COMPUTER VISION TECHNOLOGY IN REHABILITATION AND TRAINING

20BKT0095 | ADWAITA RAJ MODAK | Prof. NIHA K. | SCOPE

Introduction

One of the research papers, proposes using AI and image processing through **Media Pipe** for a motion tracker that monitors and provides feedback on exercises, enhancing workout effectiveness and physician coordination. The gaps identified in this research were, that any inaccuracies or errors in these algorithms may lead to incorrect feedback or recommendations as these rely on **body-posture detection** and **motion tracking algorithms**.

Motivation

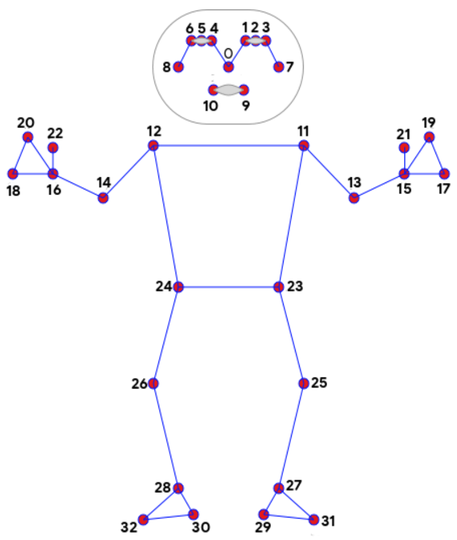
- **Technological Integration** : The rapid advancement of computer vision technology allows for innovative applications in healthcare, particularly in patient rehabilitation.
- **Need for Precision** : Accurate posture detection is crucial in rehabilitation exercises to prevent injuries and ensure the effectiveness of therapeutic interventions.
- **Empowerment and accessibility** : By automating the supervision of exercises, patients can independently manage their rehabilitation process with reduced need for physical therapist intervention.

Scope of the Project

- **Real-time posture identification and correction** through the use of machine learning models and sophisticated computer vision methods. Creating and executing an intuitive user interface to lead patients through prescribed exercise regimens.
- Using patient and healthcare professional user trials to test and validate the system's efficacy. Concentrating on certain medical issues, such as spinal disabilities, in order to customize the system's operation to meet the requirements of various patient populations.

Methodology

- The methodology adopted for this project, focused on real-time posture recognition and correction during exercises, integrates a combination of **computer vision, machine learning, and real-time feedback mechanisms**.



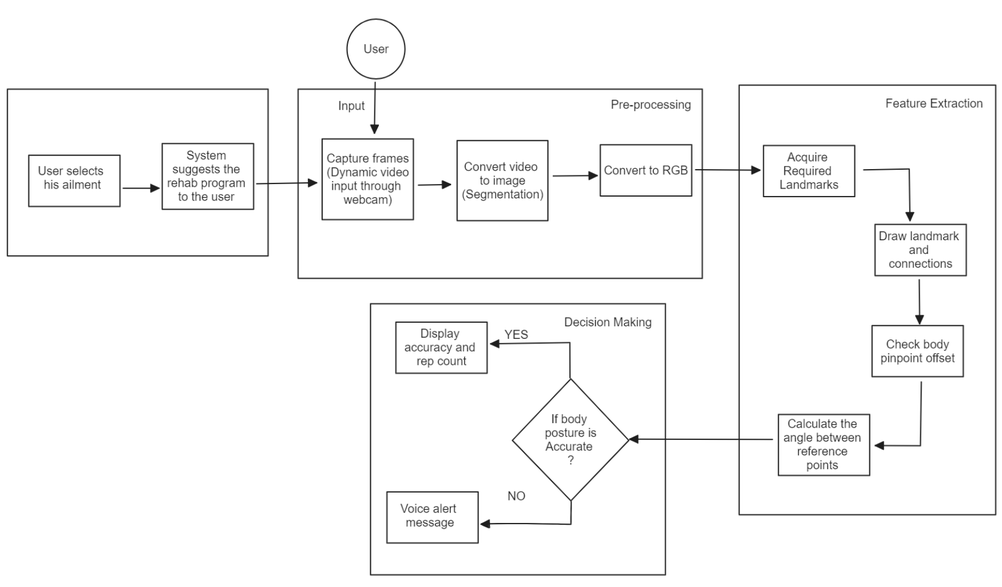
Landmarks

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. Left_mouth	26. Right_knee
10. Right_mouth	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	

