IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

THE PERFECT DIET PLATTER: DIET AND EXERCISE RECOMMENDATION AND EXERCISE MONITORING WEBSITE

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Abstract: In today's world, where people are increasingly concerned about their health and dietary choices, the primary dilemma we face is the quantity and quality of the ingredients we add to our meals. As our understanding evolves, we recognize that eating isn't just about keeping hunger away; it's also about mindful intake, essential for maintaining health and fitness. In this endeavor, we use modern technologies such as machine learning and human pose estimation techniques to address these challenges. Our users receive personalized diet plans, carefully tailored to consider the nutritional content of the recommended foods, helping them in achieving their dietary objectives. Users provide information such as age, weight, height, food preferences, and goals, which is utilized to calculate their BMI and prescribe a customized diet plan, with the flexibility to adjust according to their preferences. However, a healthy diet alone is not sufficient for fitness; a proper workout regimen is also crucial. Thus, users are provided with a curated set of exercises, monitored through Human Pose Estimation technology. This technology enables the identification of key points and angles between landmarks, facilitating the monitoring of exercise execution to ensure correct form and repetitions, ultimately guiding users toward their fitness goals.

Index Terms - BMI(Body Mass Index), K-Means Clustering, OpenCV, Media pipe

I. INTRODUCTION

1.1 BRIEF STUDY OF THE PROJECT

'The groundwork for all happiness is health', is how the saying goes. Although the proverb has been around for many years, only few practice healthy habits while rest do not have a proper nutrition intake as well as proper physical routine other than walking. This leads to a condition where the majority of the adults become unfit and develop health issues early in life.

Hence, considering all these above stated conditions of the majority of the adult population, we can say a well rounded diet which contains enough levels of nutrients such as fats, proteins, carbohydrates etc.. and proper workouts should be combined to sustain fitness and good health.

1.2 OBJECTIVE OF THE PROJECT

This project proposes a diet and exercise recommendation system using machine learning 1 algorithms along with an exercise monitoring system developed using different deep learning techniques to recommend food items as well as suitable workout routines from an already defined dataset and also to keep track of the progress in the daily workout routine. Based on the goal of the individual such as weight loss, weight gain or maintaining a healthy balanced diet, suitable food and workouts are recommended. Each individual who is ready to make a move towards a healthier lifestyle by losing weight or by gaining weight or just by maintaining a healthy balanced diet can benefit through our project.

1.3 SCOPE OF THE PROJECT

In order for people to sustain fitness and good health they should have a proper nutrition intake as well as good workout plans. For this people have to rely on different sources to get appropriate suggestions. Thus, we are introducing this web application, “THE PERFECT DIET PLATTER”, which aims to provide dietary meal plans as well as workout plans based on the goal preferences by also taking into consideration of the users’ personal details such as age, weight, height, gender etc..since some of these values are required to calculate the BMI(Body Mass Index) and daily calorie requirements of the individual. For the suggestion of meal plans and workout routine we are using a machine learning algorithm.

We have also included an Exercise monitoring system which uses deep learning techniques provided by the Mediapipe framework. We have included this module to bring about the help of a virtual gym trainer within the individual’s comfort place, hence making their daily workout plans less hectic.

II. LITERATURE REVIEW

2.1 DIET AND EXERCISE RECOMMENDATION

The paper, “A Food Recommender System Considering Nutritional Information and User Preferences” [1] presents a Food Recommender System that integrates nutritional information and user preferences to provide personalized daily meal plan recommendations. It addresses the increase of non-communicable diseases due to unhealthy diets and aims to offer tailored food intake advice. It uses personal data to recommend food choices that meet individual nutritional needs. It filters out inappropriate foods using AHPSort, a decision analysis tool, before optimizing the meal plan.User Preferences are considered alongside nutritional requirements to ensure the recommended foods are also liked by the user. Advantages include the holistic approach and user engagement whereas the disadvantages include complexity and data sensitivity.

In the paper, "Diet and Workout Recommendation Using ML"[2],user details like age, weight, height, health details, physical activity days etc are obtained from user and based on these informations .K-Means clustering is used to partition the data points into clusters.The dataset is split into 70% training and 30% for testing.Random Forest classifier is used to provide the best diet based on their preferences.K-Means Algorithm is used to limit the categories as healthy, weight loss and weight gain. Dataset is used to calculate the calories intake of the user and exercises are recommended according to it. The main advantage of this model is that it incorporates used preferences and nutritional values of the proposed diet is also taken into account.

