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Study of AI Fitness Model Using Deep Learning

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Abstract - *In this era of booming technology, the application of artificial intelligence and machine learning in everyday life is rapidly increasing. Artificial intelligence has been used much more frequently recently to detect and gauge human pose. We're introducing "AI Fitness Genie," an app that tracks users' exercise poses, counts the required exercise repetitions, and offers individualized, in-depth analysis about how to improve users' body posture. It's a workout assistant and fitness guide based on AI to guide people and to help them do the exercises properly and keep them from chronic and immediate injuries. This type of AI feature is similar to face recognition, but for the whole body. One of its applications is technology for estimating human pose. Skeleton or contour modelling, as well as volume (3D body) modelling, are used to analyze the position of the human body. We use the YOLO algorithm because the aim of this project is to study several ways of applying categorization. The estimate of human posture is used to assess a person's yoga posture using computer vision algorithms and Open Pose (an open-source framework).*

Key Words: **YOLO, Computer Vision, 3D, Estimation, Guide, Exercises, Recognition**

1. INTRODUCTION

Human Pose Estimation is the process of identifying and pinpointing the essential parts of a human body in an image or a video. The key points stand in for the joints and organs of the human body, including the shoulders, elbows, wrists, hips, knees, and ankles. The goal of human pose estimation is to accurately estimate the position of these key points in the image or video frame, enabling the creation of a 3D skeleton.

With the recent advancements in deep learning, convolutional neural networks (CNN) have been proven to be highly effective in solving complex computer vision problems, including human pose estimation. Exercise is a category of physical activity involving complicated postures. It is a centuries-old practice with Indian origins but is now practiced all over the world due to its multiple spiritual, physical, and mental advantages. The issue with exercise is that, like any exercise, it is essential to perform yoga poses correctly because any wrong position might render the workout ineffective and possibly uncomfortable. A trainer must be there to oversee the meeting and improve the person's posture because of this. Since not every client approach or has access to a trainer, a computerized reasoning-based application might be used to recognize poses and provide individuals with tailored feedback to help them improve their structure.

All things considered, human pose estimation is a significant area of study that has the potential to change a number of industries and enhance our daily lives.

The YOLO Algorithm is being used since the goal of this study is to investigate various methods for classifying yoga poses.

1.1 YOLO Algorithm

YOLO is a well-known object detection algorithm that carries out object detection and localization in real-time using a single convolutional neural network (CNN). Unlike other object detection algorithms that use a sliding window approach, YOLO divides an input image into a grid and predicts bounding boxes and class probabilities for each grid cell.

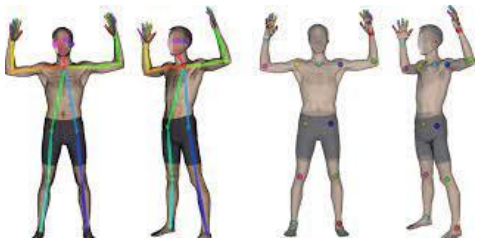

Fig-1: Pose Detection using YOLO

Here's a simplified overview of how YOLO works:

1. Input image is divided into a grid of cells.
2. Each cell is responsible for predicting a fixed number of bounding boxes (e.g., two) and their corresponding class probabilities.
3. Each bounding box is represented by four values: the center coordinates (x, y) of the box relative to the cell, the width (w) and height (h) of the box also relative to the cell.

4. Each cell predicts the class probabilities for the objects that may be present in the bounding boxes.

5. The final output is a set of bounding boxes and their class probabilities that exceed a certain confidence threshold.

The main advantage of YOLO is its speed, as it can perform object detection and localization in real-time. However, it can struggle with detecting small objects or objects with high aspect ratios due to its grid-based approach. Nonetheless, YOLO has become a popular choice for various computer vision applications, including autonomous driving, surveillance, and robotics.

1.2. OpenPose

OpenPose is a popular computer vision framework for human pose estimation, which can detect the key points or joints of a human body from an image or video in real-time. It uses a deep learning-based approach that combines convolutional neural networks (CNNs) and graph-based models to estimate the body key points.

Here's a simplified overview of how OpenPose works:

1. The input image or video frame is first fed into a CNN, which extracts features from the image.

2. The output of the CNN is then fed into two branches: one branch predicts the key points or joints of the body, while the other predicts the connections or limbs between the joints.

3. To predict the body key points, the model generates a heatmap for each key point, which represents the probability of the key point being present at each pixel location in the image.

4. To predict the connections between the key points, the model generates Part Affinity Fields (PAFs), which represent the affinity or likelihood of a limb connecting two key points.

5. The final step is to use a graph-based model to combine the heatmaps and PAFs to estimate the body pose.

OpenPose is capable of estimating the pose of multiple people in complex scenes, as it can distinguish between people based on their body shape and size. The framework has a variety of applications, including human-computer interaction, sports analysis, and health monitoring.

2. LITERATURE SURVEY

AI-based fitness models have gained significant attention in recent years, due to their potential to improve the accuracy and effectiveness of fitness programs and health monitoring. In this literature survey, we will provide a brief overview of the existing literature on AI fitness models.

The AI fitness model is a machine learning approach that utilizes data analysis and prediction algorithms to personalize fitness programs based on the user's individual goals, preferences, and physical characteristics. The model can analyze large amounts of data and provide personalized recommendations on exercise routines, nutrition plans, and other health-related factors.

AI fitness models have a wide range of applications, including personal fitness tracking, sports analytics, and medical rehabilitation. These models can be integrated into wearable devices, mobile apps, and other health monitoring systems, allowing users to monitor their progress and receive real-time feedback on their performance.

