ISSN: 2633-4828 Vol. 5 No.4, December, 2023

International Journal of Applied Engineering & Technology

MACHINE LEARNING BASED YOGA POSE CORRECTION.

Meghana J H[1] and Chethan H K[2]
[1]Research Scholar, Maharaja Research Foundation, University of Mysore, India
[2]Professor, Department of Computer Science and Engineering, MIT Thandavapura, Mysore, India
[2]meghanajravi@gmail.com

ABSTRACT

Yoga practice often requires precise body positioning to maximize its benefits and prevent injuries. However, self-correction of yoga poses can be challenging, leading to suboptimal results or potential physical strain. Machine learning-based yoga pose correction systems, highlighting their potential to revolutionize the yoga experience.

Machine learning algorithms, particularly deep learning models, have shown promise in accurately identifying and correcting yoga poses. By leveraging computer vision techniques, these systems can analyse live or recorded video feeds of individuals performing yoga poses and provide real-time feedback on posture alignment, balance, and form.

Key components of these systems include pose estimation, which involves identifying key body joints and angles, and comparing them to ideal reference postures. Additionally, machine learning models can provide personalized feedback tailored to the user's specific needs, thus enhancing the overall yoga practice experience.

Lastly, prospects for machine learning-based yoga pose correction systems are explored, including expanding the scope to encompass a wider range of yoga poses, improving user interface and experience, and integrating user progress tracking for personalized training programs.

As AI systems become more intricate, there's a growing focus on ethical considerations, explain-ability, and interdisciplinary collaboration to ensure responsible development and deployment. Furthermore, advancements in edge computing, personalized experiences, and generative models like GANs and VAEs highlight the multifaceted impact of advanced AI on industries, economies, and societal norms, necessitating thoughtful governance and ethical frameworks.

Keywords: Artificial Intelligence, Machin Learning, Media Pipe, Pose correction, Yoga pose,

INTRODUCTION

Precise alignment matters in yoga for both maximizing benefits and preventing injuries. expand more However, achieving proper form can be challenging, especially when practicing alone. This abstract explores the potential of machine learning-based systems to revolutionize yoga practice by providing real-time feedback on pose accuracy.

A key component of these systems is poise estimation. This process involves identifying key body joints and angles and comparing them to ideal reference postures to determine the accuracy of the practitioner's pose Moreover, these machine learning models can provide personalized feedback, which is tailored to the user's specific needs, thereby enhancing the overall yoga practice experience.

Deep learning models, powered by computer vision, can analyse video footage of yoga poses and identify key body joints and angles. expand more by comparing these to ideal reference postures, the system can provide real-time guidance on alignment, balance, and form. This personalized feedback tailors to individual needs, enhancing the overall yoga experience.

Beyond basic pose correction, the abstract looks to the future, envisioning systems that:

- Expand to encompass a wider range of yoga poses.
- Offer improved user interfaces and enhanced user experience.

- Integrate user progress tracking for personalized training programs.

The abstract acknowledges the importance of ethical considerations, explainability, and interdisciplinary collaboration in developing and deploying such AI systems responsibly. Additionally, it touches on the broader implications of advanced AI, including:

- Edge computing
- Personalized experiences
- Generative models

These advancements highlight the multifaceted impact of AI on various aspects of society, emphasizing the need for thoughtful governance and ethical frameworks.

REVIEW OF LITERATURE

[1] The research paper titled "Yoga Pose Estimation and Feedback Generation Using Deep Learning" by Vivek Anand Thoutam et al. presents a novel deep learning-based technique for yoga pose estimation and feedback generation. The authors address the challenge of incorrect yoga postures during self-learning, which can lead to health issues. They propose a three-step methodology involving feature extraction, classification, and feedback generation. The system uses Keras multiperson pose estimation for feature extraction and Multilayer Perceptron (MLP) for pose classification. The proposed method achieved an impressive accuracy of 0.9958, outperforming other models like SVM, CNN, and CNN+LSTM. The authors suggest that their system can be expanded to include more yoga poses and can be used for real-time predictions and self-training on a mobile device.