Google Media Pipe Landmark Map

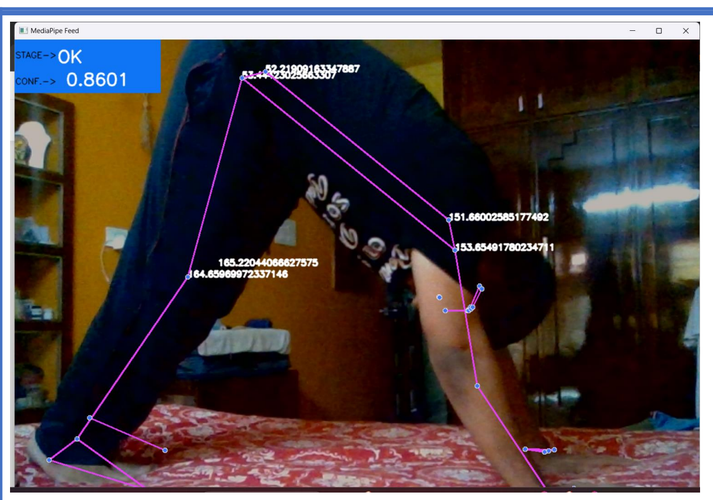
- The project utilized **OpenCV** for capturing webcam feeds and **MediaPipe** for identifying 33 body landmarks to create skeletal models, with data augmentation used to enhance the training dataset.

System Architecture



- Video Feed input and converting image frames to RGB make up the **Pre-Processing** stage, next up, the pose() class of MediaPipe, processing the frames to draw landmarks on the body of the person is the **Feature Extraction** phase.
- In the **Decision Making** phase, joint angles are calculated, compared with pre-determined values to provide feedback if the posture is correct or not.

