Department of Information Technology
NBA Accredited

A.P. Shah Institute of Technology
G.B.Road, Kasarvadavli, Thane(W), Mumbai-400615
UNIVERSITY OF MUMBAI
Academic Year 2022-2023

A Project Report on

FormMatters-Posture Detection System using Computer Vision and Machine Learning during Workouts

Submitted in partial fulfilment of the degree of Bachelor of Engineering(Sem-8)

INFORMATION TECHNOLOGY

By
Tanay Dilip Jain (20204004)
Aadarsh Naresh Khant (20204003)
Keval Kantilal Gada (20204002)

Under the Guidance of
Prof. Manjusha Kashilkar

1. Project Conception and Initiation

1.1 Abstract

- Owing to the advent and dissemination of the COVID-19 Coronavirus pandemic in the world in 2020, lockdowns and work from home have become common-place.
- To increase daily activity and keep themselves fit and active people have resorted to indoor workouts. But due to lack of proper guidance, form, and execution, many individuals end up injuring themselves severely causing more harm than good.
- To alleviate this problem, we aim at creating an web application **FormMatters** that will aid users in correcting their form and posture. The system will capture all the needed key points (left and right shoulder, arm, torso, knee, etc) and angle on the human body and compare the user's current posture with the expected exercise posture, providing feedback in real-time.

1.2 Objectives

- To create a user interface where end-user will be able to interact with the web-application using Django Framework.

- To identify and rectify the form/posture of a user performing exercises with the help of Deep-Learning (Convolution Neural Network).

- To give information to the user about form of the exercise they are performing by providing recommendation videos.

- To provide the number of repetitions of the poses user is performing using OpenCV and Machine Learning.

1.3 Literature Review

Sr. No.	Title	Key Findings	Year
1.	Activity Recognition with Combination of Deeply Learned Visual Attention and Pose Estimation	Two-dimensional and three-dimension pose estimation is obtained for human activity recognition in a video sequence, and final activity is determined by combining it with an activity algorithm with visual attention. Soft visual attention and a multilayer recurrent neural network using long short term memory is used.	2021
2.	OpenPose: Realtime Multi-Person 2D Pose Estimation Using Part Affinity Fields	The second paper proposes a 3D model rather than 2D skeletons and then measure the differences between the joint angles of the 3D skeletons. Deep latent variable models, and a positive-definite kernel are used to provide a more accurate pose estimation. Experimental results show the superiority of the proposed 3D pose estimation.	2021

1.3 Literature Review

Sr. No.	Title	Key Findings	Year
3.	Pose-based CNN features for action recognition. In Proceedings of the IEEE International Conference on Computer Vision	This paper states that, they explore CNN features obtained separately for each body part in each frame and use appearance and motion-based CNN features computed for each track of body parts, and investigate different schemes of temporal aggregation.	2015
4.	Deeppose: Human pose estimation via deep neural network	They have proposed a system to detect a posture of a person sitting and working infront of his/her computer. They took a dataset from COCODATASET and applied ResNet (CNN based model) to gather the information about the posture of a people and done their analysis in detecting Shoulder Alignment, Right Arm adduction, Left Arm abduction, Neck Lateral bend.	2014

1.4 Problem Definition

- Develop a system that will assist users in their everyday workouts by comparing the expected exercise posture with the user’s current posture, providing personalized, feedback, to correct the user’s form and execution, preventing injuries and enhancing their overall workout.

- The system should cater to exercises such as Push Up, Bicep Curl, etc.

- The system should also be able to detect known set of Yoga Poses such as T-Pose, Tree Pose and Warrior 2 Pose.

1.5 Scope

- Can be used for everyone to learn new exercises.
- Can be used to perform different exercises in their proper posture.
- Can be used to avoid injuries.
- Can be used to save time.

1.6 Technology stack

- Deep Learning : Trained CNN to detect object.
- Django framework : Backend of the website.
- Web scraping : Using BeautifulSoup to create dataset.
- Machine Learning: Cosine similarity : To find angle between coordinates.
- Open CV: Finding coordinate points on the object, displaying result, detecting the object.

