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AI Application for Body Stiffness in Parkinsons Disease

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Abstract: National projections indicate that the number of people over 60 years old is expected to increase, bringing with it an increase in the number of people affected by Parkinson's Disease (PD). This makes PD an important public health problem. Therefore, the development of effective approaches for intervention in people with Parkinson's disease needs to be more thoroughly investigated. End-to-end application will make exercising at home more convenient for patients. We can project prescribed exercises and determine whether the patient is completing them correctly. The Flutter app enables patients to register themselves, communicate with specialists over the app, and make virtual appointments. The pose detection library will help us detect angles of the exercises, and determine whether patients are performing them correctly.
Keywords: Parkinson's disease, Pose detection, Flutter

I. INTRODUCTION

Parkinson's disease is a common progressive disorder of the central nervous system that affects an estimated 8 to 18 per 100,000 individuals. Individuals with symptoms of motor neuron disease may present with impaired gait, balance and freezing of gait, as well as with a variety of non-motor symptoms, most commonly cognitive decline and depression. Strong evidence indicates that exercise reduces motor and non-motor symptoms, improves quality of life and reduces falls in people with Parkinson's disease.
People with Parkinson's disease engage in less physical activity than the general population, even at earlier stages of the disease. As physical activity levels progressively decline, however, people with Parkinson's disease generally require more vigorous exercise to stay healthy. Exercise interventions are likely to be cost-effective and can be cost-saving in people with milder disease severity, particularly if delivered by physiotherapists with expertise in Parkinson's disease. Therefore, it is important to investigate ways to encourage this population to engage in exercise.

II. LITERATURE SURVEY

Parkinson's disease (PD) is a complex neurodegenerative disorder that affects patients' and their caregivers' overall quality 31 of life (QoL). Approximately 60,000 individuals in the United States are diagnosed with PD each year, while more than 10 32 million people are living with PD worldwide [1], [2]. PD is often seen together with many significant motor signs, such as 33 tremor, rigidity, bradykinesia, hypokinesia, postural instability, and gait difficulties. While its clinical diagnosis is usually based 34 on these motor symptoms, many non-motor symptoms also manifest themselves with the disease. These non-motor symptoms 35 are commonly evident and sometimes more disabling than motor symptoms. Common non-motor signs of the disease are 36 cognitive impairments, reduced ability to smell, dementia, depression, and emotional changes. It is a progressive disorder whose 37 symptoms become more noticeable with age. Wearable sensors are used to track the body and measure exercise in many studies. Pernek et al. proposed a system for measuring upper-body exercises by using five acceleration sensors attached to the upper body [1]. The system can recognize the kind of exercise and the intensity. Prabhu et al. proposed a movement analysis framework that recognizes local muscular endurance exercises automatically and counts repetitions by using a wrist-worn inertial sensor [2]. Our system is available to users who have mobile devices, so the cost of installation is low and no sensors need to be attached to a user's body.
Due to the prevalence of mobile devices such as smartphones and tablet computers, exercise support applications have been studied for use with these devices. Medical and health care research with the assistance of intelligent equipment has increased in recent years. Gandomkar et al. developed a system that recognizes 10 exercises by using the accelerometer, magnetometer, and gyroscope built-in a smartphone [3]. The user attached a smartphone to the arm with an armband, so attachment was easy, and the system can recognize exercise and count repetitions with high accuracy. Deponti et al. developed a game application in which a user holds their phone to perform wrist rehabilitation activities [4]. The user can know if their activities are effective or not. In addition, some commercially available applications exist [5] [6]. Applications can recognize exercise routines by estimating what parts of the body are involved in each exercise and whether or not the user is performing the exercises correctly.

We observed that all the existing applications needed external hardware. Also, we saw that patients may need to exercise, and it is not possible for doctors to guide them for each exercise and track its progress. Exercise is defined as a subcategory of physical activity and includes those activities that are planned, structured, repetitive, purposive in nature, and intended to improve one or more components of physical fitness [12]. However, in humans with PD, there is a paucity of evidence suggesting a neuroprotective effect of exercise [13]. Hence it was necessary to create application which was portable and user efficient. It should also help doctors to track its patients and provide feedback.

