

Architecture Document

1. Introduction

This document details the comprehensive system architecture for the knee osteoarthritis (KOA) gait analysis pipeline using video-based input. The system leverages sequential data processing and deep learning techniques, specifically Long Short-Term Memory (LSTM) networks, to extract and analyze gait features from MOV-format video files. This non-invasive approach provides healthcare professionals with objective measurements and insights into gait abnormalities associated with KOA.

The architecture is designed with modularity and scalability in mind, allowing for future enhancements and integration with existing clinical workflows. By using widely available video formats and consumer-grade cameras, the system aims to democratize access to sophisticated gait analysis that traditionally required specialized equipment and controlled laboratory environments.

This document outlines the core components, information flow, technical requirements, implementation considerations, and potential future enhancements for the KOA gait analysis system.

2. System Architecture

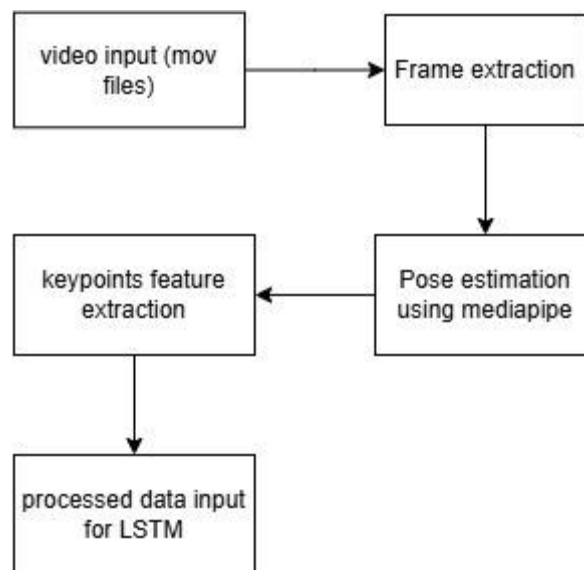


Fig 1 – Architecture Diagram

Fig 1 showing the flow from video input to LSTM processing

- **Video Input:**
MOV files are recorded, capturing subjects' walking patterns in a controlled environment using standardized camera setups.
- **Frame Extraction:**
The system extracts individual frames from the MOV video files to facilitate downstream analysis.

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- **Pose Estimation (MediaPipe):**
Each extracted frame is processed using MediaPipe to estimate skeletal keypoints, providing a spatial representation of the subject's posture and movement.
- **Keypoints Feature Extraction:**
The detected keypoints are used to compute relevant gait features, such as joint angles and stride parameters, forming a structured dataset for modeling.
- **Processed Data Input for LSTM:**
The extracted and organized gait features are formatted as sequential input data for the LSTM model, which is responsible for learning temporal gait patterns and supporting KOA classification or assessment.

5. Conclusion

This architecture provides a streamlined and modular approach for video-based KOA gait analysis, integrating video processing, pose estimation, feature extraction, and deep learning. The pipeline supports objective, non-invasive assessment of gait abnormalities and KOA severity through a technically sophisticated yet user-friendly implementation.

The system's design emphasizes accessibility, allowing for deployment in various clinical settings without specialized equipment. By leveraging consumer-grade video recording and powerful open-source technologies like MediaPipe and LSTM networks, the architecture democratizes advanced gait analysis that was previously available only in specialized motion laboratories.

Future enhancements may include real-time video analysis for immediate feedback, integration with clinical decision support systems for treatment recommendations, expansion to multi-camera setups for improved 3D reconstruction, and adaptation for telemedicine applications. As computational capabilities and pose estimation technologies continue to advance, the architecture is positioned to incorporate these improvements while maintaining its core workflow and usability.

The ultimate goal of this architecture is to provide healthcare professionals with a reliable, objective tool for early detection, accurate assessment, and longitudinal monitoring of knee osteoarthritis, potentially improving patient outcomes through earlier intervention and personalized treatment plans.