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A Review of Machine Learning Technique for Yoga Posture Classification

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Abstract **-** Yoga is a healthful practise that originated in India that aims to revitalise a man's physical, mental, and spiritual well-being. With the rapid growth of technology, there is a significant possibility for computational probing across all social domains. However, applying artificial intelligence and machine learning techniques to an interdisciplinary area like yoga is somewhat difficult. Because the subject of this work, Yoga, is not well-known, just a few works on the subject have been discovered. As a result, this section is logically divided into two parts: one that describes works related to Yoga posture classification, and the other that describes important works in the overall problem of human posture estimate and classification. With the use of Machine Learning Techniques, a complete evaluation that recognises a yoga pose from an image or a frame of a video has been built in this study.

Keywords **-** Artificial Intelligence, Convolutional Neural Network, Long Short Term Memory, Machine Learning Algorithms, Yoga Poses.

I. Introduction

Yoga is originated in ancient India and is a group exercise related to mental, physical and spiritual strength. Yoga and sports are attracting people for so many years but from the last decade, an outsized number of individuals are adopting yoga as a part of their life. This is often thanks to the health benefits. It's important to try to this exercise within the right way, especially within the right posture. Due to lack of assistance or knowledge people start doing yoga in improper method without any guidance, thus they injure them-self during self-training due to improper posture. Yoga should be done under the guidance of a trainer but it's also not affordable for all the peoples. Nowadays people use their mobile phones to find out the way to do yoga poses and begin doing that but while doing that they don't even know that the yoga pose they're doing is within the right way or not. To beat these limitations, many works are done. Computer vision and data science techniques are wont to build AI software that works as a trainer. This software tells about the benefits of that pose. It also tells about the accuracy of the performance. Using this software one can do yoga without the guidance of a trainer.

The innovations in technology and science are happening in a drastic phase, which makes human life more and more hassle-free. Nowadays everybody is conscious of its relevance in day to day life. As in every domain, the influence of computers and computer-powered technologies are well established in health care and related domain. Apart from the standard medical practices, other practices like Yoga, Zumba, martial arts, etc are also widely accepted among society as how to realize healthiness. Yoga (Catherine Woodyard 2011, Ross *et al*. 2016) is a set of practices that sprout out in ancient India which deals with the wellness of the physical, mental, and spiritual condition of a man. Yoga has gained a big significance in the medical community. The benefits of yoga are improved health, mental strength, weight loss, etc. But Yoga must be practised under the supervision of an experienced practitioner since any incorrect or bad posture can cause to health problems like ankle sprain, stiff neck, muscle pulls, etc.

II. Image Processing Techniques

For any image-based application, picture pre-processing and feature extraction techniques are required. To ensure the success of the next steps, the accuracy and convergence rate of such procedures must be extremely high. However, most of the time, the importance of these strategies goes unappreciated, resulting in subpar results.

III. Pre-Processing

In general, the image pre-processing method are often divided into three processes: Image Graying, Image Geometric Changing, and Image Enhancement. The purpose of Image Graying is to transform the colour images into grayscale images to reduce the amount of data. The purpose of Image Geometric changing is to correct the image error caused by the image acquisition

system. The purpose of Image Enhancement is to improve the image effect, remove the background noise, expand the difference between different object features in the image, and improve the image quality (Bradley 2000).

At present, most image preprocessing literature studies are basically supported these three processes to optimize the image preprocessing methods. Li and Liu (2011) proposed an improved image preprocessing method called Research on license Plate Image preprocessing. In this method, image size normalization, median filtering, and image enhancement are adopted to realize image denoising and enhancement. Li et al. (2011) proposed another new image preprocessing method called Research on license Plate Image preprocessing method based on VC++. This method takes full account of the skew, blur, and damaged images caused by various reasons and gets better image effect than the normal preprocessing method. However, the methods in these literature studies are all the innovations of the traditional preprocessing method. They only consider the effectiveness of the methods in terms of image effect without considering the processing speed requirement. Therefore, during a modern production process, these preprocessing methods are difficult to satify the real-time requirements.

