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# USABILITY STUDY ON VIRTUAL FITNESS APPLICATION USING ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

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**ABSTRACT:**
**When the Pandemic hit the world, everything came to a standstill. To avoid large social gatherings, public spaces have been shuttered. Gym is one such location that has made it difficult for many people to maintain their health. Individuals are facing a variety of health-related concerns as a result of the poor state of disengagement, including weight, irregular sleep patterns, eye strain, mental pressure, and decreased invulnerability, and are thus at a larger risk of contracting the Coronavirus. Because the gyms are closed and people don't know where to go, they need another choice. We learned that we needed to develop a new normal lifestyle, which later became the daily routine, and is now known as the 'Future of Fitness.'In this effort to adapt to modern standards, a solution based on gamified concepts is intended to help people with their health routine and keep them prepared for day-to-day exercise. As a result, we came up with the concept of creating a Virtual Fitness and Lifestyle Studio, which brings our goal to life and makes it a virtual reality.**

## I. INTRODUCTION

Infy-Verse is an AI-powered fitness and wellness application that allows you to practise and perform fitness-related exercises such as bicep curls, pull-ups, pushups, and all traditional workouts, as well as modernised fitness arenas such as yoga asanas (with over 80 Traditional Poses) from the comfort of your own home, virtually. We can assess the client's posture and compare it to the best posture using Artificial Intelligence, Machine Learning, and Deep Learning Algorithms such as KNN, Open Pose, Media Pipe, TensorFlow, Digital Image Processing, and Speech-Processing. This results in a precision score that helps the client decide whether they are doing the Fitness activities or Yoga asanas correctly or not.

This eliminates the need for any instructor or master's mediation to know the proper technique for performing and redressing these postures. To run this fantastic programme, all you need is a PC with a camera! It's perfect for everyone, from beginners to specialists, thanks to its large library of positions. This might be the Fitness Industry's Future, since it opens up new dimensions throughout the world in terms of adopting fitness and lifestyle in a virtual manner that helps humanity. Pose estimate is important for human detection and activity identification issues, and it may also help solve difficult problems involving human movement and posture. Within Posture Trainer, we employ a state-of-the-art pose estimation deep neural network called Open Pose for inference.

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## II. RELATED WORKS

*This section discusses the various related works which were useful in our research on creating a new Virtual and Fitness Lifestyle store. The various studies have been included in this section with mere information and with a brief disclosure.*

There are few applications which help in virtual fitness platform that provides services such as calorie tracking, one-on-one nutrition and fitness coaching, and diet and workout plans. Developed for both Android and iOS platforms, these app takes a holistic lifestyle tracking approach to keep users engaged and motivated.Users with premium subscriptions get to choose from a team of in-house certified nutritionists, fitness trainers and yoga coaches. Alternatively, the users can access the AI-driven nutritionist for assistance. Few apps also combine these services with wearable technology as the app syncs with activity trackers

**The process of App Selection**: Not all apps in the Google Play or Apple Store are free. Apps for fitness may be classified into three categories: Apps at Level 1 are free to download, although they lack some functionality. To get further capabilities, the user must subscribe and pay; at Level 2, the apps are not totally free. The user must pay to download the apps; however, in Level-3, the programmes are absolutely free.

We chose a fitness app to test its usability and see how the app's features impact the user experience. The app follows the 13 evidence-based principles to a great degree. We believe this software will offer unique features and be usable because it is popular in Saudi Arabia and has great reviews on both Google Play and Apple Store. The app's research will help us figure out how to improve the usability of fitness applications. The app chosen is free, so participants in the usability testing can use it without incurring any costs.

The majority of the study focused on improving the usability of mobile apps to help users stay motivated and achieve their objectives. We feel it has overlooked one crucial factor, namely, social and cultural standards. To be functional, an app must adhere to users' social and cultural conventions, including being in their local language and taking into account social practises. In their study, Soroa-Koury and Yang enlisted 343 individuals to see how conventional attitudes and social traditions influence the prediction of a user's response to mobile apps.

Social norms were shown to predict perceived ease of use (PEOU) and perceived usefulness in the research (PU). Many academics have discovered that social norms influence human behaviour in the past. Social standards have been utilised to interfere in unwanted behaviours like as drinking, smoking, and sexual propensity, according to a number of studies. Researchers looking into technology adoption have shown that social norms are crucial indicators of user behaviour when adopting a new technology.

