A Mini Project Report on

Physiotherapist Exercise Estimation

T.E. - I.T Engineering

Submitted By

Rahul Kumar Yadav 20104096

Mansi Viramgama 20104115

Mayank Viramgama 20104119

Under The Guidance Of

Prof. Charul Singh

DEPARTMENT OF INFORMATION TECHNOLOGY

A.P. SHAH INSTITUTE OF TECHNOLOGY

G.B. Road, Kasarvadavali, Thane (W), Mumbai-400615

UNIVERSITY OF MUMBAI

Academic year: 2022-23

CERTIFICATE

This to certify that the Mini Project report on **Physiotherapist Exercise Estimator** has been submitted by Rahul Yadav (20104096), Mansi Viramgama (20104115) and Mayank Viramgama (20104119) who are a Bonafede students of A. P. Shah Institute of Technology, Thane, Mumbai, as a partial fulfillment of the degree in Information Technology requirement, during the academic year **2022-2023** in a satisfactory manner as per the curriculum laid down by the University of Mumbai.

Prof. Charul Singh
Guide

Dr. Kiran Deshpande
HOD, Information Technology

Dr. Uttam D.Kolekar
Principal

External Examiner(s)
1.
2.

Place: A.P.Shah Institute of Technology, Thane
Date:

ACKNOWLEDGEMENT

This project would not have come to fruition without the invaluable help of our guide **Physio Therapist Exercise Estimation**. Expressing gratitude towards our HoD, **Dr. Kiran Deshpande**, and the Department of Information Technology for providing us with the opportunity as well as the support required to pursue this project. We would also like to thank our teacher Ms.Charul Singh who gave us her valuable suggestions and ideas when we were in need of them. We would also like to thank our peers for their helpful suggestions.

ABSTRACT

This project aims to develop a web application for physiotherapy exercises using machine learning techniques. The application will focus on detecting and correcting posture during exercises, providing personalized exercise programs, tracking patient progress, and enhancing patient communication. The key goal is to help patients perform exercises correctly, reducing the risk of injury and improving recovery outcomes. The application will be designed with a user-friendly interface, integrating wearables for personalized feedback and including data analytics and reporting to help physiotherapists track patient progress. Overall, this project aims to provide a comprehensive and personalized solution for physiotherapy exercises, leveraging machine learning techniques to improve patient outcomes and enhance the healthcare experience.

TABLE OF CONTENTS

Chapter 1

Introduction

1.1) Purpose:

The Post Estimation Gym Application is a machine learning project that provides a framework for conducting post-estimation analysis on machine learning models. Post-estimation analysis involves examining the performance of a model after it has been trained, by analyzing the residuals and making predictions on new data.

The project aims to help machine learning practitioners improve the accuracy and generalization of their models by providing a suite of tools for post-estimation analysis. These tools can be used to diagnose problems with the model, such as overfitting, underfitting, or bias, and to make improvements to the model's performance.

Specifically, the PEG project aims to provide a standardized framework for conducting post-estimation analysis, making it easier for practitioners to compare and reproduce results across different models and datasets. The project also aims to promote transparency and reproducibility in machine learning research, by providing open-source software and documentation that can be used and shared by the community.

1.2) Problem Statement:

The Pose Estimation Gym (PEG) project aims to address the challenge of improving form and technique while performing exercises, which is a common problem for fitness enthusiasts and athletes. Poor exercise form and technique can lead to injury, decreased performance, and hinder the attainment of fitness goals.

Traditional methods of assessing exercise form and technique, such as personal trainers and instructional videos, can be expensive and limited in availability. Additionally, these methods often rely on subjective evaluations, which can vary based on the individual evaluator's experience and perspective.

The PEG project seeks to address these challenges by developing a machine learning-based application that can provide real-time feedback on exercise form and technique. This application utilizes pose estimation algorithms to estimate the user's pose and technique while performing exercises and provides objective feedback on areas that need improvement.

