CSC490 HW1

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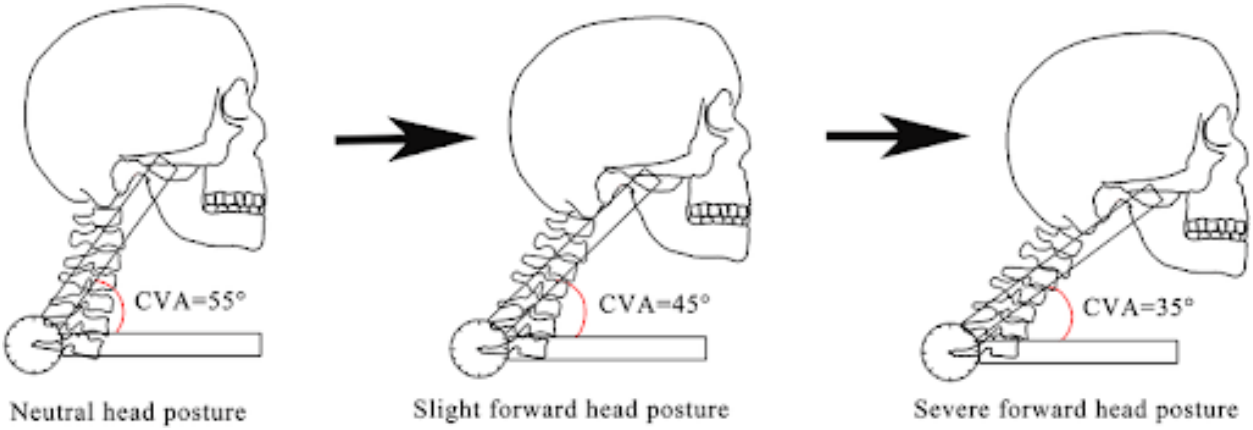
Part One: Interest Statements

Problem & Why We Care

Prolonged use of laptops, phones, and other screens is driving an increase in **forward head posture (FHP)** and **rounded shoulders (RSP)** among students and professionals. These postural issues are associated with neck and shoulder pain, fatigue, and reduced focus, affecting productivity and well-being. Existing posture apps typically only detect slouching, rely on additional hardware like wearables, or fail to provide clinically grounded guidance. We aim to develop an accessible, webcam-only, privacy-preserving system that can detect poor posture and actively coach users back to a neutral posture in real time. By leveraging existing pose estimation models and clinical posture metrics, our app will provide gentle, low-friction feedback that can seamlessly integrate into daily work and study routines. We care about this problem as we have all personally experienced the physical and cognitive toll of long hours in front of screens. We see an opportunity to combine human-computer interaction and clinical insights to create a tool that is effective and easy to use, helping people improve posture without requiring extra devices or disrupting their work.

Forward Head Posture Example



Team Member Interest Statements

- **Son:** I'm excited to work on testing different models/frameworks, and using those to create metrics for users.
- **Kyle:** I am excited to work on optimizing the pose estimation model to work with simple hardware like a laptop and webcam.
- **Daniel:** I would like to work on the evaluation and data quality for the detect-guide-verify loop, instrumenting metrics, with adaptive experimentation.
- **Jinbo:** It would be interesting to build a real-time pipeline that runs smoothly on a standard laptop webcam and integrates detection, guidance, and verification.

