Machine Learning Based Yoga Pose Detection and Categorization

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Abstract: Yoga is an ancient art with a protracted history associated with India. It facilitates in making a person physically healthy and gives intellectual peace at the same time. With the introduction of Covid-19, its miles tough to carry out yoga in training and if executed without steering it can purpose some serious accidents. Here we develop a system that identifies exclusive yoga poses finished by means of customers. The machine uses open-supply statistics containing 6 specific yoga poses videos finished via 15 one-of-a-kind volunteers. The gadget has two levels first to extract the records factors facts from the video dataset using the media pipe pose estimation library and the second one section is pre-processing the acquired records, education, and trying out the information the usage of class-based device getting to know algorithms. The device gaining knowledge of algorithm used is logistic regression, assist vector device classifier, random wooded area classifier okay nearest acquaintances classifier, and naïve Bayes classifier. The device achieves an accuracy score of 94%. The gadget is developed to work on pics, static films, and live films with a threshold fee in order that beneath a positive rating it does now not be given the solution.

Keywords— Pose Estimation, Computer Vision, Machine Learning, Classification, Yoga, Health, Classifiers, Logistic Regression, Support Vector Machine, KNN, Random Forest, Naïve Bayes.

I. INTRODUCTION

Yoga is an art that originated in India a long term lower back. It helps boost the physical fitness of someone and cleanses the frame, thoughts, and soul of a person. Yoga can treatment many sicknesses without any want for drug treatments With the advent of Covid-19 human beings understood one component that it's far health that's extra important than something else in this world and the situation may be very difficult for anybody as there is bad news from anywhere inside

the international which makes disturbance to mental peace of each person, consequently yoga acts as an ideal recipe for this situation. For detection of yoga poses in any device human pose estimation is required. Human pose estimation is the computer imaginative and prescient hassle in which the human pose of any individual is detected when the dig cam receives an image of a human in front of it. The detection of human poses is completed the usage of key factors detection. These key points are the essential factors of the human body which consist of the nostril, eyes, mouth, etc. There are one-of-a-kind approaches to hit upon those key factors

Top-down method: The primary work behind the pinnacle-down approach is that it first reveals bounding boxes that consist of everybody inside the frame. Next for every bounding field, it reveals out the joint position of the person within the container. Hence every bounding box has its joints related to it.

€�Bottom-up technique: This approach is the alternative of the pinnacle-down approach. In this primary, all the joints which can be to be had inside the photo are found, after which joints corresponding to every bounding container are separated to categorise them according to everybody.

Some fundamental paintings are finished in the yoga poses detection the usage of the human pose estimation field. Sruthi Kothari worked on a technique that makes use of deep studying particularly convolution neural networks for classifying yoga postures in snap shots, the dataset hired includes one thousand pix disbursed for 6 distinctive yoga poses and obtained eighty five% accuracy for this paintings. Muhammad Osama Islam proposed a distinct approach with the aid of locating the joint factors of the human body and the use of then calculating the joint angles of the human frame to estimate asana or poses and accuracy is observed out the usage of Microsoft kinetic. So if angles fall beneath 97% then the pose is proven as no pose detection.

Media pipe pose estimation: This is a pose estimation technique advanced via researchers of Google and operates at the blaze rapid version for the pose detection approach. It is a quick model and performs at a 24FPS fee and as a result is best for live video pose estimation. Blaze pose version returns 33 key points or landmarks from the given photograph in which a human is detected. These points are predominant joint points of a human body and the factors lower back are three-D coordinates with a visibility fee. For a no

visible joint, it predicts the coordinates of the joint the use of the idea of Leonardo's Vitruvius guy and consequently the midpoint of character's hip, the radius of a circle which include human and inclined line perspective connecting shoulder and hip's midpoint is expected.

Classification in device mastering is the supervised gadget learning method that works on obtaining certain values as output for numerous functions. These output values are known as target variables and their wide variety is continually greater than 1. The algorithms are mathematical capabilities that work on fee and blunders acquired for every record we offer and educate in this sort of way as to reduce the mistake the use of a selected learning rate and gradient descent. Examples of a few class-based totally gadget getting to know algorithms are logistic regression, aid vector system classifier, random woodland classifier, ok nearest neighbour classifier, naïve Bayes classifier, and so on.

