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# HealSmart Homes: Integrating Technology for Enhanced Convalescent Care

***Abstract: -*** The hospital facility's events are managed by Smart Convalescent Home. It provides modules for novice and experienced doctors, keeping track of patients' records, scheduling visits, etc. Major concerns, such as Lack of immediate retrievals; Going through the register to retrieve healthcare data is a challenging and time-consuming operation. Insufficient data storage: While storing these data requires additional space and work to be placed in the proper location. A lack of timely updating makes it challenging to make various adjustments to historical data. It has six modules. Doctor Module where doctors can write new prescriptions, schedule patient visits, and view their patients' medical histories. Patients module where the patient has the option to access his or her own personal record, request an appointment with the doctor, and update any medical information. Admin module where the admin module offers the ability to accept a doctor and patient, manage their information, and discharge the patient. Disease prediction module that provides analysis for three diseases, namely for the prediction of the coronavirus, chronic kidney disease, and cardiac disease. The affection stage of the disease is evaluated in a scenario where the disease is predicted in the patient's body using various parametric values and by creating some datasets the machine learning model has been deployed into a website based on the predicting findings. Yoga posture analysis feature that teaches users how to perform any asana accurately and correctly. Encourage people to train independently of a trainer. Any type of exercise can be performed within the home. Therapy that functions as a mood enhancer, similar to how music has healing properties. Users can play games that promote brainstorming while also learning something new in a pleasant way.

***Keywords:*** Machine Learning, Image Processing, Hospital Management, Disease Prediction, Python

## I. Introduction

Healthcare is one of the most rapidly developing disciplines of science and technology, with several remedies for various problems. It varies throughout the world, with various nations, groups, and people impacted by social and economic factors, as well as health regulations, to obtain healthcare. Contributing health care services to people is “the timely use of personal health services to produce the highest potential health results". Nowadays, in this contemporary and digital age, it is difficult for individuals to take care of themselves and to go to the doctor for a condition or for some advice. When a patient enters a hospital, it takes a substantial amount of time until the patient's updated health reports come, making proper detection and hence decision making for the health official difficult. Meanwhile, some suffer from diseases but are unable to pay a doctor's visit owing to a lack of or insufficient health care. Furthermore, if the patient identifies his or her symptoms and we can tell him or her what condition he or she is likely to be impacted with, he or she can take measures at home solely. Seeing a doctor after having all of our bodily metrics taken as become a pretty stressful procedure in these days. People must travel to the hospital and wait for the doctor. We can't even guarantee that doctors will always be accessible to us; even if they are, we must

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schedule an appointment and wait our turn. There were no sophisticated technologies to bring the exact diagnosis or treatment of individuals online than in person till today.

As a result, a computer-aided diagnosis system (or illness prediction system) that uses machine/deep learning to determine whether a person is infected with a certain ailment. They must fill out a form with their medical information. Second, there is a tool to input the symptoms they are having (either just write the symptoms or record the audio in the browser) and the patients will learn what probable diseases they may have as well as the measures that they must take. So the goal of our website is to collect all of the data from the patients and present preliminary information on the sickness they are suffering from. Our online doctor is simple to use, saves time, and is dependable. Humans should be more conscious of the importance of mental health. Anxiety disorder instances have increased by 41%, while suicide cases related to mental health problems have increased by 67%.

Smart Convalescent Home will analyze an individual's mental health state using enjoyable psychological tests and give pre-built solutions to enhance mental health issues. The user may identify his stress level and gain insight into what actions are essential. We also have a ChatBot to help our users. Then there's music therapy, which allows users to meditate while soothing music plays in the background. Additionally, our Yoga & Exercises program offers users access to guided yoga sessions and exercises to foster physical and psychological wellness. Through interactive games and quizzes, users can not only learn new things but also engage in stimulating activities that promote cognitive health.

At Smart Convalescent Home, our mission is to empower individuals to address their mental health concerns proactively, offering effective solutions without necessarily requiring professional intervention in most cases.

