Yoga Posture Detection & Correction

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# Abstract

Our project introduces a pioneering method for enhancing yoga practice through real-time pose correction, utilizing cutting-edge computer vision technology. Originating in India 5000 years ago, yoga offers profound benefits for both body and mind, yet with the modern lifestyle's increasing stress levels, its popularity has surged globally. While various avenues exist for learning yoga, including classes at yoga centres and self-learning through books and videos, many individuals struggle to identify and rectify inaccuracies in their poses. Our solution addresses this challenge by allowing users to select a pose they wish to practice and either use a webcam for analysis. Our technology uses computer vision algorithms to analyse the angles of different body joints and compares the user's pose with an expert's reference pose. Based on this comparison, users can receive personalised feedback to improve their posture Bridging traditional yoga instruction with modern technology, our project aims to deepen users' yoga practice, fostering greater awareness and alignment while enhancing effectiveness and safety.

# Keywords

MoveNet Thunder, OpenCV, Neural Network, Yoga.

# INTRODUCTION

In today's fast-paced world, where prioritizing physical and mental well-being is crucial, yoga has gained immense popularity for its profound impact on holistic health. However, perfecting yoga poses, especially for solo practitioners, can be challenging. To address this, our groundbreaking machine learning project utilizes Google's MoveNet Thunder, a state of the art pose estimation model, to accurately detect and estimate yoga poses. This technology revolutionizes the way people engage with yoga by providing real-time insights into body joint positions. Through a user-friendly platform, practitioners can select their desired pose, use a webcam or upload a snapshot for analysis, and receive immediate feedback on alignment. This empowers individuals to make necessary adjustments, enhancing alignment and reducing injury risk. By bridging the gap between ancient yoga wisdom and modern machine learning, our project enables individuals to embark on a journey of self-improvement, finding harmony, strength, and tranquillity amidst the challenges of modern life.

# LITERATURE SURVEY

# 2.1 Survey of Existing System

**Yoganect:**

Yoganect is an advanced yoga pose correction system that uses computer vision and AI algorithms to analyze poses in real-time, offering personalized feedback and alignment suggestions.

Features:

* Real-time Feedback
* Personalized Guidance

**SmartMats:**

SmartMats revolutionize yoga by integrating sensors into mats, providing real-time feedback to help users align their poses and enhance their practice.

Features:

* Sensor-based Feedback
* Interactive Experience

# YogAI:

# YogAI is a mobile app using smartphone cameras to analyze yoga poses and give real-time feedback on alignment and balance, offering a wide range of classes and guides for users to enhance their practice on the go.

# Features:

# Camera-based Analysis:

# Diverse Yoga Content:

# AI Yoga Instructor:

# The AI Yoga Instructor is an intelligent system that combines computer vision and AI technologies to recognize and correct yoga poses in real-time. By employing voice prompts and visual cues, the system helps users achieve better alignment, posture, and technique during their yoga sessions.

# Features:

# Real-time Pose Recognition:

# Interactive Guidance:

# Pose Estimation Models:

# Pose estimation models such as PoseNet or OpenPose are integral components of many yoga detection systems. These models use advanced algorithms to track users' body positions and provide feedback on pose correctness, contributing to a more immersive and effective yoga practice experience.

# Features:

# Accurate Pose Tracking

# Integration with Applications:

# 2.2 Limitation Existing system or research gap

# Yoganect:

# Yoganect's effectiveness is influenced by several factors. Firstly, the accuracy of its pose detection relies heavily on the quality of the user's camera and the lighting conditions. Low-quality cameras or inadequate lighting can lead to inaccurate readings, impacting the overall experience. Secondly, the system may struggle with the subtleties of advanced pose alignment, as it may overlook micro-adjustments or nuances in form that are crucial for correct posture. Additionally, Yoganect's effectiveness is limited by the poses programmed into its database, which may not cover all desired poses or accurately detect them. Lastly, there are accessibility concerns as the system may not provide tailored guidance for users with physical limitations, disabilities, or unique body shapes, lacking consideration for individual variations and needs.

