NeckWatcher: A Real-time Monitoring Tool for the Assessment of the Neck Posture

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Background

- **Poor sitting posture** at a computer put more weight on the neck [1].
- **Studies** have shown that working in a low-screen setup with an increased neck flexion angle is a risk factor for, e.g., neck pain and headaches [1, 2].
- **Musculoskeletal symptoms and diseases** are experienced by 4–50% of individuals who spend 3–5 hours a day in front of a computer [3].
- **Office workers** have, in comparison to other professions, a prevalence for neck-shoulder pain (40–70%) and lower-back pain (35–40%) [2].

NeckWatcher

- **NeckWatcher** is an attempt to cope with these issues. It is a **real-time**, **vision-based** tool that utilizes a **single** webcam, alerts users about an incorrect neck posture, and promotes a healthier sitting position (see Figure 1).
- The **development process** of NeckWatcher, consisted of the following three objectives:
  - Conducting a review of existing methods and technologies for the tracking of the neck posture to determine their advantages, disadvantages, and limitations.
  - Based on that, developing a user-friendly standalone tool that utilizes a single webcam to monitor the neck posture in real-time.
  - Identifying the limitations of this tool and exploring ways for its future improvement.
- Our work's **main contribution** is an effective posture tracking solution that provides a convenient and practical tool that does not require complex setups for its daily use.

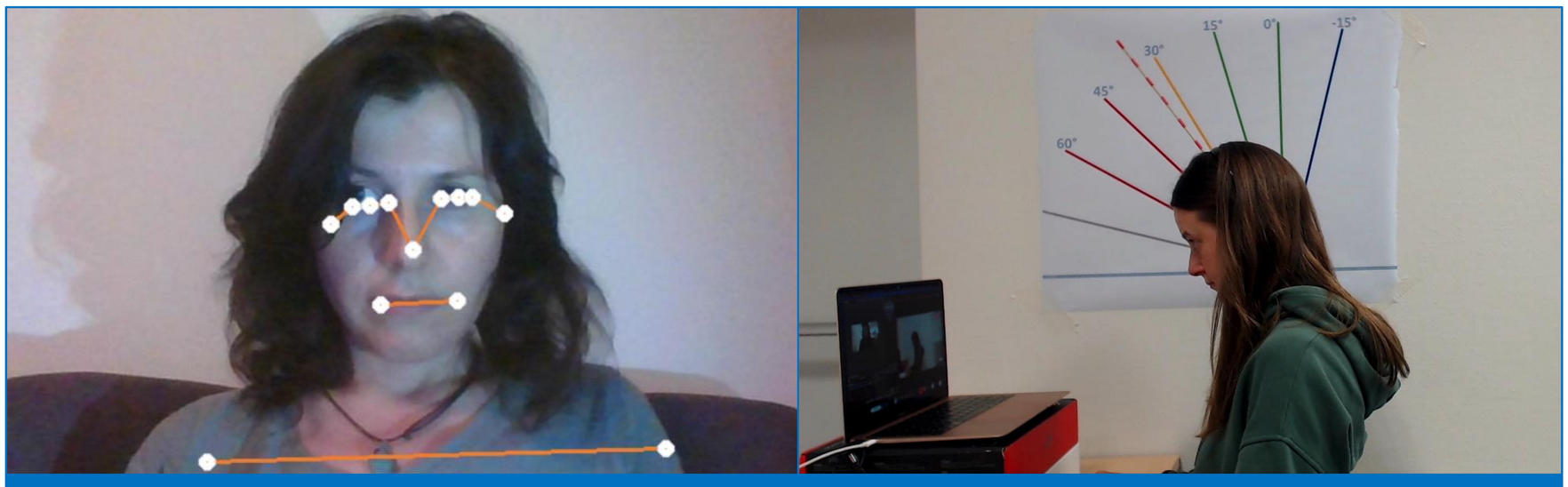

Figure 1. Left: The relevant landmarks detected by NeckWatcher. Right: A participant during data collection in our experimental setup.

Method

- An **experimental setup** was created to gather data, which included a table, a laptop equipped with an integrated webcam, a side camera, a wall poster displaying angles ranging from 0–60°, and a wooden pointer attached to a hairband for determining the user's neck angle (see Figure 2).
- Overall, **five participants** (2 males, 3 females) were recruited for our experiment and data were recorded using the webcam displayed in Figure 1. We collected data for healthy (0–30°) and unhealthy (30–60°) postures in two distinct sessions.
- **MediaPipe Pose** was used to extract landmarks from the videos, while we concentrated on landmarks of the shoulders, the mouth, the brows, the eyes, and the nose (see Figure 1).
- A **dataset** was created, consisting of 78,871 entries with 27-dimensional feature vectors and corresponding labels (healthy or unhealthy).
- A **fully-connected neural network** with 9 hidden layers and 1 output layer was trained and used to determine healthy and unhealthy postures.

Figure 2. The experimental setup in our laboratory used to collect data.

Results

- The model was tested for 25 epochs with a test set of 15,774 entries (20%), randomly selected from the dataset before training.
- The model achieved an average **accuracy** of 84.4%, with a **F1 score** of 79%, **precision** of 99%, and **recall** of 66%.
- The low value of recall suggests that there was a notable number of false negatives (the model was more likely to misclassify unhealthy postures as healthy).

Future Work

There are several ways to improve NeckWatcher, for instance:

- Involving a **broader range of participants** with different body proportions to make the dataset more diverse and representative.
- Recording videos with angle ranges of circa 0–28° and 32–60° to **better differentiate** between healthy and unhealthy postures.
- Providing a user-friendly **API**.

References

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