1.**Paper Title**: Ergonomic risk assessment based on computer vision and machine learning\

Methodology Used:

**RULA Assessment**:

* RULA (Rapid Upper Limb Assessment) is a tool designed to provide a grand score representing the postural load on a worker's musculoskeletal system based on joint angles of different body parts. The score is derived from a hierarchical combination of individual body part scores, which are then integrated into intermediate scores summarizing upper limb and overall body stress. Finally, these are combined into a single grand score indicating the need for ergonomic intervention.

**Pose Estimation using OpenPose**:

* The OpenPose CNN architecture is employed for human pose estimation. OpenPose detects and tracks key points on the human body from video inputs, which are then used to compute joint angles necessary for RULA scoring.

**Data Collection and Experimental Setup**:

* Synthetic and real-world datasets are used to evaluate the proposed method. The synthetic dataset involves a 3D model performing regulated movements, captured from various viewpoints. Real-world data comprises videos of actual working scenarios.

**Validation Methods**:

* The method is validated using several approaches:
  + **Self-Occlusion Tests**: A simulated 3D model is used to assess the impact of occlusions on joint detection accuracy.
  + **Controlled Image Sequences**: Real and synthetic datasets are compared to evaluate joint angle accuracy.
  + **Expert Comparison**: RULA scores computed by the method are compared with those given by experienced ergonomists using Cohen’s kappa to measure agreement.

**Pros**:

* **Robustness**: The proposed method shows resilience to common visual challenges such as uneven lighting, occlusions, and varying camera angles, which often hinder traditional observational assessments.
* **Automation**: It automates the process of ergonomic risk assessment, reducing reliance on subjective expert judgment and potential human errors.
* **Cost-Effectiveness**: Utilizing low-cost, off-the-shelf RGB cameras and open-source CNN architectures makes the solution affordable and easily replicable.
* **Flexibility**: The methodology can be adapted for various real-world conditions and different ergonomic assessment needs beyond just RULA, such as REBA (Rapid Entire Body Assessment) and MRULA (Modified RULA for computer workers).

**Cons**:

* **Dependence on Technology**: The accuracy of the CV-based assessment relies heavily on the performance of the OpenPose algorithm and quality of video input.
* **Complexity of Real-World Conditions**: Despite advancements, challenges like extreme occlusions and highly variable lighting conditions can still affect the precision of joint detection and pose estimation.
* **Limited Scope**: Currently, the methodology may be limited to assessing single workers and may face difficulties with multiple workers or highly dynamic environments.

2. **Paper Title:** Light-Weight Seated Posture Guidance System with Machine Learning and Computer Vision

**Methodology Used:**

**Pose Estimation via BlazePose**: The BlazePose model is employed to extract 33 different body keypoints from each frame captured by a webcam or smartphone camera. BlazePose is chosen for its real-time inference capabilities and high accuracy on mobile devices.

**Data Collection**: Videos of eleven participants (nine males and two females, aged 19 to 46) were recorded in various postures. The data was collected under IRB Protocol #2016-0693. Participants were recorded in both good and bad postures from multiple angles, and the videos were then sliced into frames for analysis.

**Normalization of Keypoint Coordinates:** To account for variations in camera angles and positions, the keypoints were normalized by translation and scale. This involves finding the midpoint between the left and right hips and adjusting the coordinates to remove translational variations. The maximum distance from the pose center is used to normalize the scale of the pose.

**Posture Classification:** The normalized keypoints are fed into a machine learning model to classify the posture as good or bad. Two models were trained: one using all keypoints and another using only upper body keypoints for cases where the lower body is occluded. The system continuously classifies frames and issues a notification if ten consecutive frames show bad posture.

**Pros**

1. Accessibility: The system can be implemented on any device with a webcam or smartphone camera, making it highly accessible and cost-effective.
2. Real-time Performance: Utilizing the BlazePose model ensures that the system can operate in real-time, providing immediate feedback to users.
3. High Accuracy: The posture classification model achieves 98% accuracy, ensuring reliable monitoring and feedback.
4. No Additional Hardware Required: Unlike other posture correction systems that require expensive trackers or sensors, this system relies solely on existing devices.

**Cons**

1. Camera Placement Sensitivity: Although the machine learning model is trained to handle various angles, the accuracy can still be affected by improper camera placement.
2. Occlusion Handling: While the system has a model for upper body keypoints, significant occlusions can still impact the accuracy of posture classification.
3. Limited Participant Diversity: The study involved a relatively small and homogeneous sample size, which may limit the generalizability of the results.
4. Potential Privacy Concerns: Continuous video monitoring may raise privacy concerns among users, especially in home environments.