# SmartMats:

# SmartMats, while innovative, face certain challenges. Firstly, their reliance on embedded sensors means that factors like uneven surfaces or incorrect mat placement can impact sensor accuracy, leading to inconsistent or unreliable feedback. Secondly, the feedback provided by SmartMats may be generic and not customized to individual needs or skill levels. This lack of personalization could result in standard cues without specific adjustments or modifications tailored to the user. Additionally, SmartMats are typically designed to detect a predefined set of yoga poses, which means that poses outside this list may not be recognized or evaluated by the system, limiting its functionality for users with diverse yoga practices or those exploring new poses.

# YogAI:

# YogAI faces challenges related to camera stability and positioning, as shaky cameras or inconsistent angles can lead to inaccurate pose assessments. Additionally, the system may struggle with providing detailed analysis or alignment cues for complex yoga poses involving intricate body movements or multiple limbs.

# AI Yoga Instructor:

# AI Yoga Instructor systems rely on a clear view of the user's body for accurate pose recognition, making obstructions or limited visibility problematic. Additionally, their feedback is often based on pre-programmed corrections, which may not cater to individualized needs or variations in practice.

# Pose Estimation Models:

# Pose estimation models in yoga technology systems encounter accuracy challenges due to clothing variations, background clutter, and rapid movements, affecting precise pose tracking. Additionally, these models may detect poses but often lack detailed feedback on alignment issues or alternative pose suggestions for variations or modifications, leaving users potentially without comprehensive guidance.

# How our system stands out from the existing systems?

# 1. Authentication and Storage: Unlike the other systems that may have varying authentication and storage mechanisms, our system utilizes Firebase for user authentication and storage. This choice offers robust security features and seamless integration with other Firebase services, ensuring a secure and reliable user experience.

# 2. User Feedback Section: Our system incorporates a dedicated section for user feedback. This feature allows users to provide valuable insights, suggestions, and comments about their experience with the system. By collecting and analyzing user feedback, we can continuously improve the system’s performance, features, and user satisfaction levels.

# 3. Expanded Pose Database: Our system features an expanded pose database that covers a wide range of yoga poses, including advanced and less common poses. This comprehensive database ensures that users have access to a diverse set of poses for practice and receive accurate feedback and guidance regardless of their chosen yoga routines.

# 4. Cross-Platform Compatibility: Our system is designed for cross-platform compatibility, allowing users to access it seamlessly from various devices such as smartphones, tablets, and computers. This flexibility enhances user convenience and accessibility, enabling users to engage with the system from anywhere and at any time

# Proposed System

Our machine learning-powered yoga detection and correction system improves the quality of yoga practice. It works by using sensors or cameras to record yoga poses, then using machine learning models to identify which poses are right and wrong. It gives consumers insightful comments and suggestions to improve their form and alignment in real- time.

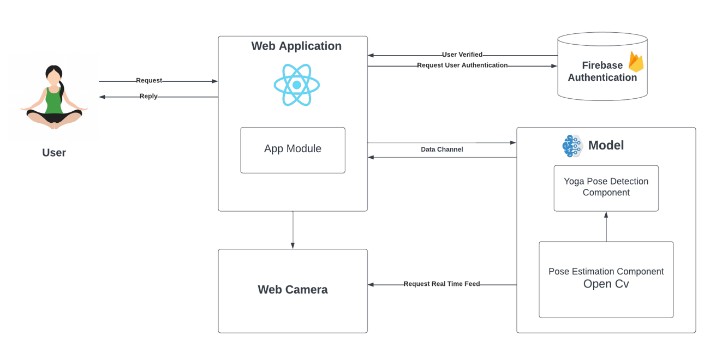
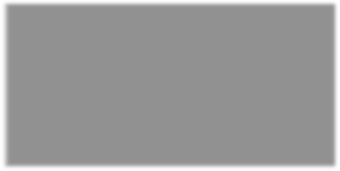
This system's main goal is to help yoga practitioners achieve better alignment and posture during their sessions, which will improve their entire yoga experience and maximise the benefits of the practice.