## II. LITERATURE REVIEW

Priyanka Patil proposes a web-based medical management system that incorporates a patient database in the cloud in [1]. It depicts the concept of cloud storage as well as android programming technology, both of which serve as key roles in online medical management. Tablets with Android programming can display patient management and other customized applications. Doctors can then evaluate the findings and prescribe medication.

Xiaojun Zhang outlines an online system for scheduling patient appointments, utilizing a Web Services architecture in [2]. The CHC created and implemented an online appointment system. On the front page of the medical center's website, there is a web link that, when clicked, allows the user to submit web-based information into the online appointment system.

Fayezah Anjum designs and delivers an effective method of electronically storing information based on an online health care system in [3]. It also provides a speedier communication method between patients and doctors, as well as improved user security.

Aakash Chatline discusses many characteristics that make portable medical devices employing the Internet of Things in [4]. It displays numerous networks and replaces the existing health-care system. Furthermore, this article describes important technologies used to access portable medical information and elaborates on the central principle that will revolutionize the area of healthcare in the near future.

As stated in [5] this research suggested a flexible system with semantically annotated datasets for encoding and decoding for security purposes. User information and illness data are examples of input datasets. The input data is in an unstructured format, and components like as data preparation, feature extraction, and pattern matching are used to analyze the process task. As cited in [6], it is recommended that electronic medical records undergo ownership-controlled encryption to ensure secure transmission, access, and storage. The maintenance of electronic information should prioritize preserving content authenticity, patient privacy, and data integrity. Furthermore, information sharing and access should be facilitated through source verification mechanisms such as signatures and certification processes to prevent unauthorized access or alterations to EHR content.

## III. DISEASE PREDICTION ALGORITHMS

### *A. DECISION TREE CLASSIFIER*

Discrete and continuous properties may both be predicted using the classification and regression approach known as the DT method. The algorithm predicts discrete attributes based on the relationships between input columns in a dataset. It utilizes the values of these columns, termed as states, to anticipate the states of a specified column designated as predictable. The approach explicitly identifies the input columns linked to the predicted column.

### *B. RANDOM FOREST*

Random forest is the most potent and well-known algorithm in machine learning. It is a part of supervised computer learning. In machine learning, it is applied to classification and regression issues. a The steps in the random forest method are as follows:

- Information is gathered and Decision trees are built using various samples. It uses the decision tree average.

When compared to a single dataset, it can accommodate categorical variables.

### *C. LOGISTIC REGRESSION*

Logistic regression is employed for classification tasks, distinguishing between different categories, while linear regression is utilized for regression tasks, predicting continuous values. This method employs an "S"-shaped logistic function that outputs two maximum values (0 or 1) instead of a traditional regression line. The curve of the logistic function represents the likelihood of events occurring. Due to its ability to handle both discrete and continuous datasets, logistic regression is a popular machine learning approach widely used for categorizing new data.

## IV. POSE CLASSIFICATION

### *A. LSTM*

To tackle the challenge of long-term dependencies, a specialized type of Recurrent Neural Network (RNN) known as Long Short-Term Memory (LSTM) is utilized. LSTMs are renowned for their inherent ability to retain information over extended periods. This is made possible by the concept of a cell state, which facilitates uninterrupted information flow akin to a conveyor belt. LSTMs incorporate regulatory mechanisms called gates, which control the addition and removal of data from the cell state. These gates allow selective passage of information as needed. Specifically, LSTMs feature three types of gates: input, update, and forget. Consequently, LSTMs possess the capability to selectively retain or discard learned information. By enabling prolonged retention of input states within the network, LSTMs effectively manage and process lengthy sequences. Figure 1 shows the LSTM architecture.