In the paper, ”Website on Diet Recommendation using Machine Learning[3] “, K means clustering and random forest classifier is used to provide a healthy and nutritious diet plan. The system would be clustering and classifying the food items based on the inputs given by the user and then predict the three categories for the user,which is breakfast, lunch and dinner ,according to the user’s BMI and the current state. It does not consider any nutritional factors necessary for a balanced diet and also this system has not addressed any specific diseases.

‘FoodScan App :Food Monitoring App by Scanning the Groceries Receipts’[4], a mobile application designed to help elderly individuals with limited technical knowledge in rural areas to simplify food monitoring and thereby manage their diet by scanning grocery receipts without the need for manual entry of food items.The app utilizes Optical Character Recognition (OCR) to expedite food entry and a knowledge base of food tailored for individuals over 70. It is easy to download and use, provides dietary recommendations, and does not require an internet connection for management. Disadvantage is that it tracks purchased food, not consumption, which may not accurately reflect actual intake and also relies on user's adherence to recommended practices. User evaluation is positive feedback on ease of use and helpfulness in improving healthy eating habits, with suggestions for future improvements.

2.2 EXERCISE MONITORING

In this paper of "Smart Gym Trainer using Human Pose Estimation"[5], they have used both machine learning as well as deep learning. In machine learning they have used the concept of neural networks (CNN) in order to detect the human pose. On detection of the human pose on this trained model ,everybody part will be having an unique identity coordinate, where this trained model is termed as COCO model and MPII model. After some training this model is trained with the professional, athletic trainer, whose exercise will be considered as the ideal workout.Which will be compared with the videos or the images uploaded by the user , then it will be producing a graph that shows the differences in how the user works out.

The paper on "Workout Prediction using Machine Learning"[6] aims to provide personalized diet and workout recommendations using machine learning algorithms, enhancing user experience. It includes meal planning, workout routines, fitness tracking, and expert chat support, offering a complete fitness regime. Utilizes data from wearable devices and a MEMS accelerometer to predict health habits and recommend dietary plans. Employs TensorFlow and K-means clustering for prediction, ensuring tailored workout recommendations based on calorie intake.The accuracy of predictions depends on the quality of user data and the correct input of personal details, which could be a disadvantage if not accurately provided. 2

The paper on "Human Pose Estimation using Artificial Intelligence with Virtual Gym Tracker"[7] aims to propose a method for counting curls with the help of landmarks on human pose.Here the gym tracker is implemented by estimating human pose for extracting joint coordinates to calculate angle between the coordinates which helps in building artificial gym training Inteilligence.is used for video capturing and MediaPipe is used to extract landmarks from the videos. A curl counter is also implemented to accurately calculate the reps.

III. MATERIALS & METHODS

3.1 DATASET

The dataset consists of food items along with its nutrients values and meal types. In our dataset there are 165 instances and 16 features.