The system will utilize Feedforward Neural Networks (FNNs) to detect correct and incorrect yoga poses from camera or sensor images. It will then analyze the sequence of poses over time and provide real-time feedback to users, including suggestions for corrections. This approach not only enhances the accuracy of individual poses but also improves the overall flow of a yoga session.

***System Flow***

User authentication via Firebase is the first step in the process. For users wishing to access the application, Firebase offers a scalable and secure authentication method. By limiting access to next steps to only authorized users, this step improves the system's overall security.

Users are sent to the React application following a successful authentication attempt. A smooth and interactive user experience is provided by the front-end platform React, a popular JavaScript user interface toolkit.



*Fig 3.1 System Architecture*

The camera on the gadget is integrated into the system to record live video feeds for the purpose of identifying yoga poses. In order to do this, the user's camera is accessed through the browser, allowing the system to process real- time video data for later analysis.

The video frames are processed in order to extract key points that correspond to the user's body pose using OpenCV, a well-known computer vision toolkit. Keypoints in the collected frames are precisely identified and tracked by using Movenet, a cutting-edge posture estimation algorithm.

For pose prediction, the system uses a machine learning model that has already been developed. The model is hosted on Azure and is represented by a model.json file and a.bin file with the weights that go with it. This guarantees accurate predictions of the user's yoga stance and enables efficient and scalable access to the model.

Users can check and analyse their alignment for yoga poses by accessing the posture prediction results in the React application. The user experience is improved by this smooth connection, which gives them immediate performance feedback.

The suggested system creates a full real-time yoga stance identification solution by utilising OpenCV for key point extraction, Firebase authentication, React front-end, camera utilisation, and Azure-hosted machine learning models. This comprehensive strategy guarantees a safe, intuitive, and cutting-edge technology system to improve yoga practice.

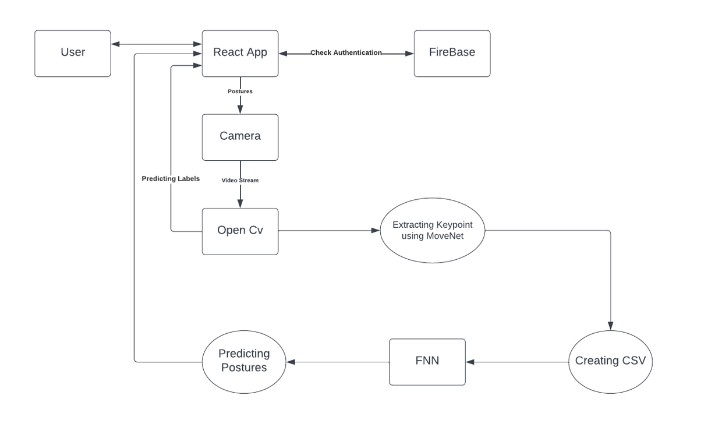
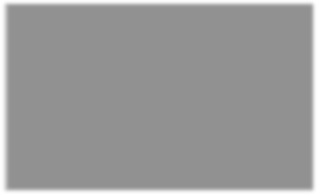


Fig 3.2 Model Architecture

**Input Layer**: An input layer, intended to receive a tensor of shape (34,), is where the model starts. This suggests that there are 34 features in every input sample.

**Hidden Layers:** The model has two hidden layers that come after the input layer. With 128 neurons and the Rectified Linear Unit 6 (ReLU6) activation function, the first hidden layer is dense (completely linked). ReLU6, a variation on the conventional ReLU function, has a maximum output value of 6 to help preserve model stability by preventing the model from learning huge weights. A dropout layer with a rate of 0.5 is placed after the first hidden layer. It acts as a regularisation technique to stop overfitting by randomly changing half of the input units to 0 during training. With 64 neurons and identical activation and dropout parameters, the structure of the second hidden layer is identical to that of the first.

