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Student Name: Ajoob Sagar Kansakar

London Met ID: 23056153

College ID: np01cp4s240080

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Internal Supervisor: Ms. Astha Sharma

External Supervisor: Mr. Srawan Shrestha

I confirm that I understand my coursework needs to be submitted online via MST Classroom under the relevant module page before the deadline for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

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I am also thankful to the entire Islington College community for providing the necessary resources and academic support essential for the successful initiation of this project.

Abstract

The rapid rise of home-based fitness solutions has highlighted the need for intelligence, personalized workouts assistance that ensures proper exercise form and minimizes the risk for injuries specially for beginners. KasRrat is a mobile application designed to address this need by utilizing real-time human pose estimation and computer vision techniques to analyse user posture and offer corrective feedback during workouts. By leveraging TensorFlow Lite and MediaPipe pose estimation models, the system detects and tracks the user's body movements through the device camera, evaluates posture accuracy using joint-angles calculations, and provides instant audio feedbacks to improve the user's performance.

In addition to real-time posture correction, the application features and animated workout instructor (bot) that demonstrates exercises clearly, enabling users to follow guided routines without external supervision. The platform aims to enhance workout quality, reduce injuries risks, and create a more interactive and effective exercise experience. The project follows the Agile Scrum methodology to ensure iterative development, continues testing, and steady progress toward a functional prototype. Ultimately, KasRrat seeks to bridge the gap between technology and fitness by offering a smart, accessible, and engaging solution for individuals seeking structured workouts with proper beginner guided assistance.

Table of contents:

Table of Tables:

Table of Figures:

1. Introduction

Physical activity is beneficial to health and well-being and conversely, physical inactivity increases risk for noncommunicable diseases (NCDs) and other poor health outcomes. Together, physical inactivity and sedentary behaviours are contributing to the rise in NCDs and placing a burden on healthcare systems. Improving levels of physical activity benefits and contributes to attainment of global NCD targets and a number of sustainable development goals. People who are insufficiently active have a 20% to 30% increased risk of death compared to people who are sufficiently active (World Health Organization, 2024).

Digital fitness platforms are a powerful force driving fitness industry growth, nowadays with innovations like virtual fitness solutions, wearable technology, and AI-driven personalization, workouts can be done in new ways. As the industry recovers from the disruptions caused by the COVID-19 pandemic, it is clear that digital fitness will remain a big part of the future (Ashley Miller, 2024).

The global fitness industry has proven its resilience, with significant recovery post-pandemic. In 2022, the global market was valued at $104.05 billion and is projected to reach $202.78 billion by 2030, reflecting a robust compound annual growth rate (CAGR) of 8.4% (Alexandra, 2025).

KasRrat a mobile application aims to address this limitation by integrating real-time pose detection, computer vision, and audio feedbacks, enabling users to train safely and effectively without needing a physical trainer. The system will use the device camera to detect full-body movements, analyse posture using machine learning models, and guide the users through animated exercise demonstrations so that the user could easily follow the bot and perform the exercises in a simple easy way.

1.1 Problem Scenario

Engaging in physical activity with poor posture can put undue stress on specific muscles and joints, leading to various problems and cause problems such as muscle pain, joint pain, and can restrict blood flow and circulation, leading to fatigue and potentially affecting healing and recovery. Bad posture harms the body and affects performance. Proper posture helps maintain balance and coordination, which is critical in doing exercises correctly and without risking well-being (ghpnews, 2024, September 24).

Developing an exercise habit is hard enough without having to guess what exercises are good as a beginner. We are all beginners at one time or another there is no shame in that. The sheer amount of content available online can make it even more difficult to get started. The biggest problem with tagging videos as beginners is that often the exercises are demonstrated but the proper form and technique to perform those exercises are not shown (Bradbury, December 30, 2022).

Many people spend tons and tons of money on personal trainers especially as a beginner which cost them a lot, and existing fitness apps offer general workout guidance but lack the ability to:

- Correct the user’s form in real-time
- Detect and track actual body movements
- Give instant audio feedbacks
- Provide an interactive AI trainer that dynamically responds to user actions

Incorrect posture during exercise can lead to injuries, reduced effectiveness, and long-term health issues. Users who exercise at home without supervision are especially vulnerable to performing movements incorrectly.