FOOD	VEGN/NONVEG	BREAKFAST	LUNCH	DINNER	SERVINGS	CALORIES	FATS	PROTEINS(in g)	IRON(in mg)	CALCIUM(in mg)	SODIUM(in mg)	POTASSIUM(in mg)	CARBOHYDRATES(in g)	FIBRE(in g)	VITAMIN D	SUGARS
Aloo Paratha	0	1	0	1	2 medium parathas	600	22	12.2	3.6	56	740	631.6	92	17.4	0	8.4
Palak Paratha	0	1	0	1	2 medium paratha	320	12	8.2	5.4	120	722	470.1	46	3.6	0	1.2
Egg Paratha	1	1	0	1	2 medium paratha	558	15	22	5.4	80	222	578.7	90	13.6	1	2.2
Onion Paratha	0	1	0	1	2 medium paratha	554	22	11.4	3.4	68	756	386.8	80	17	0	10
Paneer Paratha	0	1	0	1	2 medium parathe	352	15.6	15.4	2.2	276	890	297.1	42	6	1.2	2.2
Dosa	0	1	0	1	2 medium dosa	336	7.4	7.8	1.7	11.4	188	151.2	58	1.7	0	0.3
Ragi Dosa	0	1	0	1	2 medium dosa	270	15.6	4	1.1	24	136	122.7	30	1.5	0	2
Onion Dosa	0	1	0	1	1 medium dosa	191	3.9	4.6	1	20	685	170.8	35	1.8	0	2.6
Idli and Sambar	0	1	0	0	1 cup sambar,3 idli	304	2	12	4.9	84	427	650.6	61	8.9	0	9.4
Rava Idli	0	1	0	0	2 pieces	150	2	3	0.7	10	500	40	30	2	0	1
Uttapam	0	1	1	1	1 piece	188	7.2	4.4	24	6.4	522	91	26.4	2.2	0	0.24
Chappati	0	1	1	1	1 piece	120	3.7	3.1	0.9	14	119	78.4	18	3.9	0	1.2
Appam	0	1	0	1	1 piece	94	2.4	1.5	0.3	2.5	68	34	17	0.6	0	1.6
Broccoli	0	1	1	1	3 pieces	10.5	0.1	0.7	0.2	12	12.3	87.9	2.2	1	0	0.4
Celery	0	1	1	1	1 stalk	6.4	0.1	0.3	0.1	16	32	104	1.2	0.6	0	0.5
Tomato Soup	0	1	1	1	1 bowl	170	1.1	3.5	1.4	39	910	1342.2	36	2.6	0	20
Cucumber	0	1	1	1	1 medium size	30	0.2	1.3	0.6	32	4	295.5	7.3	1	0	3.4
Milk	0	1	0	1	1 cup	122	4.8	8.1	0.1	293	115	341.6	12	0	2.9	12
Vermicelli Upma	0	1	0	1	1 cup	222.6	8	5.8	2.8	16	259.3	148	31.9	6.7	0	2.6
Poha	0	1	0	0	1 cup	158	0.2	2.9	0.4	4.2	4.2	33.4	35	0	0	0
Idiyappam	0	1	0	0	1 cup	281	6.2	3	0.6	18	2414	97.2	54	3.4	0	19
Brown Bread	0	1	0	1	1 slice	77	0.9	3.1	1	39	147	51.3	14	1.2	0	1.7
Green Salad	0	1	1	1	2 plate	40	0.4	2.4	1.7	74	62	482.2	8.4	3.4	0	3.6
Egg Salad	1	1	1	1	1 cup	471	41	18	2.7	95	550	266.6	5.3	1.1	2.8	2.4
Sweet Corn Soup	0	1	1	1	1 bowl	245	6.6	5.8	1.5	48	1410	478.6	47	5	0	12
Chicken Soup	1	1	1	1	1 bowl	168	3.7	10	1.3	71	1168	678.3	24	4.6	0	5.2
Tomato slices	0	1	1	1	5 slices	18	0.2	0.88	0.27	10	5	237	3.92	1.2	0	2.63
Naan	0	1	1	1	1 piece	262	5.1	8.7	2.9	76	419	112.5	45	2	0	3.2
Aloo Naan	0	1	1	1	1 piece	300	11	6.1	1.8	28	370	315.8	46	8.7	0	4.2
Mutton Curry	1	1	1	1	1 cup	381	28	24	3	43.5	76	450.6	8	1.6	0.1	2.2
Prawn Toast	1	0	1	1	1 triangle(3 to 5 prawns)	58	3.4	4.1	0.4	24	101	49	3.1	0.2	0.1	4.1
Tandoori Chicken	1	1	1	1	2 pieces	526	24	62	3	210	264	856	12.2	1.4	0.4	7.4
Chicken Salad	1	1	1	1	1 cup	508	36	38	2.2	34	452	416.4	6.6	0.7	0	4.8
Chicken Keema	1	0	1	1	1/2 cup	215	16.9	19.5	2.3	12	665.37	221.6	8.3	1.9	0.3	3.1
Chicken Pulao	1	0	1	1	1 plate	615	26	26	3	83	564	462	69	4	0	2
Chicken Tikka Masala	1	1	1	1	1 cup	365	24	28	2.9	166.5	1300.5	595.1	11	2.2	0.9	7
Chilli Chicken	1	1	1	1	1 bowl	566	34	36	9.6	144	1973	888	29	2.4	0.5	5.3
Boiled Egg	1	1	1	1	1 egg	78	5.3	6.3	0.6	25	62	63	0.6	0	1.1	0.6
Lemon Rice	0	1	1	0	1 plate	221	2.9	4.9	0.7	11	104	121.6	43	0.3	0	1.1
Pongal	0	1	1	1	1 cup	319	8.1	7.3	1.8	29	3.4	207.2	54	3.8	0	1
Curd Rice	0	0	1	1	1 cup	207	3.2	6.1	0.6	123	167	232.6	38	0.5	0.2	4.5
Pudina Rice	0	0	1	1	1 cup	171	5	3.4	2.1	32	393.5	210	28.5	1.5	0	2.8
Puliyogare	0	0	1	1	1 cup	344	13	7.4	1.2	32	277	245.2	51	2.5	0	4.5
Mushroom soup	0	1	1	1	1 can(630 g)	410	23	15	0.6	428	2249	648.9	36	1.9	4.4	18
Paneer Butter Masala	0	1	1	1	1 cup	201	16	8.2	0.9	224	503	290.6	6.9	1.5	1.1	3.7
Paneer Mattar	0	1	1	1	1 serving(440 g)	599	46	23	3.3	636	1026	455.3	25	6.4	2.7	9.2
Paneer Tikka	0	1	1	1	1 cup	201	16	8.2	0.9	224	503	290.6	6.9	1.5	1.1	3.7
Dal Curry	0	1	1	1	1 cup	235	5.7	14	5.4	50	35	795.2	35	13	0	6
Pumpkin curry	0	1	1	1	1cup	191	11	5.5	2.9	58.5	462	549.9	21	3.7	0	5.5
Carrot Bread	0	1	0	0	1 piece	380	18	6	120	0	360	0	48	0	0	24