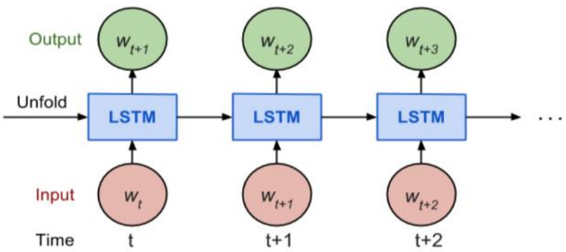


Fig.1 LSTM Architecture

### *B. CNN*

CNN, a neural network widely utilized in computer vision tasks, has become the standard approach for processing image data due to its effectiveness. Typically, CNNs consist of one or more convolutional layers, which serve as the initial layer responsible for extracting features from images. These convolutional layers employ filters to gather features from different sections of the input image, generating feature maps. Subsequently, pooling layers, often using max pooling, are employed to reduce dimensionality, thereby accelerating training and preventing overfitting.

CNNs play a major role in performing posture classification tasks, making them a preferred choice. CNNs are trained on either human skeleton joint positions or directly on images. In the case of key points, CNNs utilize convolutional filters to extract features from the 2D coordinates of OpenPose key points. Nonlinearity is introduced into the network by using common activation functions like Rectified Linear Unit (ReLU) which is applied after convolution. Although alternatives such as Tanh and sigmoid exist, ReLU is preferred for its superior performance in handling nonlinear real-world data. Below mentioned image depicts CNN architecture.

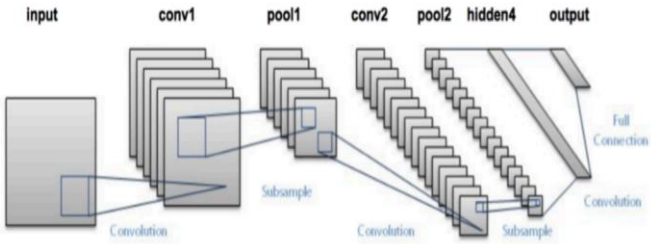


Fig. 2 CNN architecture

## V. POSTURE ESTIMATION

The field of recognizing human posture has undergone significant developments in recent years, thereby transitioning from 2D to 3D pose estimation and from single to multi-person posture analysis. To develop a machine learning program for detecting shoplifters, real-time 3D postures of multiple individuals are captured using a single RGB camera.

Human posture estimation methods are broadly categorized into two types: generative techniques and discriminative methods. Generative techniques represent posture estimation as a geometric computation, while discriminative methods model it as an image processing problem. Additionally, these algorithms can be classified based on their operational principles.

### *C. KEY POINT DETECTION*

A deep learning framework PoseNet, which is similar to OpenPose, is employed for detecting human postures in images or video sequences by identifying joint positions in the human body. These key points, or joint locations, are assigned a "Part ID" along with a confidence score ranging from 0.0 to 1.0, with 1.0 denoting the highest confidence level. The performance of the PoseNet model may vary depending on the device and the chosen output stride.

Notably, PoseNet exhibits robustness based on changes in image size, enabling it to predict stance positions at the original image's scale regardless of any downscaling that may have occurred. Softmax layer is replaced with a series of fully connected layers in PoseNet's architecture.

The architecture comprises three main components:

1. The encoder, responsible for generating the encoding vector v, a 1024-dimensional representation of the

input picture's characteristics.

2. The localizer, which produces the vector u, representing features of localization.

3. The regressor, consisting of two interconnected layers used to regress the final position.

### *D. DISEASE PREDICTION MODULE*

Using machine learning, an illness is predicted. High accuracy may be achieved with an effective machine learning system. The illness prediction is crucial since even a small error might put people in danger. As a result, it's crucial to accurately assess and choose the most popular algorithms. Here, predictive models are developed for three diseases

- Coronavirus prediction.
- Chronic Kidney Disease Prediction.
- Heart Disease Prediction.

