International Conference on Advances in Modern Technology of Research in Engineering Field (AIMTREF) April, 2026
Organized By: SKN Sinhgad Institute of Technology& Science, Kusgaon (Bk), Lonavala, Pune

International Journal of Science, Engineering and Technology
ISSN: 2348-4098, P-ISSN: 2395-4752

Yoga Pose Estimation and Prediction

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Abstract- Physical activity is essential for maintaining health and fitness. Recent advancements in computer vision and machine learning have enabled highly accurate human pose estimation models that can track and analyze body movements in real time. This paper reviews state-of-the-art techniques in pose estimation and prediction, highlighting their applications in sports science, rehabilitation, and computer animation. It also presents the development of a virtual fitness trainer using MediaPipe, integrated with deep learning frameworks like TensorFlow and Keras. The system leverages posture estimation algorithms to detect key body landmarks, enabling accurate tracking of exercises and performance evaluation. By analyzing user movements, it provides feedback and predicts future poses to improve exercise quality.With the rapid evolution of deep learning techniques, pose estimation models continue to improve in accuracy and efficiency. These advancements hold strong potential to transform fitness and health monitoring by enabling smarter, real-time movement analysis and personalized training systems.

Keywords: Computer Vision, Deep Learning, Human Pose Estimation, Machine Learning, MediaPipe, Yoga Pose Detection

I. INTRODUCTION

Yoga, with its holistic benefits for physical and mental well-being, faces challenges in mastering poses, particularly for beginners lacking access to experienced instructors. The need for innovative solutions is evident, prompting the emergence of real-time yoga asana recognition systems using computer vision and deep learning. These technologies analyze users' movements, offering immediate feedback and personalized guidance for correct posture and alignment during practice. Our research proposes a robust system leveraging pose estimation and deep learning to empower individuals in yoga practice, irrespective of location or instructor availability. Through extensive experimentation, we validate the effectiveness of our approach, envisioning its integration into mainstream yoga practice, fitness monitoring, and wellness applications, thereby advancing accessibility and precision in yoga learning and implementation.

In recent years, the integration of machine learning techniques into various fields has driven significant advancements. This success can be attributed to the invention of more sophisticated machine learning models, the availability of large datasets for tackling complex problems, and the development of software platforms that enable the easy utilization of computational resources for training and inference . Among the domains benefiting from these advancements is physiotherapy, where machine learning plays a crucial role in enhancing rehabilitation and overall well-being through targeted fitness exercises [1]. However, ensuring correct posture and movement during these exercises is essential to maximize their benefits and minimize the risk of injury.

Human pose estimation have emerged as critical components in this domain, allowing for automatic and precise analysis of patients movements during exercise sessions [2, 3]. By leveraging sophisticated algorithms, researchers can detect and track key body joints and gestures, enabling the identification of incorrect postures and movements [15].

International Journal of Science, Engineering and Technology
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These systems empower physiotherapists to offer personalized corrective guidance, optimizing the rehabilitation process and improving patient outcomes [8]. Despite these advancements, challenges remain, particularly regarding the computational complexity and model size of existing human pose estimation networks [13]. Traditional approaches often involve wide and deep networks, which are resource-intensive and not suitable for deployment on resource-limited devices such as smartphones and robots [13]. Thus, there is a growing need for lightweight and efficient models that can provide accurate pose estimation while conserving computational resources [13].

Leveraging a multi-class exercise dataset comprising 133 features derived from human skeleton movements, applied machine learning and deep learning methods are employed to develop a lightweight and efficient model.

II. METHODOLOGY

The system uses MediaPipe to extract body landmarks from real-time video input. These landmarks are converted into numerical keypoints and stored as .npy files. A machine learning model is trained using these keypoints to classify yoga poses. During execution, the system captures live video, processes pose landmarks, and predicts the corresponding yoga posture.

III. SYSTEM ARCHITECTURE

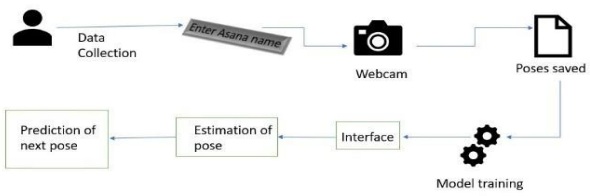

Fig.1. System Architecture

The proposed system is designed as a multi-stage pipeline for yoga pose estimation and prediction. The architecture begins with data collection, where the user inputs the name of the yoga asana. Using a webcam, images of different yoga poses are captured and stored in the system.

The captured pose data is processed and saved as numerical keypoints representing body landmarks. These keypoints are used to create a dataset for training the model. The training process involves feeding the stored pose data into a machine learning model, which learns to classify different yoga poses based on body posture.

Once the model is trained, it is integrated with the user interface. During real-time execution, the system captures live video through the webcam and processes it using pose estimation techniques to extract body landmarks.

These landmarks are passed to the trained model, which performs pose estimation and predicts the current yoga pose. Additionally, the system can suggest or predict the next pose based on the current posture.

Thus, the overall system flow can be summarized as:
Data Collection → Webcam Input → Pose Data Storage → Model Training → User Interface → Pose Estimation → Pose Prediction

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IV. RESULTS

Fig.3. start page

Fig.4. pose estimation and prediction

The system successfully detects yoga poses in real-time with good accuracy.

V. CONCLUSION

The proposed system provides an efficient solution for real-time yoga pose detection using machine learning and computer vision. It helps users improve posture and enables applications in fitness and rehabilitation.

Future Scope

Future improvements include mobile app integration, real-time feedback system, and support for more yoga poses.

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