Assignment 2: Novelty in Data Preprocessing and ROI Segmentation

Real-time posture monitoring and correction systems are crucial for preventing **musculoskeletal disorders**, particularly in environments where prolonged sitting is common. Traditional methods of posture monitoring rely on **external sensors** or **manual observations**, which are often **intrusive** and **lack real-time feedback**. With advancements in computer vision, using **laptop cameras** to monitor posture offers a **non-intrusive**, **scalable solution**. However, existing techniques face challenges in accurately segmenting the Region of Interest (ROI) in varying **lighting conditions** and **complex backgrounds**.

1. Existing Methods and Limitation

- **Sensor-based Approaches:** These methods, such as those using accelerometers or gyroscopes, provide high accuracy but require **additional hardware**, making them **less convenient** and **scalable** (1).
- **Computer Vision-based Methods:** Approaches using OpenPose or MediaPipe for posture detection have shown promise, but they often struggle with accurately segmenting the ROI in diverse environments, particularly in the presence of occlusions or non-uniform lighting (2)(3).

2. Proposed Method

Rationale

The proposed method enhances the ROI by leveraging advanced preprocessing techniques combined with conventional segmentation algorithms. By focusing on the **key body parts relevant to posture** (e.g., shoulders, back, and head), the method aims to improve the **accuracy** and **reliability** of posture detection in real-time.

Proposed Preprocessing Technique

- **Pose Estimation and ROI Enhancement:** Using MediaPipe + Blaze poseto identify and **isolate key body joints**. The ROI is dynamically adjusted based on these key points, ensuring that only the relevant parts of the body are processed.
- **Background Subtraction:** Adaptive background subtraction is employed to **remove irrelevant background elements**, allowing for a cleaner segmentation of the body parts.

Segmentation Algorithms

- **Thresholding:** A simple and fast technique that segments images based on pixel intensity. Useful for binary segmentation but may struggle with complex or non-uniform backgrounds.
- **Watershed Algorithm:** A region-based segmentation approach that treats the image as a topographic surface. Effective in separating overlapping objects, making it suitable for delineating different body parts within the ROI.

