International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Computer Vision Based Workout Application

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DOI: https://doi.org/10.55248/gengpi.4.423.37565

A B S T R A C T

Our lives are significantly impacted by virtual assistants, and unintentionally, we have grown to rely on them for many of our daily tasks. In this project of an OpenCV-based exercise application, we seek to explore the emerging topic of computer vision. Our project's main goal is to create a computer vision-based exercise program that is practical, user-friendly, and self-contained. The program will be able to direct the user through workout sessions and suggest appropriate postures as needed. We want to make this program hands-free so that the user can exercise without using a mouse or keyboard.

Keywords: Computer Vision, DNN Classifier, Auto_fit, MediaPipe, OpenCV, Dynamic Time Warping, Optical Flow tracking, Pose Detection.

1. Introduction

In our study, we introduce an application, that counts the repetitions of a certain exercise while detecting the user's exercise pose and providing individualised, in-depth information regarding enhancing the user's body posture. An AI-based workout assistant and fitness guide is intended to help those who don't have access to a gym but still want to exercise at home to keep their bodies in good form. to assist them in performing the workouts properly and guard against both immediate and long-term injury. Together with a personalized daily workout calorie count, this also offers a personalized health guide and food plan. The program also lists essential health insurance and policies offered by the Indian government to the general public and uses API and Web services to determine eligibility. Long stretches of time spent inside can get tiresome, especially when the majority of enjoyable things are performed outside, which is challenging given the present pandemic and lockdown situation. It is a good idea to invest the extra time we have in our own health, thus this cannot be a valid justification for being unproductive. The majority of gyms include a selection of workout machines as well as trainers that may instruct us on the activity and the proper form. Nonetheless, the absence of the aforementioned tools and trainers may be a significant deterrent to us exercising at home. Our goal is to create an AI-based trainer that will enable you to exercise more effectively at home. The goal of the project is to develop an AI algorithm that will assist you exercise by calculating the number and quality of repetitions using posture estimation running on the CPU.

This project aims to make working out easier and more enjoyable. It will have a non-distractive UI. We will examine a summary of the contribution made by these families, their algorithms, benefits, drawbacks, efficiency in comparison to other technologies now in use, applications, and potential future work.

2. Literature Survey

Realtime Indoor Workout Analysis Using Machine Learning & Computer Vision

The goal of this research is to make it easier for people to exercise on their own, independently. For those who struggle to follow directions accurately, aid comes in the form of improving body posture. positions when they go to the gym. The claim is that adopting the wrong posture when exercising hurts the person more than it helps. Visual feedback is provided when exercising to address this issue. With this model, the user's postures are captured and contrasted with a professionally filmed video. The system's foundation for detecting human poses is deep learning. To synchronize and contrast user and reference films, time series data alignment techniques called DTW (Dynamic Time Warping) and optical flow tracking are used. With a certain threshold divergence between the limb angles, errors in the user's poses can be identified. The user's video that is shot must first be compared with this reference video, which is why the model calls for a professional to record the exercise video. A high frame rate video is split up so that only a small number of frames at specified time intervals are taken into consideration for analysis because the requirement only applies to select frames of the reference video.

2.2. Development of a learning aid tool using a human-computer interaction System based on hand gestures

This study primarily focuses on interactive learning aids that use a vision-based hand gesture detection system. For the purpose of recognizing hand motions, Media Pipe is used by the system. A virtual mouse-based object controlling system is used with the recognized motions to manipulate (control) virtual objects created with Unity. To facilitate Sign Language recognition, MediaPipe's open-source infrastructure and machine learning method are offered. The prediction model is simple to use and can be customized for different smart devices. The steps for hand tracking are: Real-Time Hand Detection, instead of training a hand detector, we train a palm detector because it is simpler to estimate the bounding boxes of rigid objects like fists and palms than it is to identify hands with articulated fingers. Regression is utilized for their next hand landmark model to achieve perfect key point localization of 21 3d hand-knuckle coordinates within the detected regions of the hand, i.e., direct coordinate prediction, using palm detection throughout the full image. Gesture classification, the projected hand skeleton is used to generate gestures. A multi-platform library called Media Pipe provides excellent, ready-to-use ML solutions for computer vision workloads. We may build cross-platform multimodal (video, audio, and any time series data) applied ML pipelines using the structure known as Media Pipe.