Part Two: Landscape Analysis

Relevant Item	Description	Commentary
Nekoze (macOS, webcam app)	Mac app that uses the Mac camera to check posture and alerts when you hunch. (Apple)	Confirms demand for camera-only slouch detection; mainly alerts (detection-first), not clinical, quantitative coaching—gap we fill with CVA/ear–shoulder metrics. (Apple)
Zen (desktop, webcam)	Desktop posture app that mirrors posture and sends alerts when you slouch; YC company and press coverage. (Y Combinator)	Strong reference for alert-based UX; again detection/alerts over clinical guidance—opportunity for clinical-anchored feedback.
Kaia Health—Motion Coach (camera PT)	Smartphone/tablet camera provides real-time exercise form feedback with CV/AI. (Kaia Health)	Validates camera-only coaching; focus is MSK rehab/exercise, not desk FHP/RSP—our ergonomic niche remains open.
MediaPipe Pose Landmarker	On-device pose estimation that outputs body landmarks including 3D world coordinates. (Google AI for Developers)	Ideal backbone for webcam FHP/RSP: we can compute CVA and ear–shoulder z-displacement directly.
OpenPose (CMU)	First real-time multi-person system for body/face/hands/feet keypoints (≈ 135 keypoints). (GitHub)	Rich landmarks for desktop prototypes; heavier than MediaPipe—latency/compute trade-off.
MMPose (OpenMMLab)	Comprehensive pose estimation toolbox (2D/3D) with many models & inference APIs. (GitHub)	Research-friendly baseline hub; good for comparing models and future extensions beyond MediaPipe.
VideoPose3D (FAIR)	Temporal-convolution network that lifts 2D sequences to 3D pose; CVPR'19. (CVF Open Access)	Can stabilize z-axis from a single webcam (sequence-based), at some latency cost—useful for robust CVA/Δz.
Clinical anchor: CVA $< 50^\circ$ = FHP	Studies define FHP when CVA $< 50^\circ$ (tragus–C7 vs horizontal); ≥ 50–55° normal range. (PMC)	Provides absolute threshold for our detection and progress reporting (not just heuristic "slouch").
Photogrammetric CVA reliability	Recent work reports inter/intra-rater reliability of camera-based CVA assessment in students. (PubMed)	Supports the validity of webcam-based CVA if protocol (camera angle, repeatability) is controlled.
Rounded Shoulder metrics (ATD/AWD)	Clinical measures like acromion-to-table (ATD) and acromion-to-wall (AWD) quantify RSP. (PubMed)	Gives us concrete RSP thresholds so we can extend beyond FHP (shoulder forward displacement).

Problem Statement

Students and professionals spend long hours at screens often leading to **forward head posture (FHP)** and **rounded shoulders (RSP)**, which are associated with neck and shoulder pain as well as reduced focus. Existing consumer posture apps typically only alert users when slouching, require specialized hardware (e.g. wearables), or lack evidence-based guidance using clinical metrics. There is a need for an accessible system that can detect poor posture and actively coach users to return to a neutral position.

Proposed Solution

We propose a webcam-based posture coaching app that guides users toward neutral posture. The app detects FHP and RSP, provides intuitive real-time corrective feedback, and tracks posture habits with weekly reports. Unlike existing apps, our solution integrates clinically grounded metrics, adaptive feedback for diverse users, and optional calibration for real-world measurements. It delivers real-time corrective cues, verifies correction via a detect $\rightarrow$ guide $\rightarrow$ verify loop, and tracks habits for weekly reports.

High-Level Technical Approach

- Webcam pose estimation $\rightarrow$ 3D head/shoulder landmarks $\rightarrow$ clinical metrics (CVA, Δz, RSP Proxy)
- Smoothed, duration-gated thresholds for metrics are used to reduce false alerts.
- Directional cues (arrows/colors) are given to correct posture, optionally calibrated to real-world units
- Log sustained corrections, time in neutral, correction latency, false alerts; provide weekly summaries.
- Targets: **+25%** time-in-neutral, < 5 **s** correction latency, ≤ 1 false alert/15 min, **SUS** ≥ 75.

Milestones (13 weeks)

- **W1–W2:** Set up repository, select pose backbone, define clinical thresholds (CVA, Δz, RSP proxy).
- **W3–W4:** Landmark capture and feature computation; baseline FHP detection (unit test with video).
- **W5 (stretch):** `ArUco`-based distance calibration for real-world units; otherwise finalize normalization.
- **W6–W7:** Real-time guidance UI; implement smoothing/hysteresis/time-in-state; add RSP detection.
- **W8:** Small pilot study to measure false alerts, correction latency, and usability (SUS).
- **W9–W10:** Test/improve robustness (camera angle, low light, multi-screen distance); refine thresholds.
- **W11:** Implement habit report (time-in-neutral %, max forward displacement, trends).
- **W12–W13:** Final user study and ablation (with/without calibration); polish; document; demo video.