1.2 Project as a solution

In the age of digital transformation, fitness tracking has evolved from simple pedometers to systems which are capable of analysing movement, posture, and performance in real-time. Computer vision a ground-breaking technology that enables machines to interpret and analyse visual data. With the use of advance algorithms and machine learning techniques to analyse visual data captured through cameras enables system to identify, monitor, and evaluate human movements, providing detailed insights into physical activities, posture, and performance (Meegle, 2025).

MediaPipe being used as a framework used in computer vision to access and solve several real-life problems through pose-estimation and joint angle calculation provide feedback on exercise form as well as expanded rep count. This application employs an unique method by using dynamic angle thresholds and joint distance computation to provide precise feedback about user posture assisting users in maintaining proper form and tracking their workout progress (IEEE, 2024).

KasRrat will be a mobile app that uses computer vision technology to track the user's body joints in real-time, analyse posture accuracy, and provide instant corrective feedback. The app will also feature an animated virtual bot that demonstrates the proper form of the exercise so the user could follow the proper exercise form side-by-side along with the virtual bot.

1.2.1 Core features

1. Real-Time Movement Tracking
   - Uses device's camera and TensorFlow Lite pose model to detect user joints.
2. Real-Time Posture Analysis
   - Measures joint angles, posture alignment, and checks form correctness.
3. Live Audio Feedbacks
   - Provides feedbacks to the user with text-to-speech instructions to guide the user during the workout.
4. Animated Workout Instructor
   - A Mixamo-based animated character demonstrates exercises on screen.

2. Aims and Objectives

2.1 Aims

The project aims to design and develop a mobile fitness application that enables the users to perform guided exercises safely by providing real-time posture tracking features and real-time audio feedbacks through AI-driven computer vision.

2.2 Objectives

The major objectives of the project are listed below:

1. To build a mobile app using Flutter that accurately detects and tracks user body joints in real-time using TensorFlow Lite pose estimation.
2. Implement movement and posture analysis using joint-angle computation and detect a minimum of 17 body key points per frame.
3. The posture correction algorithm should achieve 80% accuracy when tested on different users.
4. The system should provide real-time audio feedback/guidance using text-to-speech using Flutter packages (TFLite, camera, flutter_tts) to simplify integration.
5. Include a minimum of 4 exercises with complete animated demonstrations using Mixamo animations to avoid manual animation work.
6. Helps prevent workout injuries by ensuring correct posture.
7. Develop an intuitive UI/UX using Flutter.
8. Achieve all the objectives within the allocated timeline.

3. Expected Outcomes and Deliverables

By the end of the project, the following outcomes are expected:

- A fully functional app that detects user movements in real-time.
- An accurate posture evaluation system based on joint-angle measurement.
- Real-time corrective feedback.
- Integrated animated exercise instructor.
- A user-friendly UI suitable for fitness beginners.
- Project documentation and testing results.

4. Project risks, threats and contingency plans

Table 1: Risks, Threats and Contingency plans

Risks	Threats	Contingency Plans
1. Pose detection Performance	Low FPS on specific devices may clause the application to lag.	Reduce camera resolutions dynamically when FPS drops to maintain performance.
2. Posture Detection Accuracy	Due to inconsistent joint detection or angle miscalculation incorrect feedback provided to the user.	Start with simple exercises and calibrate joint-angle thresholds using real test users.
3. Animation Integration	Rendering issues may occur if the animation is too complex for the device.	Use Mixamo animations converted to MP4 format instead of live rendering to ensure smooth playback.
4. Audio Feedback Failure	Misleading instructions or silence when the user needs guidance, causing confusion during the workouts.	Preload audio prompts to avoid runtime delays and test various text-to-speech engines for reliability.
5. Insufficient Testing	System failure in real-world scenarios if the model cannot recognize different body types or lighting.	Conduct testing with a minimum of 5 real users of different body types and test in various lighting conditions.
6. Camera permissions denied	Major blocker where the app functions become completely inaccessible.	Display a permission dialog with a clear explanation and redirect the user to Settings if access is initially denied.

5. Methodology:

5.1 Considered Methodology

a. Prototype:

One of the most popularly used Software Development Life Cycle Models (SDLC). This model is used when the customers do not know the exact project requirements beforehand. A prototype of the end product is first developed, tested, and refined as per customer feedback repeatedly till a final acceptable prototype is achieved (geeksforgeeks, 2025 jul 11).