1.7 Benefits for Society

- Preventing injuries: Poor posture can increase the risk of workplace injuries, especially in jobs that involve heavy lifting or repetitive motions. By using a posture detection system, individuals can prevent injuries by maintaining good posture and avoiding unnecessary strain on their bodies.
- Enhancing self-awareness: A posture detection system can help individuals become more self-aware of their posture habits and how they affect their overall health and well-being. By providing real-time feedback, individuals can make adjustments to their posture habits and develop healthier habits over time.
- Improving quality of life: By promoting better posture and preventing pain and injuries, a posture detection system can improve the overall quality of life for individuals. This can lead to a happier, healthier, and more productive society as a whole

2. Project Design

2.1 Proposed System

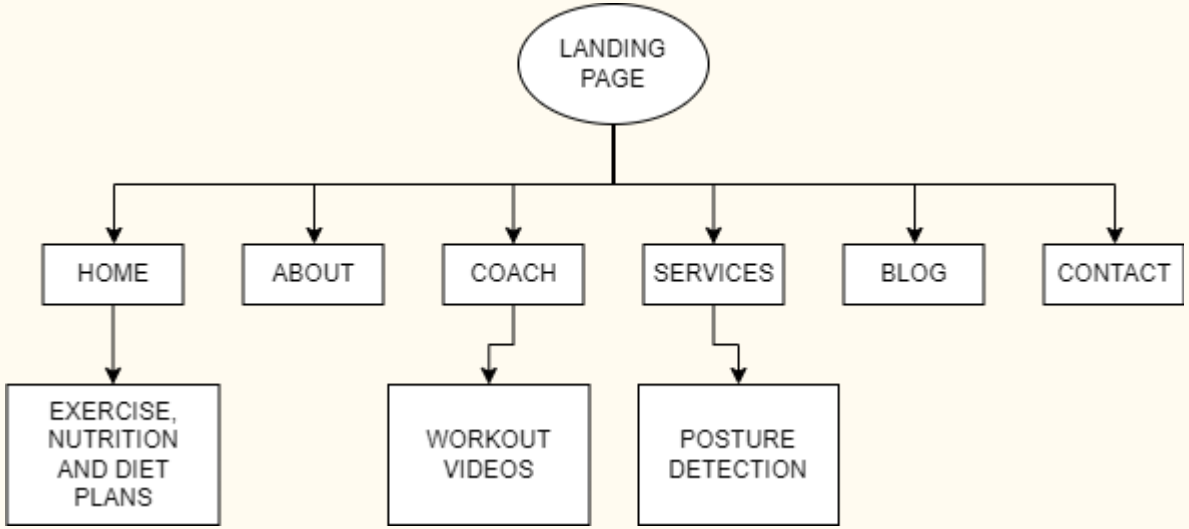
- User Interface: The system would have a simple user interface that displays the video stream and the detected posture. The user would be able to see their posture in real-time and make adjustments as needed to maintain proper form during their workout.

- Posture Detection: The system would use OpenCV to detect the user's body position and posture based on keypoints such as head, shoulders, elbows, hips, and knees. The CNN model would then classify the posture as correct or incorrect based on predefined criteria.