[2] The research paper titled "Yoga Pose Estimation Using Angle-Based Feature Extraction" by Debanjan Borthakur, Arindam Paul, Dev Kapil, and Manob Jyoti Saikia, published in Healthcare 2023, presents a novel approach to detecting correct yoga poses and providing real-time feedback using computer vision and machine learning techniques. The authors address the challenge of maintaining proper yoga postures, especially in the context of virtual yoga instruction. They used the Yoga-82 dataset and MLKit Pose Detection to calculate yoga pose angles, which were then used as features for training classifiers. The extremely randomized trees model outperformed other models, achieving a prediction accuracy of 91% on the test dataset and 92% in a fivefold cross-validation experiment. The authors suggest that their approach has significant potential for implementation on low-powered smartphones, enabling real-time feedback for users practicing yoga at home.

[3] The research paper titled "Deep Learning Models for Yoga Pose Monitoring" by Swain, D.; Satapathy, S.; Acharya, B.; Shukla, M.; Gerogiannis, V.C.; Kanavos, A.; Giakovis, D., published in the journal Algorithms in 2022, presents a novel approach to monitoring yoga poses using deep learning models. The authors propose a self-guidance practice framework that uses a combination of Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) for yoga pose recognition through real-time monitored videos. The system consists of three main phases: key points extraction, pose prediction, and pose correction. The system achieved an accuracy of 99.53% on the test dataset. The authors suggest that their system provides a reliable method for real-time yoga pose monitoring and that future work could explore variations and combinations of the proposed models to further improve accuracy.

[4] The Research Paper: A Step-by-Step Approach" by Abdullah Ramdhani, Muhammad Ali Ramdhani, and Abdusy Syakur Amin, published in July 2014, provides a comprehensive guide on how the authors discuss the importance of literature reviews in research and outline the skills required for conducting one, such as defining topics, literature searching and retrieval, data analysis and synthesis, and adept writing and reporting. They provide a step-by-step approach to the literature review process, including choosing a review topic, searching and selecting appropriate articles, analyzing and synthesizing the literature, and

organizing the review. The authors emphasize the importance of conducting systematic literature reviews in increasing knowledge through evidence-based practice and highlight the need for future research in areas where gaps in knowledge have been identified.

[5] The Research paper “” Deepak Kumar, Anurag Sinha discusses the application of deep learning in yoga pose detection and classification. It delves into the challenges of human pose estimation, including factors like image scale, illumination variation, and background clutter. The paper explores keypoint detection methods such as OpenPose, PoseNet, and PIFPAF, and their role in pose estimation. It emphasizes the effectiveness of deep learning in image classification tasks, particularly in learning and classifying different yoga poses. The document also highlights the health benefits of yoga and its increasing significance in the medical community.

[6] The Research paper "Prediction of Yoga Pose from YouTube Dataset using Skeleton Feature Extraction Based ISDL Model" covers a wide range of topics related to yoga pose detection and classification using deep learning. It discusses advancements in human pose estimation, generative and discriminative methods, deep learning approaches, keypoint detection methods, and pose classification using deep learning. The document also reviews existing systems for yoga pose detection and the current state of the art. It suggests future work could involve expanding the dataset, implementing the system on a portable device, and exploring multi-person pose estimation.

[7] “Novel deep learning models for yoga pose estimator” The study compared various machine learning models for yoga pose recognition. Agarwal used a dataset of 5,500 images for 10 yoga poses, achieving a high accuracy rate. Liaqat et al. combined deep neural networks with traditional methods for posture identification. Generalized Discriminant Analysis (GDA) and Linear Discriminant Analysis (LDA) techniques were employed in the research. The LGDeep model emerged as the top performer, surpassing other models in accuracy and performance. LGDeep achieved 100% accuracy, making it a promising choice for a yoga posture recognition system.

[8] The research focuses on enhancing accuracy in yoga pose estimation through deep learning algorithms, particularly utilizing Convolutional Neural Network (CNN) architecture. ResNet34 and ResNet50 models are employed for pose classification, with ResNet50 achieving a notable accuracy of 90.5%. Through optimization and final training, a substantial increase in accuracy by nearly 10% is achieved. A comparison between ResNet34 and ResNet50 demonstrates the superior performance of ResNet50 in pose classification tasks. This study aims to advance the field of yoga pose estimation for medical and fitness applications by leveraging deep learning methodologies to accurately classify and identify yoga poses, showcasing the potential for improved health and wellness monitoring through intelligent systems.

