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CLASSIFICATION OF SURYA NAMASKAR YOGA ASANAS: A SEQUENTIAL COMBINATION OF PREDOMINANT POSES FOR PHYSICAL AND MENTAL HEALTH

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Abstract: Even if yoga has become more popular, it's still risky to practise on your own. For self-learning Surya Namaskar postures, we propose an automated posture classification system that integrates deep learning and machine learning. The YOLO model may identify bounding boxes in posture photographs during pre-processing. We obtain shape-based features from HOG and SURF to get postural information. When it comes to identifying postures, ANN classifiers outperform KNN. Also, CNNs boost classification accuracy. A CNN2D architecture with a Dropout layer is used to enhance taught ANN features and boost accuracy to 96% in an optimised hybrid model. Precision, accuracy, recall, and F1-score are the metrics used to train and evaluate the algorithms on Yoga10. This method improves practice and decreases injury risk by allowing anybody to complete Surya Namaskar postures correctly without expert supervision.

1. INTRODUCTION

Medical image processing, weather prediction, digital image processing for satellites, dance position classification, and detection of hand gestures and sign language are all applications of digital image processing. Classifying workout postures is also an intriguing topic [1]. In order to maintain good health, exercise is arranged, scheduled, and done repeatedly. Physical postures, breathing exercises, and mental stillness are the main components of yoga. As a regular component of health care, yoga is deeply ingrained in Indian culture. Yoga, according to research, helps one achieve inner calm and physical strength, which in turn leads to a fulfilled life [4]. Practicing yoga on a regular basis improves performance by increasing energy, concentration, physical strength, patience, and mental calm [1]. Most chronic diseases are also treated by it.

Worldwide Yoga Day is an annual event that takes place on June 21st to bring attention to the practice of yoga and its many health benefits. For 30 seconds to one minute of yoga positions, you need to be in a certain position and breathe correctly. The Surya Namaskara yoga posture is among the most popular. Another name for Surya Namaskar is the Sun Salutation. Science has proven that sunlight is an essential energy source for all forms of life on Earth. Figure 2 depicts the twelve Sun Salutation or Surya Namaskar body poses [2]. Practice involves reiterating the poses of Namaskarasana, Hastapadasana, and Ekapadaprasaranasana. Therefore, nine different perspectives are taken into account in this project.

2. LITERATURE SURVEY

a) Yoga Pose Estimation Using Rule-based Approach:
https://ieeexplore.ieee.org/abstract/document/10234979

Recognising a yoga pose is challenging since there aren't enough datasets and the processing requirements are high. Due to the potential negative repercussions of even small modifications, concrete suggestions are required[1-2]. Pradhan provides guidelines for those who do yoga at home. In order to forecast people's postures, pose estimate finds their elbows, knees, wrists, etc. In this study,

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we present a rule-based method for processing each frame using the Mediapipe Framework. Using either uploaded photos or doing the poses in front of a camera, this system may categorise yoga postures from a pre-trained set of ten. Dolphin, Half-Moon, High Lunge, Mountain, Side Plank, T-Pose, Tree, Upward Salute, Warrior II, and III are some of the yoga poses. In actuality, the user's computer-based webcam is utilised to approximatively capture the yoga posture. With 93% accuracy, this study classified yoga postures using angle heuristics for pose detection.

b) Yoga Pose Estimation using Artificial Intelligence:

https://ieeexplore.ieee.org/abstract/document/10245467

Mental and physical well-being throughout the world have been impacted by the COVID-19 pandemic. The importance of yoga is growing as nations begin to recover from the pandemic. The benefits of yoga on mental wellness are immense. Research shows that practicing yoga regularly can help alleviate some of the symptoms of the pandemic, such as anxiety, despair, and stress. The pandemic has also contributed to the rise of unhealthy sedentary lifestyles. Yoga, which doesn't require any special tools, is a fantastic at-home exercise option. Yoga position recognition using machine learning or deep learning algorithms has been the subject of much study. Using ML and DL, our proposed study may identify yoga positions and provide guided practice to assist practitioners improve their technique. A trained model identifies important body parts using Media Pipe and OpenCV, then gives feedback on the yoga position. With a detection accuracy of 99.53%, the suggested model surpasses state-of-the-art approaches. To train the model and choose your yoga position, you may use public datasets.

