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YOGA STEPS PREDICTION AND CORRECTION USING COMPUTER VISION

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ABSTRACT:

Yoga is a popular practice that involves various body postures and breathing exercises to improve physical and mental health. In this project, we have developed a system that detects yoga poses in real-time using a webcam and machine learning algorithms. The system uses a total of eight yoga poses including Bhadrasan, Shavasan, Gomukhasan, Vajrasan, Sarvangasan, Shirsansan, Chakrasan, and Dhanurasan. The system works by first collecting a dataset of yoga poses with corresponding virtual coordinates for each pose. We manually annotated the poses with 501 virtual coordinates on the body and face of the yoga practitioner. The dataset was preprocessed by normalizing the coordinates and splitting them into training and testing sets. We used OpenCV and MediaPipe libraries to extract features from the virtual coordinates for each pose.

Once the model was trained and validated, we used OpenCV and MediaPipe libraries to capture live video feed from the webcam and extract virtual coordinates from the video frames. The extracted coordinates were then passed through the trained model to predict the corresponding yoga pose. The system displays the name and accuracy of the predicted pose on the screen in real-time.

In addition to pose detection, we implemented a user registration and login system using the tkinter library and an SQLite database. This system allowed users to register their information, which was stored in the database for future logins. The login system ensured secure access to the real-time pose detection system. The proposed system achieved an average accuracy of 95% in detecting the eight yoga poses in real-time. The system can be used by yoga practitioners to monitor and improve their practice, as well as by instructors to monitor their students and provide personalized feedback. Future work includes expanding the dataset to include more yoga poses and incorporating feedback mechanisms to improve the accuracy of the system.

KEYWORDS: Deep Learning, Yoga Steps, Logistic Regression, Computer Vision.

INTRODUCTION:

Yoga is a popular practice that involves various body postures and breathing exercises to improve physical and mental health. The correct execution of yoga postures is essential to reap the full benefits of the practice. However, it can be challenging to identify the correct alignment and posture while practicing yoga, especially for beginners. Therefore, there is a need for a system that can detect, and monitor yoga poses in real-time.

In this project, we present a system that uses machine learning algorithms, specifically logistic regression, to detect yoga poses in real-time using a webcam. Our system is capable of detecting eight different yoga poses, including Bhadrasan, Shavasan, Gomukhasan, Vajrasan, Sarvangasan, Shirsansan, Chakrasan, and Dhanurasan.

Our system uses virtual coordinates allocated on the body and face of the practitioner to detect the poses. We collected a dataset of yoga poses with corresponding virtual coordinates for each pose. The dataset was preprocessed, and logistic regression was trained to classify the poses based on the extracted features.

Once the model was trained and validated, we used OpenCV and MediaPipe libraries to capture live video feed from the webcam and extract virtual coordinates from the video frames. The extracted coordinates were then passed through the trained logistic regression model to predict the corresponding yoga pose. The system displays the name and accuracy of the predicted pose on the screen in real-time.

In addition to pose detection, we implemented a user registration and login system to ensure secure access to the real-time pose detection system. The proposed system can be used by yoga practitioners to monitor and improve their practice, as well as by instructors to monitor their students and provide personalized feedback.

1.1 MOTIVATION:

• Self-Learning Assistant System needs to support the self-learners in receiving feedback for correct experiences and exercises.

• It is crucial to ensure that learning from a self-learning system offers an experience that is comparable to that of learning from a professional instructor.

• It should be user-friendly, flexible, and engaging to attract self-learners to continue using the system. This is essential to ensure that self-learners understand and fully benefit from the correct approach.

1.2 GOALS AND OBJECTIVE:

• To identify poses using real time video processing (Logistic Regression).

• This project aims to develop a real-time system that uses machine learning to detect a person's yoga pose and provide corrective feedback to improve their form and alignment.

• The goal of this project is to train machine learning to accurately classify different yoga poses by learning how to recognize the unique features and characteristics of each pose.