[9] Region-based Network for Yoga Pose Estimation with Discriminative Fine-Tuning Optimization This paper explores deep learning networks for precise yoga pose estimation, targeting 45 complex asanas. It adopts a two-step methodology: employing an RCNN for joint identification and a CNN for pose classification. Training on the Yoga-82 dataset, optimized ResNet models achieve a notable 90.5% accuracy. Addressing complexities like overlapping poses and multi-person scenarios, the authors propose a dense network of 17 critical points. This comprehensive approach demonstrates substantial progress in accuracy while tackling real-world challenges in yoga pose recognition.

[10] Yoga Pose Detection Using Deep learning This paper proposes four ensemble-based Yoga pose estimation models that improve the performance of the individual three DL techniques: Xception, VGG-Net, and SqueezeNet. A core new residual convolutional neural network combines the DL techniques to make three models. The core model is integrated with LDA and GDA features together or separately. LGDeep, GDeep, LDeep, and Deep are the proposed novel models that have been examined on a publicly accessible dataset, exceeding earlier state-of-the-art approaches. The LGDeep surpassed other previous approaches designed

for the same purpose since the ensembling technique aided in the acquisition of complementary information, allowing individual models to outperform.

METHODOLOGY:

The AI Yoga Pose Detection and correction mechanism is a novel technique that works by analyzing and collecting the angles between the main body components. Below is a summary of the software's main attributes and parts:

- **Unique Approach:** This solution uses angles between important body parts to record information and correct the user's posture during asanas, which sets it apart from existing AI-based yoga position Detection and correction mechanisms. This method provides a more thorough evaluation of the user's posture and alignment.
- **Versatility:** Users can pick from more than 30 distinct asanas to do using the app. This adaptability meets the needs of people with different yoga styles and habits.
- **Accuracy:** For every particular asana, the system precisely records the user's body component locations and compares them with pre-set values. Through the analysis of position vectors and angles between body components, the program offers accurate feedback regarding the alignment of the user.
- **Real-time Feedback:** The system computes and verifies the angles between the main limbs and body components in real-time as soon as the user reaches the intended final position of an asana. Users may make any necessary repairs and adjustments thanks to this instant feedback.
- **Timer and Warning System:** The program has a timer to stop users from hurrying through asanas. The technology may alert a user to the danger of doing an asana too rapidly, urging a slower and more deliberate mindful practice approach.
- **Text-to-Speech (TTS) Engine:** By offering audio feedback on modifications that need to be made and which body components need to be adjusted, the TTS engine improves the user experience. With the help of this function, users may get direction and instruction without needing to look at the program interface.
- **Heatmap Generation:** To graphically represent the disparities between the angles the user attained and the necessary modifications, the system creates heatmaps. This visual input facilitates comprehension and enhances alignment of the posture.

AI Yoga Pose Detection and correction mechanism provides a thorough and intuitive way to enhance alignment and posture when practicing yoga. Through the integration of machine

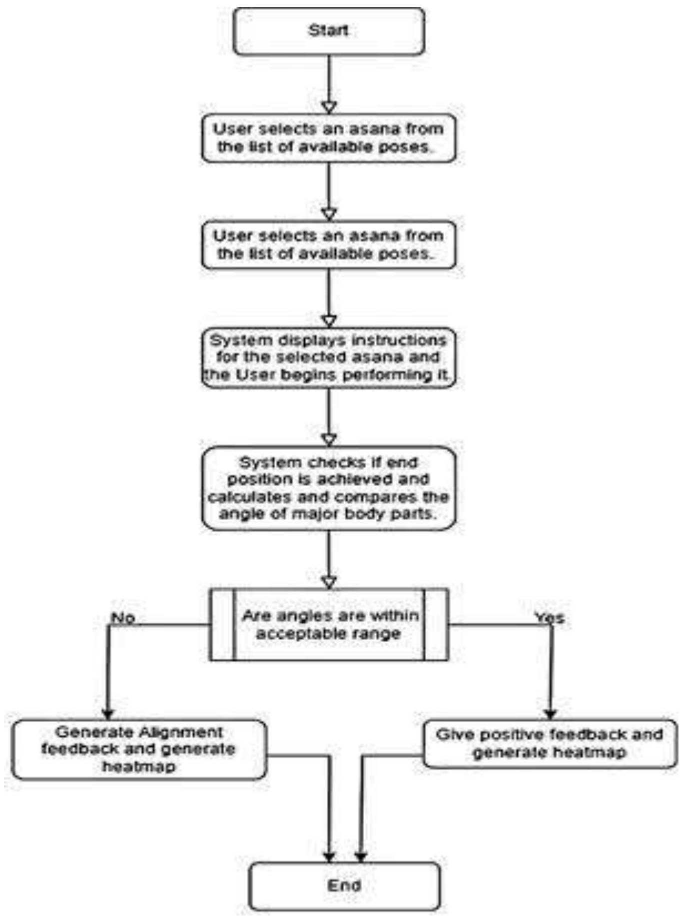

Figure 1: Dataflow of Pose detection and correction.

