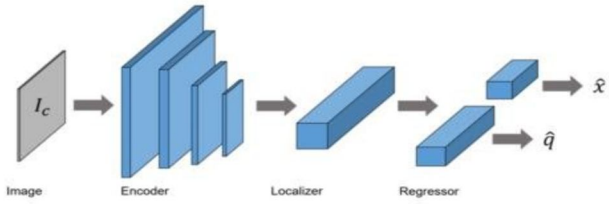

Fig.1 System architecture of PoseNet

The various body joints detected by the PoseNet model are tabulated below:

Id	Part Identified
0	nose
1	left eye
2	right eye
3	left ear
4	right ear
5	left shoulder
6	right shoulder
7	left elbow
8	right elbow
9	left wrist
10	right wrist
11	left hip
12	right hip
13	left knee
14	right knee
15	left ankle
16	right ankle

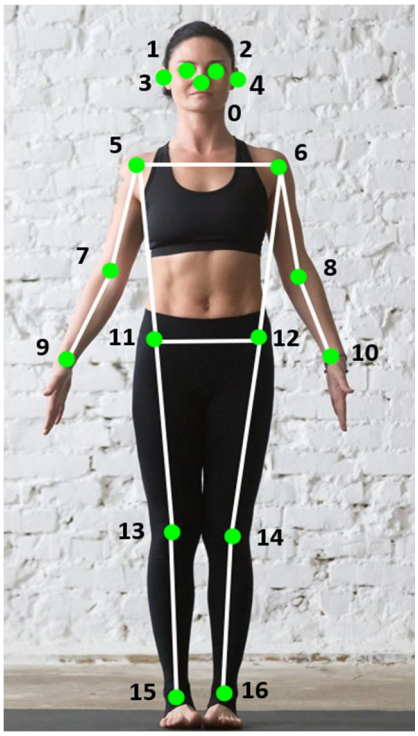

Fig.2 Seventeen key points identified by PoseNet

1) *Pose* – Overall, PoseNet will return a pose object containing a list of key points and an instance-level confidence score for a detected person.
2) *Pose confidence score* - Determines the overall confidence in the estimation of a pose, ranging between 0.0 to 1.0. It can be used to hide poses which are not deemed strong enough.
3) *Keypoint* - A part of a person's pose where the key body part is estimated, such as the nose, right ear, left knee, right foot, etc.
4) *Keypoint Confidence Score* - Determines the confidence of an estimated keypoint position is accurate, ranging between 0.0 and 1.0. It can be used to hide key points are not deemed strong enough.
5) *Keypoint Position* - 2D x and y coordinates in the original input image where a key point has been detected.

C. Ml5.js

ml5.js is an open-source project and a machine learning for the web in your web browser. Through some astute and invigorating headways, the people building TensorFlow.js sorted out it is feasible to utilize the internet browser's underlying designs preparing unit (GPU) to do computations would otherwise run very slowly using a central processing unit (CPU). The library is upheld by code models, instructional exercises, and test informational indexes with an accentuation on moral registering. ml5.js is intensely roused by preparing and p5.js.

D. SpeechSynthesis API

Text-to-speech (TTS), which is a type of speech synthesis application, is used to create a spoken sound version of the text in a document, such as a text document in a computer, or a web page. TTS can empower the perusing of PC show data for the outwardly tested individual, or may essentially be utilized to expand the perusing of an instant message. Currently, TTS applications include voice-empowered email and spoken prompts in voice reaction frameworks. The SpeechSynthesis API provided by JavaScript can be used to provide verbal instructions to the user for the pose correction.