Fig.1. Overview of the dataset used.

3.2 OPENCV

OpenCV is an open source computer vision and machine learning library. It is developed by Intel. OpenCv is a free cross-platform library for real time image processing.It is written in C and C++. It is built for maximum efficiency and performance for computer intensive vision tasks and strongly focuses on real-time application of AI vision.The main goal of OpenCv is to provide an easy to use infrastructure for users that would help them develop vision applications with high degree of complexity easier and quickly. This library consists of 2500 algorithms ,documents sample code for real-time computer vision,more than 500 functions and source code. There is a range of use for computer vision from security and video surveillance to self-driving cars.The rapid advancement in the field of computer vision over years made it easier for the companies to develop builtin computer vision application which is problem specific.

3.3 MEDIA PIPE

MediaPipe is a cross platform pipeline framework which helps in developing custom machine learning solutions for stream and live media.These are mainly used for rapid prototyping of perceptron pipeline with AI models for interfacing.The main advantages of using MediaPipe are end-to-end acceleration ,built once-deploy anywhere ready-to-use solutions, open source and free.These are based on C++ libraries which help them to port to additional platforms. MediaPipe helps developers to incrementally prototype a pipeline and support GPU computing and rendering nodes .The main components of Media Pipe are packets, graphs, nodes and streams.

3.4 K-MEANS CLUSTERING

K-Means clustering is an unsupervised machine learning algorithm and it helps to group unlabelled datasets into different clusters.K-Means clustering will allocate data points into one of the K clusters depending on their distance from the center of the cluster.After allocating data points to one of the clusters new centroid points are recalculated and this repeats until a good cluster is formed.K-Means works well when data is separated and not suitable when cluster points are overlapping as they are sensitive to noise.K-Means shows better performance when dealing with numeric data so it is commonly used for continuous variable.

3

IV. METHODOLOGIES

4.1 INFORMATION GATHERING

In this project we would be collecting users personal details such as age, weight, height and activity levels. Based on this information we would be calculating the BMI and the daily calorie requirements of the person and also will categorize the user into one of the three BMI classes i.e, Underweight, Normal and Overweight.

4.2 DIET AND EXERCISE RECOMMENDATION

In this module based on the BMI and goal of the user i.e, weight gain, weight loss or healthy diet, we would provide the meal plan. In this diet recommendation we would be making use of the K-Means Clustering algorithm. The basic purpose of using this machine learning algorithm is to provide an alternative equivalent food , if in case any food within the meal plan is not to the preference of the user. This is done by clustering the dataset which contains 165 food items along with their nutrient values. If a food within the meal plan is not suitable for the user , the user can select an alternative food from the cluster in which the food belongs. As part of the diet, it is also necessary to keep our physique fit and healthy, hence, we are providing eight exercises to be performed in total. The exercises are, bicep curl, squats, shoulder press, chest press, jumping jacks, side lunges, knee raise and leg lift. Based on the BMI category of the user i.e, Underweight, Normal and Overweight , the number of times the exercise has to be done varies. The count for each exercise will be lesser for an underweight person than an overweight person. Therefore, exercise recommendation is done on the basis of BMI category.