learning and well-considered design elements, the program seeks to augment the efficiency and security of users' yoga practices. The dataflow diagram of the proposed mechanism is presented in figure 1.

Users are guided through position selection, posture capture, angle computation, and real-time feedback by the AI Yoga position Detection and correction mechanism flowchart. It uses a TTS engine to validate proper postures, track time to prevent hurrying, and indicate corrections in alignment. Heatmaps can show modifications. During yoga practice, this methodical procedure guarantees efficient posture adjustment.

Following images and tables show how when user chooses a particular asana to perform:

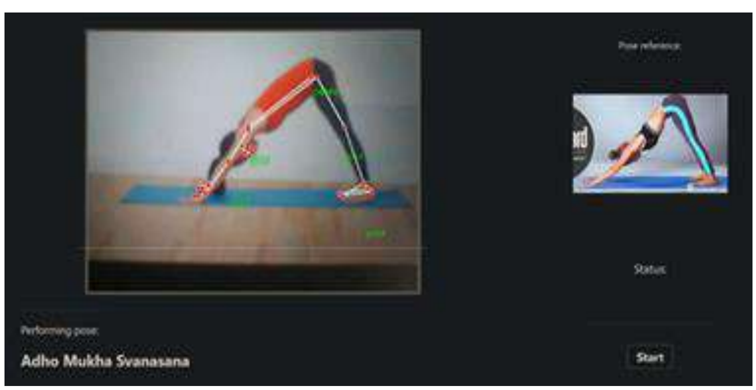

Figure 3: Performing Adho Mukha Svanasana

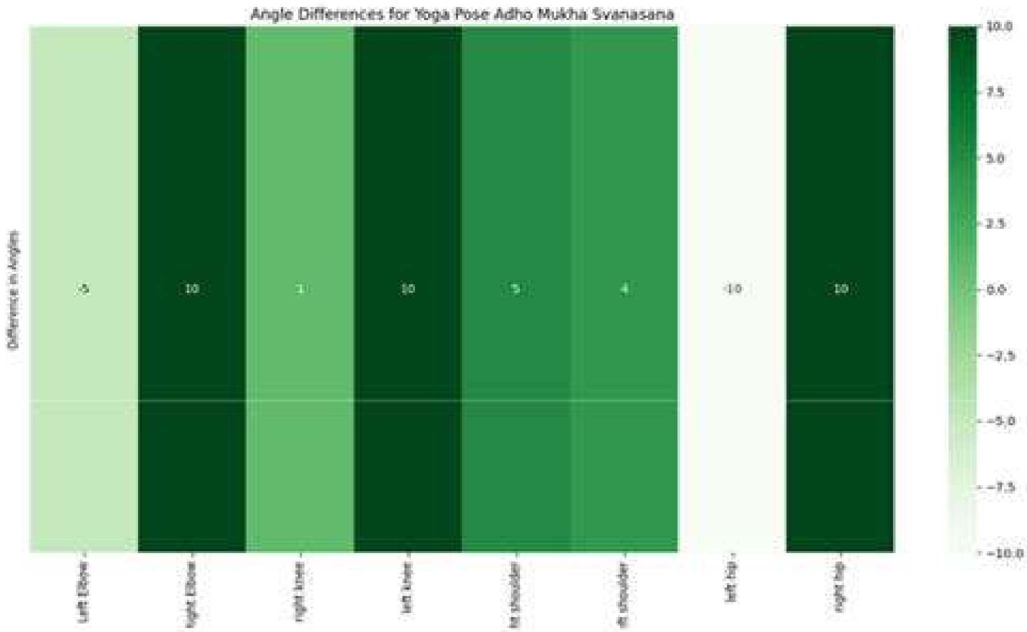

Figure 2: Heatmap of Adho Mukha Svanasana

Fig 2 shows user performing asana where Detection and correction mechanism calculates angles for asana accuracy of Adho Mukha Svanasana with its heatmap as shown above in Fig 3.