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E. Methodology

Fig. 3 shows the block diagram of methodology and the detailed description of the methodology is as follows:

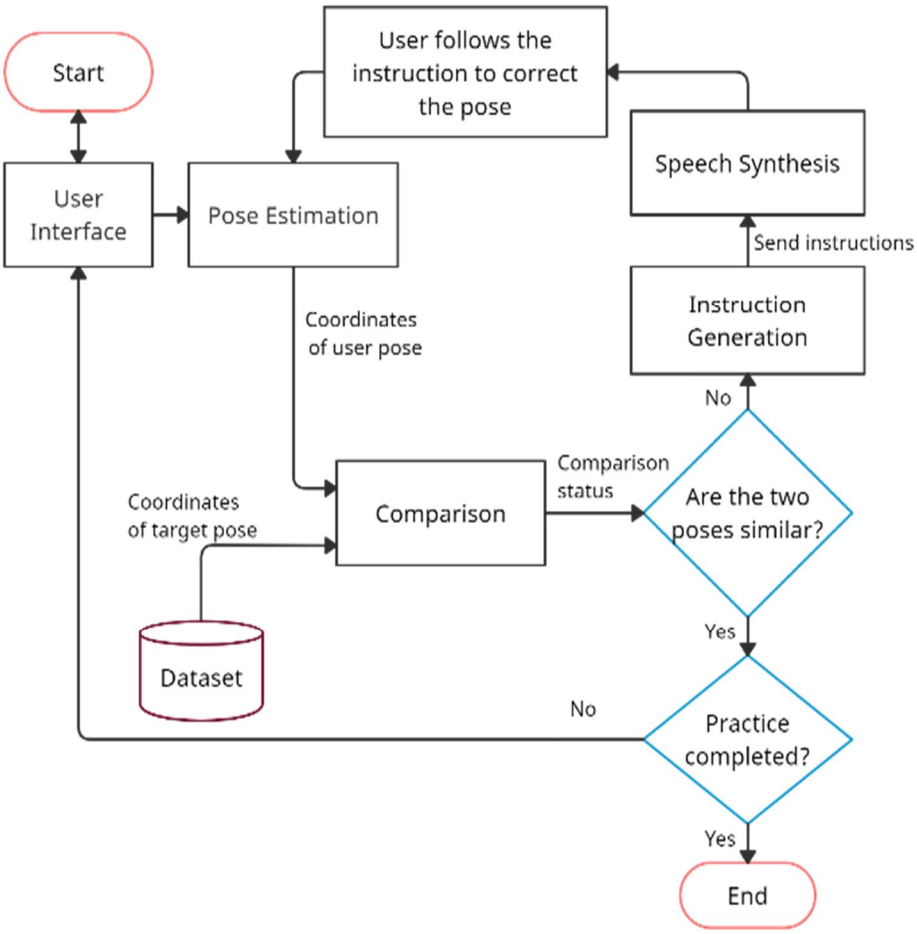

Fig. 3 Methodology

1) *User Interface:* The user interface allows the users to know about the yoga poses the system offers and their benefits. The user can either perform all the yoga poses in a sequence or can practice each yoga pose separately. Textual as well as verbal instructions are given for the users to correct their poses.
2) *Capture user movements:* Live video feed from the webcam is used to capture the user movements. PoseNet is used for yoga pose detection and correction. PoseNet is a Machine Learning model which provides constant human posture recognition for the system. The system allows the user to first fix their position in front of the camera. Then the user can perform the yoga pose as shown in the image.
3) *Identification and Comparison:* Here, the user's yoga pose is detected. The key points are identified and the skeleton diagram is drawn on the video canvas. These key points are used to compare the user's pose with the target yoga pose to see if there is any correction required. If the two poses have a high similarity status, then pose of user is treated as perfect.
4) *Instruction Generation:* If the user's yoga pose is not matching with the coordinates of the target yoga pose, instructions are generated by the system for the user to correct his/her pose. The instructions can be followed by the user to correct his/her mistakes.
5) *Speech synthesis:* The textual instructions are fed as an input to the speech synthesis API of the JavaScript which will then provide verbal instructions to the user for the pose correction.
6) *End:* After practicing yoga, the user can continue their sessions or they can stop the practice session.

