PROJECT REVIEW - 2

Artificial Intelligence-Enabled Surveillance of Knee Osteoarthritis Through Gait Analysis

Project Category: Research

Guide:

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OBJECTIVE

Develop an AI-Based Gait Analysis Model

Implement computer vision and deep learning algorithms to extract movement features from video data.

Detect Post-Surgical Abnormalities and Deviations

Identify gait deviations, improper joint mobility, weight distribution issues, and other complications.

Automate the Post-Operative Assessment Process

Generate reports with key recovery metrics

DATASET OVERVIEW

- The KOA-NM dataset is designed for Knee Osteoarthritis (KOA) detection using gait analysis.
- It contains video recordings of individuals categorized based on KOA severity levels.
- A set of 6 red-colored passive reflective markers has been attached to the subject's body joints.
- The dataset is collected using a single NIKON DSLR 5300 camera placed 8m away from the walking mat.
- Videos are in .MOV format
- KOA-NM Dataset consists of gait videos classified into four categories:
  - NM (Normal Movement)
  - KOA_EL (Easy KOA)
  - KOA_MD (Moderate KOA)
  - KOA_SV (Severe KOA)

PRE PROCESSING

1. Video Format Conversion
   - Converted .MOV files to .MP4 for compatibility.
2. Frame Extraction
   - Extracted frames from videos at a uniform **FPS (Frames Per Second)**.
3. Noise Reduction & Enhancement
   - Applied Gaussian Blur and contrast enhancement for better feature extraction.
4. Pose Estimation
   - Used **Mediapipe** to extract joint movement key-points.
5. Key-Points Detection
   - Identify the maker placed in joints of subject and store.
6. Data Augmentation
   - Introduced rotation, flipping, and brightness variations to improve model generalization.

PRE PROCESSING

1. Challenges:
   - Unreadable .MOV files
   - Inconsistent FPS
   - Blurred frames
   - Missing joint key-points
2. Solutions:
   1. Converted to .MP4
   2. Standardized to fixed FPS
   3. Applied sharpening & noise reduction
   4. Improved pose estimation accuracy

FEATURE EXTRACTION

Input Data:

MOV format videos of patients walking **from left to right (side view)** across an **8-meter distance** in front of a fixed camera.

Pose Estimation with MediaPipe:

Extracts key body landmarks per frame:(x, y, z, visibility) for each joint.

Emphasis on lower-body joints (hip, knee, ankle) to assess post-knee replacement recovery.

FEATURE EXTRACTION

Preprocessing Steps:

Convert video to frames (e.g., 30 fps).Normalize and resize frames for uniformity.

Side view improves joint movement visibility during gait cycle.

Data Structuring:

Landmark data arranged as time series sequences:

Format: (frames, joints, features)

Example: 300 frames × 33 joints × 4 features

Padding/truncation applied for fixed sequence length.

Model Architecture

Architecture

1. Feature Extraction (CNNs) – Extracts spatial features from each frame.
2. LSTM Layer – Captures temporal dependencies in gait patterns.
3. Fully Connected Layer – Classifies severity levels of KOA.

LSTM for KOA Detection

- **Handles sequential gait data** effectively.
- **Remembers long-term dependencies** in walking patterns.
- **Outperforms traditional CNNs** in analysing movement over time.
- **Improves KOA severity classification** by learning time-series variations in gait

Architecture Diagram