Fuzzy connectedness based intensity non uniformity correction has been implemented by Yongxin et al (2006). During this procedure, a sequential approach with fuzzy connectedness, atlas registration and bias field correction is used. The findings revealed that the proposed technique is frequently used as long as the intensity variations between the images are kept to a minimum.

Marianne et al (2006) minimized the effects of inter-slice intensity variation with the weighted least square estimation method. The selection of weights for the least square method is that the major disadvantage of this approach.

The noise removal technique employing wavelets and curvelets was proposed by Bo et al (2008). In this study, hybrid techniques incorporating the Variance Stabilizing Transform (VST) are also used. However, this technique works for photos containing Poisson noise. Jaya et al. use a tracking algorithm-based de-noising technique (2009). This approach isn't very efficient because the tracking seed point is random. Marcel et al. use a contrast enhancement model based on the buildup of contrast agents (2009). This just improves the image's contrast; undesirable tissues aren't removed as a result.

IV. Feature Extraction

The technique of extracting certain features from pre-processed images of several anomalous categories in such a way that within-class similarity is maximised and between-class similarity is minimised is known as feature extraction. Many feature extraction strategies for medical image processing have been reported in previous studies.

Arivazhagan et al (2003) used 2D wavelet transform based textural features for classification. In this report, initially basic statistical features are used and then cooccurrence based textural features are used to improve the accuracy. But the effects of usage of different wavelets are not dealt in the report.

Kourosh et al. do a comparison of 2D wavelet transform based textural features and 3D wavelet transform based textural features (2004). According to the findings, combining 2D and 3D wavelet-based textural data produces superior results than using only 2D wavelet features.

Hiremath et al (2006) proposed a feature extraction technique based on the complementary wavelet processed image. Feature extraction from all four sub-bands is more efficient than feature extraction from only the approximation sub-band, according to the paper. All of these solutions used the basic Discrete Wavelet Transform (DWT), which did not generate better results.

Hiremath et al. implemented an enhanced version based on wavelet packet decomposition (2006). The packet decomposition technique was shown to be more efficient than the DWT technique. Apart from extracting characteristics from the entire image, features from small regions are also retrieved and employed in image segmentation applications. Ryszard describes one such project (2007).

Pantelis et al. (2007) proposed a new feature set based on run length matrices that includes aspects such as short run emphasis, run length non-uniformity, and so on. The low classification accuracy of this work is a flaw, demonstrating that these characteristics do not guarantee superior outcomes. Wavelet characteristics for image categorization were investigated by Ke et al (2008). In this work, the dimensionality reduction technique based on sub band grouping and selection was also used.

V. Classification

Liu et al. (2018) suggested a CNN-based defect classification technique that can accurately detect six types of strip steel flaws while meeting real-time production line requirements. Soukup and Huber-Mork (2014) trained CNNs on a database of photometric stereo images of metal surface defects; utilising this technology, rail flaws can be identified early and countermeasures taken in a timely manner. In these two literature studies, CNN is used to extract image

attributes automatically. However, CNN requires a large amount of training data and has poor interpretability, limiting its use in the real-world production line. Fekri-Ershad and Tajeripour (2012) suggested a single-dimensional local binary pattern-based technique for detecting irregularities in surface textures. The proposed approach has the advantages of a high detection rate and low computational complexity. Fekri-Ershad and Tajeripour (2017) also proposed a new multiresolution surface quality detection approach that is noise-resistant.

VI. Review of Related Work

Yoga is an ancient Indian science that has been practised for thousands of years. It is the remover of suffering and the destroyer of anguish, according to the Bhagavad Gita. Yoga has recently gained popularity around the world as a result of its physical, mental, and spiritual benefits. The United Nations General Assembly proclaimed June 21st as the 'International Day of Yoga' in 2014. (Guddeti et al. 2018). Yoga has gained increasing attention in the medical community over the last decade, and various literature has been proposed for a variety of medical applications, including cardiac rehabilitation (Guddeti et al. 2018), positive body image intervention (Neumark-Sztainer et al. 2018, Halliwell et al. 2019), mental illnesses (Sathyanarayanan et al. 2019), and so on. Yoga can totally cure many disorders without the need of drugs (Patil S, Pawar A, Peshave A et al. 2011). Yoga exercises improve physical health while also purifying the body, mind, and spirit (Chen).