A large number of recent studies investigated the use of wearable sensors and other technologies to assess the symptoms 61 of a patient suffering from neurological disorders [9]. There is also a growing interest in getting an unbiased analysis of the 62 efficacy of technology-based devices that can be used in scientific research of health monitoring and clinical practices [10]. For 63 examples, [10] reviewed 168 articles after searching the PubMed database and grouped the studies based on the type of device 64 used. They classified the devices as (i) 'recommended', (ii) 'suggested' or (iii) 'listed' based on the following criteria: (1) used 65 in the assessment of Parkinson's disease, (2) used in published studies by people other than the developers, and (3) successful 66 clinometric testing. They concluded that objective sensing technology is gaining attention in the study of Parkinson's Disease, 67 but the clinometric properties and testing of the devices remain a controversy.

Key areas relate to: (1) the physiological benefits of exercise with respect to disease modification; (2) the best type of exercise; (3) the optimal intensity of exercise; and (4) implementation strategies to increase exercise uptake. A better understanding of these concepts would allow for a more effective, personalized approach, rather than the current "one size fits all" and could most likely confer greater benefits. [11]

III. PROPOSED METHOLODOGY

The app will make sure you reach your desired goal through the prescribed treatment. Both yoga and exercise are available in this app. It is recommended to follow the routine of exercises already chosen by the user. It utilises pose detection and angle detection for checking if the user is exercising correctly. The app can create a progress report showing how many repetitions and exercises have been performed throughout the day and show it in a dashboard to share with others. Yoga is a popular exercise, which combines physical and mental discipline with meditative and emotional intelligence. If yoga is selected then again with help of posenet and classification model it is further classified if performed pose is correct or not.

Posesnet is a stand-alone detection module that uses advanced convolutional neural networks to detect human poses in video and images. It is well-suited for capturing the current state of the art pose recognition technology, while being engineered with the flexibility to innovate further on future use cases. Posenet is a deep learning tensorflow model that predicts human pose by estimating the parts of the body designated as key points (which are 17 in total for this model) namely being nose, right elbow, right wrist etc.

The pose estimation algorithm happens when the input RGB image is processed through a Convolutional neural network on which either multiple poses or single pose algorithms are applied by outputting the pose in the image, its pose confidence scores, key points positions and its key points confidence scores.

Angle Detection

X and Y axis are used to describe position of a body part, but angles are used to describe the movement of different body parts. To convert x & y points to lines

$$f((x_1, y_1), (x_2, y_2)) = \sqrt{((x_1 - x_2)^2 + (y_1 - y_2)^2)}$$

Example -

Left armpit angle — using the left shoulder, left elbow, and left hip
Right armpit angle — using the right shoulder, right elbow, and right hip
Left shoulder angle — using the left shoulder, right shoulder, and left hip
Right shoulder angle — using the right shoulder, left shoulder, and right hip

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$$l_1 = f((x_1, y_1), (x_2, y_2))$$
$$l_2 = f((x_1, y_1), (x_3, y_3))$$
$$l_3 = f((x_2, y_2), (x_3, y_3))$$
$$g(l_1, l_2, l_3) = \arccos\left(\frac{l_1^2 + l_2^2 - l_3^2}{2 * l_1 * l_2}\right)$$