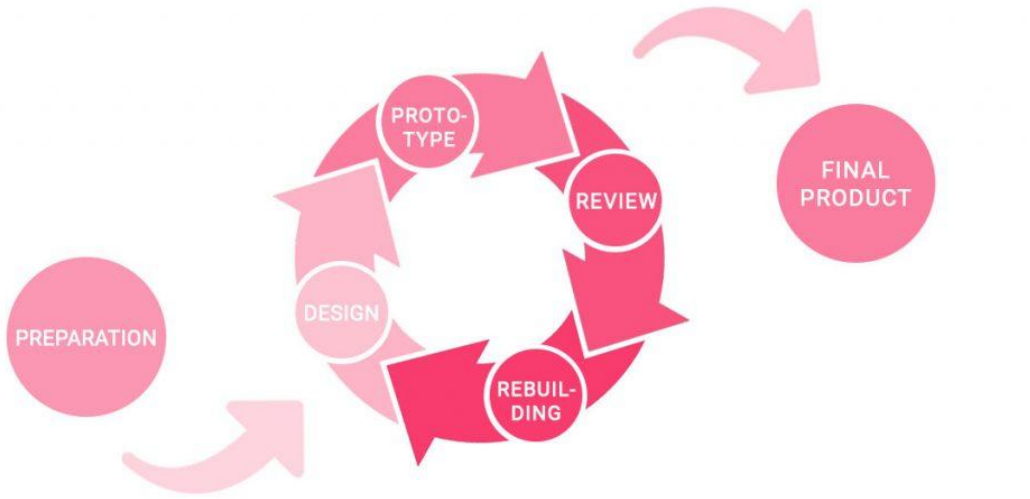

Figure 1: Workflow of Prototype Methodology

Prototype methodology is not suitable for this project because prototyping takes time, and with limited time for the project submission, creating and revising prototypes could slow things down. It also does not support the complexity involved in building an AI-driven fitness application that requires real-time pose detection, machine learning integration, and continuous performance testing.

b. XP (Extreme Programming):

Methodology that focuses on delivering high-quality software through frequent and continuous feedback, collaboration, and adaptation and emphasizes a close working relationship between the development team, the customer, and stakeholders, with an emphasis on rapid, iterative development and deployment (geeksforgeeks, 29 Sep, 2025).

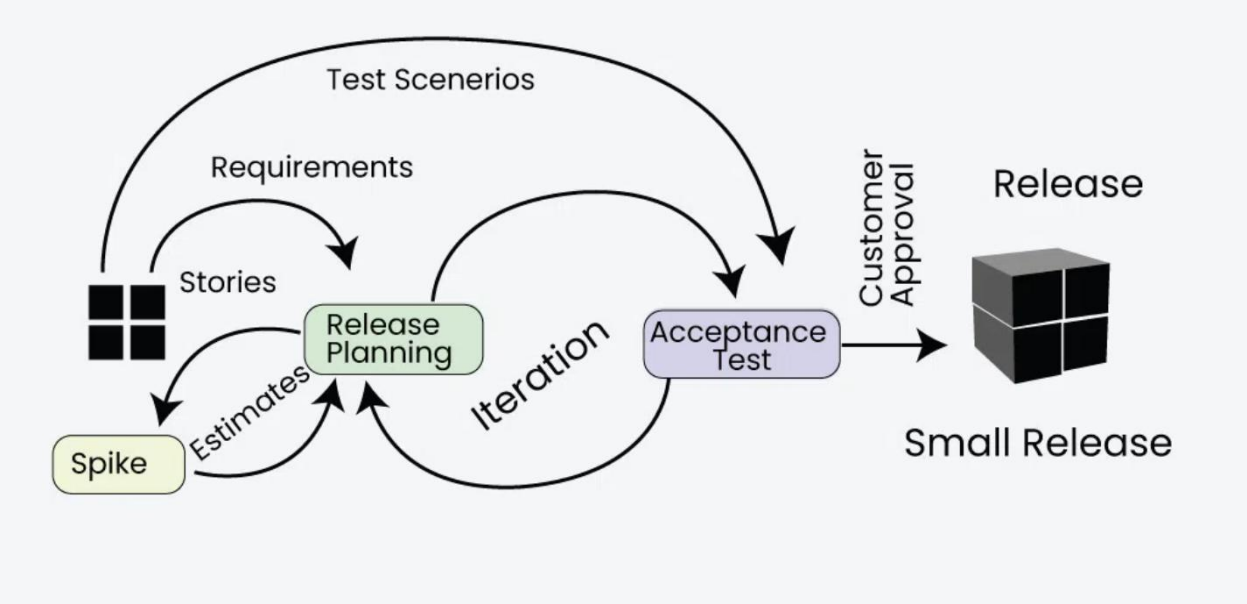

Figure 2: Workflow of Extreme Programming

Extreme Programming (XP) is not suitable for this project because it is designed for fast-paced software development environments where continuous coding, pair programming, and rapid incremental releases are required due to its complexity, team-oriented practices, and lack of alignment with AI-centric development, XP is not an appropriate methodology for this project.