Despite the significance of usability, social, and cultural norms in the success of a mobile app, there are few applications in the field of health and fitness that address usability, cultural, and social norms while building the app. Alnasser et alresearch's focused on the creation of 'Twazon,' which they claim takes into account Saudi society's social and cultural standards. However, no new function or trait that makes the app more socially acceptable or culturally relevant has been mentioned. They've mostly blamed societal standards for

women's lack of physical activity. Existing research to make it more culturally and socially relevant and acceptable has its limits.

Furthermore, the software was created without taking into account usability aspects and considerations. The success of mobile apps is dependent on their usability. As a result, the following open problems have been identified:

**There is no fitness app available to users that was created with the primary goal of assisting or assisting obese individuals in achieving their fitness goals; there is no fitness app available to users that was created with usability attributes and factors in mind; and there is no fitness app available that was created with the impact of cultural and social norms on obese individuals in mind.**

*This leads to the focus of this research:*

- **How to improve mobile fitness apps usability to help users reach their health and fitness goals and more specifically it discusses how we set a trial to identify;**

- **What makes mobile fitness apps usable and useful to be easier to use.**

## III PROPOSED SYSTEM

### A. PoseNet Application in estimating Human postures:

PoseNet is a system for recognising people's postures in images and videos that uses a constant stance area. It operates in the two scenarios as single-mode (single human stance disclosure) and multi-present detection (Multiple persons present-area) (Multiple individuals present-area). Posenet is a TensorFlow model that allows you to evaluate human stance by detecting body components like as elbows, hips, wrists, knees, and lower legs, and generating a skeleton plan of your stance by combining these primary interests. Pose Net has been used in our projects and is therefore a component of our Infy-Verse.

Pose Calculator We employ deep convolutional neural networks (CNNs) to identify RGB pictures for posture estimation. We chose to utilise the pre-trained model, OpenPose, for posture identification after experimenting with a variety of state-of-the-art pose estimators. Part affinity fields, which are vectors that encode the location and orientation of limbs, are used in OpenPose to bring a fresh approach to pose estimation. The model is made up of two branches: one for learning the confidence mapping of a key point on an image, and the other for learning the part affinity field. OpenPose is both precise and efficient, and it can scale to a large number of individuals without increasing the run-time.

Estimator of Pose Deep convolutional neural networks (CNNs) are used to identify RGB pictures for posture estimation. We choose to utilise the pre-trained model, OpenPose, for posture recognition after experimenting with numerous state-of-the-art pose estimators. OpenPose uses part affinity fields, which are vectors that encode the location and orientation of limbs, to present a fresh way to posture estimation. The

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model is made up of a multi-stage CNN with two branches: one for learning the confidence mapping of a key point on an image and another for learning the part affinity field. OpenPoseis precise and efficient, and it can scale to several users without increasing the run-time.

**B. Application of PoseNet in Virtual Fitness:**

We trained many photos of people standing, sitting, walking, and so on using the CNN technique, and then used the GPU machine to estimate our human body Checkpoints.The decomposition is accomplished by analysing key points detected from the input video frame by frame and comparing them to key points from the reference video based on specified criteria.

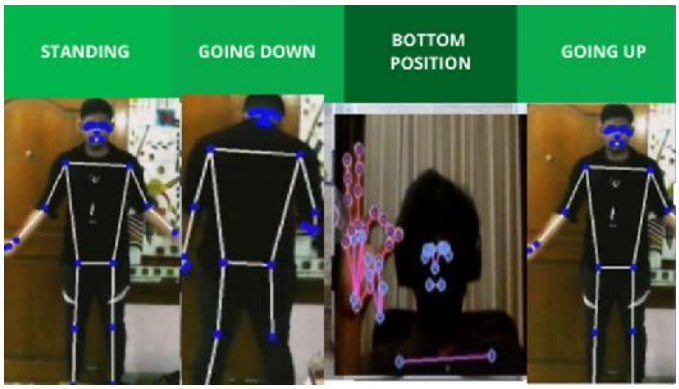


***Fig. 1. PoseNet Application in estimating Human Posture***

*Fig.1.,depicts a demonstration on how the PoseNet estimates Human Position as Standing, going down, Bottom Position and Going up. These results have been achieved through constant training of human poses and improving the*

**C. Application of Machine Learning and Deep Learning techniques in training the - Posture Identification Module: -**

We used a more data-driven, machine learning technique to evaluate workout posture given standardised key points. Because the recorded films might be of any length, each example will have a distinct key point vector length.

Many machine learning models struggle with different feature vector lengths;therefore, we use dynamic temporal warping (DTW) and a closest neighbour classifier to solve this problem.