Virtual Mouse using Hand gesture

As one of the most efficient ways to use a computer, this paper primarily focuses on how to use the functions given by the computer with the use of hand gestures and movements. Leap Motion is a term used to describe this method of hand motions used to operate laptops and computers. The following are the key actions: With the OpenCV library, the user of the system's movements and gestures can be recognized. A sizable open-source library for computer vision, machine learning, and image processing The next step is mapping hand movements to a predetermined coordinate. The evaluation of the mapping to associated cursor motions will come after that. These motions will make it easier to identify and evaluate them. Then, hand tracking is combined with fingertip detection, paving the way for the development of an accurate and basic hand gesture language that would allow a user to communicate control information to a computer system. We need a sensor to track the user's hand movements for the system to function. A sensor is made of the computer's webcam. Real-time video is recorded by the webcam at a specific frame rate and resolution that are set by the camera's hardware. If necessary, the system allows for changing the frame rate and resolution. Real Time Video is captured using a computer webcam. Depending on the camera's FPS (frames per second), video is divided into image frames. An picture is captured by the camera reversed. This indicates that the color pointer's movement and the activity of the image are opposite. As an illustration, if we move the cursor to the left, the image will go to the right, and vice versa. It resembles the reflection we see when we stand in front of a mirror (right is detected as left and Left is detected as right). We must vertically flip the photos to avoid these issues. Since the image is an RGB image, straight flipping is not possible. As a result, the image's separate color channels are split apart and then individually flipped. After independently flipping the red and blue colored channels, they are concatenated to create a flipped RGB image. This system uses a real-time camera for object identification as well as red object detection and some MATLAB code to do mouse functions including right click, left click, double click, and right and left motion. All mouse tasks can be performed by this system, which is based on computer vision techniques. Yet, because there are so many different human races, it is challenging to obtain solid results. Illumination problems plague most vision algorithms. Based on the findings, we can predict that our system will operate more effectively if the vision algorithms are capable of operating in all settings. This system might help with presentations and with saving workspace.

Workout tracking using Pose-Estimation and DNN

The authors of this study introduce Auto fit, a programme that effectively logs and tracks workouts using pose estimation and deep learning. They have utilised pose net for pose estimation to evaluate films of exercises and create body key \points, these are again supplied to DNN classifier to identify the state \of the exercise. The state data is then utilised to calculate the number of repetitions and sets completed. They have experimented with two distinct exercises, connecting training videos for each, and using pose estimation and deep learning to calculate the number of repetitions for a given exercise. They have also used machine learning algorithms to automatically detect the state of the exercise in the live camera feed. Auto fit can be easily operated on low-powered devices like the Raspberry Pi and Nvidia Jetson Nano because it doesn't require very strong hardware. Because of this, it may be created in a compact form factor and installed in less space. They have highlighted a number of extensions as promising areas for additional development in the future. Building a smartphone-compatible application is one method to make it simple to use on mobile devices and increase its user base so that more people may benefit. A further extension is the incorporation of a wider range of activities, such as HIIT and CrossFit routines. In order to make it more individualised and user-friendly, we may also design its GUI variant. A review paper states that regular physical activity is linked to an increase in life expectancy of 0.4 to 6.9 years and that all-cause mortality is reduced by between 30% and 35% in physically active people compared to inactive people. So, anyone may start exercising and live a longer, healthier life by utilising Auto fit.

Robust Hand Gesture Recognition Algorithm for Mouse Control

Asanterabi Malima et al., Park, and other researchers served as inspiration for this publication. For the purpose of directing a robot's movement, they created a finger counting method. We used their segmentation approach and upgraded their recognition algorithm, demonstrating that the new recognition algorithm is reliable for real-time application. There are two distinct issues with the gesture recognition method. 1) Hand segmentation 2) Elimination of noise; 3) Recognition. The hardest challenge in developing a hand gesture-based interaction system is robust hand detection. Ones. There are numerous cues that can be applied, including appearance, form, colour, depth, and context. The way you look is a very excellent signal for issues like facial detection. It is not bad to presume that the hand is the main component in the image because our paper primarily focuses on gesture recognition. Since the hand is the main component, Albiol et al's suggested segmentation techniques would make it simple to separate the hand into its component parts. As our eyes can distinguish the skin tone from its background with ease, this segmentation technique is more in line with how people see things. The hand was segmented using the upper and lower bound values specified by this traditional method for segmenting the skin pixels. Since it labels noisy objects as skin, noise removal from the segmented image is crucial. The photos are scaled to a fixed resolution before starting the recognition process. The photos in this instance were reduced to 640 by 480 because the camera's resolution was that size. However, there are certain lighting problems with this computer vision algorithm-developed system. Based on the findings, we can predict that this system will operate more effectively if the vision algorithms are capable of operating in all settings. This system might help with presentations and with saving workspace. They intended to use stereo vision methods in the future to gather the depth data required for more intricate hand gesture identification.