A. Classification Model

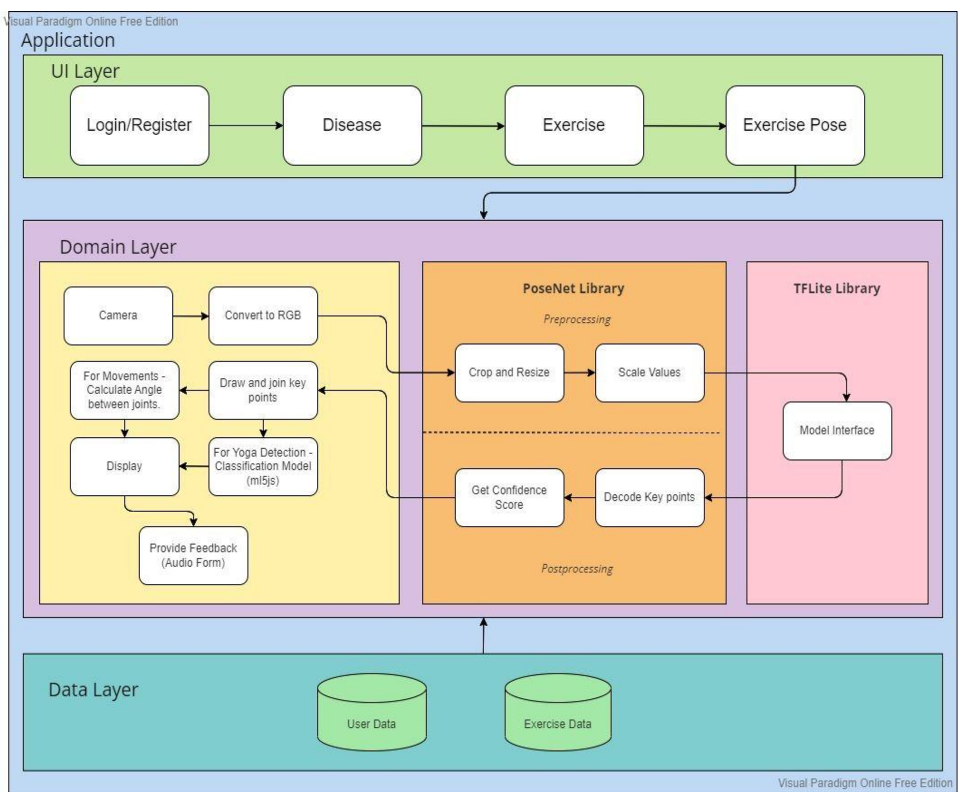
A classification is a technique where we categorize data into a given number of classes. The classification is based on similarity or distance. The main goal of classification problems is to identify the category/class to which a new data will fall under. ml5.js is an open-source machine learning library for the web. As a result, the folks building TensorFlow.js figured out that it is possible to use the web browsers built in graphics processing unit (GPU) to do calculations that would otherwise run very slowly using a central processing unit (CPU). At first, TensorFlow.js relied on GPU support in Webkit.

Application will use a camera to detect particular poses and calculate angles. However, the yoga module will require initial exercises fed to it in order to check if a patient is performing yoga correctly.

We used kaggle dataset for Yoga poses - \\ 'https://www.kaggle.com/datasets/niharika41298/yoga-poses-dataset'.The dataset was divided into train and test subdirectories, with 5 subfolders in each directory corresponding to the five yoga poses.

The app will make sure you reach your desired goal through the prescribed treatment. Both yoga and exercise are available in this app. It is recommended to follow the routine of exercises already chosen by the user. It utilises pose detection and angle detection for checking if the user is exercising correctly. The app can create a progress report showing how many repetitions and exercises have been performed throughout the day and show it in a dashboard to share with others. Yoga is a popular exercise, which combines physical and mental discipline with meditative and emotional intelligence. If yoga is selected then again with help of posenet and classification model it is further classified if performed pose is correct or not.

IV. SYSTEM ARCHITECTURE



A. Architecture of Soft Move is divided into 3 layers:

1) *UI Layer:* User Interface layer will have login and register page and will further detect disease and recommend exercise according to doctor's prescription. At first user have to login or register as per requirement. As per recommended by doctor disease section will have particular exercise and user have to perform the exercise. Now, with the help of camera which will act like visual input for the application will take poses of patient as a input and provide it to domain layer.
2) *Domain Layer:* This layer will convert images into RGB format. Then those are passed to PoseNet Library which will crop and resize the image and scale its values. TensorFlowLite library will be model interface and it will process the data. After postprocessing PoseNet library will decode key points and get the confidence score. Once done it will join all the keypoints derived and calculate the angles between the joints to predict if pose is correct or not. Further it will display and generate output in audio format
3) *Data Layer:* It will store User Data and Exercise Data. It helps to keep track of user information and provide the same when doctor needs it.

V. CONCLUSION AND FUTURE SCOPE

To build an application where doctors can prescribe exercises and track progress reports.