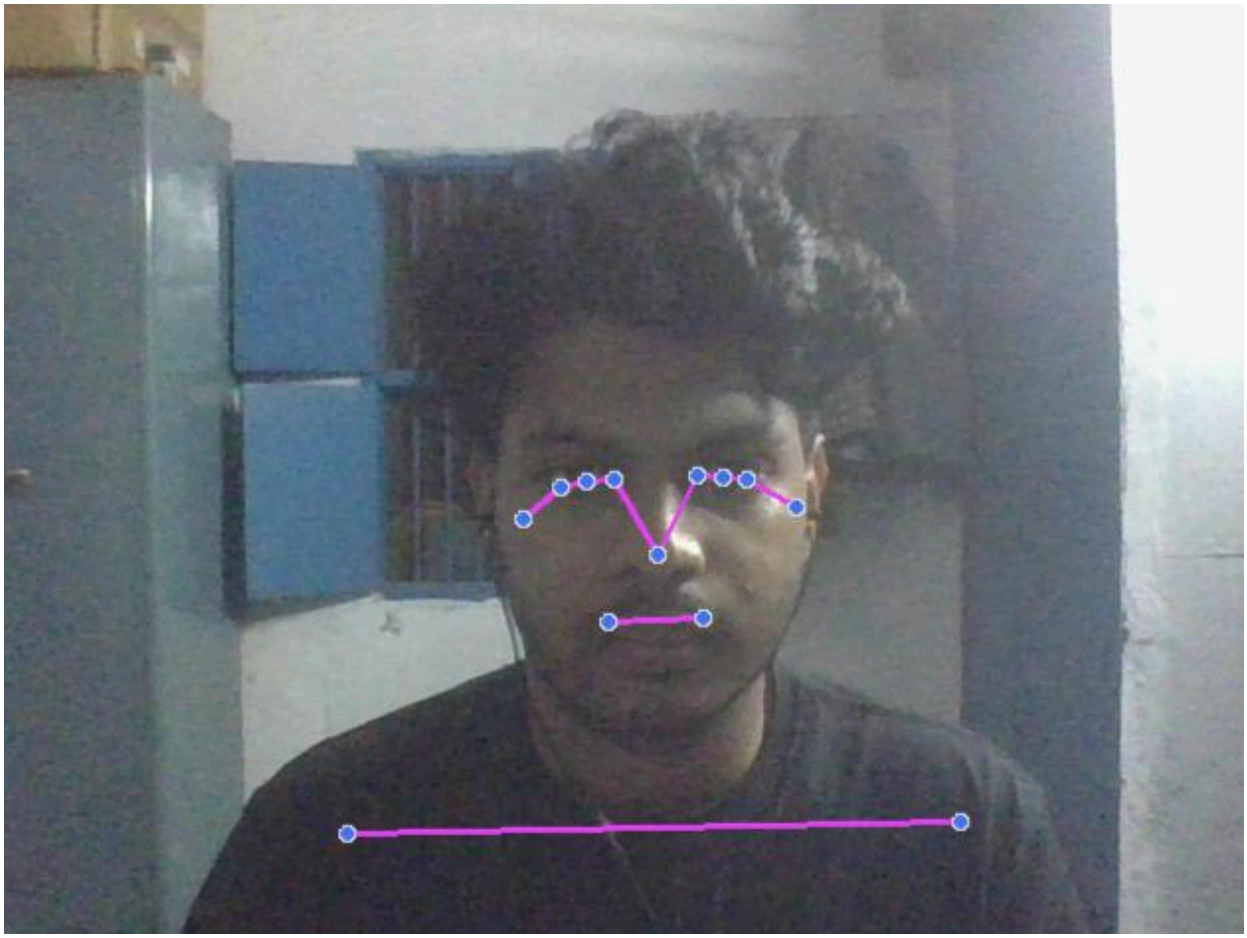
3. Implementation

1. Setup and Data Collection
    - Install necessary libraries: `OpenCV`, `scikit-image`, and `MediaPipe + BlazePose`.
    - Capture real-time video feed from the laptop camera.

