Bachelor's Thesis Engineering Technology

2024-2025

Designing a tool for measuring well-being parameters

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Introduction

In the modern workplace, employee well-being is becoming ever more acknowledged as a central element in both job satisfaction and productivity [1]. While **commercial products** like smartwatches offer health monitoring, they often **lack transparency** in how measurements are taken and are typically **limited to wrist-based sensing**, which has its limitations for parameters like galvanic skin response (GSR) and respiration.

This project explores the development of an **inexpensive, portable system** for monitoring **stress-related physiological parameters** in real time. Using the **Arduino Nano ESP32** microcontroller and a set of suitably selected sensors, the system records the vital measures of **heart rate, GSR, and respiration rate**. These are transmitted wirelessly via Bluetooth to a mobile app specially designed for this purpose.

The application is **user-friendly and accessible**, offering clear visual feedback, an estimation of the stress level, and the possibility to observe trends over time. By making health information easier to interpret and utilize, this system enables both individual users and organizations to more effectively monitor their health in an informed and cost-effective manner. The objective is to create a healthier and more sustainable work environment by introducing effective, data-driven stress management tools.

Materials & methodology

Materials

The portable stress measurement device is powered by the **Arduino Nano ESP32**, chosen for its compact size, low power consumption, and built-in Bluetooth, enabling real-time wireless data transmission to a smartphone. It collects data from three main sensors, as shown in figure 1.

- **MAX30102:** An optical sensor that measures **heart rate and blood oxygen saturation** (SpO_2) using red and infrared LEDs.
- **Grove GSR Sensor:** Measures **skin conductance**, an indicator of stress, by detecting changes in sweat gland activity.
- **Plux PZT Sensor:** Captures **respiration rate** using a piezoelectric belt that detects chest movement.

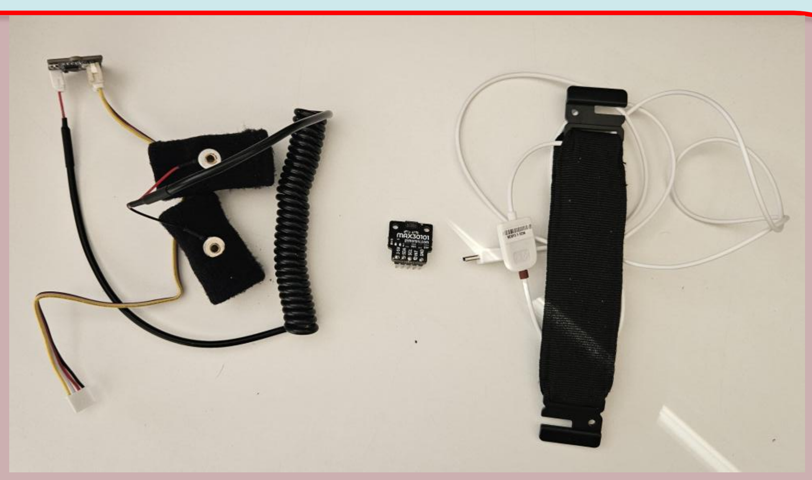

Figure 1: From left to right: GSR sensor, MAX30102 and Plux PZT sensor

All sensor data is processed by the ESP32 in real-time and transmitted via Bluetooth Low Energy (BLE) using a custom GATT service. The firmware, written in C++, includes commands for starting/stopping individual or combined measurements. Sensor readings are combined into a single BLE message and sent to the smartphone for visualization.

Mobile application

To complement the stress measurement device, a mobile application was developed that focuses on **usability, personalization, and clear data presentation**. The app enables real-time monitoring and historical tracking of key physiological signals, making stress and health data accessible and understandable, even for non-technical users. Below is a summary of the main features and the reasons behind each design choice.

- **Shared Device, Multiple Users:** A multi-user login system allows organizations to use a single device for several users, minimizing hardware costs and improving accessibility in budget-constrained settings.
- **Personalized Setup:** New users enter their age to calculate personalized heart rate zones and complete a baseline measurement for heart rate, respiration, and GSR. This helps tailor the app's feedback to individual physiology.
- **Intuitive Visualizations:** Each parameter is shown using easy-to-read graphics: radial gauges for heart rate, GSR, and respiration and a progress bar for SpO_2 color-coded zones to help users instantly understand their health status. Figure 2 shows an example of the heart rate gauge.
- **Stress Detection:** A color-coded stress indicator combines respiration and GSR data. Although exact thresholds are not the focus, this simplified system by using dummy thresholds allows the interface's usability to be tested and refined.
- **Trend Tracking:** Users can review past data in a history view, with filters like "Today" or "Last 7 Days." As shown in figure 3, bar graphs display daily min/max values to show trends without overwhelming detail, ideal for mobile screens.
- **Info Panels:** Each health metric has an information button explaining what it measures, how it works, and why it matters. This improves understanding and builds trust in the system. As seen in figure 4, it shows the zones and how this parameter is obtained.