As in the first part (Coronavirus prediction), the logistic regression method, which is a classifier without multi-collinearity on a graph and is used to predict probability, is used to determine if the individual is afflicted by the coronavirus or not. Logistic regression yields a 96% accuracy rate. In the next section, the presence or absence of chronic renal disease is determined in the section that follows. The supervised machine learning algorithm decision tree divides the datasets into more manageable subsets (Divide and conquer) and achieves high accuracy. Decision trees may be used in medicine, diagnostics, and other fields. This model has a 92% accuracy rate.

Finally, Random forest is employed to predict cardiac illness. It uses decision trees as part of a supervised machine learning method, which aggregates the output of many decision trees and the outcome on majority vote. It manages values that are missing. Random forest is used to obtain an accuracy of 94%.

## VI. POSTURE ANALYSIS MODULE

### *A. DATA SET*

The dataset used in this work is available to the public as part of the Open Source collection. It features 15 different people practicing six distinct yoga positions (5 females and 10 males). Bhujangasana (Cobra posture), Padmasana (Lotus pose), Shavasana (Corpse pose), Tadasana (Mountain stance), Trikonasana (Triangle pose), and Vrikshasana are other few yoga postures. There are 92 videos in all, with a total run time of 1 hour, 7 minutes, and 6 seconds. The videos were shot at 30 frames per second frame rate (frames per second). All the videos were filmed indoors, maintaining a consistent distance of 4 meters from the camera. For the train, test, and validation sets, videos of various subjects were used.

**TABLE I: Model Performance and Result**

| S.No | Asana | Number of Videos | Number of Persons |
|---|---|---|---|
| 1 | Trikonasana | 13 | 13 |
| 2 | Padmasana | 14 | 14 |
| 3 | Vrikshana | 12 | 12 |
| 4 | Bhujangasana | 15 | 16 |
| 5 | Tadasana | 15 | 15 |
| 6 | Shavasana | 15 | 15 |

### B. DATA PRE-PROCESSING

The OpenPose software is used to extract key points of postures in video frames as the initial step in preparing the data. Pose extraction is done offline for recorded movies, but online for real-time videos, with key points detected from camera inputs provided to the model. Each frame of the video is processed through OpenPose, and the accompanying output is saved in JSON format. This JSON data contains the positions of each individual detected in the video frame's bodily parts. For optimal efficiency, the OpenPose default configuration was utilized to extract posture key points.

The JSON data is retrieved and saved in numpy arrays in 45-frame sequences, which is approximately 1.5 seconds of video. Sixty percent of the dataset was utilized for training, twenty percent for testing, and twenty percent for validation. The training data consists of 7989 45-frame sequences, each comprising the 2D coordinates of the 18 key points recorded by OpenPose. The validation data comprises 2224 such sequences, whereas the test data has

2598.At the video level, the number of frames changed between 60,20,20. This was due to the variation in video length.