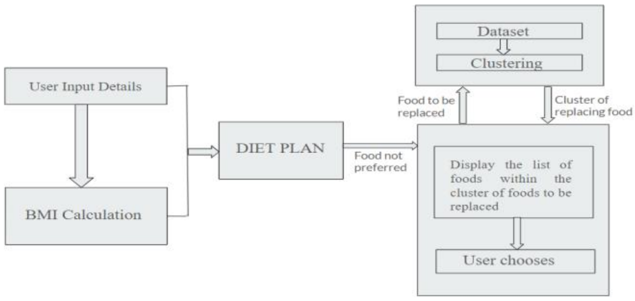

Fig.2. Overview of Diet Recommendation Module

4.3 EXERCISE MONITORING

In this module, we would be monitoring the user to check whether the user is doing the exercise to the recommended count. Each day the user has to perform the recommended exercise and based on whether they are doing it or not the progress in their goal varies. Another motive of the monitoring phase is to guide the user to perfectly do the recommended exercises. In order to guide the user we are extracting different landmarks points in the users' body. For each of the eight exercises we are recommending there would be key landmark points that have to be considered , for example, bicep curls, the landmark points to be considered are the shoulder, elbow and the wrist and then the angle between them is calculated. Based on the variation in the angle the count will increment. Once the count value has reached the recommended amount of times the exercise has to be done, a message indicating that the exercise is complete is also shown in Fig.3. .

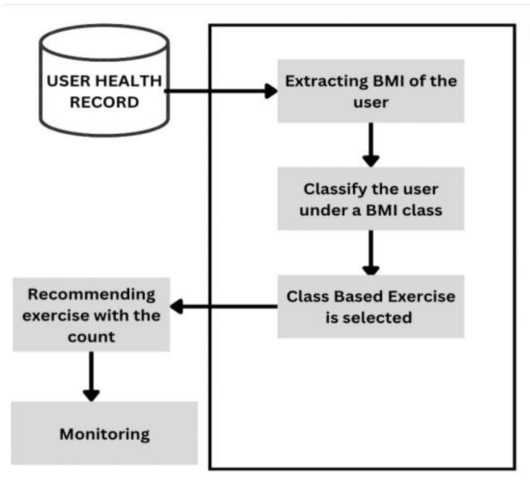

Fig.3. Overview of Exercise Monitoring Module

V. IMPLEMENTATION

5.1 IMPLEMENTATION OF DIET AND EXERCISE RECOMMENDATION

Using the weight and height we have received we would be calculating the BMI. Based on the BMI and the goal of the user we would be providing a meal plan. If the user doesn't prefer any of the food in the given meal plan then the user is given the privilege to select an alternate equivalent food from a given list of food. This list of foods are those foods that are present within the cluster of the food the user wants to replace, which means that they are similar to the food. Since the data points in a cluster are of similar properties we are applying that property in this project to make the service we are providing much more flexible and user-friendly.

In order to provide the flexibility of choosing users' preferred food we have used the K-Means Clustering algorithm which clusters the dataset into 3 clusters.

Working of K-Means Clustering Algorithm in Diet Recommendation phase:

1. Initializing the K-Means Clustering Model with three clusters.

2. Fit the model to the data.

3. Assign cluster labels to the dataset:

    3.1 Each food will be assigned to a label indicating the cluster they belong to.

    3.2 Adding a new column to the data frame to store the cluster labels

4 Define a function to find similar foods

    4.1 Check if the given food name is within the data frame

    4.2 If present in the data frame then retrieve the cluster to which it belongs

    4.3 Return the list of food within the cluster excluding the input food

    5. Use the function to find the similar food items

The visual representation of the clusters formed and the relationship between the data points are shown in the below given Fig.4 .

