Romberger Web Application

Hi!

I would like a web application (Romberger) that analyzes human balance using smartphone sensor data (csv files) and tells people using the app whether their balance looks normal or "off" (simulated), which is inspired by the Romberg test.

The app needs to be intuitive for people who use the app and needs to have some sleek, clean design so that people feel enticed to use it. The purpose is not for diagnosis but for fun, educational classification system and for users to learn more about the Romberg test.

Romberg Test

The Romberg Test is a neurological exam used to assess balance and proprioception.

Proprioception is the sense of knowing one's own position and movements without thinking about it. For example, someone with good proprioception can use their right hand to touch their left foot and be able to do it without looking.

The Romberg test determines if the brain obtains enough information to maintain balance. There are three sensory inputs that work together to contribute to balance:

i. Proprioception
ii. Vision
iii. Vestibular apparatus

Clinical Romberg Test Procedure

1. Patient stands upright with feet together and arms at the sides.
2. Patients maintain this pose with eyes open for several seconds while stability is observed.
3. The patient then closes their eyes without changing position.
4. The observer monitors for sway, loss of balance, or stepping to recover. If so, this suggests the patient has impaired proprioception.

To approximate the Romberg conditions using smartphone sensors with a mobile app like Sensor Logger:

Balance Check Protocol (the one you want to implement):

1. The participant stands upright with feet together.
2. A smartphone is placed flat against the center of the chest (screen facing inward) and then held in place with crossed arms.
3. A 30-second recording is collected with eyes open as the control.
4. A 30-second recording is collected with eyes closed or blindfolded to simulate impairment.
5. Increased sway in the blindfolded condition is analogous to the Romberg Test.

The idea is that users can use an external phone app called Sensor Logger to collect accelerometer data for ~30 seconds with the phone placed screen-side on the center of the chest (crossed-arm hold). Sensor Logger exports a CSV file, and that CSV is what gets uploaded to the site.

The website should not only store the data but ideally use a simple machine learning classifier to estimate whether the balance of the user appears normal or impaired. As more CSV files are uploaded, there is an improvement to the algorithm.

User Workflow

- Record 30 second trials in the Sensor Logger phone app using the Balance Check Protocol.
- Export the CSV from an app like Sensor Logger and upload the CSV file to the website.
- Upload CSV to Balance Check website
- Website analyzes motion and returns result:
  - "Looks like normal/stable balance"
  - "Looks like simulated impaired balance"

Required Features

I. Website

1. Clean, minimal upload page
2. Results page showing outcome of the results
3. CSV validation
   - Checks for wrong format, missing columns, too short, etc.

II. Data Pipeline

1. CSV upload is stored in database as a new sample
2. Extract sway/motion from accelerometer data (csv)
3. Run classifier (control vs simulated impaired state)
4. Stores prediction and attribute data.

III. Database

Each upload is saved as a sample with attributes:

1. sample_id
   A unique id assigned to each uploaded recording.
2. timestamp
   The date and time when the recording were uploaded/collected.
3. subject/session_id
   An id linking recordings from the same person/recording session for tracking.
4. label (if known)
   the condition of the recording, if it was control or blindfolded.
5. extracted_features
   numerical motion measurements computed from the accelerometer data.
6. prediction_output
   classification result produced by the model (i.e. stable or impaired).

Aim for at least ~500 total recordings (this can be generated quickly with repeated trials, even from one person, if they label samples clearly).

IV. Machine Learning

SVM or some other model for a binary classifier works.

V. Model Evaluation

- k-fold cross-validation, or grouped by subject/session (e.g., group by person/session so the model isn't "cheating" by seeing near-duplicate trials from the same recording conditions in both train and test)

Then it should report basic metrics (accuracy, precision/recall) and show that performance holds up.

Optional Features

Visualization

- sway magnitude plot over time graph
- comparison to dataset average
- confidence score display

Educational Content

If possible, I would also like optional informational pages explaining:

What is balance?

- Roles of vision, vestibular system, proprioception

What is loss of balance?

- Neurological vs sensory factors
- Fatigue, injury effects etc.

About the Romberg Test

- Clinical purpose
- Interpretation limits

Intended Outcome

I would like this project to result in:

- A clean upload and analysis web app
- A growing sensor-based balance dataset
- A validated control/baseline vs simulated impaired classifier
- An engaging way for users to explore human balance

The goal is for users to learn about their own stability and the Romberg Test while contributing data that improves the model over time.

Thanks!

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