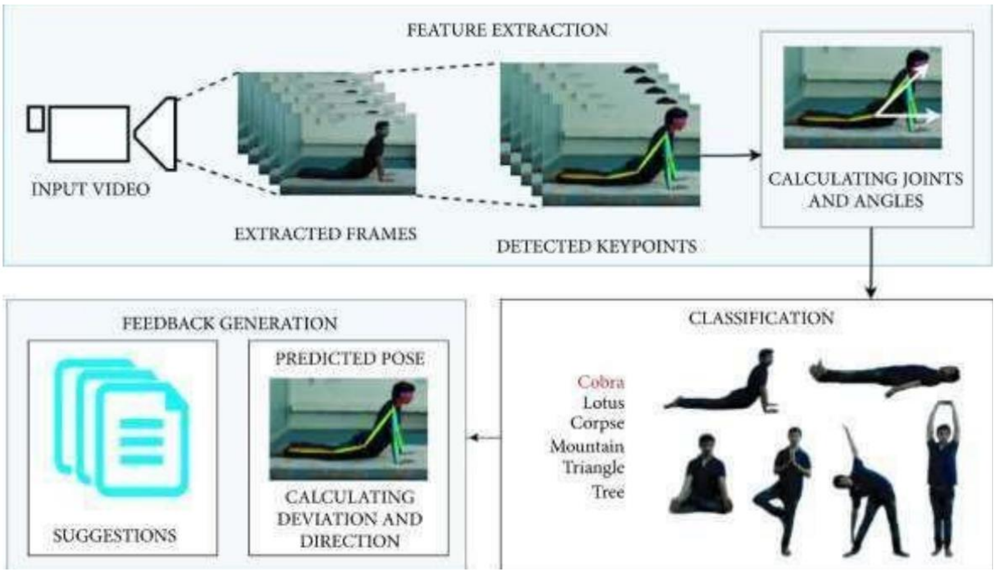


Fig 3 Yoga pose estimation

C. MODEL RESULTS

CNN+LSTM: Deep learning models such as CNN and LSTM are employed. CNN is used to analyze frames and discover patterns, whereas LSTM predicts based on temporal data. The CNN layer gathers feature from key points and delivers them to the LSTM cells, which investigate variances in the characteristics between frames. The CNN input has the following dimensions: 45 x 18 x 2, which represents 45 frames, 18 key points in each frame, having two coordinates: X and Y with each key point. The convolution layers are temporally spread, thus the output from CNN is sent tothe LSTM in a series of 45 frames (1.5 seconds). The below mentioned diagram shows the architecture CNN and LSTM.

TABLE II: Model Performance and Result

| | **Train Accuracy** | **Validation Accuracy** | **Test Accuracy** |
|---|---|---|---|
| SVM | 0.9953 | 0.9762 | 0.9319 |
| CNN | 0.9878 | 0.9921 | 0.9858 |
| CNN + LSTM | 0.9992 | 0.9987 | 0.9938 |

The time dispersed layer is advantageous for actions involving motions and is therefore employed. The CNN output is flattened into a one-dimensional vector and sent into the LSTM layer, which consists of 20 units, each with a forget bias of 0.5. Below mentioned figure picturizes architecture of CNN and LSTM.

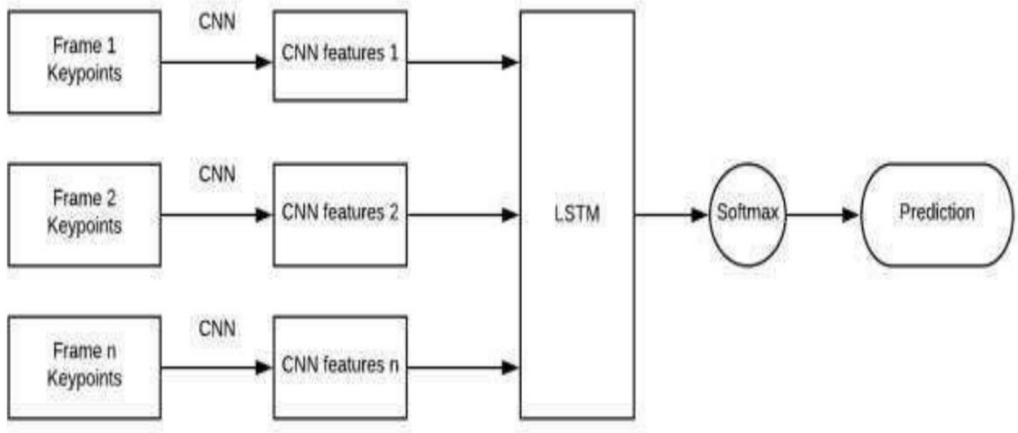


Fig 4 CNN+LSTM

LSTM can be used to identify the temporal changes in the properties recognized by the CNN which helps utilize the sequential nature of the input video data, thereby considering the full yoga posture as a complete activity from its origin through stance alterations and release.

D. DATA SET

Following the classification of the projected posture as accurate in relation to the chosen pose, the user is provided suitable feedback, and a similarity percentage is calculated and displayed to the user. Critical angles have been discovered and rules have been developed for each of the six yoga positions included in the dataset. A threshold is established for each rule, which is the greatest departure permitted for the user from the conventional stance. If the user surpasses this value, feedback is sent in the form of text and speech.