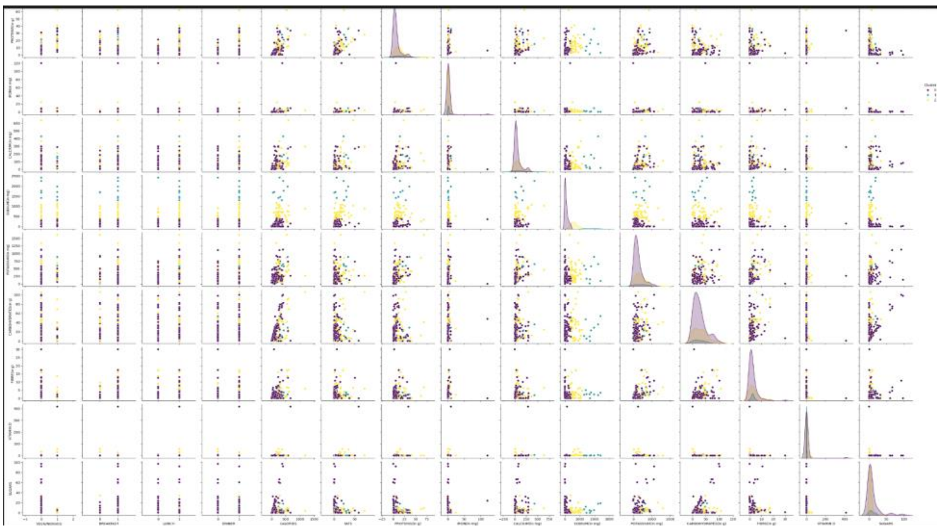

Fig.4. Visualization of the clusters formed and the relationship between the data points.

The Exercise recommendation is done by categorizing the user in one of the three BMI classes (Underweight, Normal, Overweight) and based on that the count for each exercise is recommended.

5.2 IMPLEMENTATION OF EXERCISE MONITORING

In order to implement the exercise monitoring module we require the image of the person in order to identify the coordinates, commonly known as the key points. In the Figure ,shows all the 33 human pose estimation key points. The name referred to each of these key points are listed in the Fig.5.

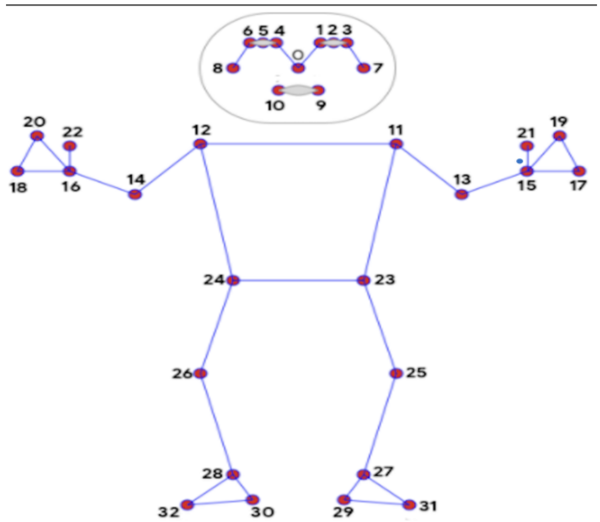

Fig.5. Human Pose Estimation Key Points

0. nose	17. left_pinky
1. left_eye_inner	18. right_pinky
2. left_eye	19. left_index
3. left_eye_outer	20. right_index
4. right_eye_inner	21. left_thumb
5. right_eye	22. right_thumb
6. right_eye_outer	23. left_hip
7. left_ear	24. right_hip
8. right_ear	25. left_knee
9. mouth_left	26. right_knee
10. mouth_right	27. left_ankle
11. left_shoulder	28. right_ankle
12. right_shoulder	29. left_heel
13. left_elbow	30. right_heel
14. right_elbow	31. left_foot_index
15. left_wrist	32. right_foot_index
16. right_wrist	

Fig.6. Landmarks of Human Pose

Installing the required dependencies:

OpenCV and Media pipe is installed here in order to gather pixels from the image while examining it and also for pose estimation and integrating the pose into the pipeline

Estimate Poses:

Here we are setting up a new instance to use the Media pipe pose estimation model. This model is accessed through two parameters min_detection_confidence=0.5 , which is detection of confidence and min_tracking_confidence=0.5, which is to maintain the state.

