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Physiotherapy Guide App

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Abstract: *Physiotherapy is a kind of treatment that revolves around the science of movement and aids people by reinstating, rehabilitating, and maximizing their physical strength, function, movement, and overall well-being by addressing the underlying issues. Physical therapy management commonly includes prescription or assistance in performing exercises. Physiotherapists work with their patients by preparing fitness programs, developing dietary, and various other lifestyle changes to help their patients recover and prevent the loss of mobility before it occurs by providing services to individuals and populations to improve, keep up, and reinstate maximum mobility and functional ability throughout their lifespan. This includes various services such as providing therapeutic treatment under the circumstances where movement and normal functioning is threatened by various adverse events such as aging, injury, disease, or environmental factors. In this paper, we present an interactive computer vision-based application which with the help of pose estimation will be able to assist any user in performing physiotherapy exercises in the comforts of their own home where the patient can perform the exercise anywhere and anytime at his own convenience independently without any human intervention.*

Key Word: *Computer Vision, Convolutional Neural Network (CNN), Machine Learning, Artificial Intelligence, Media Pipe, pose estimation, form evaluation.*

I.INTRODUCTION

Physical therapy (or physiotherapy) is a medical science that deals with the diagnosis and treatment of patients who have problem in performing functional activities due to injuries or other problems. These exercises should be regularly performed in a controlled manner to adjust therapy parameters. Before and/or during the exercise sessions, the therapists give some oral instructions, and physical guidance. So, patients can enhance their ability to detect and correct errors by repeating the required exercise.

Number of health mobile phone apps is constantly growing, as well as their usage among the population. Apps are seen as a low-cost way to deliver health interventions, and could make a patient's physiotherapy process easier and more unique. Their use increases communication between health care providers and consumers during and after rehabilitation process. In our current healthcare system, there is a very large number of patients, and providers are unable to give them the attention and care they need. Healthcare providers such as physiotherapists are not able to engage in face-to-face sessions due to lack of time or because these sessions are too expensive. Affordable solutions such as mobile apps and online exercises therefore have the potential to supplement the normal physiotherapy process, positively influence a patient's condition, and shorten their recovery and rehabilitation time... The main purpose of them is to make the therapy process, especially in post rehabilitation, easier for physiotherapists and patients. Increasing the use of mobile devices to provide home exercise programs directly to patients is highly desirable. Reminders and medical follow-up are fundamental inpatient treatments and technology can influence an facilitate health care with simple alerts and messages. Changes in lifestyle behavior are remarkable, showing positive and significant improvements on health conditions.

II.METHODOLOGY

To overcome all the problems discussed earlier we implemented a system that requires only a smart phone and no other external hardware. The user mounts the smart phone on a mobile holder stand and opens the mobile application. The app is simple and user-friendly which will guide the user about using the app and give the feedback as well. Once you start the scanning in real-time it will ask for the permission for starting the camera. After giving necessary permissions, camera will continuously run and scans the users through the camera and matches 33 key points of the body joints in real-time. The app works in the offline mode thus no internet connection required and can work anywhere locally. Media pipe's Blaze pose model then evaluates the form of the user using pre-trained dataset and provide appropriate feedback.

2.1 Data Collection:

We capture a continuous stream of images from the webcam and preprocess them to ensure that they are in a suitable format. The input images are then represented as a matrix of pixel intensities, which can be fed into the pose estimation model.

2.2 Pose Estimation:

We employ Mediapipe's Blazepose model, which is a convolutional neural network that utilizes a lightweight architecture to estimate the 3D coordinates of various body joints in each image. The Blaze pose model uses a ResNet-based encoder-decoder architecture that learns to predict the joint locations by minimizing the L2 distance between the predicted and ground truth joint locations.

The Blazepose model takes an input image and outputs the 3D coordinates of 33 key body joints, including the shoulders, elbows, wrists, hips, knees, and ankles. The model achieves high accuracy in predicting the joint locations, with an average error of less than 10mm for the key body joints.