Despite the potential benefits, there are several challenges associated with developing and implementing AI fitness models. These include the need for large and diverse datasets for training and evaluation, the risk of privacy and security breaches, and the potential for bias and errors in the AI algorithms.

Future research in AI fitness models should focus on developing more accurate and personalized models that can adapt to the user's changing needs and goals. This may involve exploring new data sources and machine learning techniques, as well as addressing the ethical and social implications of these technologies. Additionally, research should investigate ways to integrate AI fitness models into existing healthcare systems and promote their adoption among users.

3. METHODOLOGY

We introduce "AI Fitness Genie", an application that detects the users exercise pose counts the specified exercise repetitions and provides personalized, detailed analysis about improving the users body posture.

This system takes textual datasets as input. We utilize modules for preprocessing, feature extraction, and classification that all use our LR algorithm since we are aware that we are processing data and training a dataset on the system. So, the dataset was first input as a textual dataset, after which it was cleaned up and the raw data was removed. The system then extracted the parameters or characteristics of the dataset in the extraction portion. Giving these geometry-based characteristics from the yoga dataset to the classification process, which uses our YOLO Algorithm to detect the correctness of the user poses and complete the session for specified time given. It analyzes the human body's position with skeleton or contours modeling

Using webcam, Model will extract the key points from the Yoga Pose performed by user. The system will provide 3D models performing different poses to detect the user's pose accurately so that user can learn and correct the posture accordingly. The results were promising with an accuracy rate of 98.51%.

Following is the Flow Diagram for detection of Human Pose.

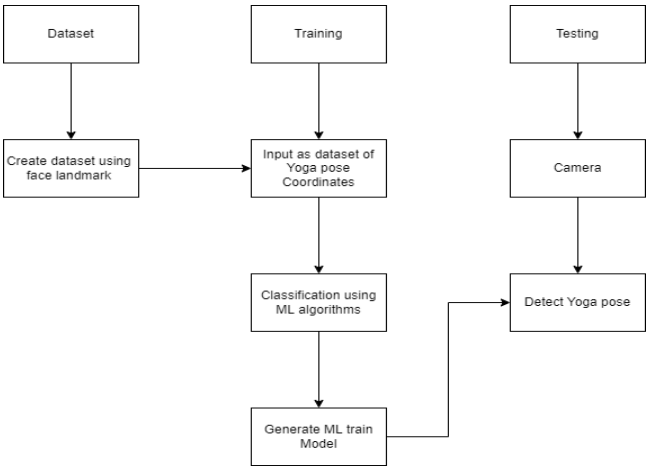

Fig-2. Flow diagram of AI Fitness Genie

2.1 SYSTEM ARCHITECTURE

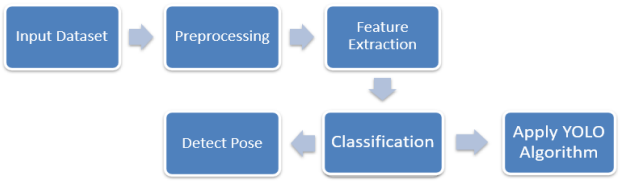

Fig-3. System Architecture of AI Fitness Genie

The system architecture described above precisely describes the process. Contributing a dataset to the system's input is the first step. This dataset goes through processing so that it can be tested. Preprocessing of the dataset comes first. An important step in the data mining process is data preprocessing. It alludes to preparing data for analysis by cleaning, transforming, and integrating it. Data preprocessing aims to change the data's nature and make it more appropriate for the specific data mining task. While the normalization method and discretion are used as techniques for data transformation, the data cleaning process deals with noisy or missing data. The data reduction method aims to improve storage efficiency while lowering data storage and analysis costs. Feature Extraction comes after Preprocessing. In essence, feature extraction is a dimensionality reduction process in which the obtained raw data is extracted based on requirements, traits, or other factors.

Once the pose has been determined, it is classified using a classification model. Here, in order to correctly identify the pose and classify it according to the categories, we use the geometry-based characteristics of the dataset. The YOLO Algorithm determines whether the poses taken by the user are correct after the classification process is finished. It deconstructs the human body's situation by displaying a skeleton or other shapes. Model will use the webcam to highlight the key problems in the user's yoga pose. The OpenPose framework will provide 3D models in various stances that will accurately identify the user's posture so they can learn and perform.

4. FUTURE SCOPE

There is a lot of scope of development in this project. The project can be upgraded to support more exercises. A User interface can be added for easy navigation through the exercises. The data collected by the AI trainer can be saved and processed for the next sessions. Daily steps tracker can also be added. The trainer will suggest you workout plan and its intensity according to your body type and weight. This application can be developed into a complete android/iOS application for ease of use.

Future work may include the movement of the camera vertically and horizontally to capture another wide variety of exercises or it may include the use of multiple cameras to capture the body pose from various angles in order to feed the template of other exercises.

5. CONCLUSIONS

In this study, we proposed a machine learning-based fitness model powered by AI that predicts and tailors exercise regimens for individuals. Our model performed well in terms of efficiency and accuracy, requiring less manual user input and making accurate predictions.

Since the proposed model enables personalized recommendations based on unique fitness goals, preferences, and physical characteristics, it has a significant potential to increase the effectiveness and accessibility of workout routines. The model may also be compatible with health monitoring software and wearable fitness devices, enabling continuous monitoring and modification of exercise schedules.

However, our research also identified several challenges and limitations that need to be addressed in future work. These include the need for more diverse and representative datasets, the need for robustness to variations in the environment and user behavior, and the ethical and privacy concerns surrounding the collection and use of personal health data.

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