III.RESULTS AND DISCUSSION

1) Home Page

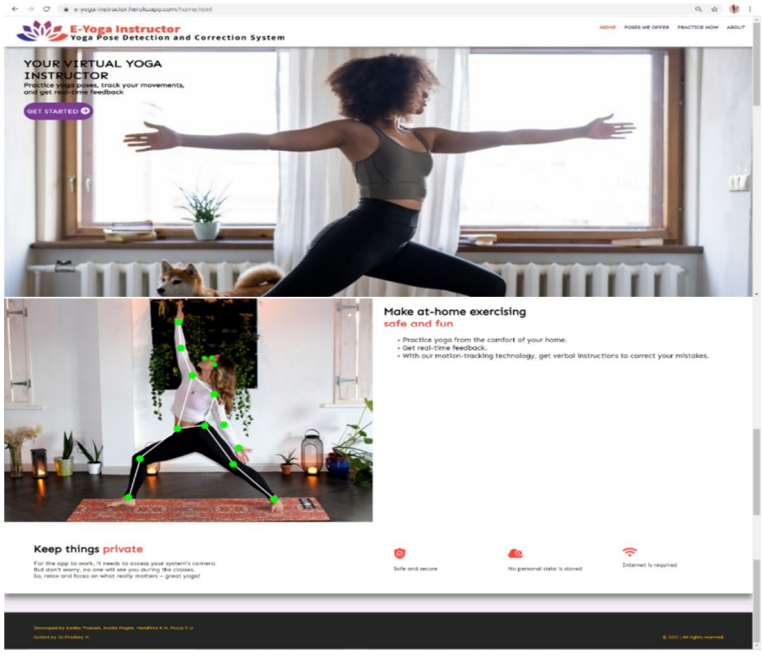

Fig. 4 Home Page

- *Description:* On visiting home page, verbal greetings are provided to the user. The user can click on the GET STARTED button to proceed with the practice session, which navigates to the PRACTICE NOW page.

2) Practice Now Page

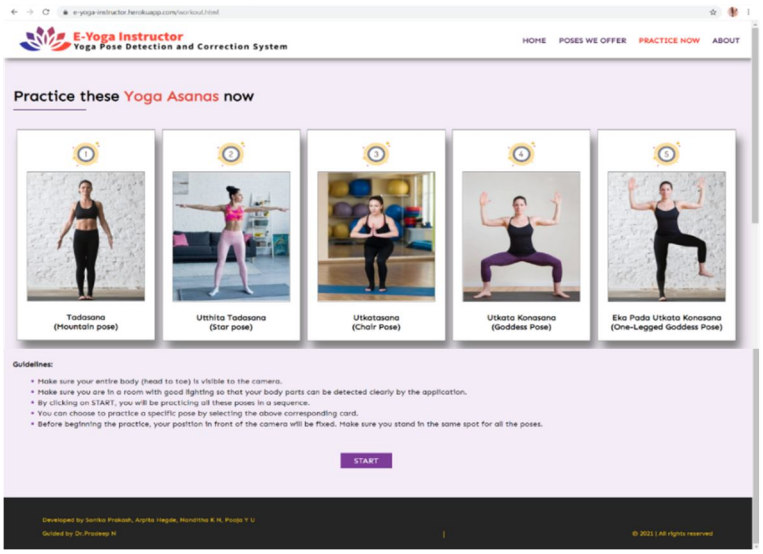

Fig. 5 Practice Now Page

Description: Practice now page will show all the poses offered by the system and the guidelines to be followed by the user. Here, the user can choose the particular pose or they can click on the START button to perform all the yoga poses in a sequence.

