Yoga Pose Detection, classification & Correction Using Machine Learning

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Abstract - One Yoga is a popular form of physical exercise and meditation that requires precise body postures or poses. Performing yoga poses correctly is crucial to maximize the benefits and prevent injuries. Therefore, a reliable and accurate yoga pose detection system can assist practitioners in achieving proper form and alignment during their yoga practice. This abstract presents an overview of a yoga pose detection system that utilizes computer vision and machine learning techniques to automatically identify and track yoga poses in real time.

The proposed system leverages deep learning algorithms and poses estimation models to detect and recognize yoga poses. It takes input from a camera or a video stream and processes the visual data to extract pose information. The system employs state-of-the-art convolutional neural networks (CNNs) to perform pose estimation, capturing the spatial relationships between different body joints and body parts. A large annotated dataset of yoga pose images and corresponding labels is created to train the yoga pose detection system. The dataset is used to fine-tune the pre-trained CNN models, allowing them to learn the specific features and patterns associated with different yoga poses. The trained models are then deployed to the detection system, which can run on a desktop computer, mobile device, or embedded system.

Keywords: Machine learning, Yoga, Convolutional Neural Network, Deep Learning.

INTRODUCTION

Yoga is a physical, mental, and spiritual practice originating from ancient India. It involves performing various postures, breathing exercises, and meditation to achieve physical and mental health benefits. However, performing yoga poses incorrectly can lead to injury, making proper alignment and form essential for safe and effective practice. Traditionally, yoga instruction has relied on physical instructors to guide students in their practice.

However, this approach can be limiting, particularly in remote locations where access to a physical instructor is limited. In addition, students may not receive personalized feedback and correction in group classes, which can hinder their progress.

To address these challenges, we propose a deep learning-based solution for the detection, classification, and correction of yoga poses. The proposed solution uses machine learning algorithms to detect and classify yoga poses in real time and provide correction suggestions for incorrect poses. This approach offers many benefits, including personalized feedback, improved alignment, and injury prevention. In the following sections, we will discuss the related work in the field of yoga instruction and machine learning, and describe the details of our proposed solution, including the dataset, model architecture, evaluation, and results

Yoga pose detection systems can serve as virtual yoga instructors, offering real-time feedback and guidance to practitioners. They can help users improve their form, alignment, and balance by providing visual cues and suggesting adjustments. Additionally, these systems can track the user's progress over time, allowing for performance analysis and personalized recommendations. Yoga pose detection is an application of computer vision and machine learning techniques that aim to automatically identify and track yoga poses in real time. It involves analyzing visual data, such as images or video streams, and using algorithms to recognize specific yoga postures based on the positions and orientations of different body parts.

In conclusion, yoga pose detection combines computer vision and machine learning techniques to automatically recognize and track yoga poses in real time. It has the potential to enhance the yoga practice of individuals at all levels, providing valuable feedback and assisting in achieving correct alignment and posture.

A. Problem Statement:

To implement a Yoga, pose detection by using Machine Learning and Deep Learning.

B. Motivation:

- Alignment and Safety: Proper alignment is essential in yoga to maximize the benefits of each pose and prevent injuries. Yoga pose detection can provide real-time feedback and guidance to practitioners, ensuring they maintain correct form and alignment throughout their practice. This helps individuals avoid strain or injury caused by improper postures.
- Self-Improvement and Learning: Yoga pose detection systems can serve as a valuable learning tool for both beginners and experienced practitioners. By receiving real-time feedback and visual cues, individuals can gain a deeper understanding of correct alignment and refine their poses. This empowers practitioners to take ownership of their practice and actively work towards improving their technique and form.

- Body Awareness and Mindfulness: Yoga is not just a physical practice; it cultivates mindfulness and body awareness. Yoga pose detection can enhance this aspect by providing real-time visual feedback that encourages.

C. Objective:

- It should be able to identify various yoga postures, including standing poses, seated poses, balancing poses, inversions, and transitions between poses.
- It should be capable of processing visual data in a timely manner to deliver real-time pose detection results.
- It should be robust to noise and able to handle different body types, clothing variations, and individual differences in performing poses.
- It should capture the spatial relationships between these joints to determine the pose and assess the alignment of the practitioner's body.