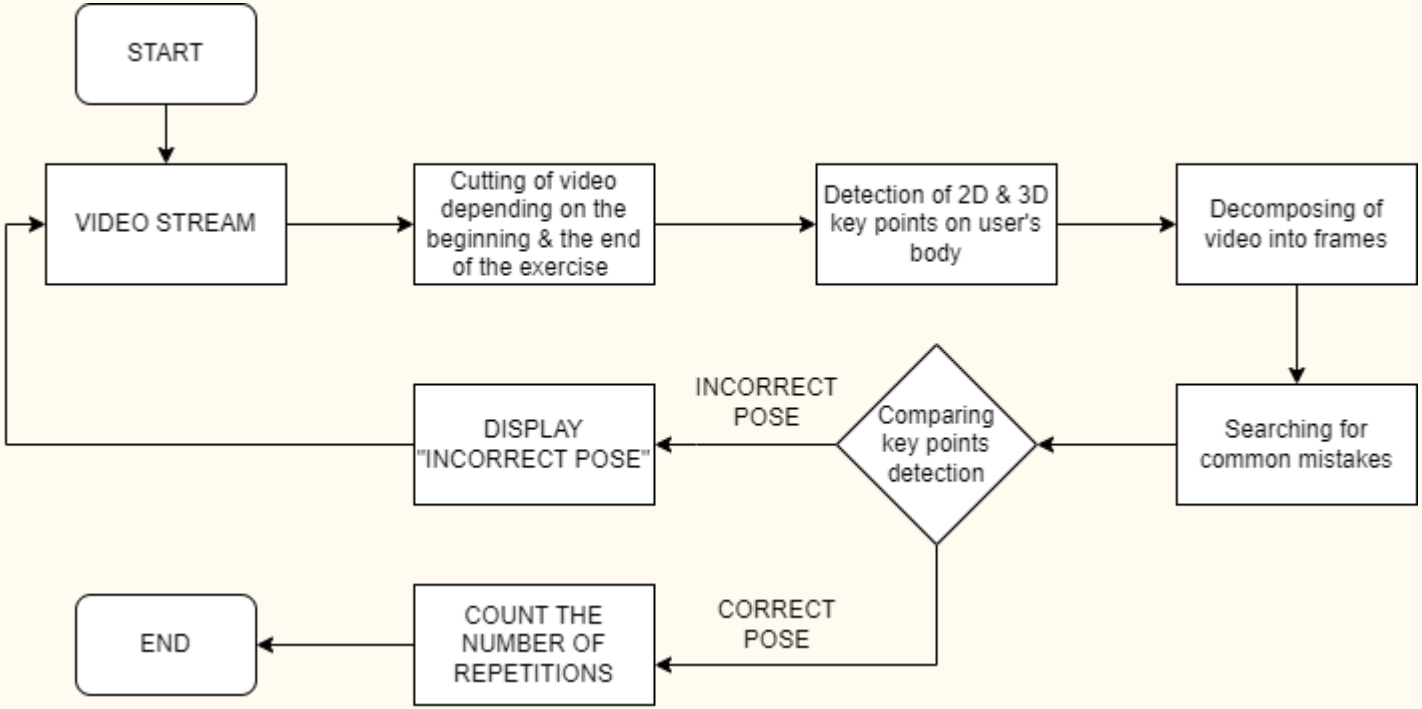
2.1 Proposed System

- Video Recommendations: The system would provide user with different workout videos from which the user can learn proper form of the exercises such as pushups, bicep curls, squats,etc.