c) Yoga Pose Estimation with ML:

https://ieeexplore.ieee.org/abstract/document/10262445

To identify yoga positions in still photos or moving films, we use computer vision algorithms. Implementing OpenPose keypoint detection, SMOTE, and LightGBM classification improves the performance and accuracy of posture estimations in this study. To improve the accuracy of posture estimate, OpenPose's keypoint detection feature locates certain parts of the body. The SMOTE method involves oversampling minority classes in order to achieve class balance. In addition, LightGBM classification boosts model performance with its lightning-fast training speed, excellent accuracy, and ability to handle enormous datasets. There are 5994 images used in the Yoga Pose Image Classification project and 5431 images used by the authors. On a self-collected dataset with 50 classes, the proposed method achieved 71.47 percent accuracy, while on the Yoga Pose Image Classification dataset with 107 classes, it achieved 56.18 percent accuracy, surpassing current methods.

d) A Real-time Machine Learning Framework for Smart Home-based Yoga Teaching System:

https://ieeexplore.ieee.org/abstract/document/10148568

More individuals are practicing yoga at home as a result of COVID-19. Without a trainer, yoga poses become more challenging and offer a risk of muscular injury. There may be smart home-based yoga instruction devices that can help with poses. The processing time required by these algorithms to identify yoga postures is an issue. This study suggests using real-time machine learning to teach suitable yoga poses. Estimation of posture, classification, and real-time feedback are utilised. Yoga positions such as downdog, tree, goddess, plank, and warrior are all part of the collection. To estimate yoga poses, we employ the BlazePose model, which takes 2D image input and generates 3D landmark points. By analysing the output of the pose estimation model, the pose classification model was able to identify yoga positions. The accuracy, latency, and size of many neural network classifiers—including Random Forest, Support Vector Machine, XGBoost, Decision Tree, and LSTM and CNN—were evaluated. When compared to other models, XGBoost's 95.14% accuracy, 8 ms latency, and 513 KB size are superior. The output of the XGBoost Classifier was used to give real-time feedback on how to correct yoga poses. Apps on smartphones may link this one-of-a-kind structure, allowing for at-home yoga without a teacher.

e) Classification of Yoga Poses Using Integration of Deep Learning and Machine Learning Techniques:

https://link.springer.com/chapter/10.1007/978-981-19-8825-7_36

In computer vision, estimating poses is a common area of difficulty. Due to worldwide change, the practice of yoga for self-care has increased. Having a healthy posture is essential for the advantages of yoga. The benefits of a yoga position are implied by its name. Among the yoga positions identified by

the majority vote classifier are goddess, downward dog, plank, tree, and warrior 2. One way to enhance stacked individual ensemble classifiers (such as AdaBoost, bagging, and dagging) is to test a voting classifier. Machine learning classification accuracy may be measured by precision, recall, F1-score, and area under the curve (AUC). The results show that voting classifiers are more effective than individual ones. Compared to bagging classifier, classifier, and AdaBoost classifier, our average F1-score of 0.9755 is higher, suggesting that we are better at accuracy, recall, and handling tiny or skewed datasets.