Results



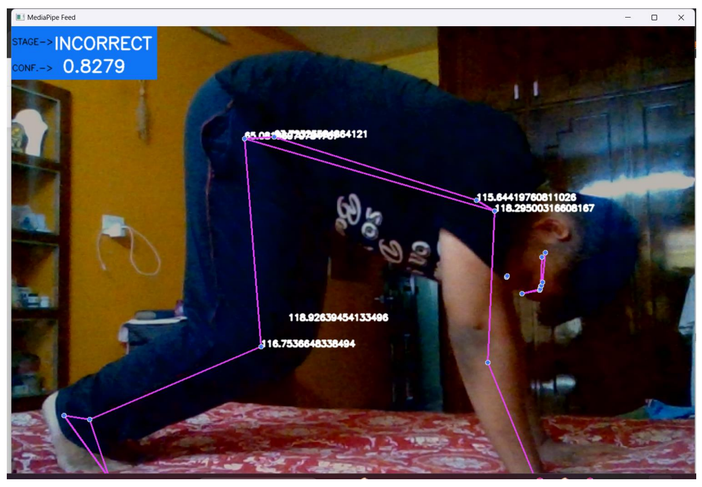
Correct Pose for Adho Mukha Savasana

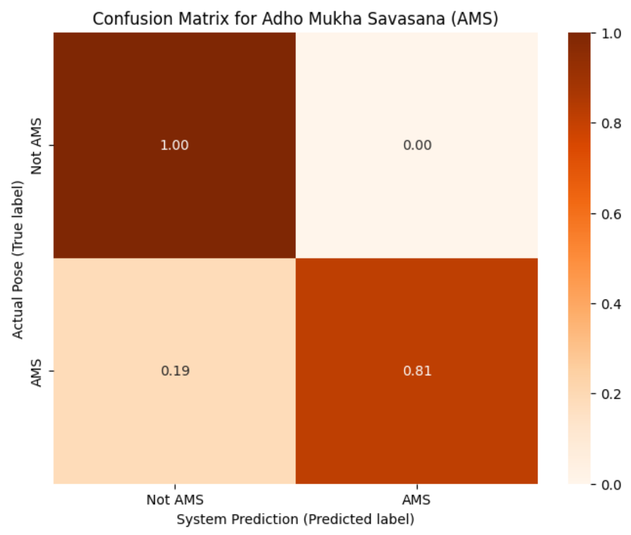
Landmark points that are being used to calculate the angles are as follows, the

- **Lower Body**(ankle-knee-hip)
- **Middle Body**(knee-hip-shoulder)
- **Upper Body**(hip-shoulder-elbow).

Incorrect Pose for Adho Mukha Savasana

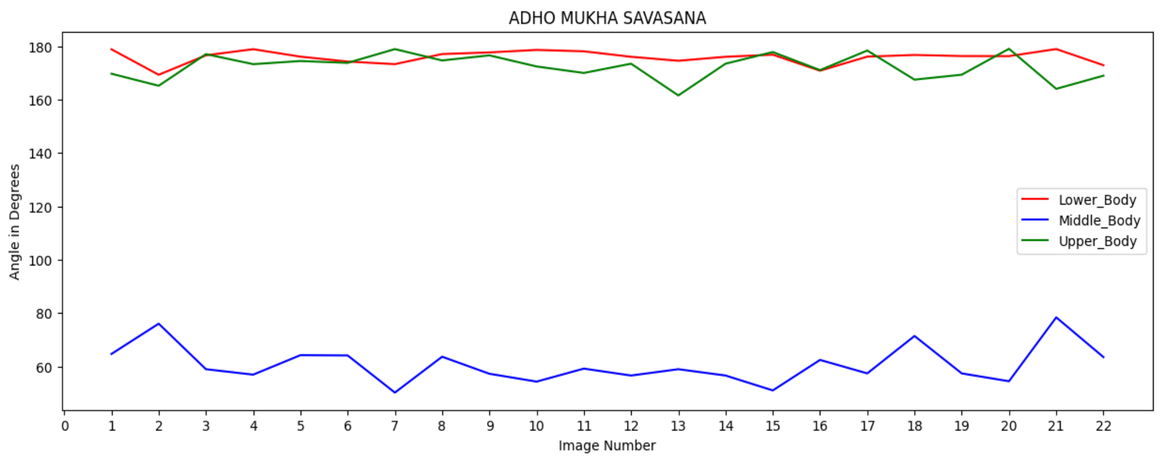
It is clearly visible that the legs have been folded from the knee and there is a change in the angle. The new angle formed in the knee region does not correspond to the optimal angle range and therefore an “INCORRECT” message is displayed.





Confusion Matrix obtained for Adho Mukha Savasana after Testing

The confusion matrix helps to determine the **accuracy**, **precision**, **recall** and **F1-score**, for better analysis and understanding of the model.



Range of angles for body sections for the Yoga Pose

- For calculating the angles formed at the different joints, the major regions that are being stressed are spotted out.
- The sets of joints were passes into the custom function, one at a time, and the angles were calculated in radians using **arctan2** function on 2 vectors.
- The value in radians was converted back to degrees.
- The model was trained by using a variety of yoga pose images and then it was tested using a specific set of images.

Conclusion

Therefore, by developing such a system we can make the entire system automated, and yet provide accurate results over time. The patients will be supervised and guided by the system, tracking and posture correction will go on concurrently at the same time. The biggest challenge is that we have to get a large number of datasets that has to be used to train the model so that it can have greater efficiency and provide the best of results.

References

- Anuj Patil, “Body Posture Detection and Motion Tracking using AI for Medical Exercises and Recommendation System”, ITM web of conferences-Vol. 44, pp 03043-03043, 01 Jan 2022
- https://developers.google.com/mediapipe/solutions/vision/poselandmarker