Exercise Form Correction using Pose Estimation

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***Abstract*—Fitness exercises are very beneficial to personal health and fitness; however, they can also be ineffective and po- tentially dangerous if performed incorrectly by the user. Exercise mistakes are made when the user does not use the proper form, or pose. In our work, we introduce Pose Trainer, an application that detects the user's exercise pose and provides personalized, detailed on how the user can improve their performance. Pose Trainer uses the state of the art in pose estimation to detect a user's pose, then evaluates the vector geometry of the pose through an exercise to provide useful feedback. We record a data set of over 100 exercise videos of correct and incorrect form, based on personal training guidelines, and build geometric- heuristic and machine learning algorithms for evaluation.**

***Index Terms*—Estimation ,Pose, Repititions, Exercises.**

I. Introduction

The number of people going to the gym has increased exponentially over the years. However, it is very important to focus on the form while exercising. Every small mistake in the gym can cause lifelong injuries. Better form gives better results and small changes in the form can lead to huge difference in the results over a period of time. Gym trainers are an expensive option and they might not be able to focus on one person completely as they have many clients at the same time. There are applications for yoga to correct user's form and other sensors that give the heart rate and calorie intake. However, there is no existing system that suggest form correction for exercises in the gym. Thus developing an application that helps a person understand his/her mistakes and gives them suggestions on how to rectify them with the best accuracy in form will solve the problem of many gym goers. Besides the form correction, suggesting diet depending on the users aim and building a complete program for him/her, recording their development which will keep them motivated can also be included in the application. The aim of our project is to provide an application that helps the user focus on-

1)The form while working out by giving the best suggestions and thus helping the user avoid major injuries in the long run.
2)Giving the users suggestions about the corrections with maximum accuracy so that the user gets maximum results from their workout.
3)Providing workout plans so the users can track their progress.
4)Give the users an economic alternative to stay fit and live a healthy lifestyle wa

II. Literature Survey

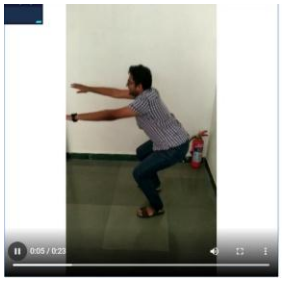
When it comes to working out quality is more important than quantity. How you lift and how you run, jump or stroke may mean the difference between going harder and getting sidelined. Beginners should expect to devote time to learning proper form. Even the more experienced can benefit from some occasional form feedback. Perfecting form will boost performance, conserve energy and reduce injuries over time. Many people work out and perform these exercises regularly but do not maintain the proper form (pose). This could be due to a lack of formal training through classes or a personal trainer, or could also be due to muscle fatigue or using too much weight.Pose estimation is basic for issues including human detection and activity recognition, and can likewise help in taking care of complex issues including human movement and posture. We utilize a cutting edge present estimation deep neural system, Posenet. The second piece of our application includes recognizing the nature of a client's anticipated posture for a given exercise. We approach this utilizing heuristic-based and AI models. [1]

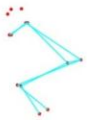
III. Pose Estimation

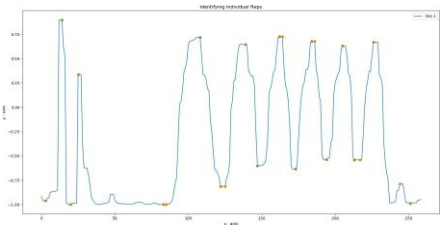
Human posture estimation is a significant issue in the field of Computer Vision. Envision having the option to follow an all individual's smalls development and do a bio-mechanical investigation continuously. [2] The technology will have huge implications. Applications may including video surveillance, assisted living, advanced driver assistance systems (ADAS) and sport analysis. [3]

PoseNet is a vision model that can be utilized to appraise the posture of an individual in a picture or video by evaluating where key body joints are.Pose estimation alludes to computer vision procedures that recognize human figures in pictures and recordings, with the goal that one could decide, for instance, where somebody's elbow appears in a picture. [4] To be clear, this technology is not recognizing who is in an image. The algorithm is simply estimating where key body joints are. The key points detected are indexed by "Part ID", with a confidence score between 0.0 and 1.0, 1.0 being the highest.

