SmartPosture: Project Proposal

Mobile and Ubiquitous Computing - CS-7470

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Prolonged sitting with poor posture has been linked to various musculoskeletal issues, fatigue, and long-term health risks. Yet, most individuals remain unaware of their posture habits during daily activities such as studying, working, or commuting. SmartPosture is a smartphone-based system designed to automatically recognize sitting postures using built-in motion sensors and provide actionable feedback for maintaining ergonomic posture. By leveraging accelerometer and gyroscope data, the system identifies common postures such as upright, slouched, and cross-legged, and offers meaningful insights to promote healthy habits. To ensure consistent and reliable readings, the system will evaluate two smartphone placements—inside a chest pocket and using a simple, low-cost chest mount—to identify which setup provides better posture detection accuracy.

1 Aims & Objectives

The main objective of this project is to develop and validate a smartphone-based posture recognition system that detects sitting behaviors and provides personalized feedback [1, 3]. To achieve this, the project will focus on:

- Identifying key posture classes relevant to everyday sitting behaviors such as upright, slouched, and cross-legged.
- Collecting accelerometer and gyroscope data from smartphone sensors using chest pocket and chest-mounted configurations.
- Designing preprocessing pipelines to segment and clean sensor data for model training.
- Extracting both statistical and frequency-domain features to train and evaluate machine learning models for classification.
- Developing a mobile prototype that provides real-time session recording and feedback summaries.

Through iterative testing and evaluation, the system aims to encourage posture awareness and promote healthier sitting habits using a non-intrusive, accessible approach.

2 Background

Posture recognition has been explored in the domains of ergonomics, healthcare, and human activity recognition (HAR). Previous studies have primarily relied on wearable IMUs, camera-based systems, or external posture monitors to identify spinal alignment and sitting position [2]. However, these approaches often require additional hardware, raising barriers to accessibility and adoption.

Recent advancements in smartphone sensor accuracy have opened the possibility for posture detection using built-in IMUs (Inertial Measurement Units) [1, 3]. Accelerometer and gyroscope data can effectively capture subtle orientation changes and motion variations associated with different postures. Prior works in activity recognition—such as walking, standing, and running classification—have demonstrated accuracies above 90% using time-series sensor features [4, 5]. Yet, fine-grained sitting posture recognition remains underexplored, especially when leveraging only smartphone sensors.

By combining data-driven modeling with intuitive feedback design, SmartPosture seeks to extend smartphone-based HAR techniques into everyday ergonomics. The proposed design focuses on realistic scenarios where users can conveniently place their phones in a chest pocket or mount them using an affordable clip, ensuring minimal effort and maximum comfort during use.

3 Outcomes & Deliverables

The deliverables of the SmartPosture system include:

- Data and Model Development:
  - A labeled dataset of accelerometer and gyroscope readings for common sitting postures.
  - Preprocessing scripts for segmentation, noise filtering, and normalization.
  - A trained machine learning model (e.g., Random Forest, CNN, or SVM) for multi-class posture classification.
- Mobile Prototype:
  - An Android-based interface allowing users to record sessions, visualize sensor activity, and receive session summaries.
  - A feedback mechanism that indicates time spent in good vs. poor posture.
- Evaluation and Documentation:
  - Quantitative model evaluation using metrics such as accuracy, precision, recall, and F1-score.
  - Usability feedback from pilot users regarding clarity and helpfulness of posture feedback.
  - Comparison of posture recognition accuracy across two smartphone placements: chest pocket vs. chest mount.
  - Final documentation detailing methodology, results, and recommendations for future improvements.

After developing and testing the system, SmartPosture is expected to provide reliable posture recognition using only a smartphone. The project will demonstrate how passive sensing and simple feedback can raise awareness of sedentary habits and support ergonomic well-being.

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Fig. 1. Setup for Postural Data Collection using the smartphone placed in the subject's upper shirt pocket. This position is commonly used for analyzing upper body sway, tilt, and head-and-neck posture.

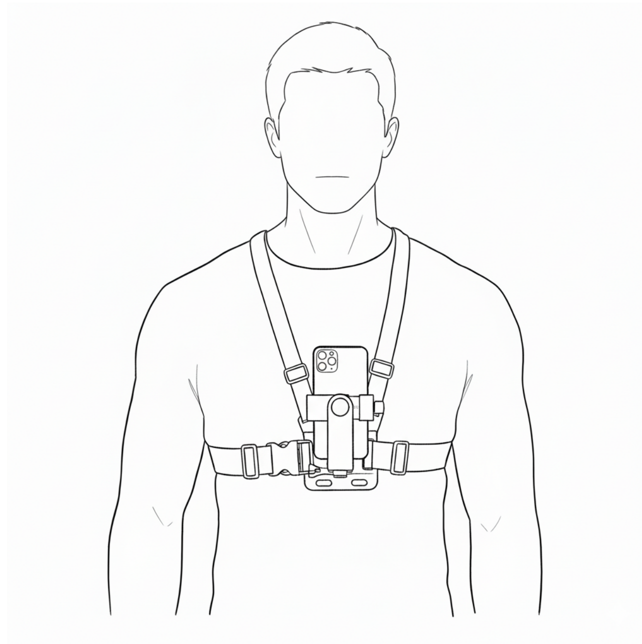

Fig. 2. Setup for Posture Analysis using a smartphone secured with a chest mount harness. This method provides a stable, centralized view of the hands, torso, and immediate environment for behavioral and biomechanical assessment.