Calculating the tangent inverse of the slope with positive X-axis yields the angle between two key points. Given the two coordinates of the key points, below given equation illustrates the method for calculating the angle.

$$\Theta = \tan -1 \; (y2 - y1 / \; x1 - x2)$$

The feedback is originally received as text, which is subsequently transformed into speech using the Pyttsx3 package. It is a text-to-speech converter that also works offline. The user is also shown cosine similarity, which is a metric that compares two vectors by computing the cosine of angles between them. The cosine similarity mathematical formula is provided below.

$$\cos\theta = A \cdot B \; / \; \|A\| \cdot \|B\|$$

In this case, A and B are two vectors in a three-dimensional space. Cosine similarity is determined between key points of the user's stance and the standard pose in this study. This method demonstrates the degree of similarity to the genuine stance. Because the distance between users varies depending on their location relative to the camera, all key points are first normalized to bring them on a same scale.

# VII. RESULTS

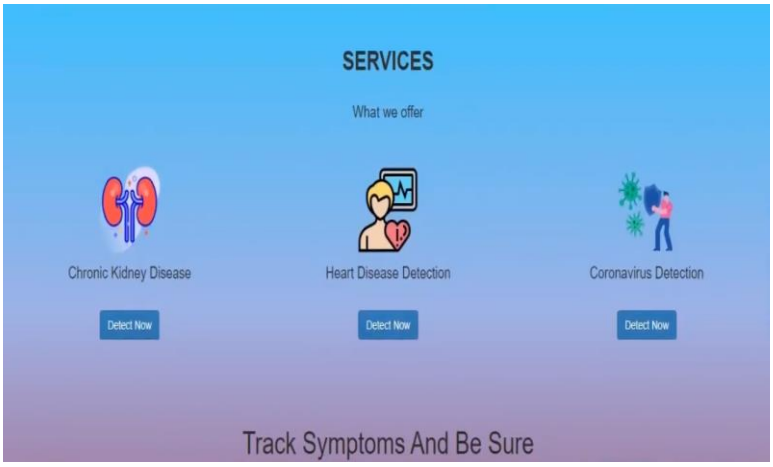


**Fig. 5 Disease Prediction Services**

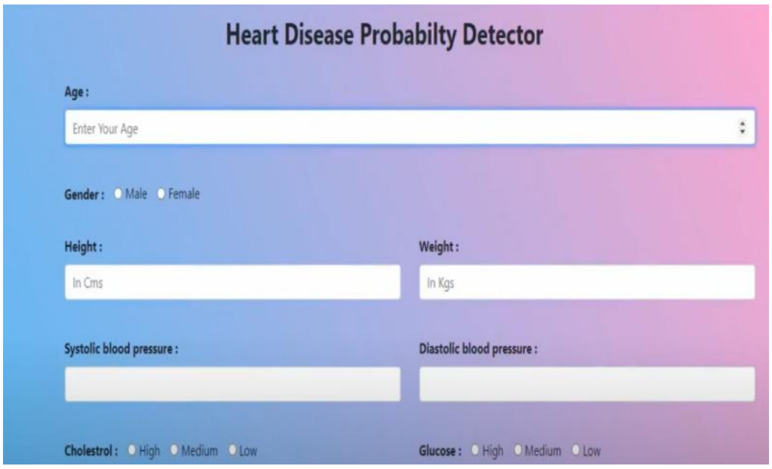


**Fig. 6 Heart Disease Probability Detector**

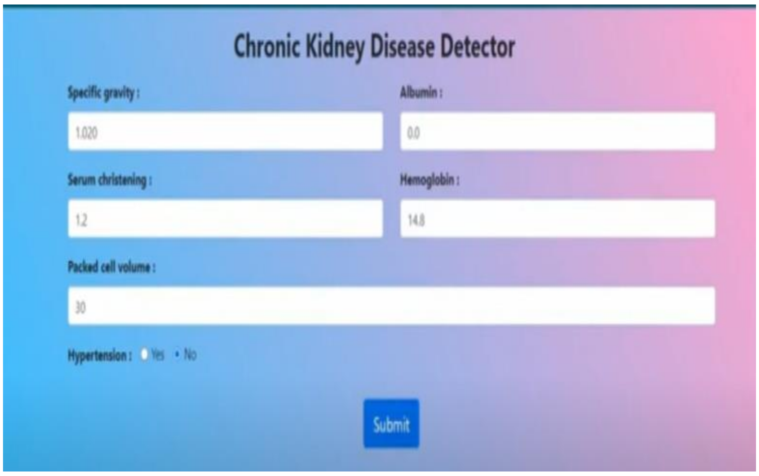


**Fig. 7 Chronic Kidney Disease Probability Detector**

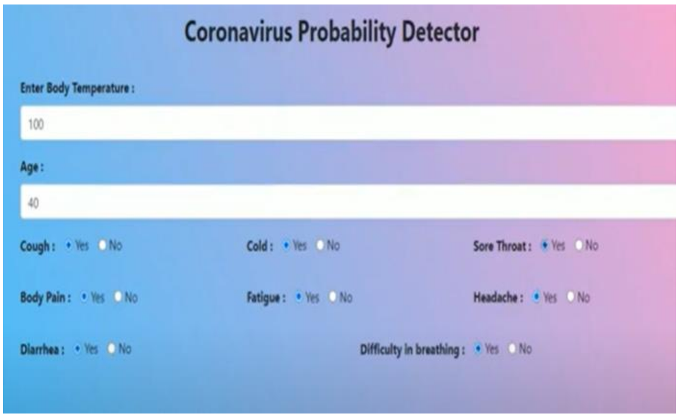