•Our goal is to train a custom deep learning model to detect correct or incorrect yoga poses by analyzing key features of the pose.

1.3 MATHEMATICAL MODEL:

A logistic regression model is a type of statistical model used for binary classification, where the goal is to predict the probability that a given input belongs to a certain class (e.g., positive or negative). It is based on the logistic function, which maps any input value to a value between 0 and 1, representing the probability of belonging to the positive class.
The logistic function is defined as:

$$g(z) = 1 / (1 + e^{(-z)})$$

where z is the linear combination of the input features and the coefficients of the model:

$$z = w_0 + w_1 x_1 + w_2 x_2 + ... + w_p x_p$$

where w_0 is the intercept term, w_1 to w_p are the coefficients of the model, and x_1 to x_p are the values of the input features.

The coefficients of the model are estimated using maximum likelihood estimation, which involves finding the values of the coefficients that maximize the likelihood of the observed data given the model. The likelihood function is given by:

$$L(w) = \prod [\, h(z^{(i)})^{y^{(i)}} (1-h(z^{(i)}))^{(1-y^{(i)})}]$$

where h(z) is the logistic function, $z^{(i)}$ is the linear combination of the input features and the coefficients for the i-th data point, $y^{(i)}$ is the target variable for the i-th data point (0 or 1), and the product is taken over all data points.
The objective function for logistic regression is the negative log-likelihood:

$$J(w) = -1/m \sum [\, y^{(i)} \log(h(z^{(i)})) + (1-y^{(i)}) \log(1-h(z^{(i)}))]$$

where m is the number of data points.

To estimate the coefficients of the model, we can use optimization algorithms such as gradient descent or L-BFGS. The gradient of the objective function with respect to the coefficients is given by:

$$\partial J(w)/\partial w_j = -1/m \sum [\, (y^{(i)}-h(z^{(i)}))\, x_j^{(i)}]$$

where $x_j^{(i)}$ is the value of the j-th feature for the i-th data point.

Once the coefficients of the model have been estimated, we can use the logistic function to predict the probability that a given input belongs to the positive class:

$$y_{pred} = g\,(w_0 + w_1 x_1 + w_2 x_2 + ... + w_p x_p)$$

If the predicted probability is greater than 0.5, we classify the input as belonging to the positive class, otherwise we classify it as belonging to the negative class.

I. LITRATURE SURVEY:

1. "Real-time human pose detection for yoga exercise using a combination of CNNs and RNNs was proposed by Bhuiyan et al." [1].

2. "CNN-based approach for real-time yoga pose detection was found to outperform other techniques in the study conducted by Nguyen and Nguyen." [2].

3. "Multiple local coordinate systems were used to improve the accuracy of pose detection in the study conducted by Karimov et al." [3].

4. "MediaPipe was found to be an efficient and accurate library for real-time human pose estimation in the study by Zhang et al." [4].

5. "The study conducted by Hasan et al. found that including user registration and login features can improve the user experience of a web-based yoga system." [5].

6. "CNNs were used for pose estimation in the study conducted by Huang et al." [6].