3. METHODOLOGY

i) Proposed Work:

The proposed system focuses on automating the classification of Surya Namaskar yoga poses to enable self-learning without the need for expert guidance. It begins with pre-processing posture images using the YOLO model, which detects human poses and generates bounding boxes. Essential posture information is captured through feature extraction techniques like HOG (Histogram of Oriented Gradients) and SURF (Speeded-Up Robust Features). For pose classification, the system employs machine learning algorithms, including K-Nearest Neighbour (KNN) and Artificial Neural Network (ANN), with ANN demonstrating superior accuracy. To further enhance performance, a hybrid model integrates ANN with a CNN2D architecture, leveraging optimized features from the ANN. A Dropout layer in the CNN2D model eliminates irrelevant features, improving classification accuracy. Trained on the Yoga10 dataset, the system ensures efficient and accurate pose recognition, enabling individuals to practice Surya Namaskar poses correctly and safely, thereby enhancing their yoga experience while minimizing the risk of injury.

ii) System Architecture:

The system architecture for the proposed solution is designed to automate the classification of Surya Namaskar yoga poses, ensuring accurate pose recognition and self-learning capabilities. It begins with input images of yoga postures, which are pre-processed using the YOLO model to detect human poses and generate bounding boxes. These bounding boxes are then passed through feature extraction techniques, such as HOG and SURF, to capture essential posture details. The extracted features are initially classified using K-Nearest Neighbour (KNN) and Artificial Neural Network (ANN) models, with ANN exhibiting better performance. To further optimize the classification accuracy, features learned from the ANN are refined through a CNN2D architecture, which includes a Dropout layer to filter out irrelevant features. The system is trained and evaluated using the Yoga10 dataset, leveraging its diverse pose variations to enhance recognition reliability. This architecture ensures a seamless pipeline from pose detection to feature extraction and classification, enabling users to perform yoga poses correctly and safely without expert supervision.

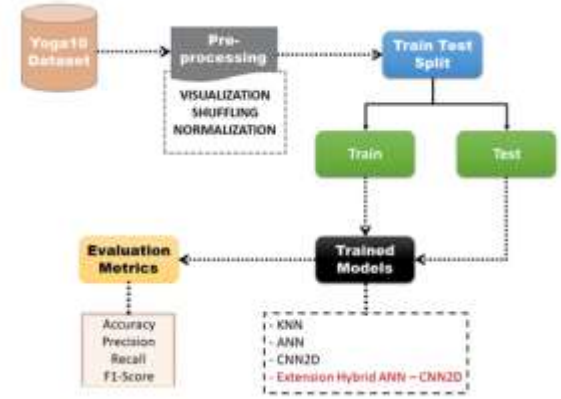

Fig 1 Proposed architecture

iii) Modules & Work Flow:

- **Data loading:** using this module we are going to import the dataset.
- **Visualization:** In order to understand the data analysed, users require visualisation. Algorithm performance is shown using confusion matrices and bar charts. This aids in evaluating the accuracy of the yoga position classification model and identifying development opportunities.

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- **Shuffling:** Shuffling is an essential preprocessing step that randomizes the order of training data, reducing potential biases and ensuring that the model learns from a diverse set of examples. This technique enhances the robustness of the training process, helping to improve the generalization ability of the algorithms during pose classification.
- **Normalization:** Scaling characteristics in a dataset to a consistent range, usually between 0 and 1, is what normalisation is all about. Ensuring that all features contribute equally to the model's performance is crucial for improving the overall accuracy of the yoga position recognition system and avoiding any one feature from unduly impacting the classification results. This technique accomplishes just that.
- **Splitting data into train & test:** using this module data will be divided into train & test
- **Model generation:** Frameworks for building hybrid ANN-CNN2D models include KNN, ANN, CNN2D, and Extension. We compute the individual algorithm performance metrics.
- **Performance Evaluation:** Achieved a high F1-score and high accuracy and precision scores.
- **Final Outcome:** final predicted displayed

iv) Algorithms:

a) K-Nearest Neighbour Using feature comparisons, KNN is able to classify yoga positions in pictures. By comparing an input posture to its nearest neighbours in the feature space, KNN enables real-time pose categorisation, providing practitioners of Surya Namaskar with immediate feedback..