**Fig. 8 Coronavirus Probability Detector**

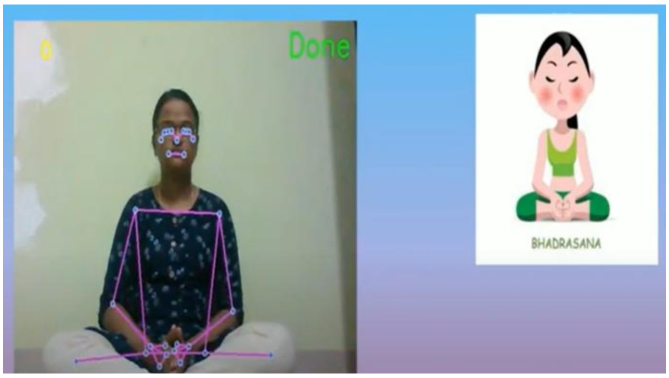


**Fig. 9 Yoga Posture module**


**Fig. 10 (a)Yoga Pose and steps**


**Fig. 10 (b) Yoga Pose and steps**

## VIII. CONCLUSION

An accuracy of 96% is achieved using logistic regression in Coronavirus prediction. Decision tree is for chronic kidney disease prediction. Using this model, an accuracy of 92% is achieved. An accuracy of 94% is achieved using random forest using which Heart disease is predicted. Deep learning techniques show great promise due to extensive research in the field. Combining Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) models with OpenPose data has demonstrated high effectiveness, achieving perfect classification of all six yoga poses. Additionally, even basic CNNs paired with Support Vector Machines (SVM) exceed expectations in performance. This success highlights the potential of machine learning algorithms, such as SVM, for tasks like pose estimation and activity recognition, offering a lighter and less complex alternative to neural networks. SVM's efficiency is evident in its shorter training times and lower computational demands. Moreover, the system extends its utility beyond classification tasks by incorporating psychological assessments to evaluate an individual's mental well-being and provide tailored solutions for mental health improvement.

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