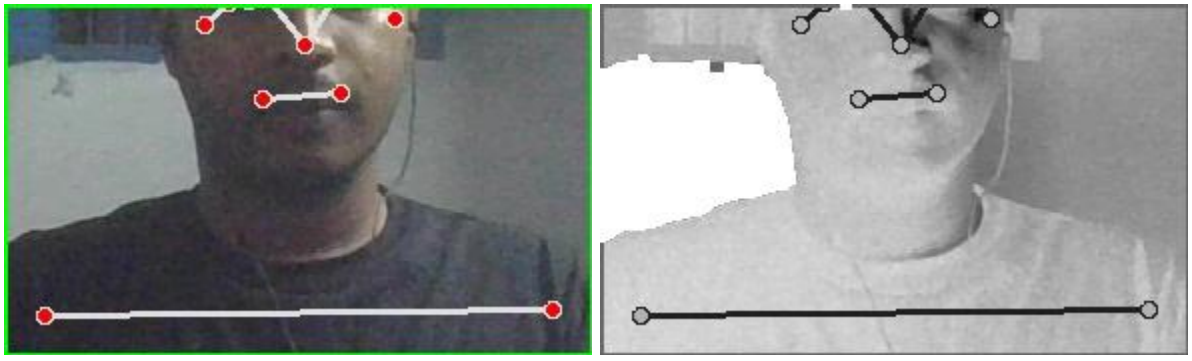
Pose Estimation using BlazePose

2. Preprocessing

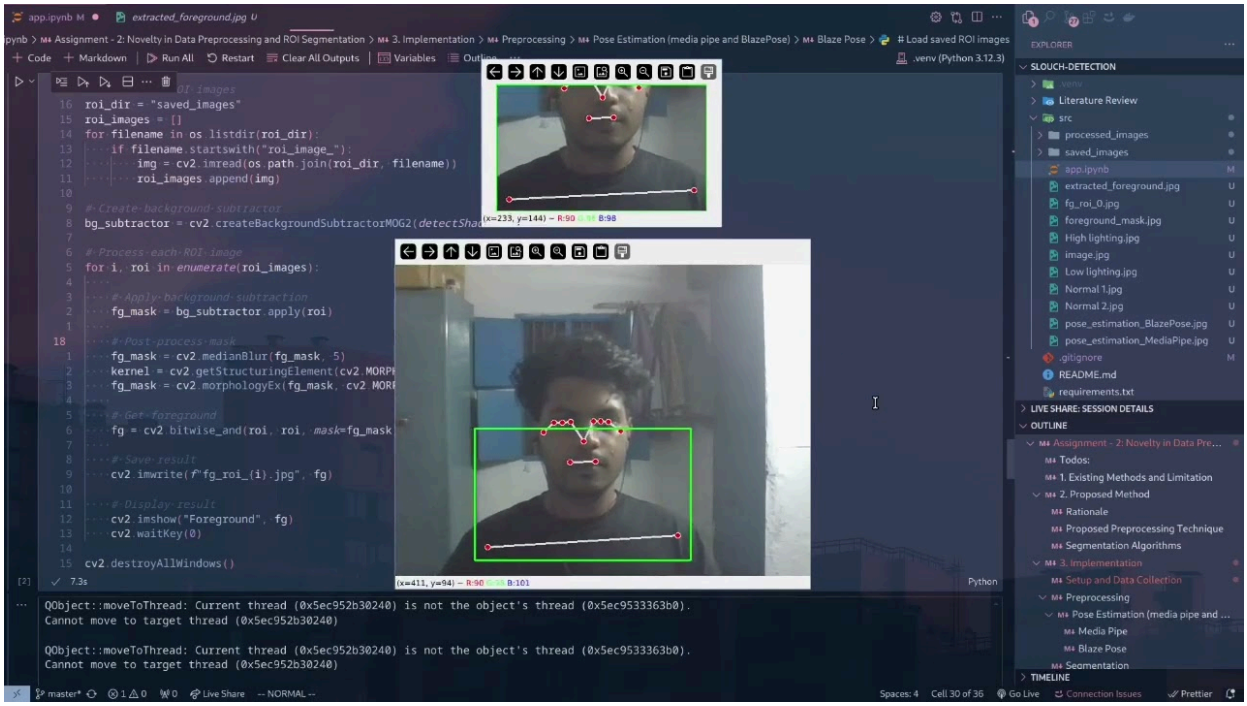
- **Pose Estimation:** Use MediaPipe + Blaze pose to detect key body joints.



- **ROI Extraction:** Define the ROI based on the detected key points (e.g., shoulders and head). Crop the image to focus on the ROI.



- **Live Feed ROI Extraction -** https://youtu.be/4OnuSvhXMEE

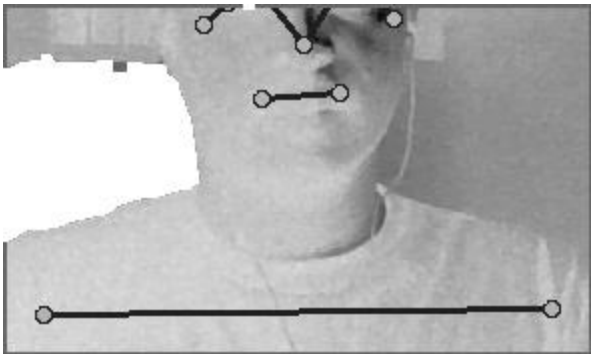


- **Background Subtraction:** Apply adaptive background subtraction to remove non-relevant background elements.