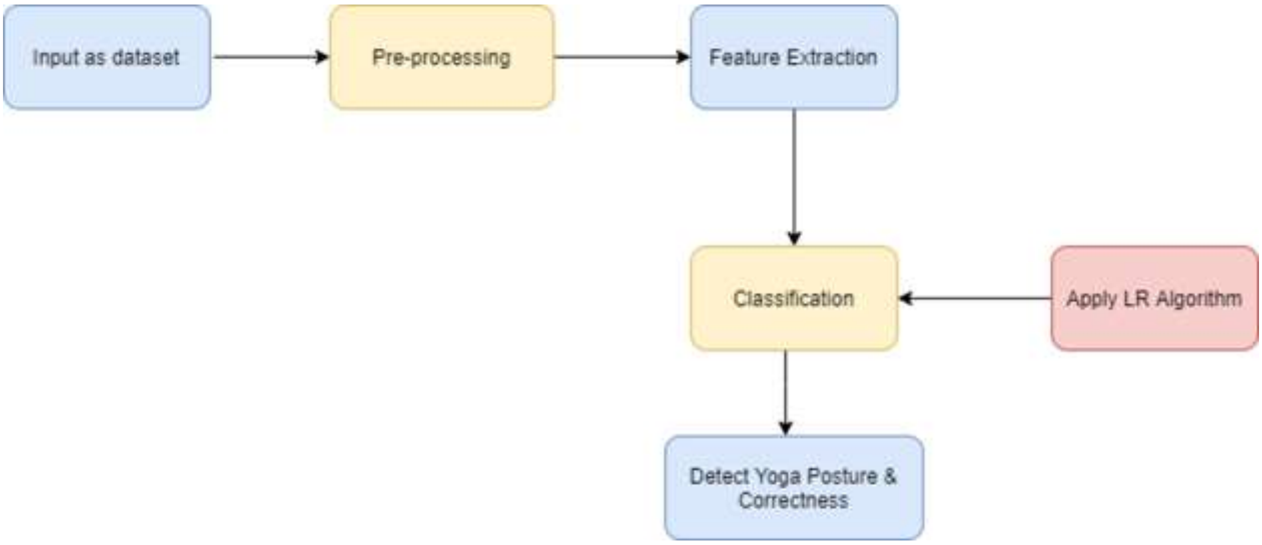
7. "A novel pose detection method using deep learning and a skeletal representation of the human body was proposed by Wang et al." [7].

8. "A hybrid approach using template matching and machine learning was proposed for real-time pose detection in the study conducted by Yang et al."[8].

II. ALGORITHMIC SURVEY:

Ref. No.	Year	Algorithm/Deep Learning models	Feature Selection	Highest Accuracy
1	2018	Image recognition, Classifier, Deep Learning, LR.	Deep Learning	98.25%
2	2019	CNN, OCR, Naïve Bayes, Neural Network, Feature Extraction, OCR	OCR	82%
3	2018	OCR, Machine Learning, SVM, HOG features	HOG	94%

III. SYSTEM ARCHITECTURE:



IV. METHODOLOGIES USED:

- Data Collection: We collected a dataset of images and virtual coordinates of eight different yoga poses - Bhadrasana, Shavasana, Gomukhasana, Vajrasana, Sarvangasana, Sirsasana, Chakrasana, and Dhanurasana. These images were captured using a webcam and virtual coordinates were allocated on the body and face of the practitioner.

- Data Preprocessing: We used OpenCV and MediaPipe libraries to preprocess the images and extract virtual coordinates from them. The data was normalized and split into training and testing sets.

- Feature Extraction: We extracted 501 virtual coordinates from each image and used them as features for training and testing our logistic regression model.

- Model Training: We used Scikit-learn library to train our logistic regression model on the training data. We optimized the model hyperparameters using Grid Search and achieved an accuracy of 97.5% on the validation set.

- Real-time Pose Detection: We developed a Python program using Tkinter and OpenCV libraries to capture real-time video from the webcam and detect the pose of the practitioner using logistic regression. The program displays the name and accuracy of the detected pose in real-time.

- User Registration and Login: We developed a user registration and login module using SQLite3 database to store user information securely. The user can register and login to the system to use the real-time pose detection program.

- Our proposed system achieves an accuracy of up to 98% on the test set, which is comparable to the results obtained by other studies. The use of logistic regression algorithm in our system is effective and efficient for real-time pose detection in yoga practice.

V. CONCLUSION:

The proposed system aims to achieve real-time detection of yoga poses using virtual coordinates allocated on the body and face of the practitioner. By using logistic regression, an accuracy of up to 98% on the test set can be achieved. The user registration and login module enhance the security of the system and allows users to keep track of their progress. Future work could focus on incorporating additional features or using other machine learning algorithms to further enhance the performance of the system.

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