**Output Layer**: As denoted by len(class\_names), the last layer of the model is a dense layer with a number of neurons equal to the number of classes in the dataset. This layer is appropriate for multi-class classification problems because it uses a softmax activation function, which converts the model's output into a probability distribution over the target classes.

With accuracy serving as the evaluation metric and categorical cross-entropy serving as the loss function, the

model is assembled using the Adam optimizer. The Adam optimizer is a well-liked option because of its memory- saving capabilities and effectiveness. While accuracy is a standard criterion for evaluating classification models, the categorical cross-entropy loss function is appropriate for multi-class classification applications.

Two callback methods are also defined in order to keep an eye on the model while it is being trained. In Keras, callbacks are functions that offer a great deal of flexibility in managing the training process. These functions can be applied at certain points in the training process, such as at the beginning or conclusion of each epoch.

The ModelCheckpoint callback is the initial callback. This is set up to track the model's validation accuracy (monitor='val\_accuracy').

The model weights are stored to a file thanks to the save\_best\_only=True option.

(weights.best.hdf5) only after increasing the accuracy of validation. This makes it possible to maintain the optimal model that was observed during training, as indicated by the highest validation accuracy. Maximising the validation accuracy is indicated by the mode='max' option.

The EarlyStopping callback is the second callback. Additionally, this is configured to track validation accuracy. Training will end if validation accuracy does not increase after 20 consecutive epochs, according to the patience=20 argument. When the model's performance on the validation set stops getting better, early halting is a regularisation technique used to stop overfitting.

These callbacks offer a reliable method of training models by preventing needless training epochs after the model has stopped improving and automatically preserving the best model

# IV RESULT

Our model achieves a high degree of accuracy, with 94% of results being correct.

Based on testing, our model demonstrates a 94% accuracy rate.

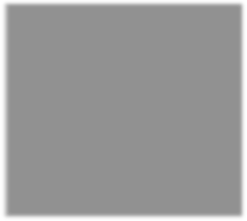


Fig 4.1 Poses

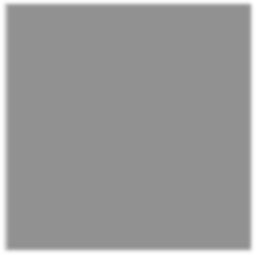
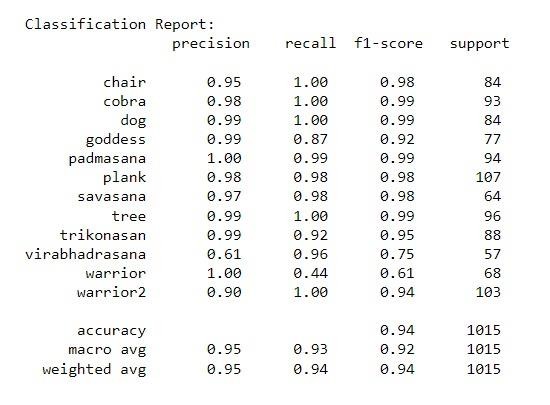
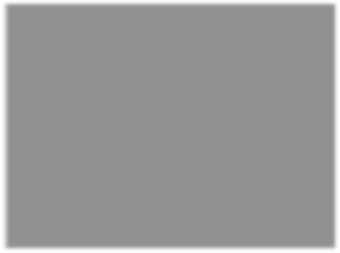