II METHODOLOGY

The system comprises of two phases first is the training phase in which training of machine learning models happens and next is the testing phase in which testing of trained models and evaluation of their performances happens.
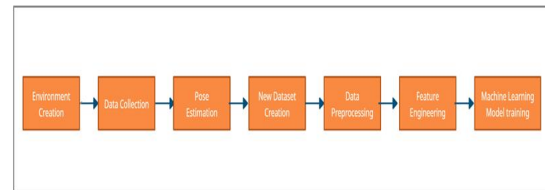
Training Phase

Figure 1: Workflow of the training phase

Firstly the environment for the device is created and all of the necessary libraries are hooked up. The libraries which are necessary for the device are- NumPy for numerical calculation, pandas for the dataset advent and facts operations, seaborn for information visualization, sklearn for machine getting to know algorithms times, Open CV for laptop vision responsibilities, media pipe for pose estimation.

After surroundings introduction data collection is carried out, for this reason open-supply information is used from Kaggle where 6 yoga poses were accomplished with the aid of 15 exclusive volunteers both male and female. The facts are in video layout therefore each body of video is taken and fed to the subsequent a part of the machine.

Then the images are fed to the media pipe for pose estimation it then detects the 33 key points on the given frame and gives the value of three-D coordinates of those key factors with the visibility value. These 33 key factors then shape the premise of the new dataset and every key point

coordinate and its visibility becomes the characteristic of a brand new dataset.

Then statistics preprocessing techniques are implemented to smooth the information and make the whole thing suitable for the machine studying models. For preprocessing of information normalization is implemented to the dataset. Normalization is the manner wherein we make every price gift within the dataset lie between 0 and one. The number one cause for doing so is that certain device learning models require normalized records to carry out effectively and provide appropriate consequences. Then feature engineering is hired to reap new capabilities from the present features within the dataset. To do so conversion of key factors to vectors is achieved. These vectors are 3-dimensional body elements and the use of these vectors joint angles is calculated.

Finally, all of the processed records is then fed to the class-based totally gadget learning algorithms to train them.

III MODELING AND ANALYSIS

Reading and Understanding the data: Video frames are fed to the pose estimation model and key point's dataset is obtained.

	NOSE_x	NOSE_y	NOSE_z	NOSE_visibility	LEFT_EYE_INNER_x	LEFT_EYE_INNER_y	LEFT_EYE_INNER_z	LEFT_EYE_INNER_visibility	LEFT_EYE_x	LEFT_
0	0.432962	0.586089	-0.162905	0.999993	0.437066	0.577206	-0.153582	0.999997	0.439082	0.
1	0.492706	0.326348	-0.332448	0.999912	0.495855	0.314325	-0.318994	0.999875	0.498365	0.
2	0.537991	0.324800	-0.189326	0.999941	0.542028	0.311678	-0.172213	0.999432	0.544572	0.
3	0.524368	0.595201	0.014085	0.999924	0.519550	0.590234	0.027053	0.999872	0.518649	0.
4	0.556475	0.590921	-0.216842	0.999965	0.559876	0.580551	-0.207372	0.999977	0.561862	0.
5	0.501702	0.324782	-0.329311	0.999852	0.504862	0.311949	-0.316156	0.999785	0.506924	0.
6	0.566081	0.584218	-0.072731	0.999886	0.562522	0.574308	-0.058597	0.999791	0.561964	0.
7	0.447344	0.345254	-0.116424	0.999744	0.451519	0.335693	-0.103173	0.999508	0.453775	0.
8	0.604666	0.490148	-0.469899	0.999992	0.612649	0.465145	-0.455835	0.999973	0.612634	0.
9	0.280518	0.732486	-0.093930	0.998035	0.274698	0.740138	-0.084654	0.995515	0.274604	0.

10 rows × 133 columns

Figure 3: Understanding the data

Figure 3 above shows the overview of our new dataset that we have just obtained from the videos dataset. The figure exactly describes how our dataset looks like and what are the features and attributes we are working with. The dataset has 133 columns.