2.2 Design(Flow Of Modules)

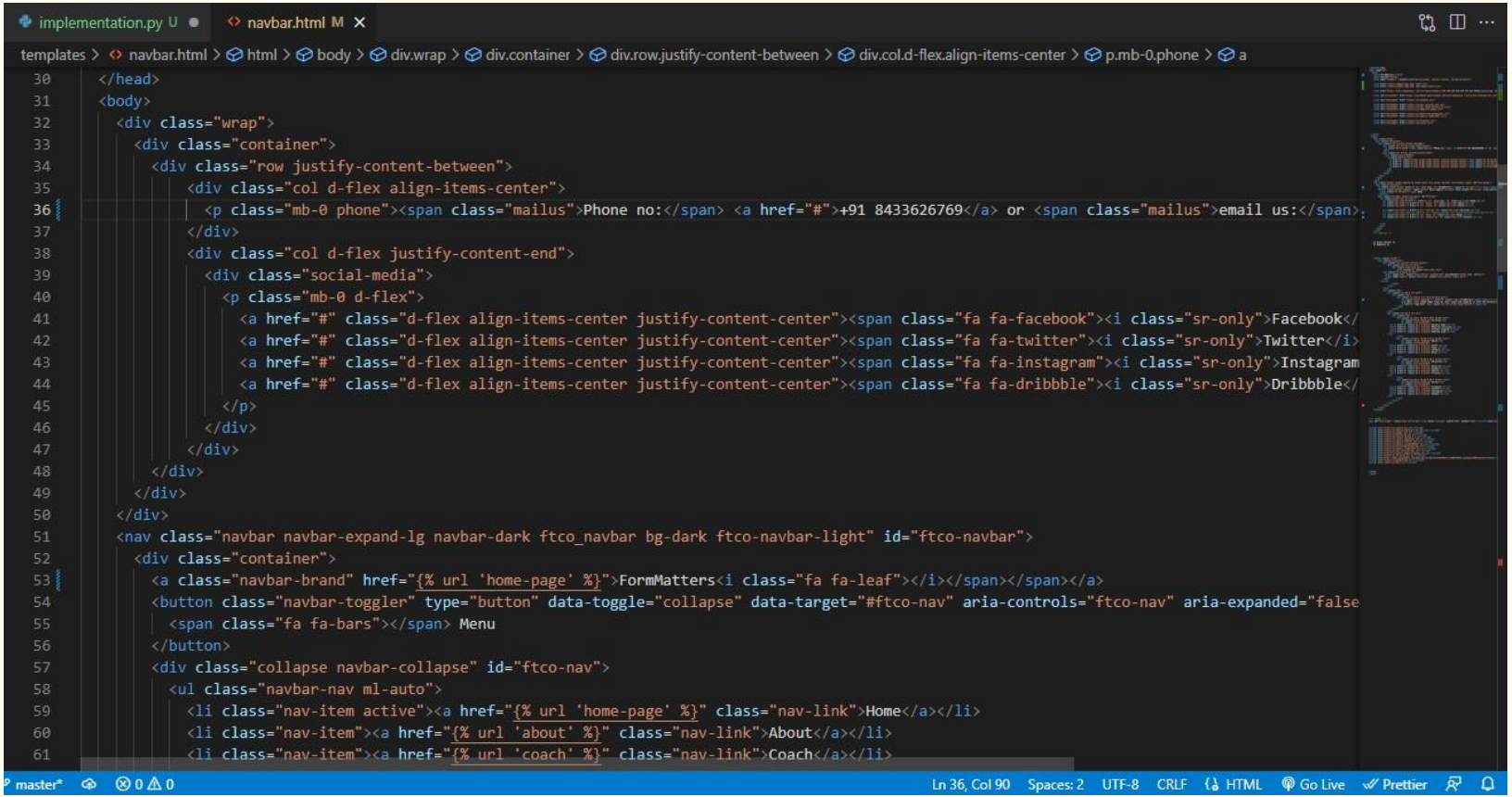


2.3 Activity diagram



3. Implementation

Homepage


implementation.py U
navbar.html M
templates > navbar.html > html > body > div.wrap > div.container > div.row.justify-content-between > div.col.d-flex.align-items-center > p.mb-0.phone > a
30 </head>
31 <body>
32
33
34
35
36 Phone no: +91 8433626769 or email us:
37
38
39
40
41 <a href="#" class="d-flex align-items-center justify-content-center">Facebook</
42 <a href="#" class="d-flex align-items-center justify-content-center">Twitter
43 <a href="#" class="d-flex align-items-center justify-content-center">Instagram
44 <a href="#" class="d-flex align-items-center justify-content-center">Dribbble</
45
46
47
48
49
50
51 <nav class="navbar navbar-expand-lg navbar-dark ftco_navbar bg-dark ftco-navbar-light" id="ftco-navbar">
52
53 FormMatters
54 <button class="navbar-toggler" type="button" data-toggle="collapse" data-target="#ftco-nav" aria-controls="ftco-nav" aria-expanded="false
55 Menu
56 </button>
57
58 <ul class="navbar-nav ml-auto">
59 <li class="nav-item active">Home
60 <li class="nav-item">About
61 <li class="nav-item">Coach
master*
0 0
Ln 36, Col 90
Spaces: 2
UTF-8
CRLF
HTML
Go Live
Prettier