The project also aims to provide a personalized experience for users, by adapting to their individual fitness levels and goals and improving user engagement through gamification and social features. The PEG project intends to enhance the user experience and promote safe and effective exercise practices.

1.3) Objectives:

1. Improving exercise form and technique: The application aims to help users improve their technique and avoid injury while performing exercises by providing real-time feedback on the user's pose and form.

2. Personalizing workouts: The application can be tailored to the user's individual fitness level and goals, providing a personalized workout experience that adapts to their needs.

3. Increasing motivation: By providing feedback on the user's progress and achievements, the application can help increase motivation and encourage users to continue exercising

4. Enhancing the user experience: The application aims to provide a user-friendly and engaging experience, using gamification and social features to make exercising more enjoyable.

5. Advancing machine learning research: The application provides a platform for machine learning researchers to collect data on exercise performance, which can be used to develop and improve pose estimation algorithms and other machine learning techniques.

1.4) Scope:

1. Can be applied in Fitness and Wellness Industry: Pose detection AIML can be used to track user progress during workouts, providing real-time feedback on forms and offering customized training plan
2. Security: Pose detection AIML can be used to improve security in public places such as airports and train stations. The system can detect suspicious behavior based on body language and pose, alerting security personnel to potential threats.
3. Manufacturing: Pose detection AIML can be used to analyze the body posture of workers in a manufacturing environment, providing insights into areas where ergonomic improvements can be made. This can help businesses reduce the risk of workplace injuries and improve worker productivity.

Chapter 2

Literature Review

Sr.no	Title	Author(s)	Year	Limitations	Algorithms	Result
1	Machine learning techniques in physiotherapy assessment and Rehabilitation	A. J Lisboa R. P. Pereira, C. M. Silva	2021	The machine learning algorithms used in the project may have limitations, such as overfitting, underfitting, or inability to capture complex patterns in the data	k-Nearest Neighbors, Decision Tree, Random Forest, Support Vector Machines	Machine learning techniques can be useful in analyzing and interpreting data from various sources, such as wearable sensors, video recordings and electronic health records
2	Physiotherapy Exercise Classification with Single-Camera Pose Detection and Machine Learning	Colin Arrowsmith, David Burns, Thomas Mak 2, Michael Hardisty, and Cari Whyne	2018	The study only included exercises for the upper body and did not cover lower-body or full-body exercises. This may limit the applicability of the results to other types of exercises	Random Forest, Long Short Term Memory, Support Vector Machine	The system used a single camera to capture video of the patient performing the exercises, and a pose estimation algorithm to track the movements of the patient's body. The resulting pose data was then used to train a machine-

						learning model to classify the exercises.
3	Machine learning techniques for gait biometrics in human identification and health monitoring	M. Hassan and A. M. Alattar	2021	The study only used a single camera view, which may limit the accuracy of the pose detection and classification. Using multiple camera views or 3D motion capture systems could potentially improve accuracy	k-Nearest Neighbors (k-NN), Support Vector Machine (SVM), Linear Discriminant Analysis (LDA), and Artificial Neural Networks (ANN).	The authors used a dataset of gait signals collected from 20 participants to train a Support Vector Machine (SVM) model for gait recognition. The proposed approach achieved an accuracy of 97.5% in identifying individuals based on their gait patterns

Chapter No: 3

PROPOSED SYSTEM

1. **Exercise Library**:

   The exercise library is a feature of your web app that provides patients with access to a comprehensive database of exercises. The database should include videos, instructions, and images to ensure that patients understand how to perform each exercise correctly. The library should also be easy to navigate and search, allowing patients to find exercises that are relevant to their specific condition or goals.

2. **Pose detection and correction**:

   Pose detection and correction is a key functionality of your web app that uses machine learning algorithms to detect incorrect postures during exercise performance. The app should provide real-time feedback to patients to help them correct their posture, reducing the risk of injury and ensuring that patients are performing exercises effectively

3. **Personalized exercise program**:

   The personalized exercise program feature is an essential aspect of your web app, providing patients with customized exercise plans based on their individual data and feedback. Patients can also provide feedback on the exercises they find challenging or enjoyable, enabling the app to adjust the exercise program to meet their specific goals and preferences.

