

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 than videos) decided to work on sensors and other pain-related data	https://github.com/No viceOfCode

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
 - Personalised 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>
(contains information about the idea we are covering)
- <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, personalised 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, personalised 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 at:
<https://docs.google.com/spreadsheets/d/1UrXNRXAJQuXJEHqeyxPApSvpcbkKqEPeg/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 analyse video input and detect key joint movements.
- **Pain Monitoring:** Integrate AI models to identify signs of discomfort based on movement patterns and physiological data.
- **Personalisation:** Develop algorithms to create customised pain management and exercise correction plans.
- **5.3 System Architecture**
 - **Front-End:** User interface for real-time feedback and plan visualisation.
 - **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:**
 - Analyse 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 is 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:** The project aims to revolutionise exercise safety and effectiveness by combining AI-driven posture correction with personalised pain management.
- **Future Work:** Potential expansion into more complex exercises, wearable technology integration, and broader physical therapy application.

10. References

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

Individual Contributions

Suryansh Patel

- Role: Leader, Research Papers Reviewer
- Responsibilities:
 - Lead the project, overseeing progress and coordinating between team members.

- Review and analyse research papers to guide the development of the AI-driven system.
- Focus on video-related datasets for posture detection and analysis.
- Current Contributions:
 - Search some research papers and got one paper that is exactly what we are looking for
 - Found one repository that can be extended for a possible solution
 - Also, setup GitHub for this.
 - Decided to work with video-related datasets and also found one research paper to develop and support the idea

Jainil Patel

- Role: Data Sets Collector
- Responsibilities:
 - Collect and organise datasets for the project.
 - Focus on sensors and other pain-related data sources.
- Current Contributions:
 - Created an Excel sheet with relevant datasets
 - Decided to work on collecting and managing data from sensors and other sources related to pain, ensuring comprehensive data collection for pain monitoring.
 - Checked different research papers for good datasets and downloaded them to see whether they would be helpful.

Cameron O'Dell

- Role: Research Paper Reviewer
- Responsibilities:
 - Review and analyse relevant research papers to inform the development of AI models and system design.
 - Focus on video-related datasets for posture correction.
- Current Contributions:
 - Search for current publications, papers, and datasets in the research topic field that may serve as a comparison or inspiration to the project.
 - Decided to work with video modality of datasets similar to those identified by Suryansh Patel, ensuring alignment in data handling and analysis.

Jacob Xayaphet

- Role: Data Analyst / UX Researcher
- Responsibilities:
 - Collect and manage data from sources other than video, including sensors and other pain-related data.
 - Help synthesise plan for working with multiple datasets
 - Focus on UX to make it approachable for most users
 - Reach out to outside sources to better understand the implications and context of datasets
- Current Contributions:
 - Communicated with the professor at UMKC related to exercise and staying as an in-between communicator for messages and meetings.
 - Reaching out to friends who are physical trainers for a time as well to better understand the use case and risks
 - Drafted and completed Ignite PPT.

Report Section / 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), and 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 personalised relief suggestions.
- **Data Preprocessing:** Prepare and clean datasets, extract features, and manage the data pipeline for 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, a 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 user feedback 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 visualisation, basic understanding of AI model evaluation metrics and how user data can inform model improvements.