Asana Name	Absolute Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]	Observed Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]
Adho Mukha Svanasana	[195.14735572565294,193.0672851212811, 182.16912170627177,181.03078806137646, 176.431833096212,177.12960182226564, 51.74293164653543,53.93222706873304]	[200.14735572565294,183.0672851212811, 181.16912170627177,171.03078806137646, 171.431833096212,173.12960182226564, 61.74293164653543,43.93222706873304]

Table 1: shows when asana is completed its Detection and correction mechanism.

Fig 1.3 shows user performing asana where Detection and correction mechanism Calculates angles are not accurate while performing Ardha Chandrasana

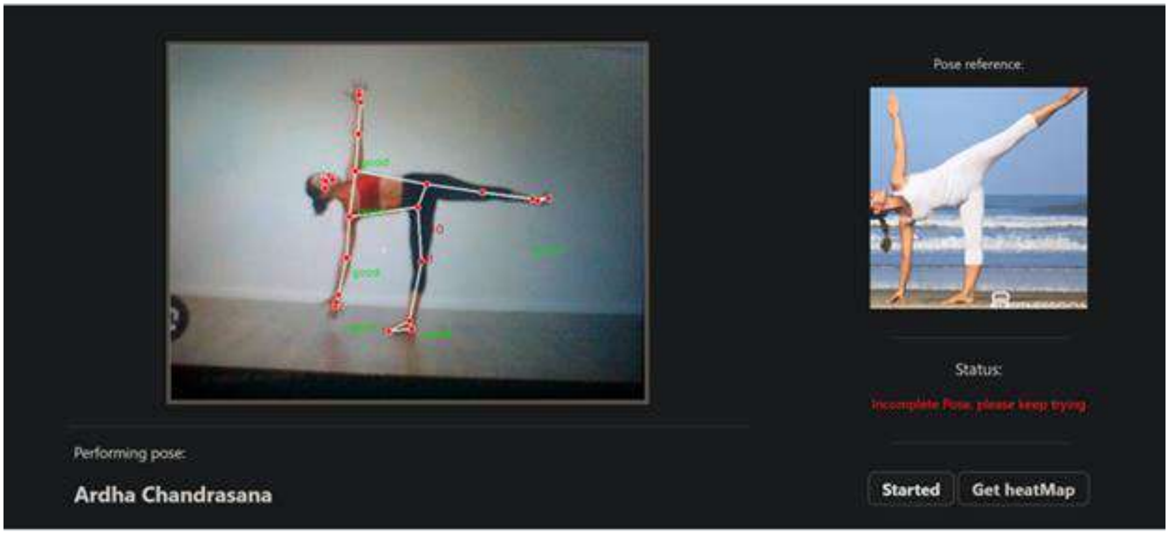

Figure 4: performing Ardha Chandrasana

Asana Name	Absolute Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]	Observed Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]
Ardha Chandrasana	[190.80606924437683,189.63865230339647, 194.99150626391793,178.11934347423912, 110.72657041089288,79.91605789710613, 207.67892166687167,72.57512574650491]	184.80606924437683,194.63865230339647, 197.99150626391793,175.11934347423912, 104.72657041089288,83.91605789710613, 210.67892166687167,70.57512574650491]

Table 2: Shows the incomplete form of Ardha Chandrasana. The detection and correction process determines the variance in the detected angle.