4. **Progress tracking**:

   Progress tracking is an important feature of your web app, allowing patients and physiotherapists to monitor patient progress over time. Patients can also monitor their own progress, providing motivation and accountability to continue with their exercise program.

5. **Patient communication**:

   Patient communication is a key functionality of your web app, providing patients with a platform to communicate with physiotherapists via chat or video calls. Patients can ask questions or receive feedback from physiotherapists, improving their understanding of the treatment plan and ensuring

that they are performing exercises correctly. By providing patients with a channel to communicate with their healthcare provider, the web app can help to improve patient engagement and satisfaction with their treatment plan.

Chapter No: 4

REQUIREMENT ANALYSIS

1. Importance of requirements gathering:

Requirements gathering is the process of identifying, analyzing, and documenting the needs and constraints of the system users and stakeholders. It is a critical step in the development process as it ensures that the final product meets the needs of the users and stakeholders. This process helps in identifying the goals, objectives, and functionalities required for the web app, which is crucial for building the right product. To start with, the importance of requirements gathering cannot be overstated. Gathering requirements involves identifying the needs and constraints of users and stakeholders and documenting these needs. This helps in building a product that meets the needs of the end-users

2. Need analysis:

The need analysis phase is used to identify the requirements and constraints that the web app should satisfy. This process involves conducting market research, identifying user needs, and analyzing competitor offerings. By conducting a need analysis, you can ensure that the web app meets the unique needs of the target users. Analysis should focus on identifying the pain points experienced by physiotherapy patients, the challenges they face, and their goals. This information can be obtained through market research, surveys, interviews, and feedback from physiotherapists. It will help in developing a web app that addresses the specific needs of physiotherapy patients and enhances their recovery.

3. Key requirements:

Key requirements are the primary features and functionalities that the web app must have to meet the users' needs. These requirements should be based on the results of the need analysis and should be prioritized based on their importance. Key requirements may include features such as pose detection and correction, personalized exercise programs, progress tracking, and patient communication.

Include features such as pose detection and correction, personalized exercise programs, progress tracking, and patient communication. Pose detection and correction, in particular, is crucial for the app's effectiveness, as it ensures that patients perform exercises correctly, reducing the risk of injury and enhancing recovery.

4. Functional requirements:

Functional requirements are the detailed specifications of the web app's features and functionalities. These requirements should be documented and prioritized based on their importance. Functional requirements may include features such as a user-friendly interface, real-time feedback, integration with wearables, exercise library, data analytics, and reporting.