Pose Detection

```python
class poseDetector() :

    def __init__(self, mode=False, complexity=1, smooth_landmarks=True,
                 enable_segmentation=False, smooth_segmentation=True,
                 detectionCon=0.5, trackCon=0.5):

        self.mode = mode
        self.complexity = complexity
        self.smooth_landmarks = smooth_landmarks
        self.enable_segmentation = enable_segmentation
        self.smooth_segmentation = smooth_segmentation
        self.detectionCon = detectionCon
        self.trackCon = trackCon

        self.mpDraw = mp.solutions.drawing_utils
        self.mpPose = mp.solutions.pose
        self.pose = self.mpPose.Pose(self.mode, self.complexity, self.smooth_landmarks,
                                     self.enable_segmentation, self.smooth_segmentation,
                                     self.detectionCon, self.trackCon)


    def findPose (self, img, draw=True):
        imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        self.results = self.pose.process(imgRGB)

        if self.results.pose_landmarks:
            if draw:
                self.mpDraw.draw_landmarks(img,self.results.pose_landmarks,
                                           self.mpPose.POSE_CONNECTIONS)

```

Pushup Workout

```
105
106 def execute_pushup():
107
108
109     cap = cv2.VideoCapture(0)
110     detector =poseDetector()
111     count = 0
112     direction = 0
113     form = 0
114     feedback = "incorrect form"
115
116
117     while cap.isOpened():
118         ret, img = cap.read() #640 x 480
119         #Determine dimensions of video - Help with creation of box in Line 43
120         width  = cap.get(3)  # float `width`
121         height = cap.get(4)  # float `height`
122         # print(width, height)
123
124         img = detector.findPose(img, False)
125         lmList = detector.findPosition(img, False)
126         # print(lmList)
127         if len(lmList) != 0:
128             elbow = detector.findAngle(img, 11, 13, 15)
129             shoulder = detector.findAngle(img, 13, 11, 23)
130             hip = detector.findAngle(img, 11, 23,25)
131
132             #Percentage of success of pushup
133             per = np.interp(elbow, (90, 160), (0, 100))
134
135             #Bar to show Pushup progress
136             bar = np.interp(elbow, (90, 160), (380, 50))
```