Figure 6: Vrksasana

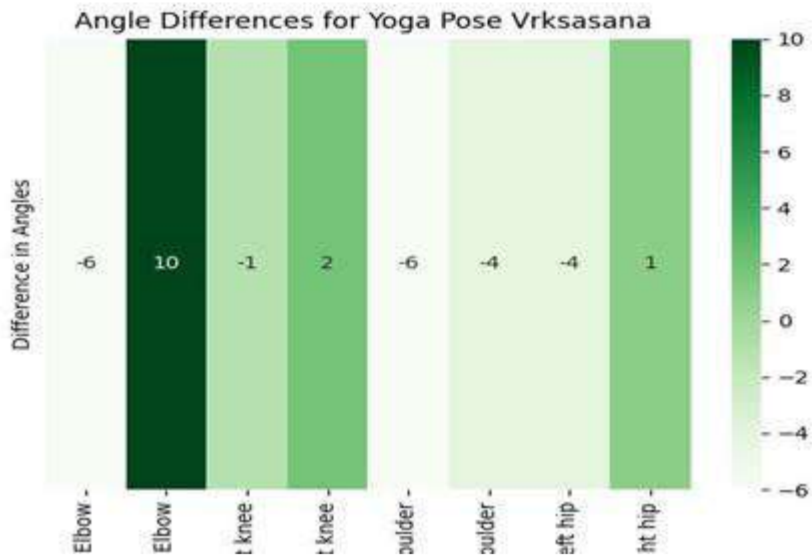

Figure 5: Heatmap for Vrksasana

Asana Name	Absolute Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]	Observed Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]
Vrksasana	[33.61999404146039, 29.540970853085263, 13.974997526266186,188.79726109968368, 66.44447374046031,72.24049417901529, 173.7480281550308,260.5400365119113]	[39.61999404146039, 19.540970853085263, 14.974997526266186, 186.79726109968368, 72.44447374046031, 76.24049417901529, 177.7480281550308, 259.5400365119113]

Table 3: Shows the various joint angles of Vrksasana pose

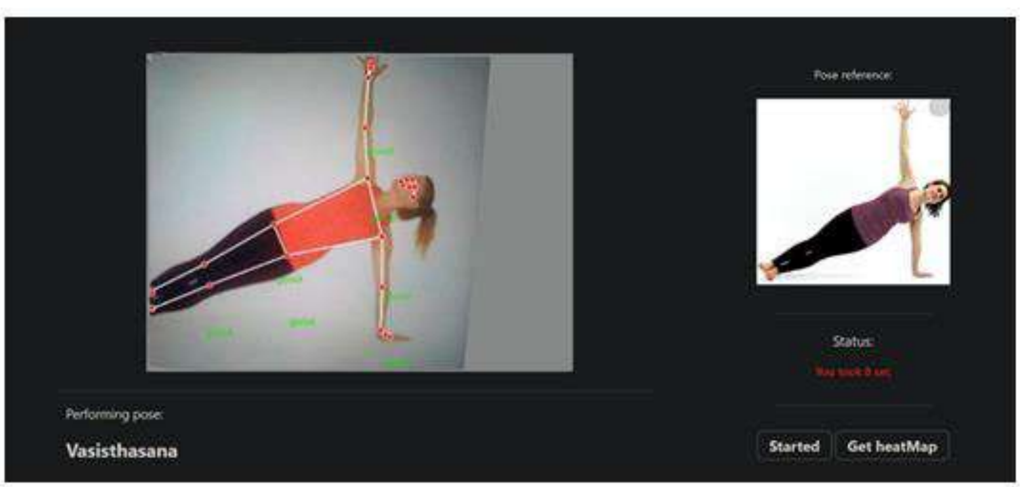

Figure 8: Performing Vasisthasana

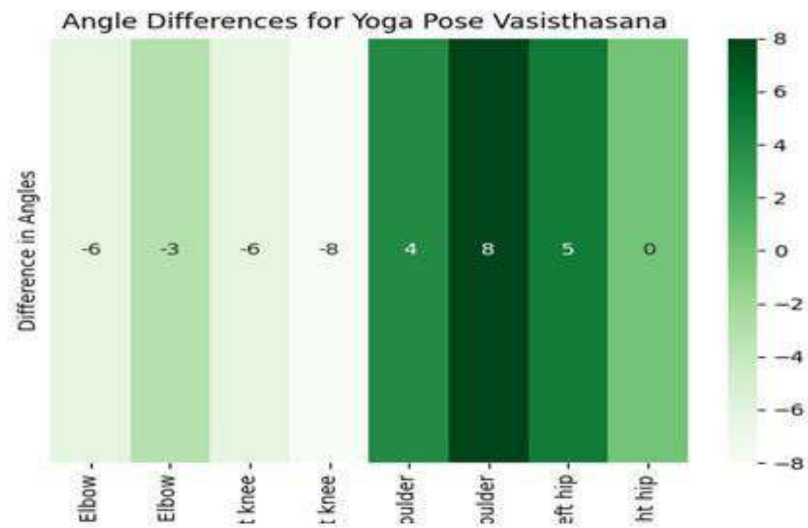

Figure 7: Heat map for Vasisthasana

Asana Name	Absolute Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]	Observed Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]
Vasisthasana	[181.4614160981745, 172.91858871891495, 186.1289051547743, 178.84621319352848, 241.8804761270079, 69.29282517447515, 179.8449862361831, 180.70760289867388]	[187.4614160981745, 175.91858871891495, 192.1289051547743, 186.84621319352848, 237.8804761270079, 61.292825174475155, 174.8449862361831, 180.70760289867388]