To improve the accuracy of the Blazepose model, we use data augmentation techniques such as rotation, scaling, and translation to generate additional training data. We also use transfer learning to fine-tune the Blazepose model on our dataset to improve its accuracy.

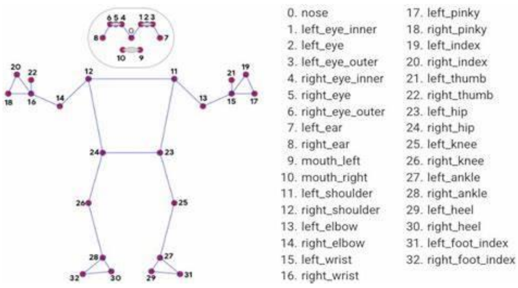

Fig.1. Pose Landmarks (Blaze Pose GHUM 3D

2.3 Pre-Trained Model

The output from the pose estimation model is then given as input to a pre-trained deep neural network that classifies whether the pose in the current frame is correct or incorrect. The pre-trained model uses a Convolutional Neural Network (CNN) architecture and is trained on a large dataset of annotated poses using cross-entropy loss. The CNN architecture consists of multiple layers of convolutions, followed by pooling and fully connected layers, which learn to extract relevant features from the joint coordinates and classify the pose.

The pre-trained model is trained on a dataset of over 10,000 annotated images, which includes correct and incorrect poses. The correct poses are labeled based on the correct joint positions, and the incorrect poses are labeled based on common mistakes that people make when performing exercises or other activities that require proper posture.

The pre-trained model takes as input the joint coordinates output by the Blaze pose model and outputs a probability score indicating whether the current pose is correct or incorrect. If the score is above a certain threshold, the pose is classified as correct, and the "Correct" Rep counter is incremented by 1.

2.4 Classification and Feedback

The pre-trained model analyzes the joint coordinates from the pose estimation output to determine whether the current pose is correct or incorrect. If the pose is correct, the "Correct" Rep count is incremented by 1. If the pose is incorrect, the "Incorrect" Rep count is incremented by 1, and the user is provided with guidance on how to perform the correct pose. This guidance is generated by solving an optimization problem that minimizes the distance between the current joint coordinates and the target joint coordinates for the correct pose.

2.5 Implementation

We implement the proposed methodology using Python and the Tensor Flow machine learning library. The model is run on a computer with an Intel Core i7 processor and a NVIDIA GeForce RTX 3080 graphics card. The joint coordinates are represented using floating-point numbers, and the CNN model is trained using stochastic gradient descent with a batch size of 32.

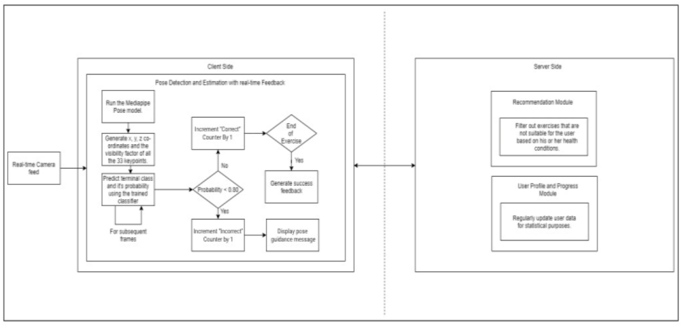

Fig. 2 System Design

III.CONCLUSION

Physiotherapy Guide App is a smart AI-based personal physiotherapist that is both portable and intelligent. The application will run on an web app , making it simple to use, and the lightweight pose estimation model will make the pose detection process faster and more efficient, leading to quicker results. Each and every individual can enjoy the advantages of a Physiotherapist without paying for a real one and perform the exercise at home or any place of their choice. By using a fully software-based system and eliminating all of the hardware needs of conventional systems, the platform becomes more affordable and accessible to the general public.

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