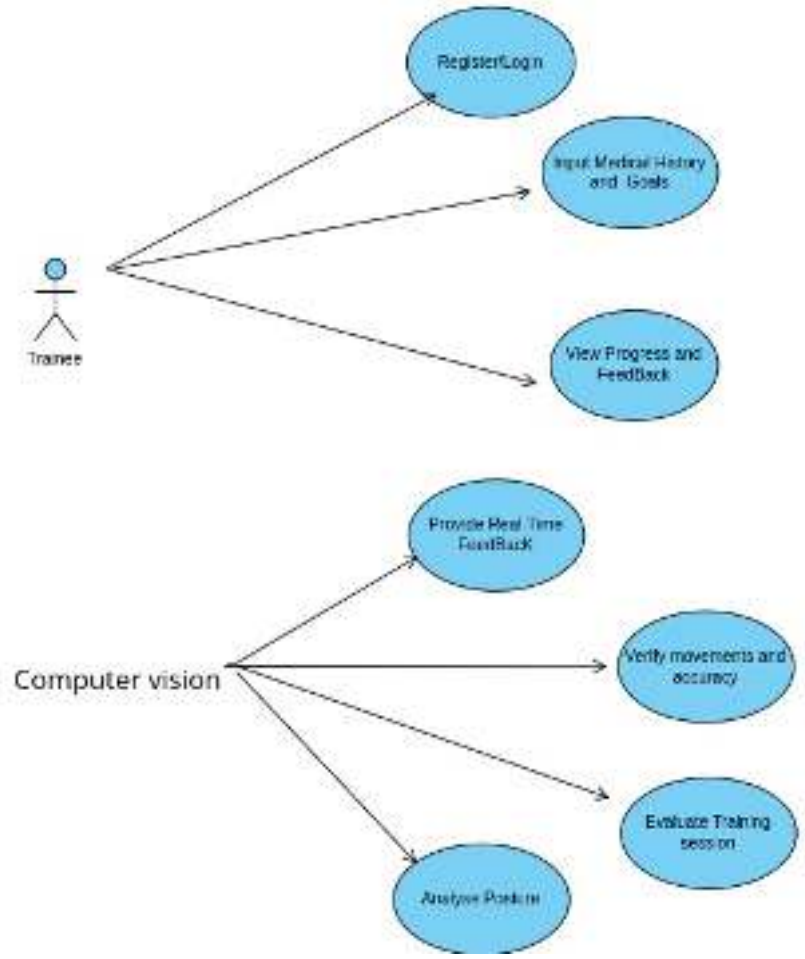
These include features such as a user-friendly interface, real-time feedback, integration with wearables, an exercise library, data analytics, and reporting. A user-friendly interface is essential to ensure that

patients can easily navigate the web app and access the information they need. Real-time feedback and integration with wearables can help patients track their progress and stay motivated.