Deep-learning is a subfield of Machine Learning and Artificial Intelligence that mimics how humans acquire particular types of knowledge. It's a three-layer Neural Network that looks like a brain. Deep learning aids in the resolution of a variety of AI consciousness and applications that aid in the future development of robotization, executing scientific and real-world tasks without the need for human intervention, and, as a result, creates problematic applications and processes. Deep learning has a place in Human Pose Discovery, for example. The Convolution Neural Network is an essential approach that has

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recently revolutionised the field of AI, and it was a tremendous contribution in predicting and categorising poses; we could compare it to other postures to get a solid estimate.

**D. Transfer Learning in creating a Virtual Fitness Machine:**

The main idea behind transfer learning is to apply information gained from activities with a large amount of labelled data to situations with a limited amount of labelled data. Because labelling data is costly, making the most of existing datasets is critical.

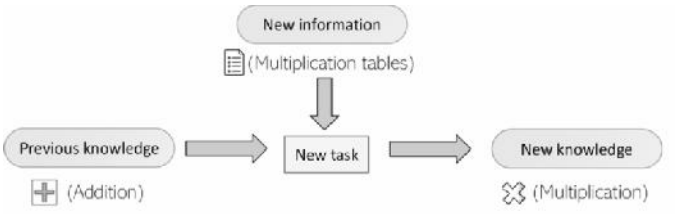


***Fig.2. Transfer Learning Mechanism***

*Fig.2. shows the simple mechanism of the working of Transfer Learning which are an extension of the Deep Learning Algorithms, as such, the new knowledge is formed out of a previous knowledge and a new information, when it is accustomed to a new task.*

***Given a specific Domain* D = {X, P(X)}, *a task consists of two components: a label space* Y, *and an objective predictive function* f(•), *which is learned from labelled data pairs* {xi, yi} *and can be used to predict the corresponding label* f(x) *of a new instance x. The task therefore can be expressed as* T = {y, f (•)}.**

***Then, given a source domain* Ds, *and a learning task* Ts, *a target domain* Dt, *and a learning task* Tt, *transfer learning aims to help improve the learning of the target predictive function* ft(•) *in* Dt, *using knowledge in* Ds *and* Ts.**

Thus, Transfer Learning is the most important tool in creating a feasible application for the Virtual fitness application for better accuracy.

**E. Digital Image processing in the back-end:**

The amplitude of 'f' at any pair of coordinates (x, y) is termed the intensity or Gray level of the picture at that location. An image may be described as a two-dimensional function, f(x, y), where x and y are spatial (plane) coordinates. The image is called a digital image when x, y, and the intensity values of f are all finite, discrete numbers. The field of digital image processing refers to the use of a digital computer to process digital pictures. It's important to remember that a digital image is made up of a finite number of pieces, each of which has its own position and value. Picture elements, image elements, pels, and pixels are all terms used to describe these components. Pixel is the most generally used phrase to describe the smallest unit of measurement.

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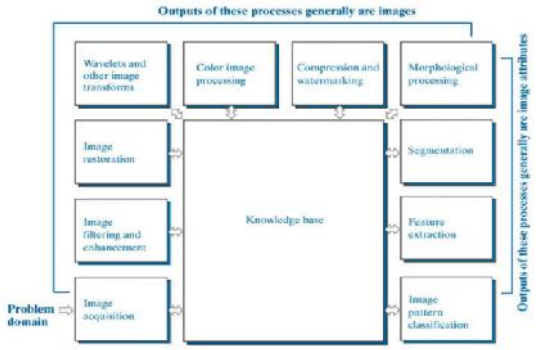


***Fig.3. Fundamental Steps in Digital Image Processing***

*Fig 3. depicts a Flow of the important components of a Digital Image Processing technique in getting an error-free estimation of an image.*

## F. Workflow of implementing a fitness studio virtually:

### Cutting of the input video based on the start and conclusion of the exercise:

To trim the videos based on the important working part of the fitness/lifestyle exercises and these data are taken from the YouTube channels which has its expertise in Fitness.

Datasets: Without data, we can't create an Artificial Intelligence system. Deep Learning models are data-hungry, requiring a large amount of data to generate the best model or a high-fidelity system. Even if you have developed outstanding algorithms for machine learning models, the quality of data is just as crucial as the quantity. The following sentence perfectly describes how a machine learning model works.

GIGO (Garbage In, Garbage Out): If we input low-quality data to an ML model, the output will be comparable. Data preparation and interpretation is one of the most critical and time-consuming aspects of the Machine Learning project lifecycle, according to The State of Data Science 2020 study.