3) Fixing of Position Page

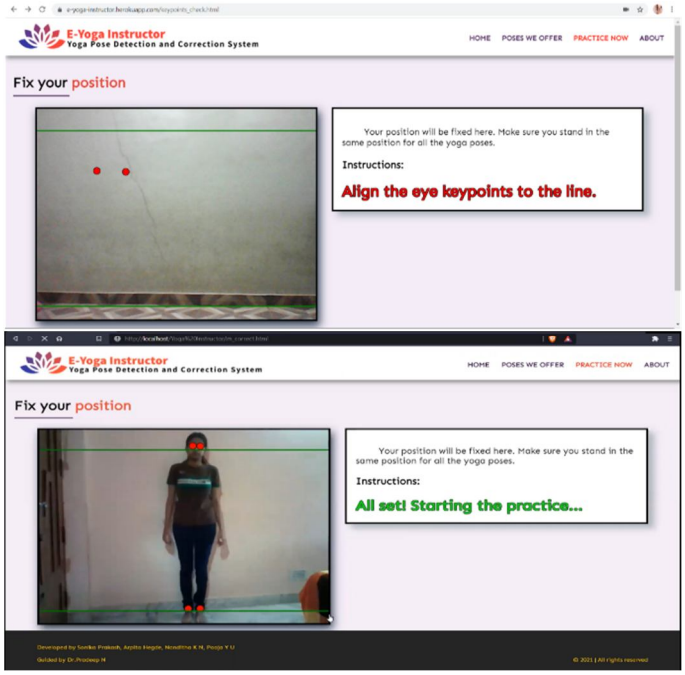

Fig. 6 Fixing of position.

Description: Fig. 6 shows the fixing of position page where the instructions to the user are given to align the eye and ankle key points, so the user's position is fixed in front of the camera. It will be done to ensure the user's entire body (head to toe) is visible in the camera.

