Title: AI-Driven Personalized Pain Management with Real-Time Feedback and Relief Suggestions

Team Name: ReliefXperts
Team Members:

Name	Role in Assignment-1	Github
Suryansh Patel	Leader, Research papers reviewer, decided to work on Video related datasets	https://github.com/suryansh-max
Jainil Patel	Data Sets collector, decided to work on sensors and other pain related data	https://github.com/jainilpatel98
Cameron O'Dell	Research Paper Reviewer,decided to work on Video related datasets	https://github.com/cam-odell
Jacob Xayaphet	Data collector(other then videos), decided to work on sensors and other pain related data	https://github.com/NoviceOfCode

Project Repository:

https://github.com/suryansh-max/AI-Driven-Personalized-Pain-Management-with-Real-Time-Feedback-and-Relief-Suggestions

Presentation link:

https://docs.google.com/presentation/d/1rZeckRa2NzYs-1Z8ynpQ9dPOPiCFbkwbMqNfy2ZipEk/edit?usp=sharing

Statement of work document:

AI-Driven Personalized Pain Management with Real-Time Feedback and Relief Suggestions

1. Introduction

- **1.1 Project Overview**
    - **Objective**: Develop an AI-powered tool that monitors exercise posture and provides real-time feedback to users, while also managing and alleviating pain during workouts.
    - **Key Features**:
        - Real-time posture correction
        - AI-driven pain monitoring and relief suggestions
        - Personalized pain management plans
- **1.2 Motivation**
    - The rising popularity of home workouts, fitness apps, and gym goers combined with the risks of improper form and injury, necessitates an intelligent system to ensure safe and effective exercise.
    - The integration of pain management helps users recover from injuries and avoid further complications.

2. Literature Review

- **2.1 Existing Solutions**
    - https://www.diva-portal.org/smash/get/diva2:1673390/FULLTEXT02.pdf (contain information about the idea we are covering)

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  - https://www.mdpi.com/1424-8220/23/3/1206
  - https://ieeexplore.ieee.org/abstract/document/10254204
  - https://github.com/leoxiaobin/deep-high-resolution-net.pytorch
  - Corrective Posture Estimator
  - Perch.fit
  - Reddit Project for Arm Raises and Posture Check
- **2.2 Gaps in Current Solutions**
  - Lack of real-time, personalized feedback on both posture and pain management.
  - Limited integration of AI-driven pain relief in existing fitness platforms.
  - Lack of proper implementation.

3. Problem Statement

- Incorrect exercise posture can lead to injuries, especially among new gym-goers.
- Managing pain during workouts is crucial to avoid aggravating injuries and to ensure a safe exercise routine.
- There is a need for a tool that provides immediate, personalized feedback on both posture and pain during exercises.

4. Objectives

- **4.1 Posture Correction**: Use video analysis to detect incorrect exercise posture in real-time and provide corrective suggestions.
- **4.2 Pain Monitoring**: Monitor signs of discomfort or pain during exercises using AI and suggest modifications to avoid injury.
- **4.3 Personalized Plans**: Develop tailored pain management plans based on individual needs, medical history, and fitness goals.

5. Methodology

- **5.1 Data Collection**
  - All Data sets collected can be found in : https://docs.google.com/spreadsheets/d/1UrXNRXAJQuXJEHqeyxPApSvpcbKqEPeg/edit?usp=sharing&ouid=115707204887365459784&rtpof=true&sd=true
  - Additional Datasets Utilize datasets from various sources:
    - **Video Dataset**: Kaggle Workout Video Dataset
    - **Image and Text Dataset**: WeightTraining Guide
    - **Annotated Image Datasets**: [ArXiv, CrowdHuman, BodyHands]
  - Further data collection from YouTube and collaboration with physical education instructors at UMKC.

- **5.2 Model Development**
  - **Posture Detection**: Implement a model to analyze video input and detect key joint movements.
  - **Pain Monitoring**: Integrate AI models to identify signs of discomfort based on movement patterns and physiological data.
  - **Personalization**: Develop algorithms to create customized pain management and exercise correction plans.
- **5.3 System Architecture**
  - **Front-End**: User interface for real-time feedback and plan visualization.
  - **Back-End**: Integration of AI models, data processing, and storage.
  - **Real-Time Feedback Loop**: Continuous monitoring and adjustment during workouts.