Unknowns & Risks

- **Depth estimation with a single RGB camera:** We can only estimate relative distances, so absolute measurements of head/shoulder positions may be inaccurate. We may need a side-profile snapshot or calibration to anchor CVA calculation.
- **Camera and ergonomic variability:** Differences in monitor height, chair position, and camera angle may affect posture detection accuracy. Investigate whether UI prompts and simple setup guidance can reduce this variability.
- **Generalization across users:** Different body types, clothing, and occlusions may reduce accuracy. Investigate adaptive thresholds or heuristics to handle these variations.
- **Distinguishing head tilt vs. forward head movement:** It is unclear whether a simple head pitch will be mistaken for forward head translation. Investigate combining vertical displacement (Δz) with torso-plane orientation to correctly interpret posture.

Turtleneck: Your Personal Posture Coach

TORONTO – September 16, 2025 – We announce **Turtleneck**, a webcam-based posture coach that helps students and professionals improve neck and shoulder health while working at a screen. Turtleneck is an accessible, privacy-preserving tool that guides users to correct forward head posture and rounded shoulders without additional devices. Using a standard laptop or desktop webcam, Turtleneck tracks key body landmarks, delivers real-time corrective guidance, and monitors posture habits to reduce pain and fatigue caused by prolonged screen time. This system brings expert posture coaching to users at a low cost.

The Problem: Today, people spend more and more time hunched over screens. Prolonged device use is causing more people to develop forward head posture and rounded shoulders, leading to neck pain, shoulder pain, fatigue, and reduced focus. Current solutions are often expensive, require additional devices, or fail to provide clinically informed, real-time coaching that integrates easily into daily routines.

How Turtleneck Solves It: Turtleneck runs entirely on-device, protecting user privacy while monitoring shoulder, neck, and torso alignment with AI. The app converts this data into actionable clinical metrics and provides intuitive, real-time guidance with precise instructions to correct posture. Corrections are continuously verified, and weekly habit reports motivate users to maintain healthy habits.

"We designed Turtleneck to empower users to take control of their ergonomic health using technology they already own," said Son Nguyen, Turtleneck developer. "Our goal is to make clinically precise, gentle posture coaching seamless and affordable for everyone."

How to Get Started: Download Turtleneck on your Windows or macOS laptop or desktop. The app runs locally via your webcam, requiring no additional devices, and guides you through a quick setup to calibrate posture metrics. Once set up, Turtleneck provides real-time coaching while you work or study.

"As a remote worker, Turtleneck helped me notice and fix my bad posture without annoying alerts. I feel less pain and more focused throughout the day," said Joe, an early user.

Availability: Turtleneck will be available later this year for Windows and macOS. Visit www.turtleneck.com to sign up for early access and start improving posture from the comfort of your workspace!

Appendix: Iterations

Iteration 1: Student-Focused Version
Headline: Chin Up: A webcam buddy that reminds you to sit tall.
Subhead: Simple, no-hardware coaching to help students avoid tech neck.
Summary: Focus on casual, approachable tone for younger audience of students.

Iteration 2: Professional/Workplace Version
Headline: DeskAlign brings clinical posture metrics to your laptop.
Subhead: Protect employee health with real-time ergonomic coaching.
Summary: Aimed at companies/employees, emphasize increasing productivity.

Iteration 3: Health/clinical focus
Headline: Detect Forward Head Posture before it causes pain.
subhead: Webcam-based CVA and acromion metrics give you clinician-grade feedback.
Summary: More technical, appeals to health/physio stakeholders.