4) Practicing a Pose

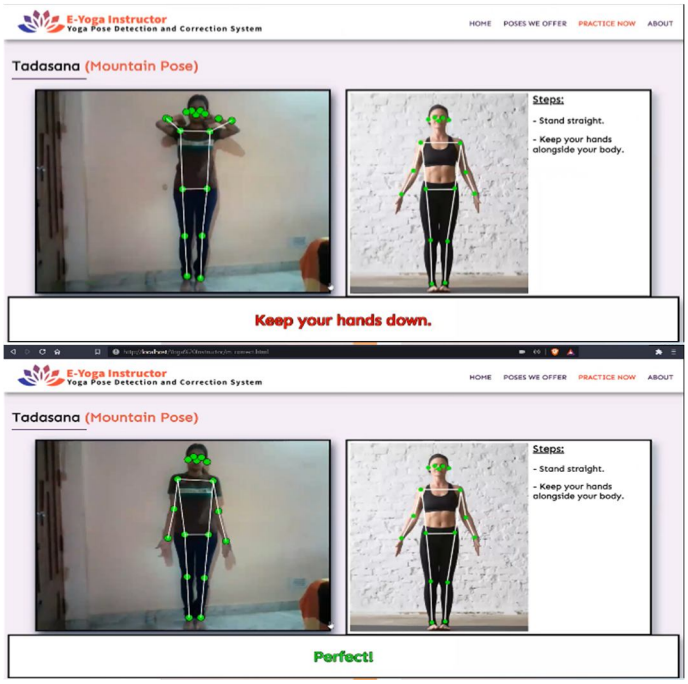

Fig. 7 Mountain Pose

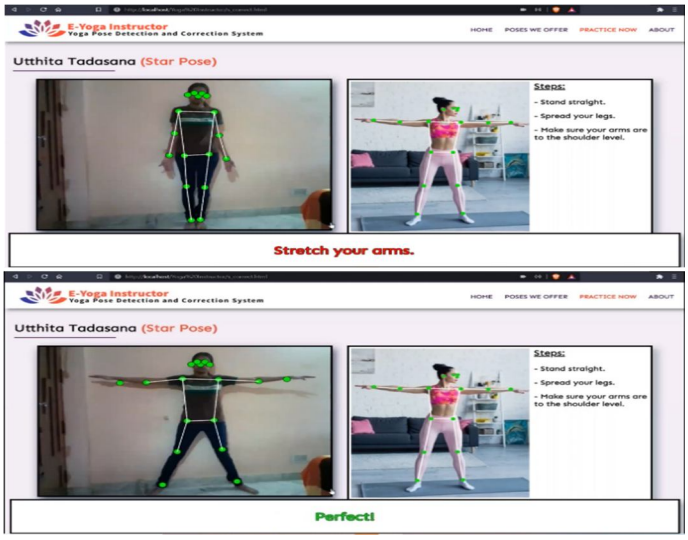

Fig. 8 Star Pose

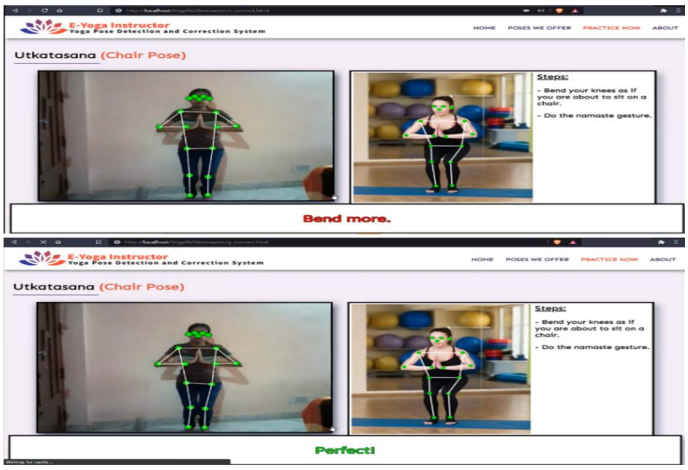

Fig. 9 Chair pose

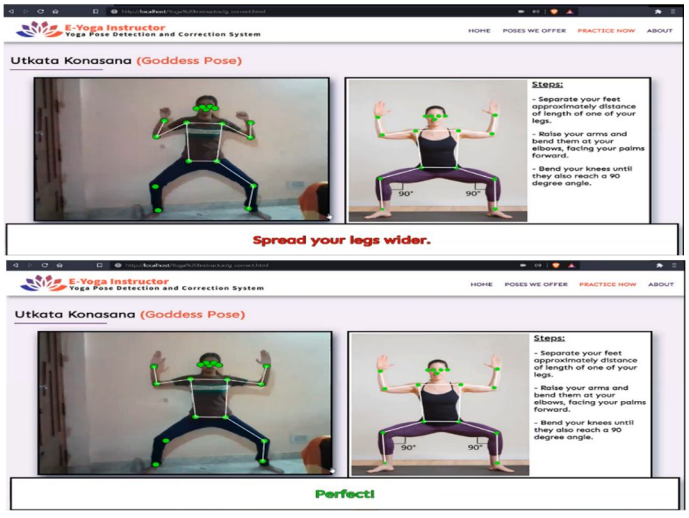

Fig. 10 Goddess Pose

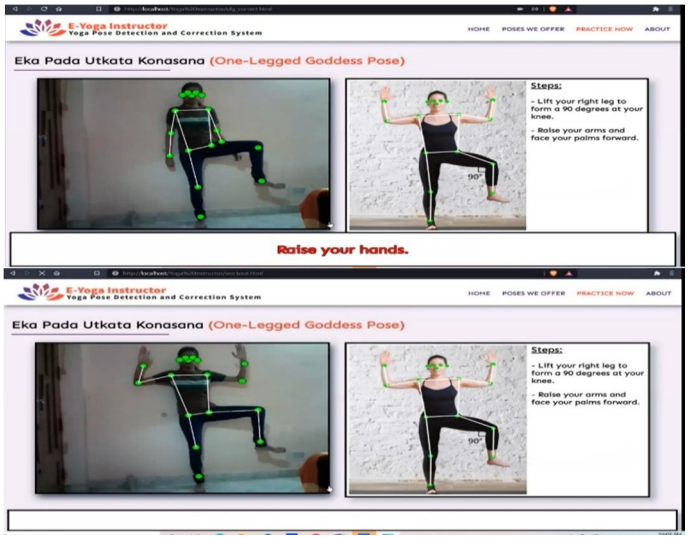

Fig. 11 One-Legged Goddess Pose

Description: While practicing a pose, first the user's pose is identified and the generated key points and the skeleton is drawn on the video canvas. Instructions are provided for the user to do the yoga pose correctly. Upon successfully performing the yoga pose, the system tells the user to hold the pose and breathe deeply.

IV. CONCLUSION

The application done on the Yoga pose detection and correction system can operate without any sensors. The literature review helped to understand the drawbacks of the existing systems. As compared to other computer vision problems, human pose estimation is different as it has to localize and assemble human body parts based on an already defined structure of the human body. The presented solution will help users practice yoga poses without the help of a yoga tutor. Self-instruction systems for Yoga carry the potential to make yoga popular along with making sure it is performed in the right manner. Deep learning methods are promising because of the vast research being done.