Design a system that lets the user enter his/her health condition and then asks him/her to select from a list of different types of training exercises. After selecting one, the system will suggest a personalized program that includes recommended volume and intensity for each exercise. The user can also modify the program if he/she wants to change any of the variables. The program will then be saved in a database. Further we can also add blogs related to how these exercise can ease up and help certain diseases.

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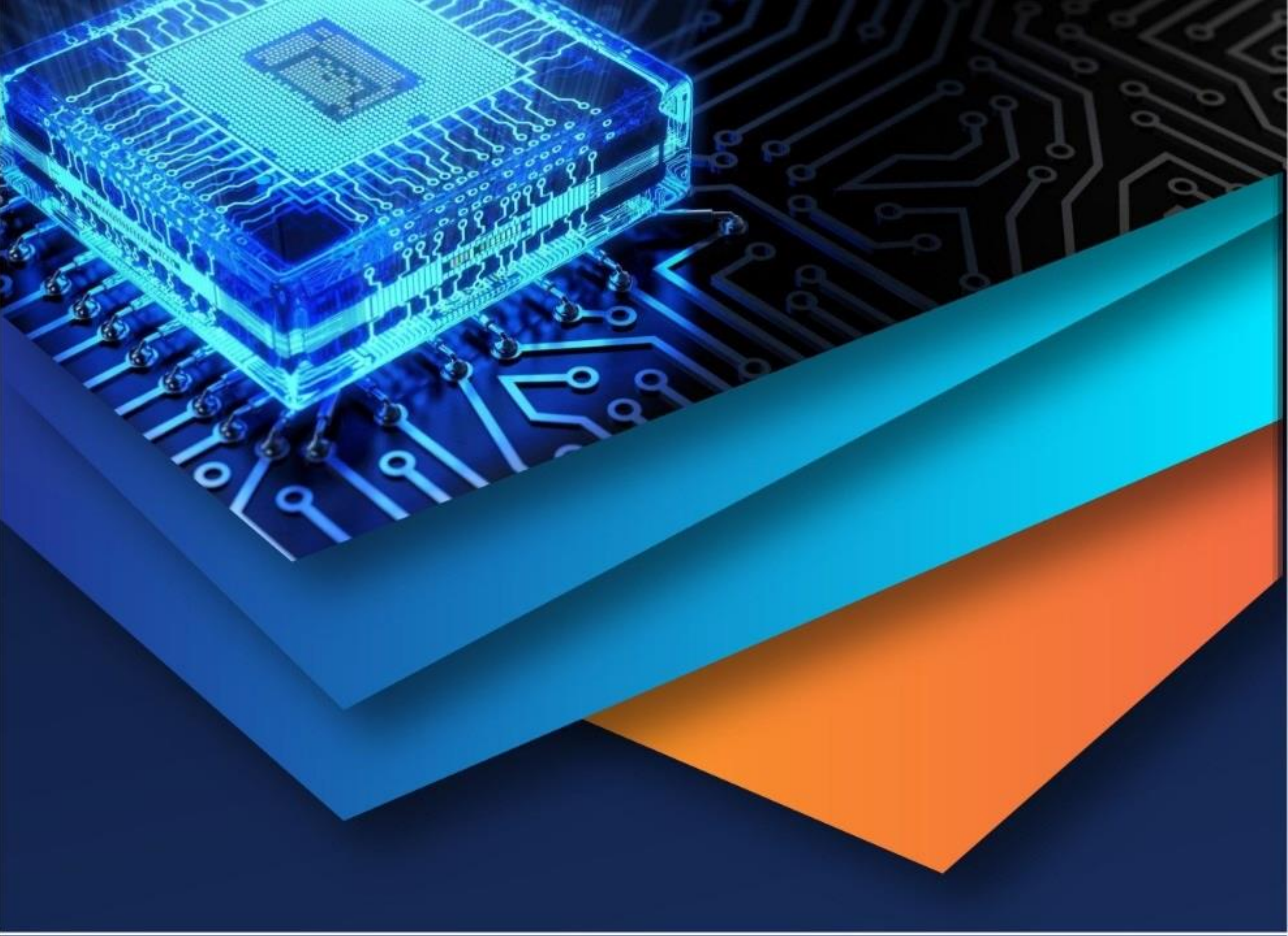

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