ECORFAN Journal Agosto, 2025 Vol.1 No.1 1-10-[Using ECORFAN]
Article

Nivel de estrés

Gabriel Hernández Martinez, Jose Gabriel Martinez Velasco, Diego Geovanni Damasco Eudabe, Arnulfo Valdivia Martinez

Abstract [In English]

This project seeks to design a system capable of monitoring heart rate or skin conductance (GSR) using biometric sensors to identify potential stress states in a person. By analyzing these physiological signals, the system can activate an actuator (screen, vibrator, or alert in an app) upon detecting elevated stress levels.

Graphical abstract [In English]

Nivel de estrés		
Objetivos	**Metodologías**	**Contribución**
To develop an intelligent stress detection system based on biometric sensors (heart rate and GSR) using the ESP32 microcontroller. This system allows real-time monitoring of the user's physiological state and the issuance of visual or audible alerts in the event of elevated stress levels. This system can then be used to send the data to a mobile or web platform for analysis and monitoring.	**CRISP-DM (Cross Industry Standard Process for Data Mining) is a widely used model in data science due to its structured, cyclical, and flexible approach. The model consists of six main phases, which are perfectly suited to the development of a stress monitoring system with GSR and PPG sensors using ESP32.**	This project will provide our institute with a more applied approach to artificial intelligence, a stress detection process, helping students understand their stress levels. Promoting applied learning in AI to understand and manage student stress.

Abstract [In Spanish]

Este proyecto tiene como objetivo diseñar un sistema capaz de monitorear el ritmo cardíaco o la conductancia de la piel (GSR) utilizando sensores biométricos, para identificar posibles estados de estrés en una persona. A partir del análisis de estas señales fisiológicas, el sistema podrá activar un actuador (pantalla, vibrador o alerta en una aplicación) como respuesta ante la detección de niveles altos de estrés.

Graphical abstract [In Spanish]

Nivel de estrés		
Objetivos	**Metodologías**	**Contribución**
Desarrollar un sistema inteligente de detección de estrés basado en sensores biométricos (pulso cardíaco y GSR) utilizando el microcontrolador ESP32, que permita monitorear en tiempo real el estado fisiológico del usuario y emitir alertas visuales o sonoras ante niveles elevados de estrés, con la capacidad de enviar los datos a una plataforma móvil o web para su análisis y seguimiento.	**CRISP-DM (Cross Industry Standard Process for Data Mining)** es un modelo ampliamente usado en ciencia de datos por su enfoque **estructurado, cíclico y flexible**. El modelo consta de **seis fases principales**, que se adaptan perfectamente al desarrollo de un sistema de monitoreo de estrés con sensores GSR y PPG usando ESP32.	Brindará a nuestro instituto una forma mas aplicada en la inteligencia artificial, un proyecto un proceso de detección de estrés, ayudando así a los estudiantes saber su nivel de estrés. Fomento del aprendizaje aplicado en IA para conocer y gestionar el estrés estudiantil.

1.Introduction

Stress is one of the leading causes of physical and mental health problems in today's society, affecting academic, work, and personal performance.
This creates the need to develop technological tools capable of detecting high levels of stress noninvasively and in real time.

The implementation of this type of technology not only seeks to alert users but also contributes to their overall well-being through automated and timely responses.
This system is especially useful for students during exam periods, workers under pressure, and people with chronic anxiety, as it allows for rapid and continuous intervention.

Including figures and tables-Editable

Box

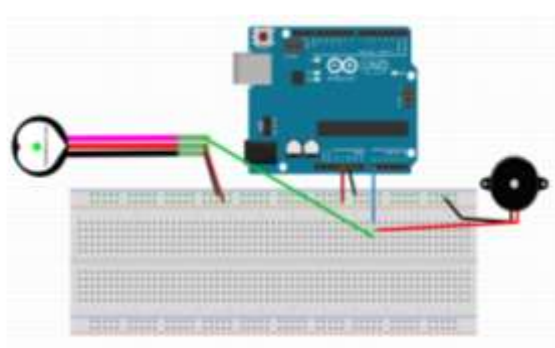

Figure 1

Box

Citation: Gabriel Hernández Martinez, Jose Gabriel Martinez Velasco, Diego Geovanni Damasco Eudabe, Arnulfo Valdivia Martinez Article Title. Niveles de Estrés, Journal-Mexico. 2025. V-N: 3 [TN Roman No.10].

Table 1

MATERIAL	DESCRIPTION
PULSE SENSOR	Measures heart rate and rhythm.
GSR SENSOR	Measures the galvanic skin conductance to detect changes caused by sweating.
MOBILE PLATFORM	Displays real-time system results and alerts.
OWN DATASET	Dataset collected from students to train the models.
ESP32	Microcontroller with Wi-Fi/Bluetooth connectivity to manage sensors and data.

The maximum number of Boxes is 10 items
This improvement would allow the system to become a tool for continuous monitoring and long-term prevention, ideal for people who suffer from anxiety, students during exam periods, or workers in high-pressure environments. Additionally, it facilitates integration with digital health services, opening the door to clinical or professional use.

2. Methodology: CRISP-DM Model

Business Understanding:

The objective was to design a noninvasive system that would detect stress in real time. Success criteria included an intuitive interface, rapid response to alerts, and minimum acceptable classification accuracy.