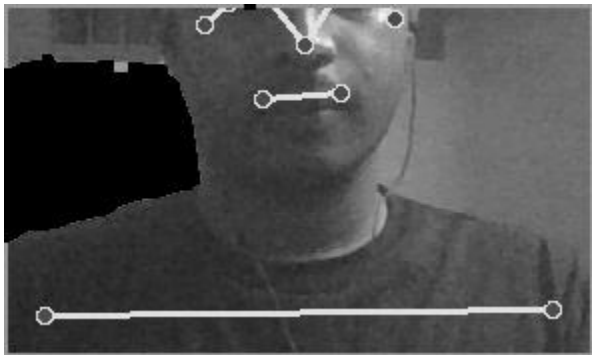
binary_roi.jpg

cleaned_roi.jpg

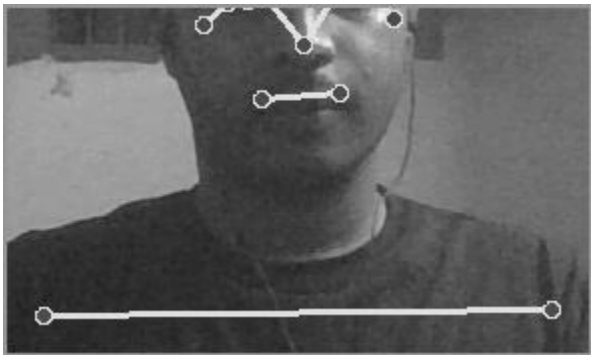
mask.jpg



result_inverted.jpg



cleaned_roi.jpg



gray_roi.jpg

3. Segmentation
    - **Thresholding:** Convert the cropped and preprocessed image to grayscale. Apply global or adaptive thresholding to segment the body parts.

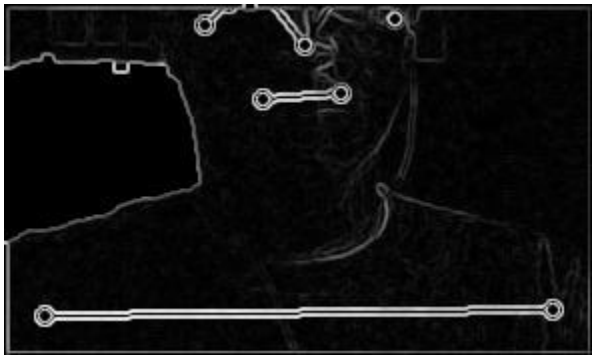
adaptive_cleaned.jpg

adaptive_thresholded.jpg

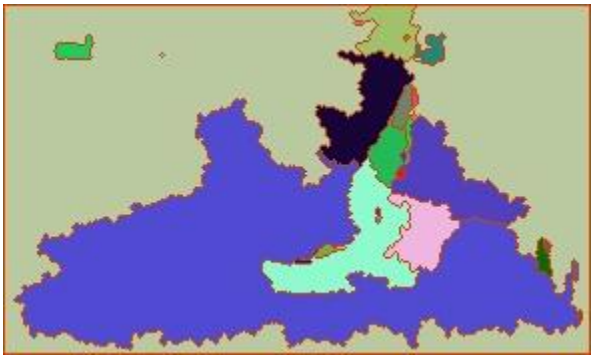
global_cleaned.jpg

global_thresholded.jpg

- **Watershed Algorithm:** Use gradient images (e.g., Sobel filter) to identify regions of interest and apply the watershed algorithm to separate different body parts.



gradent_magnitude.jpg



watershed_segmentation.jpg

4. Analysis

- **Thresholding:** Expected to perform well in controlled environments with uniform lighting but may struggle in more complex scenes. Operates by separating pixels in an image based on their intensity values, creating a binary image where pixels are classified as either foreground or background. **Advantages in Controlled Environments:** Thresholding excels in controlled settings with uniform lighting conditions.
- **Watershed:** Anticipated to handle complex scenes better, providing more accurate segmentation of overlapping body parts, though at a higher computational cost.

5. Conclusion

This approach addresses the limitations of existing methods by enhancing the ROI and applying advanced segmentation techniques that are better suited to real-time posture monitoring. The combination of adaptive preprocessing and conventional algorithms like thresholding and watershed provides a balanced solution that improves accuracy while maintaining efficiency.

6. Bibliography

1. Body Posture Detection Using Computer Vision
2. Sitting Posture Recognition Based on OpenPose
3. Advanced interdisciplinary approaches for bad posture detection using computer vision and IoT

7. Contributions

➔ Aravinthan (20S004) - ROI extraction (including Live feed)
➔ Mohammed Tawifq (20S018) - Live feed pose estimation
➔ Deepika (20S008) - Background subtraction
➔ Poornisha (20S023) - Thresholding (adaptive and global)
➔ Vishwadharani (20S040) (Watershed algorithm)