Yoga posture recognition by detecting human joint points in real time using microsoft Kinect

The goal of this research is to develop an application that aids users in performing yoga exercises correctly. The two Methods AI that functions as a trainee has been developed using data analytics and computer vision. This conveys the effectiveness of the performance as well as the benefits of that stance. With the help of the program, anyone can practice yoga with this. For the purpose of using deep learning and machine learning modules, a dataset containing yoga asanas such as Padmasana, Bhujanagasana, Vajarasana, Trikonasana, Vrukshansana, and Shavasana, among others, has been produced. Gradient boosting algorithm is the best for biased error correction and assists in handling missing values by examining huge datasets. Missing features have been retrieved using several approaches like Ridge classifiers and Logistic Regression. By checking all the joints, the program creates a body's skeleton. Joints can be used to retrieve coordinates and angles. RFC is a random forest classifier that is used to extract joint angles and coordinates, which are subsequently used as model features. Yoga is classified using RFC, which has good classification accuracy. To identify the yoga positions, the authors of this research developed a real-time dataset collection method. The presentation of human pose recognition follows, followed by a discussion of human body models and approaches. The suggested system is more advantageous and effective. Simple to use, highest accuracy improvement. increases understanding of yoga poses. Many people have been drawn to yoga because of the health benefits it offers, which help them lead healthy lifestyles. Yoga is thought to be the best treatment for anxiety because it is becoming more prevalent in modern life. Several people choose to be independent, yet it can be challenging for them to identify errors in their yoga poses on their own, according to studies. The writers of this research have demonstrated yoga posture recognition and correction in the system that has been suggested. The algorithm first analyses a learner's yoga stance by recognizing it. Second, determining the variance in body angles between the stances of an instructor and a user. Identifying the incorrect communication between the teacher and the student comes in third. Ultimately, based on the average angle difference, classifying the posture into three stages. As a result, to the best of our knowledge, automated software for identifying and detecting the stances that perform the best is still in its infancy. Future development will involve creating this kind of module with excellent performance across numerous positions.

A Study on Gradient Boosting Algorithms for Development of AI Monitoring and Prediction Systems

The modelling procedure and techniques for determining causation for Artificial Intelligence Monitoring 4.0 are covered in this study (AIM 4.0). The Time-To-Failure (TTF) in hours, which is derived based on critical tag values, is the aim of the predictive maintenance problem, which is treated as a supervised learning problem. Due to their capacity to outperform rival algorithms and their resistance to missing data, the chosen algorithms are variations of the Gradient Boosting Machine (GBM). Per piece of equipment, up to 50 models were trained, and the best one was selected based on performance as measured by the R2 measure. Regression analysis is used to establish causality, and tags are evaluated according to how well their predictions match the estimated p-value. The most significant probable causes are those labelled higher in the order. The final model is a collection of decision-tree-based GBM family models. Unbeatable prediction accuracy is one benefit of GBM, along with its resilience in the face of missing data. Up to 50 models were trained for each piece of equipment and their performances were compared using R2 (as described in the previous section). By strengthening weaker models, GBM trains multiple models incrementally, additively, and sequentially. The two variations that are employed are Lite GBM and XGBoost GBM, whose best splitting decisions are determined using various techniques. There isn't a single model that works best for all types of problems; instead, the best model is typically unique to the training/validation dataset offered, which explains the range of final models chosen for each piece of equipment. It has been extensively investigated and tested to predict machine failures using data-driven predictive maintenance. The term "predictive maintenance" refers to a machine learning technique that uses data to identify probable system malfunction and issues an alarm when a system is determined to be susceptible to failure. The suggested study introduces a unique framework called Artificial Intelligence Monitoring 4.0 (AIM 4.0), which can estimate the mean time until equipment failure and can assess the current state of an object. Gradient Boost Machine (GBM), Light GBM, and XGBoost are three ensemble machine learning techniques used by AIM 4.0 to anticipate machine failures. The stated machine learning techniques are used to make predictions with a high degree of confidence as well as monitoring results with a level of accuracy that is acceptable.

3. Conclusion

Our lives are getting busier today, and we scarcely have time in our schedules to stay healthy, active, and exercise every day. Many illnesses and health problems are results of this. Artificial intelligence can tackle a variety of issues in the fitness industry. Our lives are made easier by the health-related technologies and applications, which also facilitate our fitness path. Anyone can utilise this application in their own workouts, which will increase their efficiency and decrease their likelihood of making mistakes. We gained knowledge about the OpenCV library and package as well as how machine learning applications might help humans during this process. From the brief explanation given above, it is clear that AI-based workout assistants and fitness guides use some blaze pose concepts. These systems require a camera to capture the body pose as input to the system and, with the aid of a pose estimator, will output statistics on the number of calories burned and exercises performed in a human-readable format. Future work might involve moving the camera vertically and horizontally to record a wider range of workouts, or it can involve using numerous cameras to record the body stance from different angles to serve as the model for more activities.

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