5.2 Selected Methodology

Upon proper research on the wide range of methodologies, and weighing each one's distinct advantages and matching them to project objectives, the project will follow the Agile Scrum methodology, which allows iterative development, regular testing, and continues refinements.

Scrum Methodology is a widely used framework for managing complex projects, in the realm of software development. It operates on the principle of iteration and continuous improvement. In Scrum, work is organized into short iterations known as sprints, during each sprint a small, tangible piece of the overall project is delivered, know as a increment. Scrum aims to fulfil all the requirements through transparent communication, and a commitment to ongoing improvement. It prioritizes list of features known as the product backlog that aligns with the project goals (S, April 2, 2025).

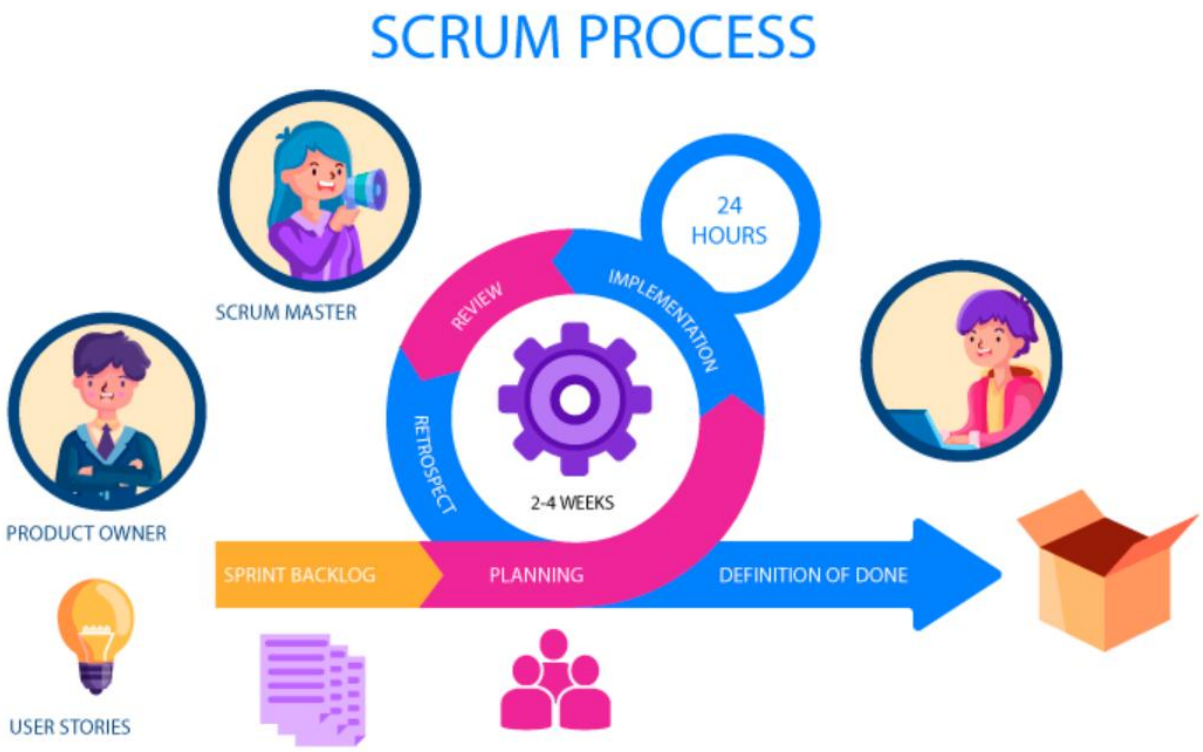

Figure 3: Workflow of Scrum Methodology

6. Resource Requirements

Basic requirements to complete this project are:

6.1 Hardware Requirements

a. Computer: Personal laptop to run development tools and applications.
b. Good internet connection to ensure that the project runs smoothly.