4 Challenges

Developing a posture recognition system solely using smartphone sensors involves several challenges [3]. Technically, sensor readings are sensitive to smartphone placement—minor positional shifts (e.g., in pocket or on lap) can introduce noise and misclassification [2]. Designing robust preprocessing techniques and data collection strategies to handle such variations is essential.

From an algorithmic perspective, achieving high model generalization across users and devices requires balancing model complexity and real-time constraints. Physiological differences such as body shape and sitting style can further affect recognition accuracy. Another practical challenge involves ensuring stable sensor orientation. The project will address this by comparing performance between chest pocket and chest-mounted configurations, analyzing which provides more consistent and reliable data for classification.

Finally, from an HCI standpoint, presenting feedback in a way that motivates rather than annoys users will be a key design consideration.

5 Project plan & timeline

The project is divided into five main phases, each with clear goals, checkpoints, and deliverables:

- Phase 1: Literature Review & Setup
  Review prior work on smartphone-based activity and posture recognition. Define key posture categories and set up essential tools, including the Android data collection app and IMU logging framework.
- Phase 2: Data Collection & Preprocessing
  Collect accelerometer and gyroscope data for each posture under controlled conditions. Evaluate two smartphone placements—chest pocket (Fig. 1) and chest mount (Fig. 2)—to compare detection accuracy. Label and segment continuous sensor streams into fixed-length windows, apply noise filtering and normalization, and align each segment with its corresponding posture label.
- Phase 3: Feature Extraction & Modeling
  Extract statistical (mean, variance, skewness) and frequency-domain (FFT) features from the preprocessed data. Train and validate multiple machine learning models using cross-validation to identify the best-performing approach for real-time posture recognition.
- Phase 4: Prototype Development & Evaluation
  Design and develop a mobile prototype for session recording and feedback delivery. Evaluate model accuracy, system responsiveness, and user experience through pilot testing. Document findings and usability feedback.
- Phase 5: Final Demonstration & Report
  Integrate all project components, conduct the final demo, and prepare the comprehensive project report for submission.

The Gantt chart in the appendix illustrates the timeline and overlapping tasks for all five phases.

Acknowledgments

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References

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A Prototype

Figure 3 shows the Home Screen, where users can initiate a new posture tracking session using a single "Start" button. Once the session begins, Figure 4 presents the Session Timer Screen, displaying the elapsed time, current posture status (correct or slouched), and a "Stop" button to end tracking. After the session concludes, Figure 5 displays the Results Visualization Screen, summarizing posture performance with clear visual feedback and session statistics. These interfaces collectively highlight the app's emphasis on simplicity, quick access, and continuous awareness of posture throughout daily activities.

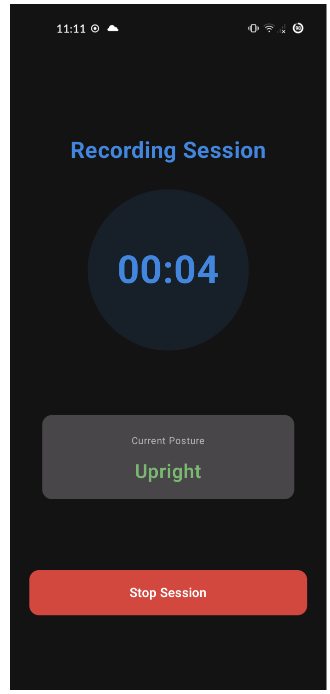

Fig. 4. Screenshot of the Session Timer Screen displaying the Time Elapsed since the session began, the Current Posture Status, and a Stop Button.

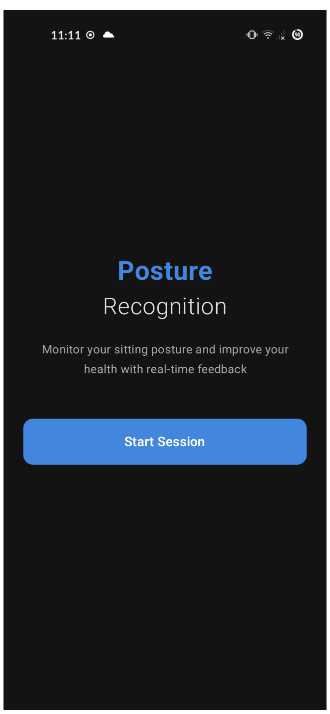

Fig. 3. Screenshot of the Home Screen. The primary interface features a clear Start Button to initiate a new posture analysis session.

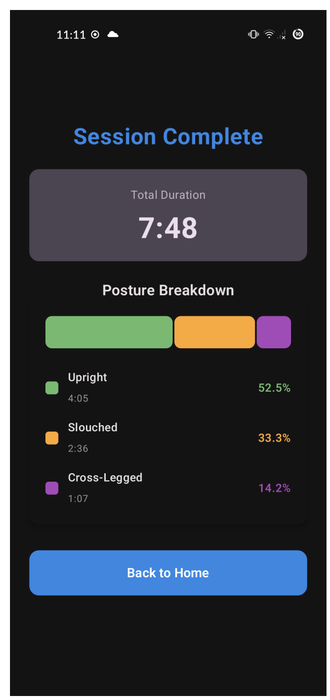

Fig. 5. Screenshot of the Results Visualization Screen which provides a summary of the completed session, featuring breakdown of time in various postures.

B Gantt Chart

Fig. 6. Project Timeline and Task Dependencies (Gantt Chart). The chart outlines the project phases and visualizes the scheduled duration and dependency flow for each major milestone, ensuring efficient resource allocation and tracking. A full-resolution version is available at https://postimg.cc/jDT2j8JT