When the image is passed through the media pipe it has to be in the format of RGB and when we get feed using OpenCV the image feed is in the format BGR

Extracting the required landmark points from the detected pose:

There are about 33 landmarks as shown in the Figure . In which each of them maps to a specific coordinate in our body

Each of these coordinates can be mapped easily as shown in Fig.7.

```
rk_x=landmarks[mp_pose.PoseLandmark.RIGHT_KNEE.value].x
rk_y=landmarks[mp_pose.PoseLandmark.RIGHT_KNEE.value].y
rk_v=landmarks[mp_pose.PoseLandmark.RIGHT_KNEE.value].visibility
```

Fig.7. Right Knee Joint coordinate

In the Figure , rk_x would give the x-coordinate of the right knee , rk_y would give the y-coordinate of the right knee and rk_v is used to detect the visibility. Here if visibility is<0.5 the right knee landmark point is considered to be not visible.

Calculate the angle between the points:

Let's consider the exercise bicep curl, then the coordinates that have to be extracted are of the shoulder, elbow and the wrist. The Fig.8. below shows how the angles between three points are calculated.

```
def calculate_angle(a,b,c):
    a=np.array(a)
    b=np.array(b)
    c=np.array(c)

    rad=np.arctan2(c[1]-b[1],c[0]-b[0])-np.arctan2(a[1]-b[1],a[0]-b[0])
    angle=np.abs(rad*180.0/np.pi)

    if angle>180.0:
        angle=360-angle

    return angle
```

Fig.8. Calculating angle between the coordinates

In the Fig.8 the parameters a, b and c indicate the coordinate value of Shoulder, Elbow and Wrist.

Building an Exercise monitoring system:

We have built an Exercise monitoring system for each of the eight exercises. In the bicep curl exercise the logic is implemented like if angle is greater than or equal to 170 then the hand is down, if the angle is between 60 and 85 then users' hand has curled to the middle and if the angle is lesser than or equal to 40 then the hands of the user has curled up.

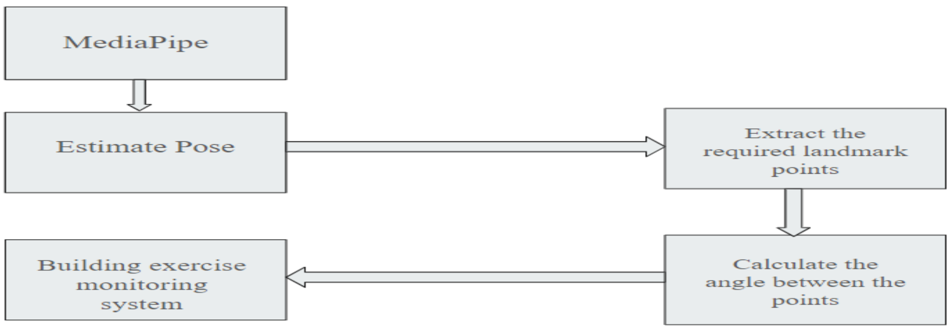

Fig.9. Working of the Exercise Monitoring System

VI. RESULTS AND DISCUSSIONS

The code for all the above implementations has been written in Python and executed in Jupyter Notebook. This working model for diet recommendation integrates the use of machine learning algorithms like K-Means clustering and providing flexibility for the user and this has led to providing an almost accurate meal plan to the user. The model for the exercise monitoring system is accurately calculating the reps as well as stages by using Media pipe and OpenCV.

VII. CONCLUSION

Our project on Diet Recommendation and Exercise Monitoring System integrates various methodologies and advanced technologies to empower individuals in achieving their health goals. By leveraging datasets of food items and user-specific information, we calculate BMI and daily calorie requirements to tailor diet plans. Machine learning algorithms like K-Means clustering enhance flexibility, allowing users to choose alternative foods based on preferences. Exercise recommendations, categorized by BMI classes, ensure tailored fitness routines. Utilizing OpenCV for real-time image processing and MediaPipe for custom machine learning solutions ensures seamless operation across platforms. Intelligent feedback and guidance provided by our system promote informed decision-making and progress tracking. This initiative not only addresses current health concerns but also sets the stage for future advancements in health technology. Ultimately, we envision a future where individuals can seamlessly incorporate personalized health and fitness practices into their daily lives, leading to improved overall well-being.

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