6.2 Software Requirements

a. IDE: Visual Studio Code
b. App development: Flutter
c. Machine learning frameworks: MediaPipe/ TensorFlow Lite MoveNet
d. Animation Tools: Mixamo/ Blender MP4 for renderer inside Flutter
e. Backend Requirements: SQLite
f. Version control: GitHub

7. Work Breakdown Structure

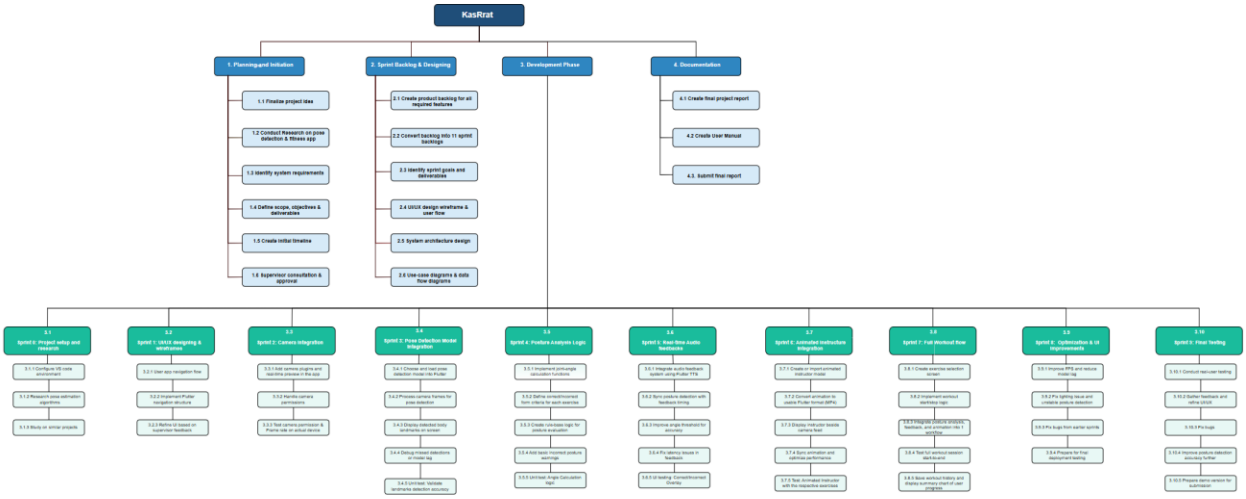

Figure 4: Work Breakdown Structure of KasRrat

Click Here for clearer view of WBS

8. Milestones

Figure 5: Milestones of KasRrat

Click here for clearer view of the milestones

9. Project Gantt Chart

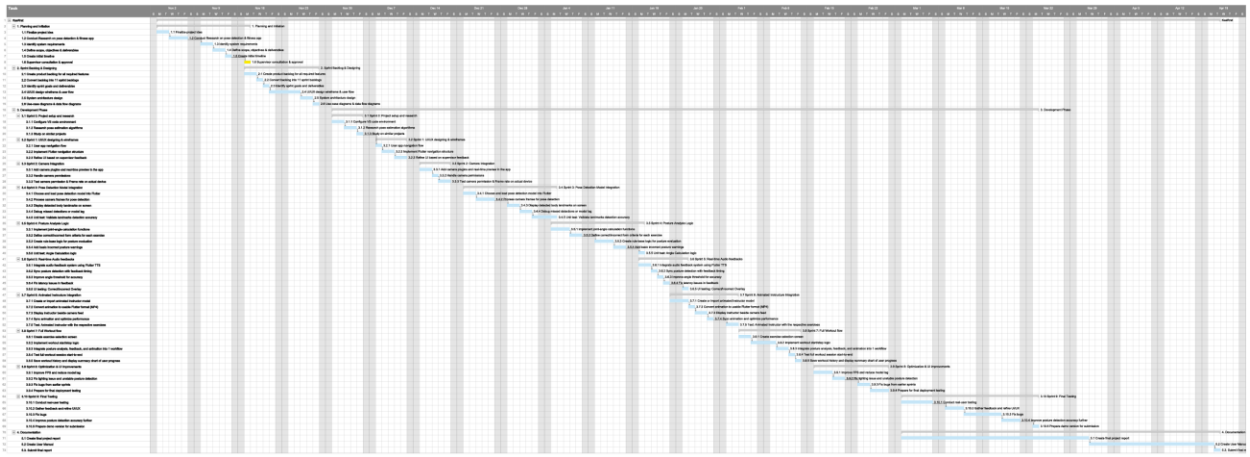

Figure 6: Gantt Chart of KasRrat

Click Here for a clearer view of Gantt chart

10. Conclusion

The KasRrat project represents a modern and innovative approach to personal fitness by integrating mobile application development with real-time pose estimation and AI-driven exercise feedback. The system aims to deliver an intuitive and interactive workout experience that helps users maintain proper form, reduce the risk of injury, and stay motivated throughout their fitness journey. The application provides an animated workout instructor, and real-time audio feedbacks.

