

Stress Diagnosis through Sensor Signals of Skin Conductance

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Abstract

Stress is a major factor behind many physical and mental health problems, and its early detection is important for timely intervention. This project presents a **Stress Diagnosis System using Skin Conductance Signals**, built with an **Arduino Nano**, a **Galvanic Skin Response (GSR) sensor**, and a display/alert unit. When a person experiences stress, the sympathetic nervous system activates the sweat glands, which changes the electrical conductance of the skin. Two finger electrodes pick up this change, the GSR module converts it into an analog voltage, and the Arduino digitizes and filters the signal to separate the slow tonic level (SCL) from the fast phasic responses (SCR).

Features such as the mean conductance level, the number of SCR peaks, and their amplitude are compared with a baseline recorded during rest, and the user's state is classified as relaxed, moderate, or high stress. The system is compact, low-cost, non-invasive, and suitable for students, working professionals, and wearable health-monitoring applications. This project shows how simple electrodermal sensing can support objective, real-time stress assessment.

1. Introduction

Stress diagnosis is the process of identifying and measuring the stress level of a person using reliable indicators. Conventional methods depend on questionnaires and self-reporting, which are subjective and cannot be used continuously. Physiological signals such as heart rate, skin temperature, and **electrodermal activity (EDA)** offer an objective alternative that can be monitored in real time.

Skin conductance is one of the most sensitive indicators of emotional arousal. The eccrine sweat glands, especially on the palms and fingers, are controlled only by the sympathetic nervous system. During stress, sweat gland activity increases and the skin becomes a better electrical conductor. This change is measured by applying a small, safe voltage across two electrodes placed on the skin. The recorded signal has two parts: the **Skin Conductance Level (SCL)**, a slowly varying baseline, and the **Skin Conductance Responses (SCR)**, short peaks that follow a stimulus.

In this work a **GSR sensor** is interfaced with an **Arduino Nano**, which processes the signal and decides the stress level. The result is shown on a display and can be sent to a phone or computer for logging. The main aim is to build a **low-cost, non-invasive, and reliable** system for continuous stress monitoring.

2. Problem Statement and Literature Review

Stress is usually assessed through psychological questionnaires or clinical interviews. These are **subjective**, depend on the person's honesty and self-awareness, and cannot track changes as they happen. Long-term unmanaged stress can lead to anxiety, sleep disorders, high blood pressure, and reduced academic or work performance, yet many people do not notice rising stress until it becomes serious.

Commercial stress-monitoring devices exist, but they are often **expensive** and not accessible to students and small clinics. Many fitness bands estimate stress only indirectly from heart rate, which can be affected by exercise, caffeine, or posture. Thus, the identified problem is the lack of a **simple, affordable, and objective system** that measures stress directly from a physiological signal and gives the result in real time.

Research by Picard et al. showed that physiological signals, including skin conductance, can be used to recognize affective states. Healey and Picard demonstrated that skin conductance and heart rate were the most closely related to driver stress in real-world driving tasks. Poh et al. developed a wearable EDA sensor for long-term, unobtrusive monitoring, while Greco et al. proposed signal-processing methods to separate the tonic and phasic components of EDA. Public datasets such as WESAD further confirmed that EDA is a strong feature for stress-versus-baseline classification. These studies motivate a simple embedded implementation using a low-cost GSR sensor.

3. Working Principle

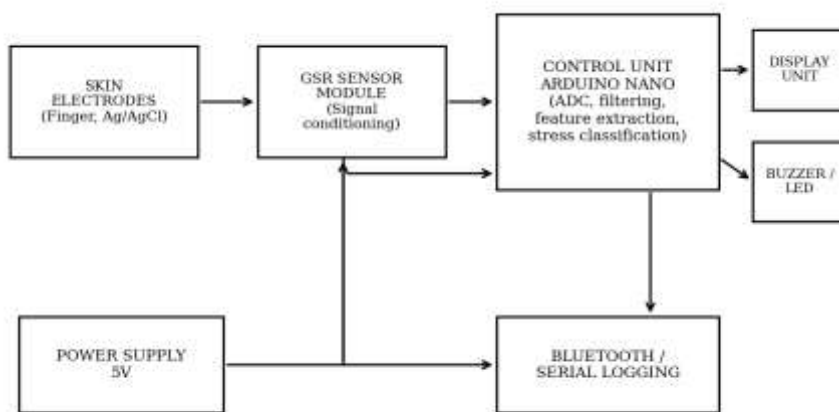


Fig. 1: Block diagram of the stress diagnosis system

The electrodes sense the skin conductance, and the GSR module amplifies it into an analog voltage. The Arduino Nano converts this voltage to digital values using its ADC, applies a moving-average filter to remove noise, and extracts SCL and SCR features. These are compared with the user's resting baseline to decide the stress level, which is shown on the display and indicated by a buzzer or LED.

- **Arduino Nano:** A small microcontroller board that reads the sensor signal, filters it, and classifies the stress level.
- **GSR Sensor Module:** Measures skin conductance through two finger electrodes and gives an analog output voltage.
- **Skin Electrodes:** Finger electrodes (Velcro strap or Ag/AgCl) that make contact with the skin.
- **Display Unit (OLED/LCD):** Shows the live conductance value and the stress level.
- **Buzzer / LED:** Gives a visual or audible alert when a high stress level is detected.
- **Bluetooth / Serial Module:** Sends data to a phone or computer for logging and graph plotting.
- **Power Supply (5V):** Provides stable power to the Arduino and the sensor.
- **Jumper Wires and Breadboard/PCB:** Used to connect and assemble the circuit.

4. Methodology

- Study the relationship between stress and skin conductance, and identify the system requirements.
- Select components such as the Arduino Nano, GSR sensor, display, and buzzer.
- Interface the GSR sensor with the Arduino analog input through proper wiring.
- Write and upload code to read the signal, filter it, and separate SCL and SCR.
- Record a resting baseline for each user before every measurement session.
- Apply mild stress tasks (such as timed mental arithmetic) and record the signal during the task and the recovery period.
- Compare the extracted features with the baseline and set thresholds for relaxed, moderate, and high stress.
- Display the result, test with different users, and adjust thresholds to improve reliability.

5. Results and Discussions

The stress diagnosis system was successfully designed and implemented using an Arduino Nano and a GSR sensor. The prototype was able to record the skin conductance signal continuously from the fingers and display it in real time. During the resting period the signal remained low and stable, while during the stress task the conductance level rose and more SCR peaks appeared, which is consistent with the behavior reported in the literature. After the task the signal gradually returned toward the baseline.

It was observed that the absolute conductance value differs from person to person, and it is also affected by finger pressure, room temperature, and moisture, so a per-user baseline calibration is necessary for reliable results. With proper electrode placement and filtering, the system remained stable and responsive. This confirms that stress diagnosis through skin conductance can be implemented in a compact, low-cost, and efficient manner.

6. Conclusion

The stress diagnosis system using skin conductance signals proves to be a simple, non-invasive, and low-cost solution for objective stress assessment. By combining a GSR sensor with an Arduino Nano, the system measures the physiological response to stress directly instead of relying on self-reporting. The project shows how embedded electronics can support early detection of stress and encourage timely relaxation or medical advice. Although the accuracy is limited by motion artifacts, individual differences, and environmental conditions, its advantages make it practical for students, workplaces, and wearable health-monitoring. In future, the system can be improved by adding heart-rate and temperature sensors and by using machine-learning classification.

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