I. LITERATURE SURVEY

The use of technology for enhancing the quality and safety of yoga instruction is a growing area of research. In recent years, there has been a growing body of literature on the use of machine learning and computer vision for yoga pose recognition and analysis.
One notable study by Nguyen et al. (2017) proposed a real time system for yoga pose recognition using depth cameras and machine learning algorithms. The system was able to accurately detect and classify various yoga poses in real time, and provide feedback to the user. Another study by Chen et al. (2018) proposed a deep learning-based approach for yoga posture recognition using RGB cameras. The study showed that the proposed approach was able to achieve high accuracy in detecting and classifying yoga poses. In addition to yoga pose recognition, there has also been research on using technology for providing correction suggestions in yoga practice. A study by Yoo et al. (2018) proposed a wearable device that uses computer vision to provide real-time feedback to users on their posture and alignment during yoga practice. The study showed that the device was able to effectively guide users towards proper form and alignment, leading to improved safety and efficacy of the practice. These studies demonstrate the potential of machine learning and computer vision for enhancing the quality and safety of yoga instruction.

II. SYSTEM REQUIREMENT

A. Hardware Requirement:

- Processor: - Intel Core 5 / AMD Ryzen 5 or more
- RAM: - 8 GB or Higher
- Storage: - Space 20 GB or above
- GPU: - 8 GB or Higher

B. Software Requirement:

- Operating System: - Windows 10/11
- Libraries: - TensorFlow, Keras, Matplotlib, NumPy, MediaPipe, torch, OpenCV.
- VSCode / Google Colab / Anaconda.
- Framework: Tkinter.

III. PROPOSED SYSTEM DESIGN

A. System Architecture

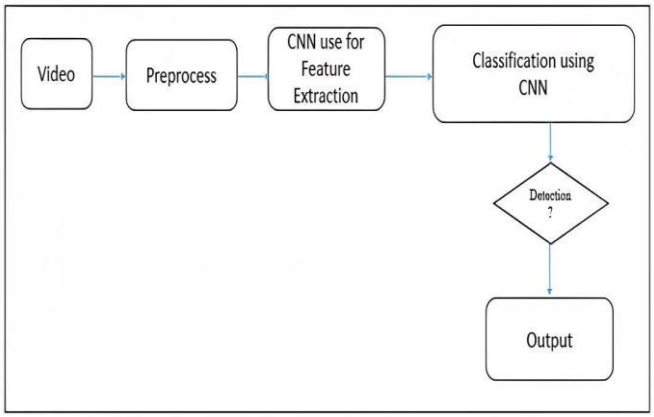

Fig 1. System Design

The diagram shows how the flow of our system or how the system works. From login to how the functions work. like the video is separated into frames and then the CNN algorithm works on it to find the co-ordinates of our body and then works on that .to draw the edges then checks with the dataset images and compare the poses and when the poses match then it shows the output. With the percentage of how many percentages the pose match and name of pose.

B. Activity workflow

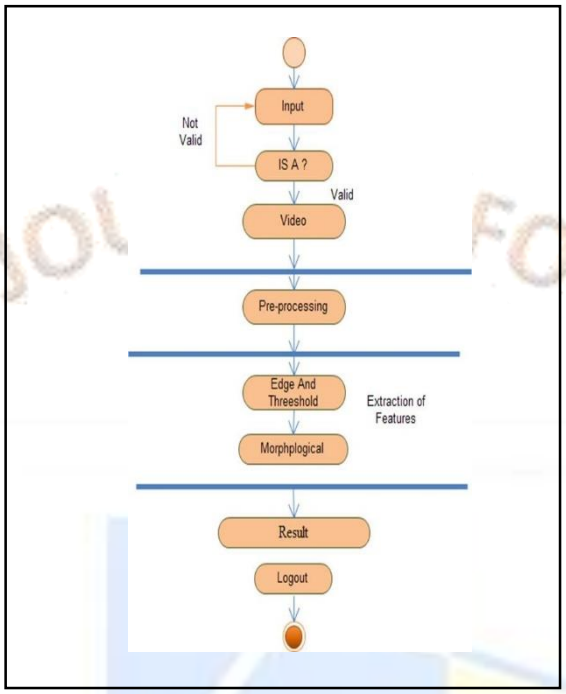

Fig 2. Activity Diagram

c. Data Flow

The diagram represents the entire system's flow of data and how each module communicates with the other. It starts with the user providing input as video file to the system of the yoga recorded. And after that the system will give the detection of the pose of the yoga to the user. In the format of the percentage and system gives us the correction part of that yoga position