Overall, the project successfully demonstrates how machine learning and mobile technologies can work together to solve real-world fitness challenges. KasRrat highlights the potential of AI in transforming home workouts and showcases how thoughtful design, iterative development, and technical research can come together to create a meaningful and impactful digital solution.

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12. Appendix

Project risks, threats and contingency plans

Project risks and threats

Developing an AI-powered mobile fitness application involves several technical and project-management risks, and with identifying such risk early ensures better planning and higher project success.

The following are the list of some of the risks and threats that the project may face:

Technical Risks

1. Pose detection performance issue:
   - Pose detection may not perform well on all the devices as the real-time pose detection model may run slowly on certain mobile devices due to low FPS issues.
2. Posture detection accuracy:
   - Posture detection accuracy may be incorrect due to angle miscalculations or inconsistent joint detection

3. Animation integration complexity:
   - 3D/2D animated instructor may not render smoothly or may cause UI performance issues.

4. Audio feedback delays or fail to trigger:

- User may experience, misleading instructions or no instructions at all if the cameras could not detect the joint angles properly.

Project management Risks

1. Time Management issue:
   - Missing milestones due to academic, personal, or technical challenges.

2. Insufficient testing:
   - Real-time posture evaluation requires multiple body types and environments.

3. Feature overload:
   - Attempting to add too many features may compromise app stability.

Tool Risks

1. Device storage or Camera Permission denied:
   - If the app cannot access camera then it’s a major blocker for the project.

2. Library or Plugin Compatibility Issues:
   - Flutter plugins (camera, TFLite) may conflict with certain android versions.

3. Hardware Limitations:
   - Some user devices may not support real-time pose detection.

External Risks:

1. Dependency on AI models:
   - Pre-trained models or documentations may be updated.

Ethical and Security Risks:

1. Privacy Concerns with camera usage:
   - User distrust if camera footage is mishandled.

Contingency Plans

Technical Risks

1. Pose detection performance issue:
   - Reduce camera resolutions when FPS drops.

2. Posture detection accuracy:
   - Start with simple exercises (push ups, pull ups, squats, and lunges) and calibrate joint-angles thresholds using test users.

3. Animation integration complexity:
   - Use Mixamo animations converted to MP4 and test animations playback.

4. Audio feedback delays or fail to trigger:
   - Preload audio prompts to avoid runtime delays and text various text-to-speech engines.

Project management Risks

1. Time Management issue:
   - Follow the defined Agile sprints and weekly check-ins with supervisors for progress validation and prioritize core features first such as pose detection, posture analysis, audio feedbacks

2. Insufficient testing:
   - Conduct testing with minimum 5 real users of different body types and test in various lighting conditions.

3. Feature overload:
   - Limit MVP to 4 basic exercises and add additional features only if time remains.

Tool Risks

1. Device storage or Camera Permission denied:
   - Display permission dialog with explanation and redirect user to Settings if access denied.

2. Library or Plugin Compatibility Issues:
   - Use stable plugin versions only and target Android API 28+ for consistency.

3. Hardware Limitations:
   - Include optional low-performance mode with reduced camera resolutions and clearly specify required device specifications in the documentation.

External Risks:

1. Dependency on AI models:
   - Download and store offline copies of MoveNet, BlazePose models and use TensorFlow Lite version control.

Ethical and Security Risks:

1. Privacy Concerns with camera usage:

- Clearly state that no video is saved or uploaded and all processing occurs on-device only.

Benefits of using Scrum Methodology

1) Supports iterative and flexible development structure, which is essential for handling technical challenges associated with machine learning and pose estimation.
2) Breaks down the project to manageable sprints, enabling to focus on small, achievable goals while continuously refining application based on testing and feedback.
3) Encourages continuous improvement, making it ideal for project that requires testing of AI models.
4) Focuses on delivering minimum viable product (MVP) early in the development cycle, reducing risk and providing a foundation for more advance features such as animated workout guidance.
5) Provides balance of structure, adaptability, and continues improvement while developing an application.