Table 4: Shows the joint angles in Vasisthasana

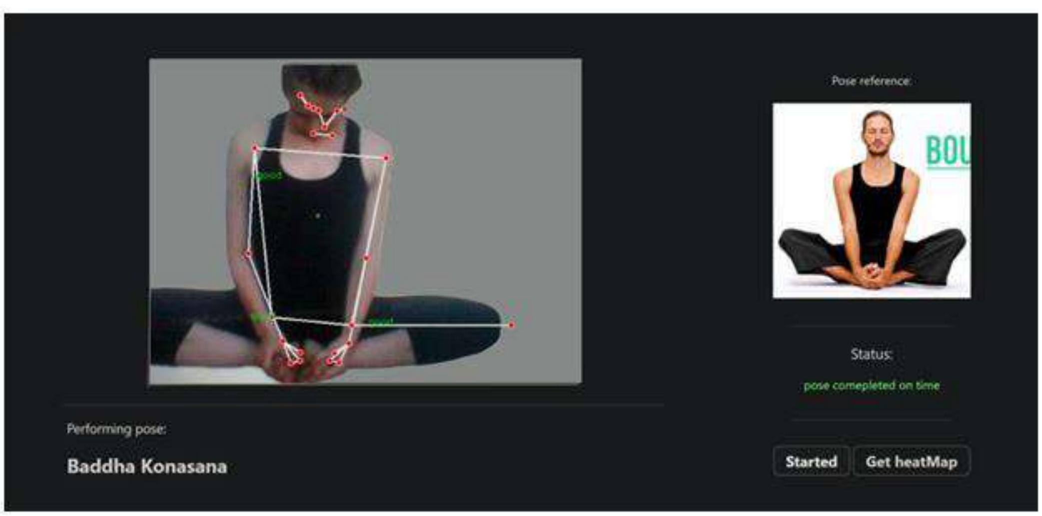

Figure 9: Baddha Konasana

Asana Name	Absolute Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]	Observed Angle Value ["Left Elbow", "Right Elbow", "Right Knee", "Left Knee", "Right Shoulder", "Left Shoulder", "Left Hip", "Right Hip"]
Baddha konasana	[185.54102600849288, 177.0557164811308, 12.699314063635237,11.326452409626384, 0.8819022936784227,0.7982515393451237, 57.67107904601468,61.02397602698018]	[185.54102600849288,174.0557164811308, 11.699314063635237,8.326452409626384, 6.881902293678422,8.798251539345124, 64.67107904601468,54.02397602698018]