### The Process of Detecting 2D and 3D key points on the user's body:

Using arbitrary thresholds, we can automatically determine the position of body control points for the start and finish points indication. When squatting, for example, we can detect the angle of arms and position of hands by height, and then we may identify the start and endpoints of an activity by utilising arbitrary criteria.

Journal of Current Research in Engineering and Science
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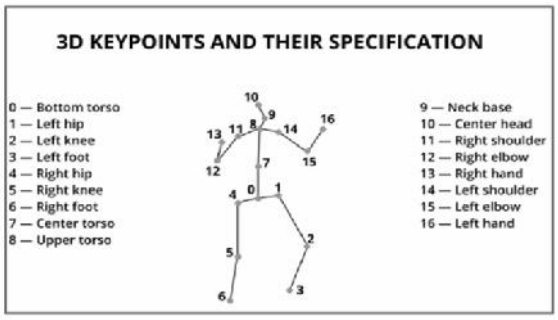


***Fig.4. 3D Key points and their specification***

*Fig. 4. displays the key points in the human body and the respective legend value.*

**Decomposition of the workout phases:**
The decomposition may be done by analysing key points recognised from the input video frame by frame and comparing them to key points from the reference video using particular criteria.

**Searching for frequent errors:**
After detecting 3D important points and specific phases of an activity, it's time to look for common errors in exercise technique in the input video. We can notice instances when the legs are bent (not straight) and the knees are closer to the centre of the body than the feet in squatting, for example.

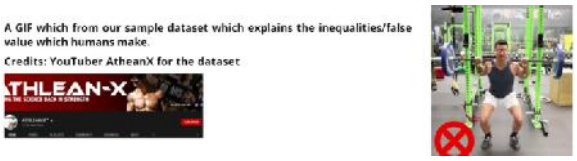


***Fig. 5. The Exercise datasets which were taken from the famous Fitness YouTube channel***

*Fig. 5., The Exercise datasets which were taken from the famous Fitness YouTube channel for processing.*

**Taking the input video frames and comparing them to the reference video frames**: Take a reference video of the exercise being done correctly, break it into stages, and identify crucial points in each frame. We may compare each phase of an activity done by a user and a professional athlete once important moments are discovered and workout phases are specified in both input and reference movies.

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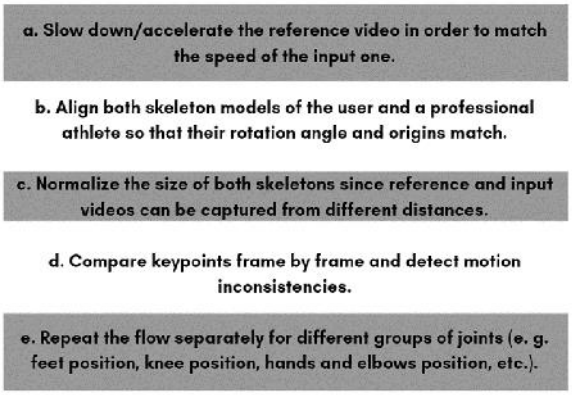


***Fig. 6. The general flow of the sliced- workflow components***

*Fig.6, shows the process of creating a usable application for fitness industry - i.e. The 'Future of Fitness' in the hands ofalgorithms which efficiently use the DL and Transfer Learning algorithms.*

Thus, The Process implied in the Fitness application has been profound and studied, Analysed and mapped, at the sight, of Usability.

## IV. RESULTS & FINDINGS

The Results were of a good accuracy and speed with the natural movement of a human, as well as, a trained professional, in fitness. The repetition counter has also got its good accuracy in the feasible use of a Fitness Application based on Artificial Intelligence

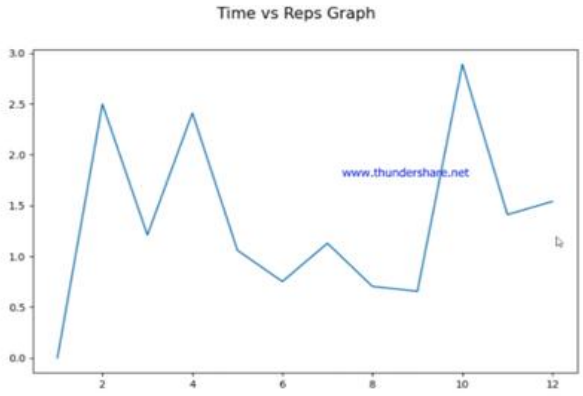


***Fig. 7. Time vs Repetition graph.***

*Fig. 7. Time vs Repetition help us to take a note on the user's performance in a particular exercise model from which we can calculate the Accuracy by taking a slope at a given time.*