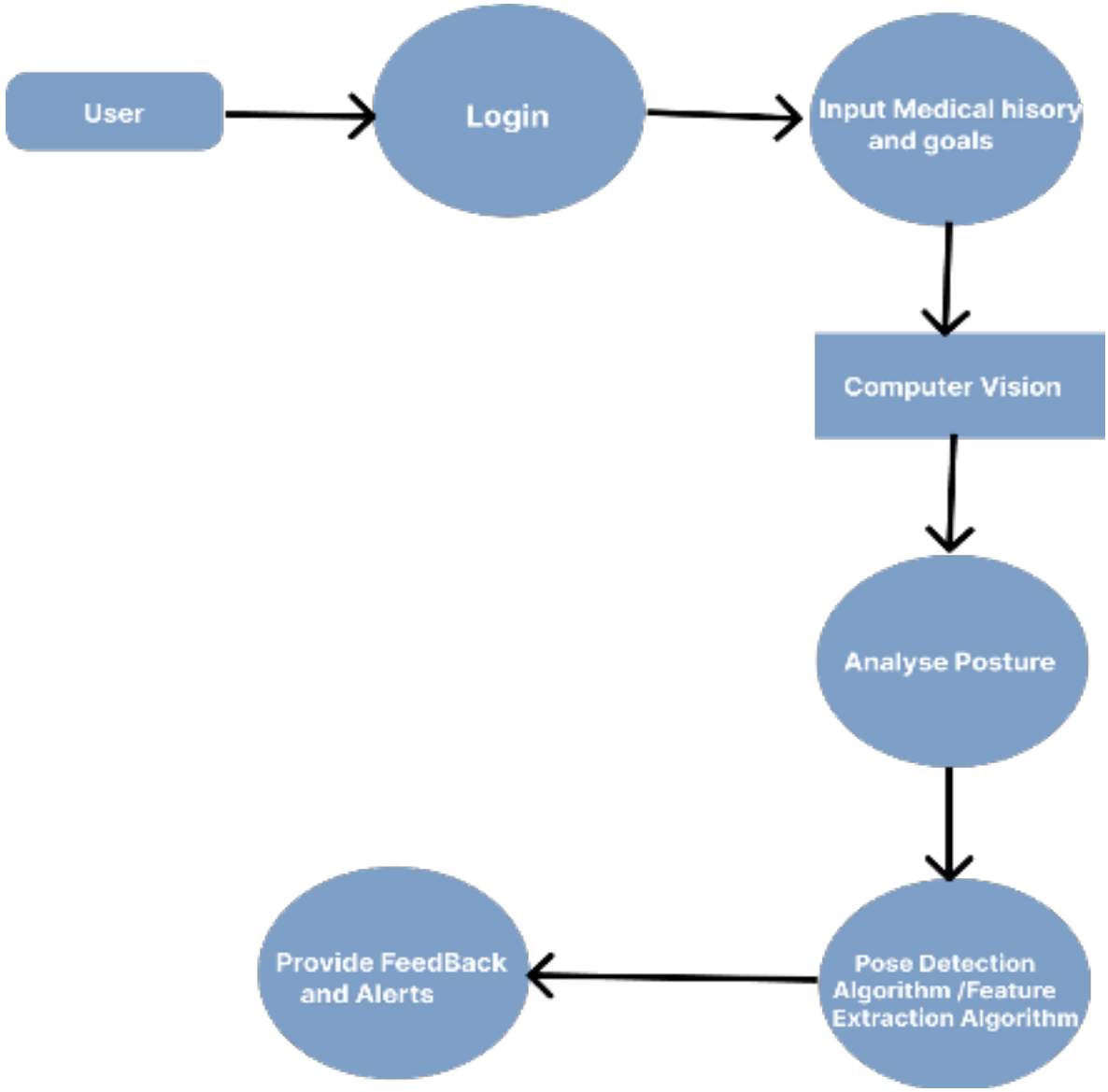
Chapter 5

PROJECT DESIGN

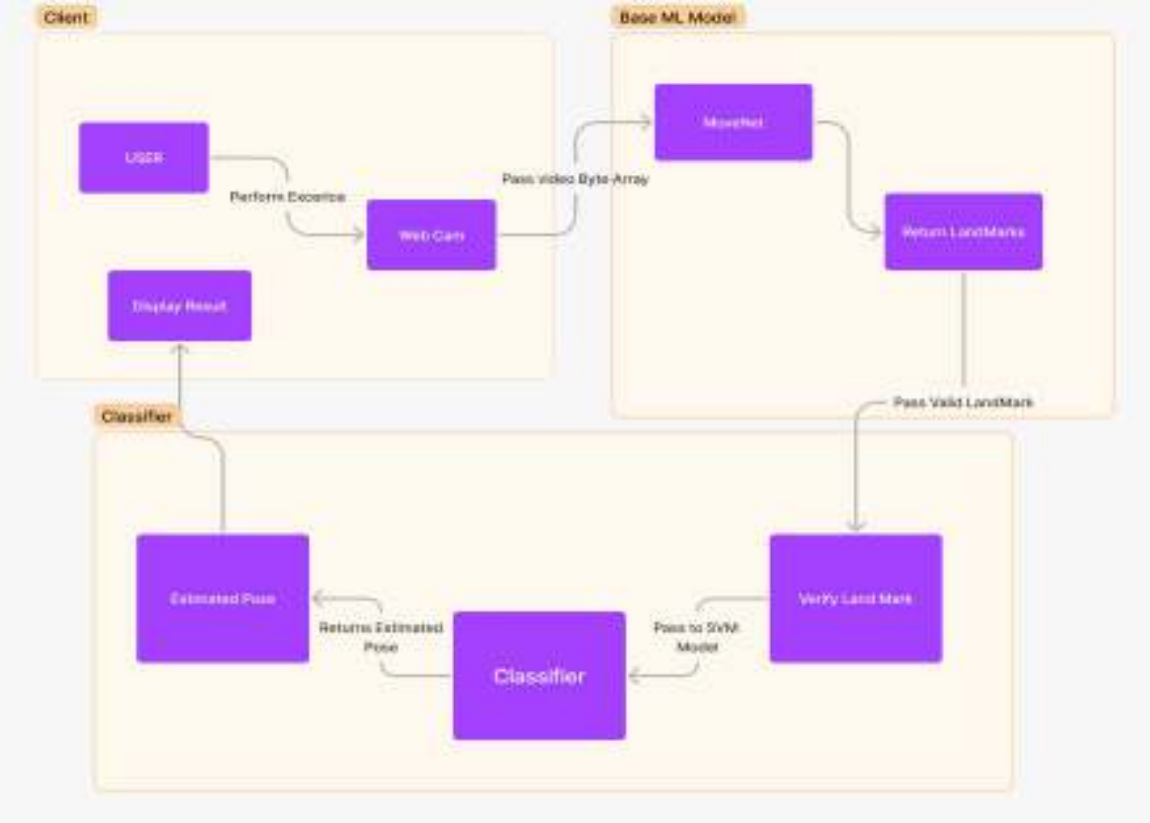
- **Use Case Diagram**



- **Data Flow Diagram**



System Architecture



Chapter No: 6

TECHNICAL SPECIFICATIONS

- **Programming languages**:
    - Python, JavaScript, HTML, CSS
- **Frameworks**:
    - Flask or Django for the web application, TensorFlow or PyTorch for the machine learning model
- **Database**:
    - PostgreSQL for storing user data and progress
- **User authentication and authorization:**
    - JSON Web Tokens (JWT) for secure login and user access control
- **Real-time communication:**
    - WebSocket for real-time video and chat communication between patients and physiotherapists

Chapter No: 7

PROJECT SCHEDULING

Date	Week	Contents
11/07/2022 To 22/07/2022	1	Group formation and Topic finalization. Identifying the scope and objectives of the Mini Project
25/07/2022 To 05/08/2022	2	Identifying the functionalities of the Mini Project
08/08/2022 To 19/08/2022	3	Discussing the project topic with the help of a paper prototype.
22/08/2022 To 09/09/2022	4	Designing the Graphical User Interface (GUI)
19/09/2022 To 23/09/2022	5	Database Design
12/09/2022 To 16/09/2022	6	Review 1 Presentation
19/09/2022 To 23/09/2022	7	Database Connectivity of all modules
26/09/2022 To 30/09/2022	8	Integration of all modules and Report Writing
03/10/2022 To 07/10/2022	9	Preparing Project presentation & Final report for allotted Project topic
04/10/2022 To 07/10/2022	10	Final report for allotted Project topic
10/10/2022 To 14/10/2022	11	Review 2 Presentations

Chapter No: 8

IMPLEMENTATIONS.