Yoga learning and self-instruction systems can popularize and spread Yoga while ensuring that it is practised correctly (Schure *et al*. 2008; Lim and Cheong 2015). Computer-assisted self-training systems for sports and exercises can improve the performance of participants and prevent injuries (Chen *et al*. 2018). Many works in the literature have proposed automated and semi-automated systems for analysing the sports and exercise activities such as soccer player ranking (Maanijou R, Mirroshandel 2019), swimming (Nordsborg 2014), tennis strokes (Connaghan *et al*. 2011), badminton (Shan *et al*. 2015), rugby (Waldron *et al*. 2011), basketball (Pai *et al*. 2017, Bai *et al*. 2016), vertical high jump (Yahya *et al*. 2018), hurdles racing (Przednowek *et al*. 2018), etc.

Chen et al. (2014) used a features-based method to design a self-training system that recognised Yoga practise. It makes use of a Kinect to extract the user's body contour and create a body map. To generate a descriptor for the human position, a star skeleton was employed for quick skeletonization. Chen et al. (2013) used Kinect to create a computer-assisted self-training system for posture correction. It considered three different postures: tree, warrior III, and downward-facing dog. The overall accuracy, however, is relatively poor, at only 82.84 percent. Trejo and Yuvan (2018) proposed a 94.78 percent accurate Yoga identification method for six asanas using Kinect and Adaboost classification. They are, however, utilising depth sensor-based cameras, which are not commonly available to people. Mohanty et al. (2017) used Convolutional Neural Network (CNN) and image recognition techniques to identify Indian classical dance and Yoga postures from photographs.

Chen et al. (2018) developed a Yoga self-training system that uses a Kinect depth camera to aid in correcting postures while practising Yoga for 12 different asanas. It, on the other hand, employs manual feature extraction and creates unique models for each asana. Delegate features, like as a human skeleton, must be extracted in order to describe human postures. Various skeletonization strategies, such as thinning and distance transformation, have been documented in the literature. These methods, however, have a high computational cost and are susceptible to noise (Chen et al. 2018). Since the introduction of Toshev et alDeep .'s Pose, the traditional skeletonization strategy has been supplanted by deep learning-based methods (2013). Deep Pose is leading the charge away from traditional techniques and toward deep network-based alternatives. It directly regresses on joint coordinates using deep neural network-based regressors. It anticipates a person's activities and also forecasts the location of hidden body parts.

Using a Kinect depth camera and 12 different asanas, Chen et al. (2018) suggested a Yoga self-training system to assist in correcting postures while practising Yoga. However, it builds different models for each asana using manual feature extraction. For describing human postures, delegate aspects, like as a human skeleton, must be extracted. Thinning and distance transformation are two examples of skeletonization procedures found in the literature. These methods, however, come at a significant cost in terms of computing and are susceptible to noise (Chen et al. 2018). Since the introduction of Toshev et alDeep .'s Pose, traditional skeletonization techniques have been supplanted by deep learning-based methods (2013). Deep Pose is a pioneer in the move away from traditional techniques and toward deep network-based methodologies. It directly regresses on joint coordinates using regressors based on deep neural networks. It forecasts a person's behaviour as well as hidden bodily parts' locations.

Luo et al. (2016) used deep learning technology and large scale cardiac MRI (CMR) datasets from the second Annual Data Science Bowl (ADSB) in 2016 to build a new LV volumes prediction method without segmentation. The findings of the experiment reveal that the projected LV volumes are highly correlated with the ground truth. These findings demonstrated that the proposed method has a lot of promise for further study and application in the clinical diagnosis and screening of heart disorders. For vision applications, CNNs are the most extensively

used deep learning architecture. Handcrafted features are used in traditional machine learning methods, whereas CNNs learn some representational features automatically.