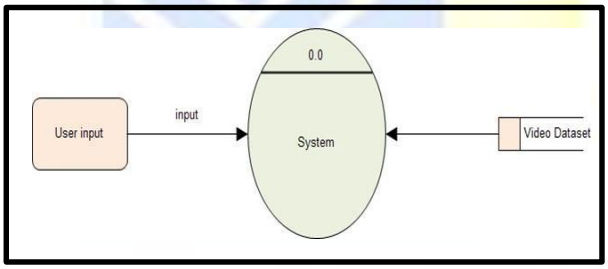

Fig 3. DFD level 0

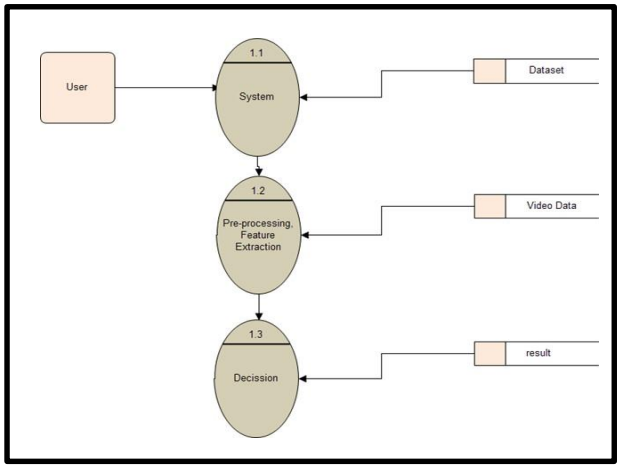

Fig 4. DFD level 1

D. Use case diagram

In the following diagram, various use cases of yoga pose detection are depicted. The first use case is for the user who can upload the recorded video file and also using the system for the detection of the poses.

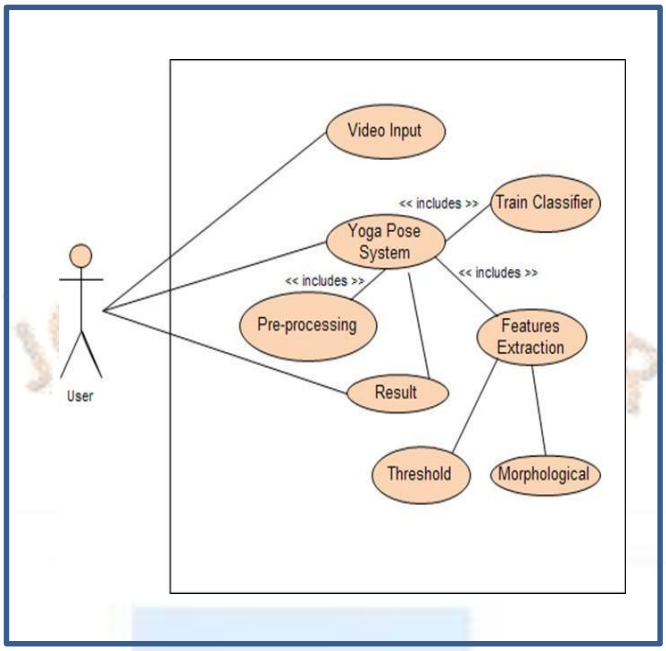

Fig 5. Use case Diagram

IV. IMPLEMENTATION

A. DATASET

The dataset used for these projects is consist of the images and the coordinates of the body parts related to the pose of the yoga. The 6 yoga poses namely are –
Bhujangasana (Cobra pose), Padmasana (Lotus pose), Savasana (Corpse pose), Tad asana (Mountain pose), Trikonasana (Triangle pose) and Vrikshasana (Tree pose).

Fig 6. Tree pose in dataset

B. Existing Methodology

In this section, we discuss the existing methodologies or approaches that have been used in the field of yoga pose detection, classification, and correction. These methodologies serve as a reference point for understanding the current state of the art and identifying any limitations or shortcomings that the proposed methodology aims to address.

1. **Rule-based Approaches**: Rule-based approaches involve defining a set of rules or heuristics based on expert knowledge or predefined criteria. These rules are used to analyze the joint positions and angles to determine the pose. However, rule-based approaches often lack flexibility and struggle to handle variations in poses and body types.
2. **Template Matching**: Template matching approaches involve creating a database of template images representing different yoga poses. The captured pose is then compared to the templates using techniques like feature extraction and matching algorithms. However, template matching can be sensitive to variations in lighting, backgrounds, and body proportions.
3. **Machine Learning-based Approaches**: Machine learning techniques, such as deep learning, have gained popularity in pose detection and classification tasks. Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) are commonly used for feature extraction and pose recognition. These approaches can handle variations in poses and body types, but they require a large amount of labelled training data.