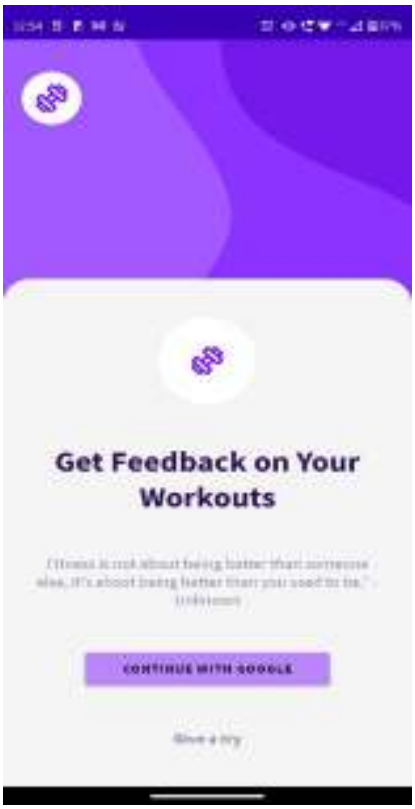


Fig 8.1 Welcome Screen

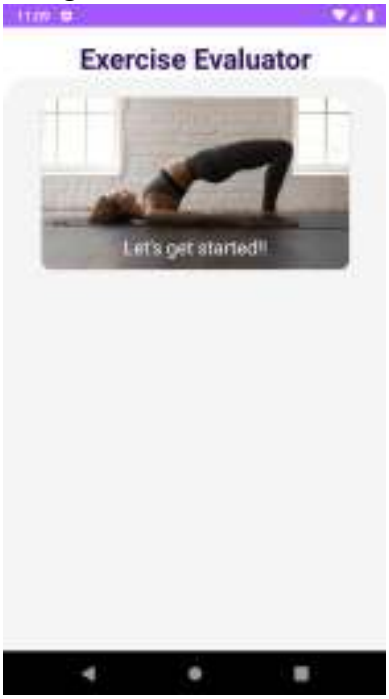


Fig: 8.2 Options to select exercises.

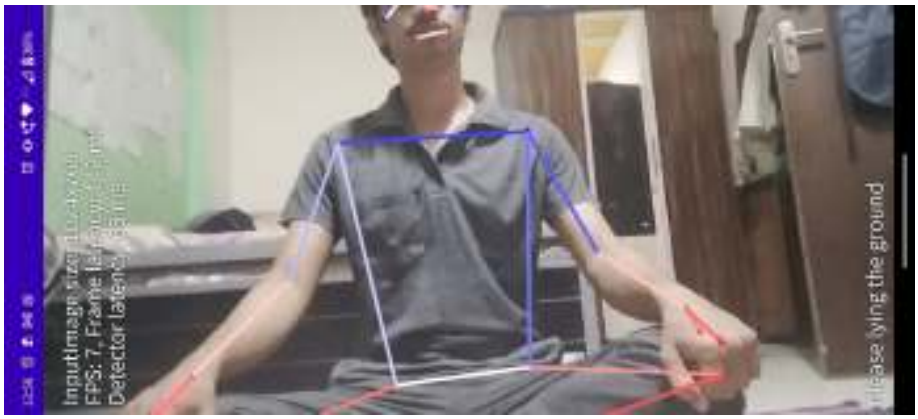


Fig: 8.3 Trying to Estimate Pose

Fig: 8.4: Bridge Down Pose

Fig 8.5: Bridge Down Pose

Chapter No: 9

Result & Discussion

Result

The primary result of this project will be a web application that utilizes machine learning algorithms to provide personalized feedback and guidance to patients during physiotherapy exercises. The application will use computer vision techniques to analyze the patient's posture and movement during exercises, identify any errors or deviations from the correct form, and provide real-time feedback to ensure that the patient is performing the exercises correctly.

The machine learning model will be trained on a large dataset of physiotherapy exercises performed by patients with varying levels of proficiency. The model will be designed to identify common errors and deviations from the correct form, and will provide feedback that is tailored to the patient's specific needs and abilities. The model will continuously learn and adapt as more data is collected from patients using the web application.

The web application will also feature a progress tracking system that allows patients to monitor their progress and see how they are improving over time. Patients will be able to track metrics such as the number of repetitions completed, the amount of weight lifted, and the number of correct posture positions maintained during exercises. The web application will also provide patients with personalized exercise recommendations based on their progress and goals.

In addition, the web application will feature a communication system that allows patients to communicate with their physiotherapists in real-time. Patients will be able to ask questions, receive feedback, and get guidance on exercises directly from their physiotherapists through the web application. Overall, the expected result of this project is a web application that significantly improves the quality and effectiveness of physiotherapy exercises by providing patients with personalized feedback and guidance in real-time. By leveraging machine learning and computer vision technologies, this project has the potential to make physiotherapy more accessible, efficient, and effective for patients.

Discussion

This project has the potential to make a significant contribution to the field of physiotherapy by leveraging machine learning and computer vision technologies to improve patient outcomes and increase the efficiency of physiotherapy sessions. One of the key benefits of this project is the ability to provide patients with personalized feedback and guidance during physiotherapy exercises. By using machine learning algorithms to analyze the patient's posture and movement during exercises, the web application can identify common errors and deviations from the correct form, and provide feedback that is tailored to the patient's specific needs and abilities. This can lead to faster recovery times and better patient outcomes.