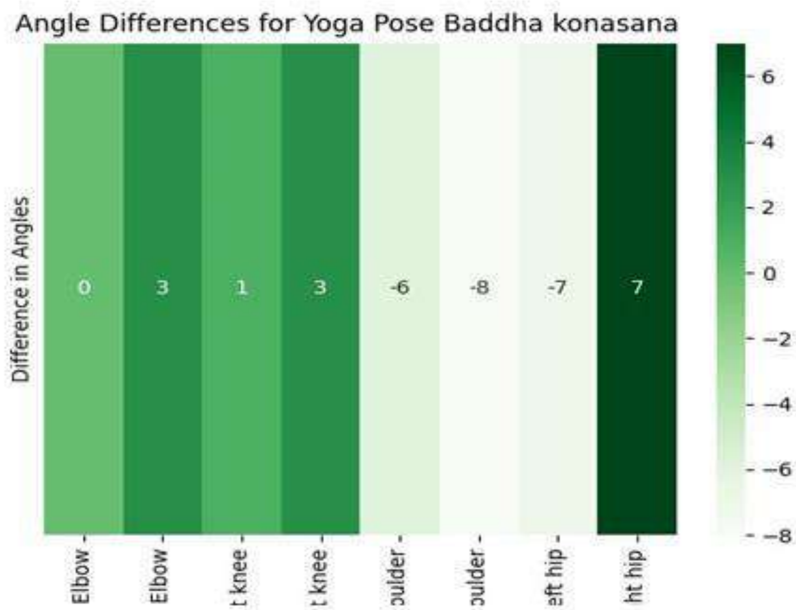

Figure 10: Heatmap for Baddha konasana

RESULT AND DISCUSSION

Precise yoga pose correction through pose estimation, which involves identifying key body joints and angles, real-time feedback on posture alignment, balance, and form by analysing live or recorded video feeds of individuals performing yoga poses. Personalized feedback tailored to the user's specific needs, is built for enhancing the overall yoga practice experience. Expansion to encompass a wider range of yoga poses, improved user interface and experience, and integration of user progress tracking for personalized training programs. Ethical and responsible deployment of the AI system, with a focus on ethical considerations, explainability, and interdisciplinary collaboration. Highlighting the multifaceted impact of advanced AI on industries, economies, and societal norms, necessitating thoughtful governance and ethical frameworks.

CONCLUSION

In summary, the AI Yoga Pose Detection and correction mechanism offers a revolutionary way to improve yoga practice with cutting-edge technology. It gives customers the ability to acquire proper posture securely and effectively with its unique technique of taking into account the angles between body parts, real-time feedback via a TTS engine, and visual assistance like heatmaps. It encourages thoughtful practice and lowers the chance of injury by including user-friendly features like posture selection and time monitoring. This initiative promotes a healthier and more knowledgeable approach to exercise by not only revolutionizing the way yoga is performed but also highlighting the potential of AI to enhance wellness activities.

REFERENCES

[1]. Yoga Pose Estimation and Feedback Generation Using Deep Learning Kumar, Vijay,Anand Thoutam, Vivek,Srivastava, Anugrah,Badal, Tapas1687-5265-https://doi.org/10.1155/2022/4311350-10.1155/2022/4311350-Computational Intelligence and Neuroscience-Hindawi

[2]. Yoga Pose Estimation Using Angle-Based Feature Extraction doi:10.3390/healthcare11243133 https://www.mdpi.com/2227-9032/11/24/3133

[3]. Swain, Debabrata, Santosh Satapathy, Biswaranjan Acharya, Madhu Shukla, Vassilis C. Gerogiannis, Andreas Kanavos, and Dimitris Giakovis. 2022. "Deep Learning Models for Yoga Pose Monitoring" *Algorithms* 15, no. 11: 403. https://doi.org/10.3390/a15110403

[4]. Ramdhani, Abdullah & Ramdhani, Muhammad & Amin, Abdusy. (2014). Writing a Literature Review Research Paper: A step-by-step approach. International Journal of Basic and Applied Science. 3. 47-56.

[5]. Kishore DM, Bindu S, Manjunath NK. Estimation of Yoga Postures Using Machine Learning Techniques. Int J Yoga. 2022 May-Aug;15(2):137-143. doi: 10.4103/ijoy.ijoy_97_22. Epub 2022 Sep 5. PMID: 36329766; PMCID: PMC9623892.

[6]. Lightweight Deep Learning Models for Resource Constrained Devices SN - 1687-5265UR-https://doi.org/10.1155/2022/4311350-DO - 10.1155/2022/4311350 -JF - Computational Intelligence and Neuroscience-PB - Hindawi Kumar, Vijay, Anand Thoutam, Vivek, Srivastava, Anugrah, Badal, Tapas,Kumar Mishra

[7]. Kumar, Deepak & Sinha, Anurag. (2020). Yoga Pose Detection and Classification Using Deep Learning. International Journal of Scientific Research in Computer Science Engineering and Information Technology. 10.32628/CSEIT206623.

[8]. Ashraf FB, Islam MU, Kabir MR, Uddin J. YoNet: A Neural Network for Yoga Pose Classification. SN Comput Sci. 2023;4(2):198. doi: 10.1007/s42979-022-01618-8. Epub 2023 Feb 8. PMID: 36785804; PMCID: PMC9907194.

[9]. Gite, Shilpa & Mane, Deepak & Mane, Vijay & Kale, Sunil & Dhotre, Prashant. (2023). International Journal of INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING Region-based Network for Yoga Pose Estimation with Discriminative Fine-Tuning Optimization. International Journal of Intelligent Systems and Applications in Engineering. 11. 166-184.

[10]. Talaat, A.S. Novel deep learning models for yoga pose estimator. SN Appl. Sci. 5, 341 (2023). https://doi.org/10.1007/s42452-023-05581-8