6. Implementation Plan

- **6.1 Role Assignment**
  - **Project Manager / Full-Stack Developer**:
    - Oversee the project timeline and implementation.
    - Develop back-end systems and ensure smooth integration.
    - Handle deployment and cloud services.
  - **AI/ML Specialist**:
    - Develop and fine-tune models for posture correction and pain monitoring.
    - Collaborate on data collection and preprocessing.
  - **Front-End Developer**:
    - Design and implement the user interface.
    - Integrate real-time feedback features.
  - **Data Analyst / UX Researcher**:
    - Analyze user data for trends in posture and pain.
    - Conduct user testing and improve system usability.
- **6.2 Development Phases**
  - **Phase 1**: Data collection and preprocessing. (data collection is partially done and preprocessing left)
  - **Phase 2**: Model development and initial testing.
  - **Phase 3**: System integration and real-time feedback implementation.
  - **Phase 4**: User testing and refinement.
  - **Phase 5**: Final deployment and maintenance.

7. Applications and Impact

- **7.1 Target Audience**
  - New and young gym-goers looking to learn proper exercise techniques and avoid injuries.
  - Users recovering from injuries or managing chronic pain.
- **7.2 Potential Impact**
  - Reduction in workout-related injuries.
  - Improved user adherence to exercise routines.
  - Enhanced overall user experience in fitness and rehabilitation.

8. Challenges and Considerations

- **8.1 Technical Challenges**
  - Ensuring accurate real-time posture detection.
  - Integrating pain monitoring with posture correction.
- **8.2 Ethical Considerations**
  - Handling user data securely and respecting privacy.
  - Providing accurate and safe exercise recommendations.

9. Conclusion

- **Summary**: Project aims to revolutionize exercise safety and effectiveness by combining AI-driven posture correction with personalized pain management.
- **Future Work**: Potential expansion into more complex exercises, integration with wearable technology, and broader application in physical therapy.

10. References

- List of datasets, academic papers, and existing projects referenced throughout the document.

Individual Contributions expected during project:

1. Suryansh Patel : Project Manager / Full-Stack Developer

Responsibilities:

- **Project Management:** Oversee the project timeline, milestones, and deliverables, ensuring that AI integration is on track.
- **Back-End Implementation:**
  - **AI Model Integration:** Implement server-side logic to interact with AI models, ensuring efficient data flow between the AI components and the database.
  - **Database Management:** Set up databases to store and retrieve data from AI models, including user pain data, posture correction feedback, and historical performance.

Skills Needed: Leadership, back-end development (Node.js, Django, or Flask), database management (SQL, NoSQL), basic understanding of AI/ML model deployment (e.g., TensorFlow Serving, Docker).

2. Jainil Patel : AI/ML Specialist

Responsibilities:

- **Model Development:**
  - **Posture Detection Model:** Develop and fine-tune machine learning models for detecting exercise posture using video data.
  - **Pain Monitoring Model:** Create and train models to detect signs of discomfort or pain during exercises and provide personalized relief suggestions.
- **Data Preprocessing:** Prepare and clean datasets, extract features, and manage the data pipeline for both posture detection and pain management models.
- **Model Integration:** Collaborate with the Project Manager to integrate AI models into the application, ensuring seamless interaction with the back-end and front-end.

Skills Needed: Machine learning, deep learning, Python, TensorFlow/PyTorch, data engineering, computer vision (for posture detection), NLP (if pain detection involves text data).

3. Cameron O'Dell : Front-End Developer

Responsibilities:

- **UI/UX Implementation:**

- ○ **AI-Driven Feedback Display:** Develop the user interface to display AI-generated posture correction suggestions and pain management advice in real-time.
  - ○ **AI Interaction:** Implement features that allow users to interact with AI models, such as reporting pain or adjusting posture based on AI feedback.
- **API Integration:** Connect the front-end with back-end services and AI models, ensuring that AI-driven insights are seamlessly integrated into the user interface.
- **User Feedback Loop:** Implement real-time pain feedback features, enabling users to receive AI-generated suggestions and corrections during workouts.

Skills Needed: Front-end development (React, Angular, or Vue.js), HTML/CSS, JavaScript, API handling, basic understanding of AI model output and how to display AI-driven insights in the UI.

4. Jacob Xayaphet : Data Analyst / UX Researcher

Responsibilities:

- **User Data Analysis:**
  - ○ **AI Model Feedback Analysis:** Analyze the performance of AI models by examining user interactions and outcomes, identifying trends that can improve model accuracy and user experience.
- **User Testing & Feedback:** Conduct usability testing focused on AI-generated suggestions, gathering feedback from users to refine the AI models and the overall UI/UX.
- **Model Validation:** Assist the AI/ML Specialist in validating models using real user data, ensuring the AI predictions and suggestions align with user needs and experiences.

Skills Needed: Data analysis (Pandas, Excel, SQL), UX research, user testing, data visualization, basic understanding of AI model evaluation metrics and how user data can inform model improvements.