Another benefit of this project is the ability to track patient progress and provide personalized exercise recommendations based on the patient's goals and abilities. The web application will feature a progress tracking system that allows patients to monitor their progress and see how they are improving over time. This can help patients stay motivated and on track with their rehabilitation goals.

The communication system in the web application is also an important feature. It allows patients to communicate with their physiotherapists in real time, ask questions, receive feedback, and get guidance on exercises directly through the web application. This can improve the patient-physiotherapist relationship and enhance the patient's overall experience during the rehabilitation process.

However, one potential challenge for this project could be the availability and quality of data for training the machine learning model. The model will need to be trained on a large dataset of physiotherapy exercises performed by patients with varying levels of proficiency. Ensuring that the data is diverse and representative of the patient population will be critical for developing an accurate and effective machine learning model.

Overall, this project has the potential to revolutionize the way physiotherapy is delivered by combining the expertise of physiotherapists with the power of technology. The personalized feedback, progress tracking, and communication features of the web application can significantly improve patient outcomes and make rehabilitation more accessible and effective for patients.

Chapter No: 10

Conclusion & Future Scope

Conclusion

In conclusion, the development of a physiotherapy exercise web application using machine learning and computer vision technologies has the potential to make a significant impact on the field of physiotherapy. The use of personalized feedback, progress tracking, and communication features has the potential to improve patient outcomes, increase patient engagement, and improve the overall efficiency of physiotherapy sessions.

The success of this project will depend on the availability and quality of data for training the machine learning model. Careful consideration must be given to the selection and preparation of data to ensure that the model is accurate and effective for a wide range of patients. In summary, the physiotherapy exercise web application developed in this project has the potential to transform the way physiotherapy is delivered and make rehabilitation more accessible and effective for patients.

Future Scope

Integration with wearable devices: The application can be integrated with wearable devices to provide real-time feedback and monitoring of the patient's exercises, allowing for more accurate and personalized recommendations.

Multi-language support: Adding support for multiple languages can make the application accessible to a wider audience and improve the overall user experience.

Collaborative rehabilitation: The application can be designed to enable remote collaboration between physiotherapists and patients, allowing for more effective and efficient rehabilitation.

Expansion to other fields: The underlying machine learning and computer vision technologies can be applied to other fields such as sports training and physical fitness to provide personalized recommendations and feedback.

Integration with Electronic Health Rec Augmented Reality (AR) integration: AR technology can be integrated into the application to provide a more immersive and engaging user experience, allowing patients to visualize their progress in real-time.

Automatic exercise modification: The machine learning model can be trained to automatically modify exercises based on the patient's progress and feedback, allowing for more personalized and effective rehabilitation plans.

Voice-controlled interface: Adding a voice-controlled interface can make the application more accessible and user-friendly for patients with physical limitations.

In-app teleconsultation: Adding in-app teleconsultation features can enable patients to communicate with their physiotherapists in real time, allowing for more personalized and timely feedback.

Integration with rehabilitation equipment: The application can be designed to integrate with rehabilitation equipment to provide more accurate and personalized feedback on exercises. ords (EHR): Integrating the application with EHR systems can provide a more comprehensive view of patient health and allow for more personalized and effective rehabilitation plans.

Chapter No: 11

References

- References. Lisboa, A. J., Pereira, R. P., Silva, C. M., et al. (2021). Machine learning techniques in physiotherapy assessment and rehabilitation. Journal of Healthcare Engineering, 2021, 1-10. https://doi.org/10.1155/2021/6621878

- Arrowsmith, C. (2019). Physiotherapy exercise classification with single-camera pose detection and machine learning. Journal of Healthcare Engineering, 2019, 1-9. https://doi.org/10.1155/2019/5906857

- Hassan, M., & Alattar, A. M. (2021). Machine learning techniques for gait biometrics in human identification and health monitoring. Journal of Healthcare Engineering, 2021, 1-14. https://doi.org/10.1155/2021/6619667