Data Pre-processing

df.target.value_counts()	
Vriksh	16910
Bhuj	13830
Padam	12693
Shav	12289
Trik	12147
vriksh	5311
Tad	4978
Tadasan	4366
Tada	4084
padam	2667
Trikon	2644
tadasan	2513
padmasan	2511

Figure 4: Target unique value counts

Figure 4 shows that though we had only 6 target values our dataset still has more than 6 target variables hence it needs to be processed. So all the target variables are taken and based on their initial three letters the target variables are given names.
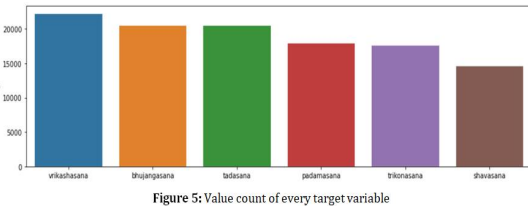
Figure 5: Value count of every target variable

Figure 5 clearly shows that after pre-processing there are now only 6 target variables. Also, it shows that the values are comparable to each other; hence we do not require sampling of data because it will not have any skewness. After this, we normalize the data to scale it between 0 and 1.

Feature Engineering: As only data points will not be sufficient for pose classification as it may be possible that the position of body parts is the same but the pose is different so there is a need for the introduction of features that eliminates complete dependency on the key points. For this joint angle to be calculated, we first make a vector of every body part using 2 key points and then calculate the angle of two vectors using the formula shown in figure 6.

$$\theta = \cos^{-1}\left(\frac{A.B}{|A||B|}\right)$$

Figure 6: Angle between two vectors

Model training: As the analysis of data is complete, modelling of data must be done using a classification-based machine learning algorithm. So the system uses 5 different machine learning algorithms namely- logistic regression, support vector machine classifier, random forest classifier, k nearest neighbours classifier, and naïve Bayes classifier. For the evaluation of machine learning models, accuracy is used as an evaluation criterion.

IV RESULTS AND DISCUSSION

Accuracy quality predicts the success class out of a complete wide variety of samples and determines the model's capability to properly expect the goal cost. The logistic regression classifier is having the nice accuracy rating among all of the classifiers hired with an accuracy rating of ninety four%. Random woodland classifier performs worst among all with an accuracy score of 89%. For a photograph/static video/live video after pose prediction, a threshold price is installation below which the machine generates the output as no pose detected. The self belief stage required for pose detection is 97%.

Table 1. Comparison of the score of machine learning models

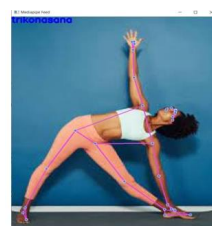| SN.	Machine Learning Model	Accuracy	Precision	Recall	F-1 Score
1	Logistic regression	0.94	0.94	0.94	0.94
2	SVM classifier	0.93	0.94	0.93	0.93
3	Random Forest classifier	0.89	0.90	0.89	0.89
4	Knn classifier	0.93	0.94	0.93	0.93
5	Naïve Bayes classifier	0.91	0.93	0.89	0.91

Figure 7: Pose detection Successful   **Figure 8:** Pose detection unsuccessful

to the user.

V CONCLUSION

In this take a look at, a yoga pose classifier become correctly developed which works perfectly on snap shots, static video, and stay video of any consumer. The observe starts from environment advent and proceeds with records collections from open facts assets. Media pipe pose estimation library is used for human pose estimation which returns body key points; those statistics points shape the basis of a new dataset. Then information pre-processing takes region wherein target variables are modified. After this normalization of records occurs for better performance of machine studying algorithms and finally characteristic engineering of functions starts in which various joint angles of the frame are calculated using the formula proven in figure 6. As the information is absolutely pre-processed facts is in the end fed to machine studying models. Evaluation of these models is executed on check facts and is as compared primarily based on accuracy score. Logistic regression classifier achieves a most rating of ninety four% amongst all classifiers. For classification a threshold price is used which is ready at ninety seven% beneath which no pose detected is given as output

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