4. **Pose Estimation Algorithms**: Pose estimation algorithms, such as OpenPose or PoseNet, utilize computer vision techniques to estimate the 2D or 3D positions of key body joints. These algorithms can provide accurate joint locations, which can be further used for pose classification and correction. However, they may be computationally intensive and require advanced hardware.
5. **Marker-based Motion Capture**: Marker-based motion capture systems involve placing reflective markers on the body joints and using cameras to track the movement of these markers. This approach provides precise joint tracking, but it requires specialized equipment and may not be suitable for real-time applications.
6. **Sensor-based Approaches**: Sensor-based approaches involve using wearable sensors, such as accelerometers or gyroscopes, to capture body movements and infer poses. These sensors can provide real-time data, but they may have limitations in accurately capturing complex yoga poses.

C. Proposed methodology

The proposed methodology for Yoga Pose Detection, Classification, and Correction aims to leverage advancements in computer vision and machine learning techniques to provide an accurate and real-time analysis of yoga poses. It combines the following key components:

1. **Pose Detection**: The methodology utilizes pose estimation algorithms, such as OpenPose or PoseNet, to detect the key body joints and their spatial relationships. These algorithms analyze input images or video frames to estimate the 2D or 3D positions of body joints, providing a foundation for further analysis.
2**. Feature Extraction**: From the detected joint positions, relevant features are extracted to represent the pose. This can include joint angles, body proportions, and spatial relationships between joints. These features capture the unique characteristics of each pose and serve as inputs for the classification and correction stages.
3. **Pose Classification**: Machine learning techniques, particularly deep learning, are employed for pose classification. Convolutional Neural Networks (CNNs) or Recurrent Neural Networks (RNNs) can be trained on a labeled dataset of yoga poses to learn the patterns and correlations between the extracted features and the corresponding poses. The trained model is then used to classify the detected pose into predefined categories.
4**. Pose Correction**: Based on the classified pose, the system provides real-time feedback and correction guidance to the user. By comparing the detected pose with the desired or reference pose, the system identifies deviations or misalignments and generates appropriate instructions for correction. This can involve visual overlays, textual instructions, or auditory cues to guide the user in adjusting their posture and alignment.
5.**Real-Time Performance:** The proposed methodology focuses on achieving Realtime performance to provide immediate feedback to the user. Optimization techniques such as model quantization, model compression, and hardware acceleration (e.g., utilizing GPUs) can be employed to ensure efficient processing and inference speed.

6. **User Interface**: The system is designed with a user-friendly interface that allows users to interact with the application easily. The interface can include features such as Realtime video streaming, pose visualization, progress tracking, and personalized settings. It should provide clear and intuitive feedback to enhance the user's understanding and engagement with their yoga practice.

V. RESULT

After running project, the first screen see by the user is the login screen which is designed to login into the system for user.
The below figure is the login credentials screen so the user can enter the username as Admin. And Password as admin so after the successful entering the data by user can see the next screen otherwise it shows the error.

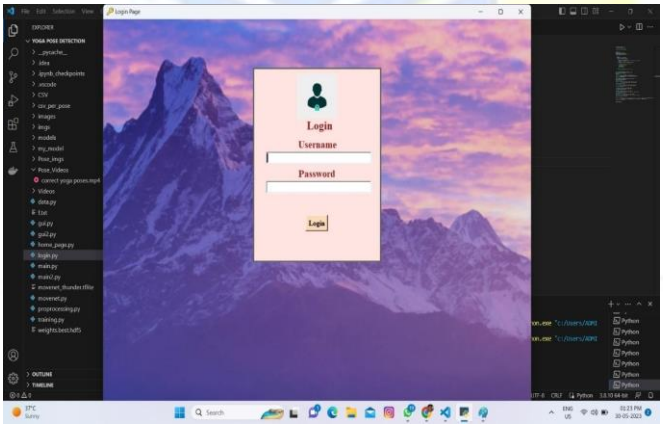

Fig 7. Login screen

The page is about the input page of the user in that user can has to enter the Age, Weight, Height and then click on next button where the home screen is opens.

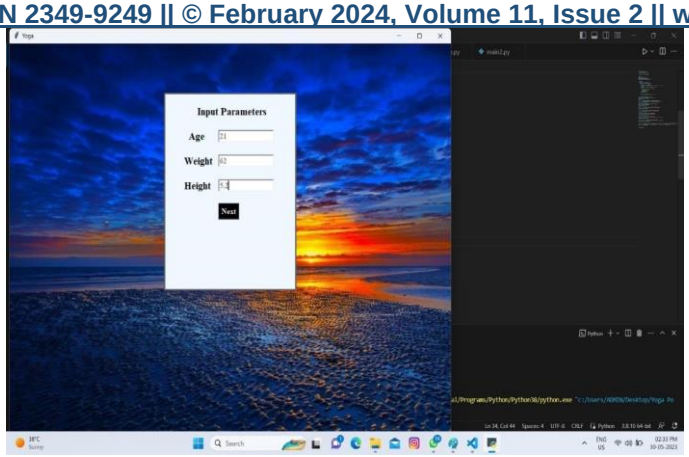

Fig 8. User's details

The below screen shows the pose detection and the pose with correction window that is the main moto of our project to detect the pose by the entering video input file of yoga.