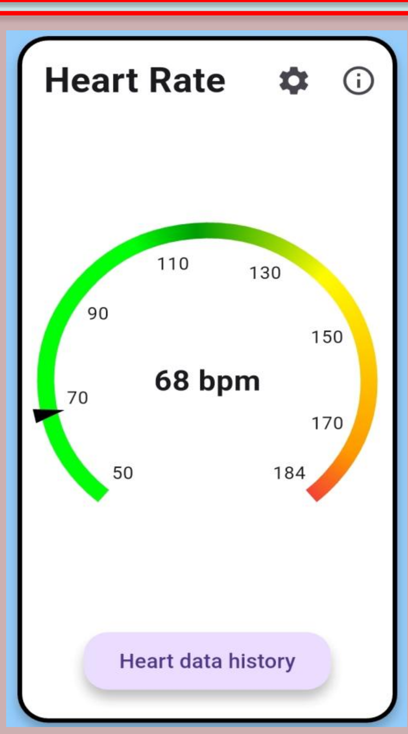

Figure 2: Heart rate widget

Figure 3: Heart rates history page, filtered on "Last 30 days"

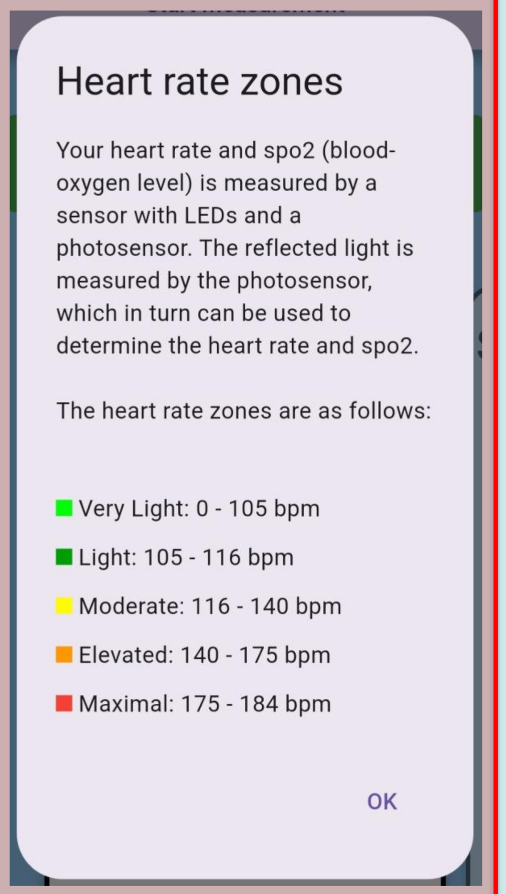

Figure 4: Info panel dialog

Results

Participants had a **positive** overall impression of the app's **onboarding experience**. Device pairing was easy, while **profile management** was slightly **less intuitive**. Some users were **confused by** the **identical login screens** for **new and existing users**. Starting a measurement was generally straightforward. The **app's layout was clear**, and the display of results was well received. Visual elements like gauges and progress indicators were appreciated, with the **color-coded system** especially **helpful** for interpreting values. Text content supported user understanding—particularly of the stress level indicator—though one participant found the amount of information a bit much. **Graphs were preferred** over tables for viewing data trends, but some users were unaware that the 30-day graph was interactive, leading to confusion about min/max values. The table format for min/max was considered unclear. The history function was fairly easy to access, and filtering by date was intuitive. **Gauge settings** were user-friendly, but their **usefulness** was **unclear** to some.

Overall, the app was **easy to use**, required little support, and was accessible to novices. However, **motivation for daily use was low**, pointing to a lack of perceived long-term value. Confidence in the app was moderate, with minimal prior knowledge needed.

Conclusion

This project demonstrates the potential of a **low-cost, user-friendly toolkit** for real-time **monitoring of workplace well-being** using physiological sensors and open-source hardware. By **prioritizing accessibility and usability**, it offers a practical alternative to commercial systems. The modular design supports future research and development, laying the groundwork for scalable, data-driven health interventions in occupational settings. With **further refinement**, the system could play a **key role in promoting healthier, more productive work environments**.

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Prof. Dr. Gustavo Rovelo Ruiz

[1] T. Bui, R. Zackula, K. Dugan, and E. Ablah, "Workplace Stress and Productivity: A Cross-Sectional Study," Kansas Journal of Medicine, vol. 14, no. 1, Feb. 2021, doi: https://doi.org/10.17161/kjm.vol1413424. Available: https://pmc.ncbi.nlm.nih.gov/articles/PMC7889069/. [Accessed: May 18, 2025]