

# Poor Posture Detection Algorithm

## 1. Landmarks

Extract 2D coordinates of the key landmarks:

$$S_L = (x_{SL}, y_{SL}), \quad S_R = (x_{SR}, y_{SR}), \quad E_L = (x_{EL}, y_{EL}),$$

and define the shoulder midpoint

$$M = \frac{1}{2}(S_L + S_R).$$

## 2. Angle Definition

For any three points  $A, B, C$ , define the angle at  $B$  as

$$\angle ABC = \cos^{-1} \left( \frac{(A - B) \cdot (C - B)}{\|A - B\| \|C - B\|} \right).$$

## 3. Posture Angles

$$\theta_{\text{sh}} = \angle(S_L, S_R, (x_{SR}, 0)), \quad \theta_{\text{neck}} = \angle(E_L, S_L, (x_{SL}, 0)).$$

## 4. Calibration

During the first  $N$  frames, compute mean angles and subtract a margin  $\delta$  (e.g.  $10^\circ$ ):

$$\tau_{\text{sh}} = \overline{\theta_{\text{sh}}} - \delta, \quad \tau_{\text{neck}} = \overline{\theta_{\text{neck}}} - \delta.$$

## 5. Decision Rule

$$\text{Poor posture} \iff \theta_{\text{sh}} < \tau_{\text{sh}} \quad \vee \quad \theta_{\text{neck}} < \tau_{\text{neck}}.$$

## 6. Stability Check

Estimate midpoint speed:

$$v = \frac{\sum_i \|M_i - M_{i-1}\|}{t_k - t_0}.$$

If  $v < v_{\text{still}}$ , trust the angle classification; otherwise ignore (movement or standing up).