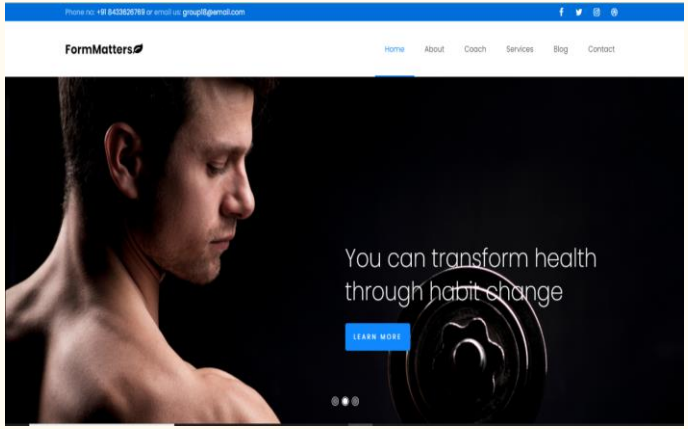
Bicep Workout

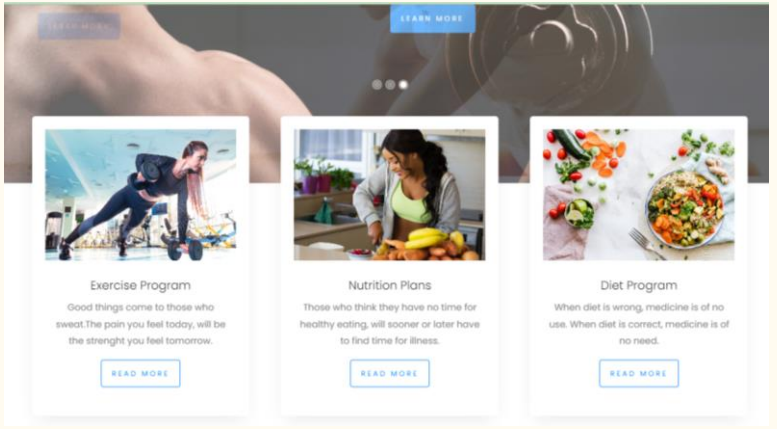
```
207  def execute_bicep():
208
209      mp_drawing = mp.solutions.drawing_utils
210      mp_pose = mp.solutions.pose
211
212
213
214      cap = cv2.VideoCapture(0)
215
216      # Curl counter variables
217      counter = 0
218      stage = None
219
220      ## Setup mediapipe instance
221      with mp_pose.Pose(min_detection_confidence=0.5, min_tracking_confidence=0.5) as pose:
222          while cap.isOpened():
223              ret, frame = cap.read()
224
225              # Recolor image to RGB
226              image = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
227              image.flags.writeable = False
228
229              # Make detection
230              results = pose.process(image)
231
232              # Recolor back to BGR
233              image.flags.writeable = True
234              image = cv2.cvtColor(image, cv2.COLOR_RGB2BGR)
```

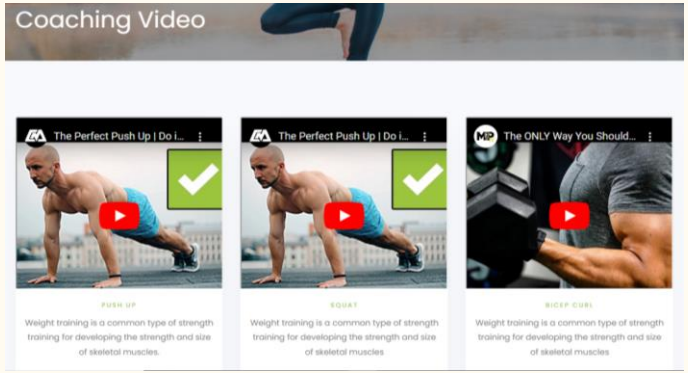
4. Testing

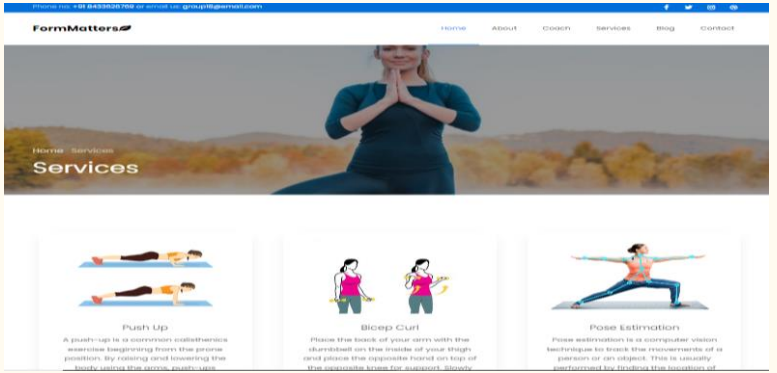
Test Case No.	Test Condition	Test Steps/ Procedure	Expected Results	Actual Results	Pass/Fail
1.	Working of UI	Launch the website	The UI should function properly	The UI is functioning properly	Pass
2.	Recommendation Videos	Click on thumbnails of videos	User should be shown the best recommended videos	User is able to watch the recommended videos	Pass
3.	Posture Detection for Pushup	Click on pushup button	Algorithm should be able to detect the posture and display the results.	Algorithm is successfully detecting the posture and displaying the results	Pass
4.	Posture Detection for Bicep Workout	Click on bicep workout button			Pass
5.	Posture Detection for Yoga	Click on yoga button		Not able to detect the yoga postures	Fail

5. Result


FormMatters
Home
About
Coach
Services
Blog
Contact
You can transform health
through habit change
LEARN MORE