To predict the VA ratings of texts, Wang et al. (2016) suggested a regional CNN-LSTM model with two parts: regional CNN and LSTM. Unlike a traditional CNN, which takes the entire text as input, the proposed regional CNN divides an input text into many areas, allowing the useful affective information in each region to be retrieved and weighted according to its contribution to the VA prediction. For VA prediction, such regional data is sequentially integrated across regions using LSTM. Both local (regional) information within sentences and long-distance dependency between phrases can be considered in the prediction process by combining the regional CNN and LSTM. The suggested method outperforms lexicon-based, regression-based, and NN-based methods proposed in earlier works, according to experimental results.

Sruti Kothari (2020) described a computer method for classifying Yoga poses from photos that uses deep learning, specifically CNN. For the classification model, they used a dataset of 1000 photos divided into six classes. This work was completed with nearly 85% correctness. Hua- Tsung Chen (2013) suggested a yoga posture identification system that can detect the trainer's yoga stance. He employed a kinetic to capture the user's body map and extract body contours in the first stage. The next stage is to create a star skeleton, which is a rapid skeletonization process that involves linking the centroid to other joint sections. A 96 percent accuracy is obtained with this strategy.

Edwin W. Trejo (2018) proposed a yoga pose correction model. The user will be given real-time instructions about an expert's pose correction. They created a comprehensive database for calculating 6 yoga positions using a recognition algorithm based on the AdaBoost algorithm. Finally, accuracy of 92 percent is achieved. Yoga is a classic activity that can bring both body and mind into balance and calm. Self-learning yoga without the assistance of an instructor, on the other hand, is a difficult task. However, here is a solution: upload a photo of oneself doing the posture, compare it to the expert's pose, and the difference in angles of various bodily joints is measured. Deepak Kumar et al. provide an alternative computationally efficient strategy for yoga position detection in the real world (2020).

Yadav *et al*. (2019) proposed a hybrid deep learning model using convolutional neural network (CNN) and long short-term memory (LSTM) for Yoga recognition on real-time videos, where the CNN layer is used to extract features from key points of each frame obtained from OpenPose and is followed by LSTM to give temporal predictions. To the best of our knowledge, this is the first study using an end-to-end deep learning pipeline to detect Yoga from videos. The system achieves a test accuracy of 99.04% on single frames and 99.38% accuracy after polling of predictions on 45 frames of the videos. Using a model with temporal data leverages the information from previous frames to give an accurate and robust result. The Authors have also tested the system in real-time for a different set of 12 persons (five males and seven females) and achieved 98.92% accuracy. Experimental results provide a qualitative assessment of the method as well as a comparison to the state-of-the-art.

Muhammad Usama Islam *et al*. (2018) proposed a method to detect different joint points of a human body and from these points, the various angle to estimate the Poses or Asanas and the accuracy is calculated by Microsoft kinetic. By this method, if a person's angle accuracy falls below 97% the authors concluded that the person could not get the pose done. Sadeka Haque *et al*. (2019) proposed a unique way to estimate human postures present in a two-dimensional human exercise image by using CNN, for this they proposed a dataset that contains 2000 images of 5 classes of exercise by conducting various experiments they finally achieved 82.68% accuracy. Sven Kreiss *et al*. (2019) introduced a multi-person pose estimation by using the bottom-up strategy with the help of two methods Part Intensity Field (PIF) and Part Association Field (PAF). The PIF method is used to localize body parts and the PAF method is used to associate body parts to each other to form a full human pose, this method is suited for delivery robots and self-driving cars. An accuracy of 96% is obtained from this method.