V. FUTURE WORK

A. Model currently focuses on detecting the asana pose of a single person. In future the model can be improved to detect multiple people in one frame.
B. More yoga poses need to be included in the system.
C. Verbal instructions can be provided in multiple languages.
D. Allowing the user to share their scores or progress.

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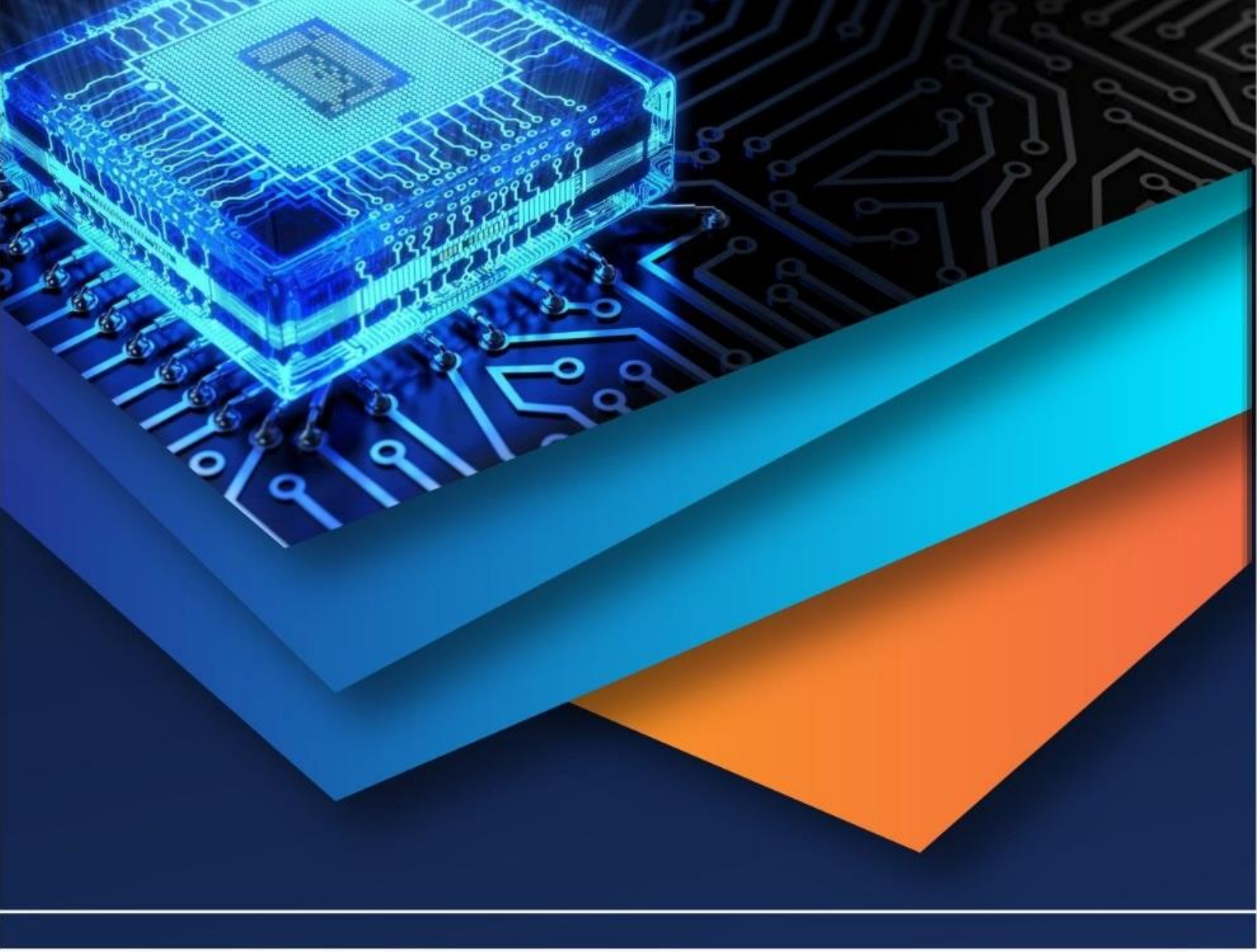

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