LEARN MORE
Exercise Program
Good things come to those who sweat.The pain you feel today, will be the strenght you feel tomorrow.
READ MORE
Nutrition Plans
Those who think they have no time for healthy eating, will sooner or later have to find time for illness.
READ MORE
Diet Program
When diet is wrong, medicine is of no use. When diet is correct, medicine is of no need.
READ MORE


Coaching Video
The Perfect Push Up | Do i...
The Perfect Push Up | Do i...
The ONLY Way You Should...
PUSH UP
Weight training is a common type of strength training for developing the strength and size of skeletal muscles.
EQUAT
Weight training is a common type of strength training for developing the strength and size of skeletal muscles
BICEP CURL
Weight training is a common type of strength training for developing the strength and size of skeletal muscles


FormMatters
Home
About
Coach
Services
Blog
Contact
Home Services
Services
Push Up
Bicep Curl
Pose Estimation

Website UI

Posture Detection

6. Conclusion and Future Scope

Conclusion

In conclusion, the machine learning-based exercise learning website revolutionized the way people learn and perform exercises. By utilizing machine learning algorithms, this type of web application offered personalized feedback and guidance to users, helping them to improve their form, technique, and overall performance. This led to more effective workouts, better results, and increased motivation for users. The web application provided a wealth of exercise options, catered to individual preferences and difficulty levels, ensuring that users have access to a comprehensive workout experience. Overall, a machine learning-based exercise learning web application provided a powerful way for anyone looking to improve their fitness and live a healthier lifestyle.

Future Scope

In order to enhance user engagement and motivation, the system can offer rewards and incentives for meeting certain exercise goals and provide personalized encouragement based on user progress. The web application must also track user progress over time, adjust the exercise plan as needed based on user feedback and results. We must also ensure user privacy and data security, the system will use industry-standard encryption protocols and only collect user data with their consent. The system will also provide options for users to opt-out of data collection and provide transparency on how their data is being used.

References

1. J. Kim and D. Lee, ”Activity Recognition with Combination of Deeply Learned Visual Attention and Pose Estimation”, Applied Sciences, vol. 11, no. 9, p. 4153, 2021. Available: 10.3390/app11094153.
2. Z. Cao, G. Hidalgo, T. Simon, S. Wei, and Y. Sheikh, ”OpenPose: Realtime Multi-Person 2D Pose Estimation Using Part Affinity Fields”, IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 43, no. 1, pp. 172-186, 2021. Available: 10.1109/tpami.2019.2929257.
3. H. Xiong, S. Berkovsky, R. V. Sharan, S. Liu, and E. Coiera, “Robust Vision-Based Workout Analysis Using Diversified Deep Latent Variable Model,” 2020 42nd Annual International Conference of the IEEE Engineering in Medicine Biology Society (EMBC), 2020.

References

4. Ch´eron, G.; Laptev, I.; Schmid, C. P-cnn: Pose-based cnn features for action recognition. In Proceedings of the IEEE International Conference on Computer Vision, Santiago, Chile, 7–13 December 2015; pp. 3218–3226.
5. A. Toshev and C. Szegedy. “Deeppose: Human pose estimation via deep neural network”. In CVPR, 2014. Available: abs/1312.4659.
6. Pi˜nero-Fuentes, E.; Canas-Moreno, S.; Rios-Navarro, A.; Dom´ınguez-Morales, M.; Sevillano, J.L.; Linares-Barranco, A. A Deep-Learning Based Posture Detection System for Preventing Telework-Related Musculoskeletal Disorders. Sensors 2021, 21, 5236. https://doi.org/10.3390/s21155236

Paper Publication

Paper entitled “FormMatters-Posture Detection System using Computer Vision and Machine Learning during Workouts” is submitted at “ ICETET-SIP 23 (11th International Conference on Emerging Trends in Engineering \& Technology-Signal andInformation Processing)” and "2023 IEEE International Conference on Computer, Electronics \& Electrical Engineering and their applications (IC2E3)"by “Tanay Jain, Aadarsh Khant, Keval Gada and Manjusha Kashilkar”

Thank You!