Dushyant Mehta *et al*. (2019) created a technique for 3D motion capture by using an RGB camera. The first step of this technique includes CNN that estimate 2D and 3D pose features along with identifying all visible joints of the individuals. In this technique, he used a new architecture called SelecSLS Net to improve the information flow without decreasing the accuracy. In the second stage, the pose features of each individual are turned into a complete 3D pose estimate by using a fully connected neural network. In the third stage, to the predicted model a space-time skeletal model is fitted, and for each subject, a full skeletal pose in joint angles is returned. Dongyue *et al*. (2017) created a model to train a golf player to make a perfect swing by capturing and remodel the swing movement in a portable way. To increase the capture accuracy a Dynamic Bayesian Network (DBN) model-based golf swing reconstruction algorithm is proposed, a smart motion reconstruction system for Golf swing (SMRG) is used based on the DBN model and kinetic as capturing device.

Computer vision and data science methods are utilized Artificial Intelligence (AI) products that act as a trainer. It depicts the benefits of that present. In some articles, there applied AI and Deep learning modules on an

enormous number of picture datasets, which includes different yoga poses (Laxman, 2020). Yoga utilizes a progression of physical postures called asana, breathing control, and meditation. Since Yoga focuses on both body and brain, it is unmistakably more remedial than work out. Yoga practice must consolidate the extending of significant muscle gatherings, adding to physical ability and adaptability (Rowland et.al, 2020). A few yoga-based mediations directed in the community have been described. Regardless of how interventions assist in decreasing falls and the dread of losing, older people with these issues may not promptly approach such network-dependent projects. Particular old individuals manifest inconvenience at rehearsing Yoga publicly, which is particularly valid for ladies who want to do much at home and recreation. It is desirable to train Yoga in a bounded area with no disturbance.

In rural zones, notwithstanding, yoga coaches are scarce (Mohan, 2021), and this factor is a significant driver in the production of a self-helped yoga training framework. Learning is frequently connected with two criteria, area and time, and is relevant to exercise or Yoga by the older too. Given an overall hesitance concerning the old to exercise or practice Yoga, the spot and season of training are adaptable by their inclinations. Also, learning depends on the person's choices and inspiration to learn at their movement. Alongside the advantages such as improved equalization, Yoga has a disadvantage.

It tends to be rehearsed at home, in a composed setting, alone, or at a gathering. Ideally, Yoga fits self-learning, too (Wang et.al, 2020). Yoga includes various successions of stances, which are assorted positions a person can expect. In Yoga, the exact posture is basic. The posture successions accepted during training are recognized and dissected to plan a self-preparing yoga framework, and wrong postures are evaluated. Due to advancements in deep neural networks, estimation of the pose has attained the best performance (Kothari, 2020 & Mathis, 2020). The nature of the central issue and skeleton comments in these datasets assume a significant part in achieving the state-of-the-art assessment models. Nonetheless, the manual explanation measure is inclined to human blunders and can be seriously influenced by different factors, for example, goal, impediment, light, viewpoint, and variety of stances (Palanimeera, 2020).

VII. Inference from the Survey

Images are becoming increasingly significant in many sectors of today's environment, where information and technology dominate with graphical improvement. Image processing is also characterised in science and technology, agriculture, biological image processing, face/iris/image recognition, and other fields. Thanks to the rapid advancement of digital technologies, it is now much easier for anyone to create complex graphical graphics than it was previously.

The evaluation covered a number of situations in which yoga visuals in the form of video sequences were dealt with, as well as machine learning approaches utilised in the yoga area. Machine learning was discovered to present a new model that aided in the improved processing of photos. It was used in image processing to solve all of the problems that had previously existed. It offers a plausible method for constructing such a structure. As in the case of diagnosing, image content recognition was not successful.

VIII. Conclusion

Yoga and athletics have been attracting people from all walks of life for decades; but, in the last decade, Yoga has become an important part of many people's lives. Yoga position identification has been studied, but due to the lack of a real-time benchmark dataset, recognition is still difficult. The developments and discoveries in science and technology provide the way for transdisciplinary fields to explore new possibilities. Many real-time applications in our daily lives leverage cutting-edge technology like artificial intelligence, machine learning, and computer vision. Yoga is one of the most commonly acknowledged life routines for both body and mental nourishment. A complete review of yoga poses and the dataset that supports machine learning classification models has been identified in this paper. The angles derived from various algorithms are used to detect the yoga stance. 94.28 percent precision.

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