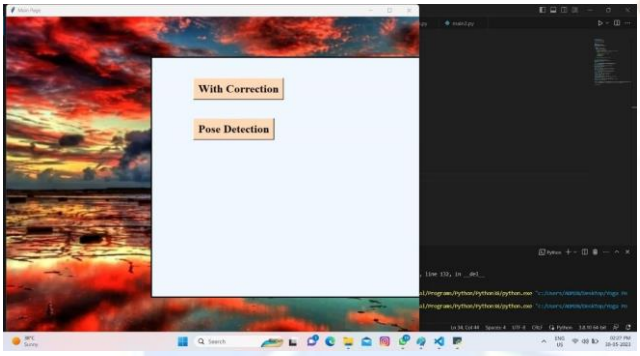

Fig 9. Home Screen

The below screen shows the entering the video file screen in that we have to browse in the application after that search the video file for detection the yoga pose. And after selection then click on the predict button so that the user can see the output of the pose detection.

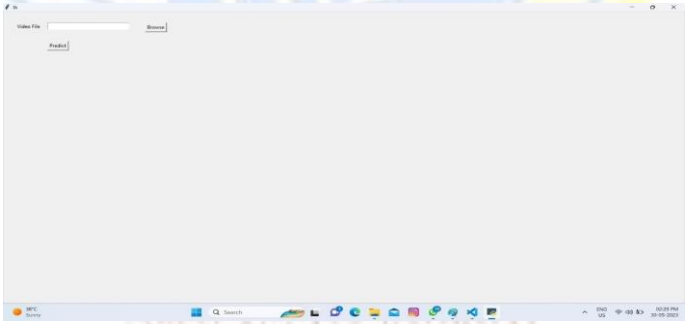

Fig 10. Entering video file

The above figure shows the successfully pose detection percentage with 99.90% & the pose detect by it is the tree pose.

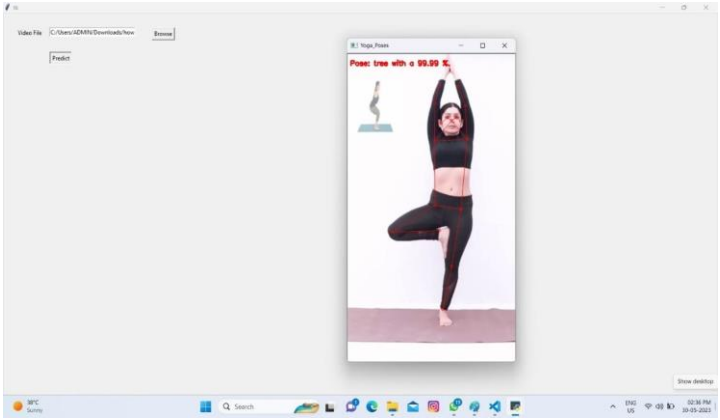

Fig 11. Final result

VI. CONCLUSION

Yoga Pose Detection, Classification, Correction using Machine Learning is a project that uses computer vision techniques and machine learning algorithms to detect and classify yoga poses with high accuracy. By providing real-time feedback on posture and form, the system can help people learn yoga more effectively and safely. The system has a wide range of applications in the fitness industry, including use in yoga studios, fitness centers, and by individuals at home.

VII. FUTURE SCOPE

present and pose estimation in such situations requires tracking and detecting the poses
of everyone. Multi-person pose estimate would be further complicated by a variety of elements, including background, illumination, overlapping figures, and others that have already been mentioned in this survey. Only six yoga asanas are currently classified using the proposed models. There are many different yoga asanas, therefore coming up with a pose estimate model that works for all of them is a difficult task.

The dataset can be increased by include more yoga postures done by people both inside and outside of buildings. The effectiveness of the models depends on the accuracy of Open posture estimate, which may not work effectively when persons or body parts overlap. This system can be implemented as a portable gadget that self-trains and makes predictions in real time. This study exemplifies activity recognition for real-world uses. For pose recognition in tasks like sports, surveillance, healthcare, etc., a method akin to this can be used. There is a ton of room for research into the brand-new problem of multi-person pose estimation. There are many situations when a single person's pose estimation would not be sufficient, such as when there are numerous people.

VIII. REFERNCE

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