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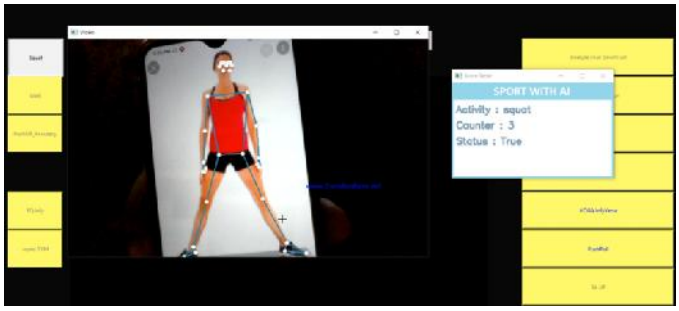


*Fig. 8. The Squat count has been recognized, categorized and counted based on the signal from the user.*

The Accuracy for this has also been about 97.8-percent in terms of coping up with the fastness of the user/image. (Accuracy calculated from manual calculation with the graph)

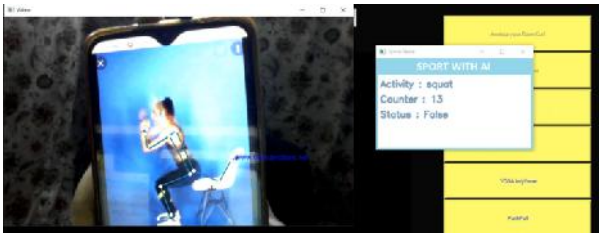


*Fig. 9. The Sideway Squat count has been recognized, categorized and counted based on the signal from the user.*

The Squat exercise has been shown up here and the accuracy can be seen as a visual proof, as the reading counts as par with the movements detected with the user w.r.t the user-interface design, is what the Deep Learning aimed at.

**Likewise, many exercises could have been fed into the same Model, which consists of many different combinations of postures, and thus many different fitness exercises can be created from the existing technology developed into a unique model of fitness application, with virtual space.**

## V. Future Development

These days our life is becoming more occupied and we scarcely carve out opportunities in our timetables to be solid, fit and work-out every day. This has caused numerous infections and medical problems. Execution of Artificial Intelligence in the field of wellness can take care of numerous issues. The wellbeing related applications and gadgets are making our lives more straightforward and facilitates our wellness process. People can involve this application in their own exercises, henceforth making them more productive are less blunder inclined. In this cycle, we figured out how to utilize the OpenCV library and bundle and how the use of AI can be advantageous to people.

There is a ton of extent of improvement in this undertaking. The task can be moved up to help more activities. A User connection point can be added for a simple route through the activities. The information gathered by the AI mentor can be saved and handled for the following meetings. Day to day advances tracker can likewise be added. The mentor will propose you exercise plan and its force as per your body type and weight. This application can be formed into a total android/iOS application for convenience.

From the concise knowledge gave above, it shows that AI-based exercise colleague and wellness guide utilizes a few ideas of blast present, requires a camera to catch the body act like contribution to the framework produced and with the assistance of posture assessor, will give the details of calories consumed and practice include as result in comprehensible structure.

Future work might incorporate the development of the camera in an upward direction and evenly to catch one wider assortment of activities or it might incorporate the utilization of numerous cameras to catch the body present from different points to take care of the format of different activities and creating a Simple Mirror.

## VI. CONCLUSION

InfyVerse - Virtual Fitness Trainer, an end-to-end computer vision programme that employs pose estimation, visual geometry, and machine learning to deliver tailored feedback on fitness exercise form, is described in this research. We take advantage of the output of posture estimates to evaluate exercise videos through key aspects of the human stance We employ both geometric heuristic methods and machine learning to deliver individualized feedback on specific workout gains. We work with four different exercises and record training films for each. using simply tagged input films, learning systems may automatically detect posture correctness.

We have highlighted many expansions as promising areas for further work beyond this course.

One option is to adapt Pose Trainer to smartphones and create an app that allows users to shoot videos and receive pose feedback at any time or location. Another option is to improve pose feedback by giving precise recommendations for where the user's pose needs to be improved (e.g., back, neck, shoulders) and recommending targeted action. Finally, we could work on better graphics, such as giving the user their labelled position diagram and comparing it to a ground truth trainer's labelled pose diagram.

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