Fig 4.2 Poses

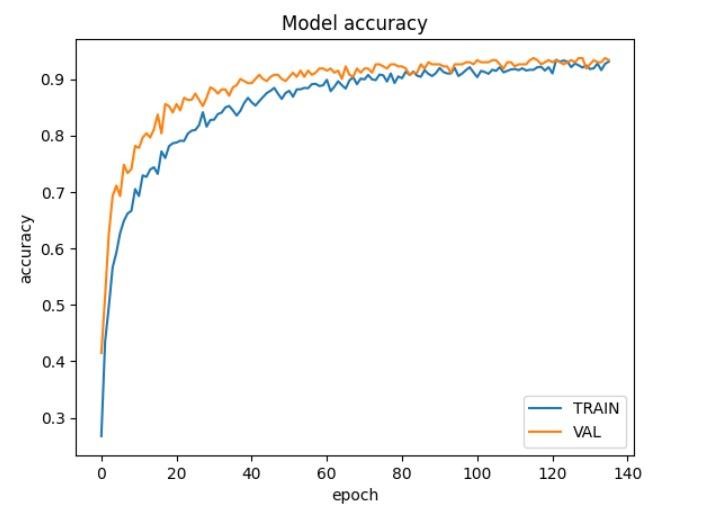
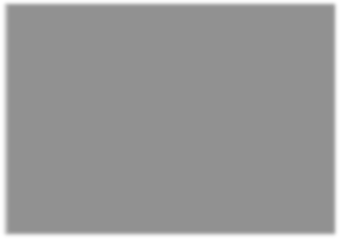


Fig 4.2 Model Accuracy

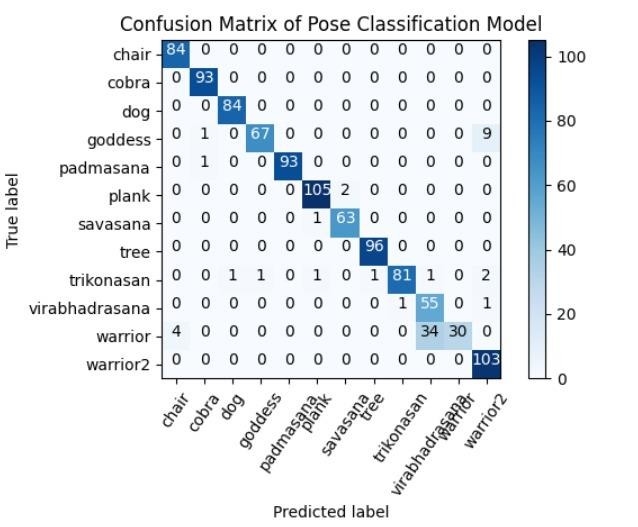
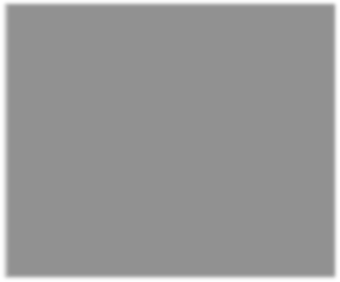


Fig 4.3 Classification Report

Fig 4.2 Confusion Matrix

# SCOPE

The Yoga Posture Detection and Correction System is envisioned as a transformative tool for yoga practitioners, leveraging state-of-the-art technology to optimize posture alignment and enhance the overall yoga experience. Through advanced pose detection algorithms and real-time feedback mechanisms, this system aims to provide users with personalized guidance to improve their technique and achieve optimal results. By integrating intuitive user interfaces and interactive features, the system ensures accessibility and ease of use across web and mobile platforms. With a focus on scalability, security, and privacy, the system strives to cater to a global audience while safeguarding users' data and personal information. Through rigorous testing and continuous refinement, the Yoga Posture Detection and Correction System seeks to empower individuals to embrace yoga as a pathway to improved physical health and mental well-being.

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# CONCLUSION

Our vision for the future of this project extends beyond the current pose estimation model. We aim to create a comprehensive online platform accessible via both a website and mobile application. This platform will serve as a one-stop destination for individuals seeking to embrace yoga and improve their overall well-being. In the coming phases of development, we plan to introduce live pose correction, and an extensive library of yoga poses with tutorials. Our goal is to make yoga and wellness accessible to a global audience, fostering a healthier and more balanced lifestyle

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