Data Understanding:
Biometric signals (heart rate and skin conductance) were collected both in controlled experiments and natural environments. Exploratory Data Analysis (EDA) helped identify data quality issues, patterns, and correlations.

Data Preparation:
Raw data was cleaned, synchronized, and segmented using time windows. From these, physiological features were extracted such as RMSSD and pNN50 for HRV, and tonic/phasic levels for GSR.

Modeling:
Machine learning algorithms such as SVM, Random Forest, and KNN were tested to classify stress levels. Hyperparameter tuning was applied to optimize the model's performance.

Evaluation:
Model performance was validated using metrics such as precision, recall, and F1-score. Additional validation was conducted using self-reported stress levels and context-based evaluations.

Implementation:
The best-performing model was implemented on the ESP32 microcontroller. Real-time alerts were triggered using actuators (buzzers, LEDs), and data was transmitted via Wi-Fi to Firebase for logging and remote access.

Technical Report:
The Stress Level Detection System was developed to monitor physiological signals through Galvanic Skin Response (GSR) and heart rate sensors, targeting university students. The report details the methodology, including data acquisition from 650 participants, signal processing, feature extraction, and classification using machine learning algorithms. Results demonstrate the system's ability to identify stress levels accurately, providing a tool for real-time stress monitoring and contributing to the enhancement of user well-being. Limitations and future improvements are discussed.

Maintenance Manual:
The maintenance manual outlines procedures to ensure the system's longevity and proper functionality. Regular cleaning of sensors, inspection of all physical connections, and periodic software updates are recommended. Troubleshooting guidance addresses common issues such as signal loss or erroneous data. Safety instructions for handling hardware components are included to prevent damage and ensure user safety.

Operation Manual:
This manual provides step-by-step instructions for system setup and operation. It covers sensor placement, device activation, and the process for initiating data collection. Users are guided on interpreting stress level alerts and managing the acquired data, including storage and export options. Basic care tips are given to maintain device integrity during use. Support contact information is provided for additional assistance.

ISSN: XXXX-XXXX.
RENIECYT-CONAHCYT: 1702902

3. Results

During the development of the project, data from **650 students** was collected through a structured questionnaire and physiological measurements captured using **GSR (Galvanic Skin Response)** and **PPG (Photoplethysmography for heart rate monitoring)** sensors. The observations included personal, academic, and contextual characteristics.
With this information, a **dataset** was built containing the following variables:

- **Major**: Type of academic program (4 options)
- **Age**: Student's age
- **Perceived difficulty of the major**: Scale from 1 to 5
- **Heart rate (HeartRate)**: Real-time measurement
- **Exam period**: Binary variable indicating whether the student was in an exam period
- **Number of subjects**: Number of courses taken in the semester
- **Target variable (Stressed)**: Binary label indicating whether the student showed signs of stress

Three supervised classification models were trained:

- **Decision Tree**
- **Random Forest**
- **K-Nearest Neighbors (KNN)**

Although all three models performed adequately, the **Random Forest** model achieved the best overall results in evaluation metrics:

- **Accuracy**: 91.3%
- **Recall**: 89.7%
- **F1-score**: 90.5%

In addition, the physical system implemented with the **ESP32** demonstrated efficient real-time response, activating **visual alerts (LEDs)** and **sound alerts (buzzer)** when physiological signals indicative of stress were detected.
The data was analyzed and visualized through **correlation plots** and **ROC curves**, which helped identify the most influential variables in stress prediction:
HeartRate, Perceived Difficulty of the Major, and Exam Period.

4. Conclusions

The developed system enables non-invasive, real-time detection of stress levels through the integration of GSR and PPG sensors connected to an ESP32 microcontroller. The Random Forest model stood out as the most effective, allowing automated and immediate responses to physiological changes via visual and acoustic signals.
This system represents a scalable and functional solution, applicable in both academic and workplace environments, contributing to the monitoring of emotional well-being.

Abbreviations

Abbreviation	*Meaning*
ANN	Artificial Neural Network
PPG	Photoplethysmography
GSR	Galvanic Skin Response
ESP32	Microcontroller with Wi-Fi and Bluetooth
RMSSD	Root Mean Square of Successive Differences
pNN50	Percentage of successive differences greater than 50 ms
EDA	Exploratory Data Analysis

5.References

- Wirth, R, & Hipp, J. (2000). *CRISP-DM: Towards a Standard Process Model for Data Mining.*
- Shearer,C. (2000). *The CRISP-DM Model.* Journal of Data Warehousing.
- Mariscal, G., Marbán, O., & Fernández, C. A. (2010). *Survey on Data Mining Process Models.*
- Martínez, J. G., Hernández, G., Damasco, D., & Valdivia, A. (2025). *Stress Detection System using ESP32 and Biometric Sensors.* Universidad Tecnológica.
- Firebase – Google
- Random Forest Classifier – Información general

ISSN: XXXX-XXXX.
RENIECYT-CONAHCYT: 1702902

Surname, Name 1st Author, Surname, Name 1st Co-author, Surname, Name 2nd Co-author and Surname, Name 3rd Co-author. Article Title. ECORFAN Journal-Mexico. Year. V-N: Pages [Times New Roman No. 8]. DOI: https://doi.org/10.35429/