Example Output-

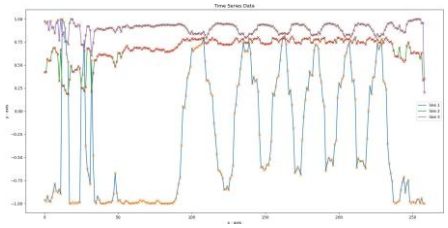




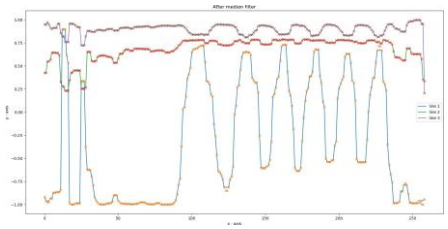


IV. Noise Reduction

The PoseNet model generates lot of noisy data depending on the speed at which the exercises were performed. Performing exercises on slow controlled speed produces significantly less noise than performing exercise at explosion speeds. Also PoseNet seems to generate fewer data points when exercises are performed in an explosive fashion, that is fewer data points for 1 repetition of the exercise. [5]



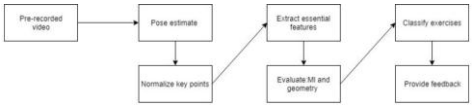
Median filter was used to remove spikes generated by PoseNet model. The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. [6]



Major issue was fitting the missing data. When lifting weights, each rep consists of a positive and a negative phase of work performed by the lifter.Positive work is performed when a force is applied to a body, and the body moves in the direction of the applied force. Negative work is performed when a force is applied to a body, but the body moves opposite to the direction of the applied force. Keeping this in mind, the positive and negative parts of the reps were extracted. Then a line fitting algorithm was implemented for each of the positives and negatives. Hence estimating the possible loss in data. [7]

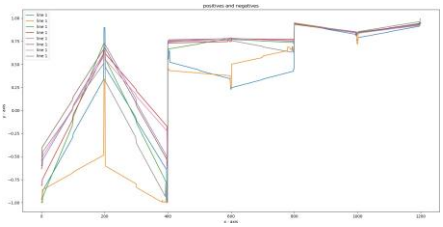
V. System Design

We now describe the Pose Trainer application from a technical perspective as a pipeline system, consisting of multiple system stages from the user recording a video of an exercise, and ends with the Pose Trainer application providing specific feed-back on the exercise form to the user.



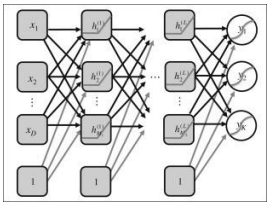
VI. Exercise Analysis

The data generated for each repetition is multivariate. For example consider a bicep curl, we have to consider many parameters like the range of motion, the initial and starting position of each repetition, is the exercise performed by involving the right muscle groups?? To consider all these parameters various position of the body has to be recorded. Now the multivariate data is converted in to single variate so that it can be easily processed by a machine learning model. Suppose a repetition depends on 3 different variables, all these variables vary exactly in the same range of time, that is these variables vary simultaneously and time when the change begins and ends is also the same. So values of the 3 variables can be appended into one and treated as one single variable. Hence the machine learning model takes input of one repetition which consists of the combined value of all the variables. Processes the input parameters and generates a result which can be used to give appropriate feedback on how well the exercise was performed.



Deep neural network models are used with different architecture depending on which exercise needs be analysed. As each

exercise has a different set of corrections and feedback generated. Current investigations show that DNNs beats GMM and HMM on an assortment of discourse preparing undertakings by a huge margin. [8] CNN is a profound neural network initially intended for picture examination. As of late, it was found that the CNN likewise has a great limit in sequent data examination. [9]



ACKNOWLEDGMENT

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CONCLUSION

The model was trained to determine the angles in each joint and also determine when a repetitions has started and when it has ended, thus being able to calculate the number of repetitions being performed by the user. Hence, a method of finding the parameters for determining the quality of a repetition has been created. With the help of Form correction using openpose, we will be able to give the user information regarding the quality of the repetition of the exercise that they've performed. Along with this, the system will also recommend changes that the user can make to their form and technique along with similar exercises for the same benefit. Acceptance of this project as a utility on an appreciable scale will help the fitness community a lot as not only will it help people with their forms consistently but it will also raise awareness for people to workout with more methodology and more properly.

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