b) Artificial Neural Network artificial neural networks (ANNs) reproduce intricate relationships between input and yoga posture. Classes are better learnt via non-linear patterns. To improve the effectiveness of the classification system, ANN is trained on the retrieved characteristics to detect Surya Namaskar poses.

c) Convolutional Neural Network To better classify yoga positions, (CNN2D) learns hierarchical properties from posture photos. The system is able to detect small changes in posture and enhance classification accuracy because to this deep learning architecture's ability to analyse image data well.

d) Hybrid ANN-CNN2D Joint optimisation of posture classification is achieved using ANN and CNN2D. By enhancing the characteristics obtained from the trained ANN using a CNN2D architecture, this technique enhances accuracy and efficiency, enabling users to safely perform Surya Namaskar postures.

4. EXPERIMENTAL RESULTS

Fig 2 sign in

Fig 3 upload dataset

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Fig 4 results

Fig 5 accuracy graph

5. CONCLUSION

Finally, the proposed system for automated Surya Namaskar posture classification improves self-learning yoga as it enables practitioners to execute the asanas correctly even in the absence of a teacher. Reliable feature extraction may be achieved by pre-processing posture photographs using the YOLO model and then detecting bounding boxes. HOG and SURF are shape-based features that collect posture data and enhance classification. When it comes to pose categorisation, the ANN classifier is far more accurate than the K-Nearest Neighbour (KNN) classifier. By enhancing classification performance, a Convolutional Neural Network (CNN) illustrates that deep learning methods work. The novel hybrid model attains 96% accuracy through the use of a Dropout layer to eliminate superfluous features. It blends trained ANN features with CNN2D architecture. This work used the Yoga10 dataset for training and evaluation, using metrics like as F1-score, recall, accuracy, and precision. Yoga practitioners may now practise Surya Namaskar with less danger of harm because to this technological advancement.

6. FUTURE SCOPE

There is exciting promise in this method for automatically classifying yoga stances. The model may be improved by adding more demographic information and yoga poses to the dataset. Users are able to enhance their form while practicing thanks to the real-time feedback. Another potential use case for wearable devices is the personalisation of user experiences and recommendations based on physiological markers. Future advancements may see an uptick in precision and productivity because to transformers and other complex deep learning designs. Finally, the method might be adapted for use in mobile applications, allowing users to perform yoga whenever and wherever they choose and therefore promoting healthier lifestyles.

REFERENCES

1. Proceedings of the 2023 World Computer Conference (WCONF), Raipur, India, July 1-6, doi: 10.1109/wconf58270.2023.10234979. "Yoga pose estimation using rule-based approach," by G. Danush, A. Pradeeshwar, and T. S. Sharmila.
2. "Yoga pose estimation using artificial intelligence" by D. R. Janardhana, P. H. Shashwatha, V. Manasa, H. R. Kavya, and R. Pruthvi was published in the proceedings of the 2023 International Conference on Data Science and Network Security (ICDSNS) in Tiptur, India, on July 1, 2023, and may be accessed online at doi: 10.1109/icdsns58469.2023.10245467.

3. '"Yoga pose esti?mation with machine learning,'" in Proceedings of the 11th International Conference on Information and Communication Technology (ICoICT), Melaka, Malaysia, July 2023, pp. 260-265, doi: 10.1109/ICoICT58202.2023.10262445, written by J. Z. Tan, C. P. Lee, K. M. Lim, and J. Y. Lim.
4. "A real-time machine learning framework for smart home-based yoga teaching system" by J. Sunney, M. Jilani, P. Pathak, and P. Stynes was published in the proceedings of the 7th International Conference on Machine Vision and Information Technology (CMVIT) in March 2023 in Xiamen, China. The article ran on pages 107–114 and has the DOI: 10.1109/CMVIT57620.2023.00029.
5. "Classification of yoga poses using inte?gration of deep learning and machine learning techniques," published in the proceedings of the International Conference on Recent Trends in Computing (ICRTC), was written by K. Kundu and A. Goswami. Springer Singapore, 2023, pages 417-428.