STRESS DETECTION SYSTEM USING ARDUINO

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ABSTRACT

Stress has become a widespread concern in today's fast-paced lifestyle, impacting both physical and mental health. With increasing awareness around mental well-being, there is a growing need for reliable and accessible tools to monitor stress levels in real time. This project, titled "Stress Detection System using Arduino," aims to design and develop a cost-effective, non-invasive system that detects human stress using biometric sensors and a microcontroller-based setup. This Stress Detection system uses an Arduino UNO as the central processing unit, integrated with a Galvanic Skin Response (GSR) sensor, a heart rate sensor, and a temperature sensor. These sensors collect physiological data such as skin conductivity, pulse rate, and body temperature, which are known to change under stress. The Arduino receives and processes this data using a threshold-based algorithm to determine whether the user is in a stressed or relaxed state. The results are displayed in real time on an LCD screen, providing instant feedback to the user. Optional extensions include Bluetooth or Wi-Fi modules for transmitting data to external devices for further analysis. The project consists of key components such as system design, hardware integration, sensor calibration, data acquisition, and software development for processing and output display. Through this system, individuals can monitor their stress levels regularly and take timely actions to manage their well-being. The project demonstrates how basic electronics and microcontrollers can be used effectively for health monitoring and opens the door for future enhancements like mobile app integration or machine learning-based stress prediction.

INTRODUCTION

Stress is one of the most common physiological and psychological responses to the challenges and demands of everyday life. It is the body's natural defense mechanism, designed to help individuals react quickly to threats or high-pressure situations. However, while short-term stress can be beneficial by improving performance, alertness, and motivation, prolonged exposure to stress can have serious negative effects on both mental and physical health. Chronic stress has been linked to a variety of health issues including heart disease, hypertension, diabetes, insomnia, digestive disorders, anxiety, depression, and weakened immune function. In the modern world, stress has become a near-constant presence due to increasing workloads, academic pressure, financial responsibilities, and rapid lifestyle changes. It affects people of all age groups—from school-going children to working professionals and even the elderly. Despite the widespread occurrence of stress, many individuals do not realize they are affected until the symptoms become severe. This is largely due to the lack of accessible, real-time stress monitoring systems that could help identify early signs and enable preventive measures.

Problem Statement

Traditional methods for stress detection are based primarily on psychological evaluations, self-reporting questionnaires, and clinical examinations. While these methods are scientifically sound, they have several limitations. They are often time-consuming, costly, and require professional interpretation. Additionally, they do not allow for continuous or real-time monitoring. In many cases, individuals may be unaware of their stress levels until symptoms manifest, making early detection difficult. This calls for a simple, affordable, and portable device that can help people monitor their stress levels effectively and in real-time.

Need for the Project

Given the current trends in health and wellness, the demand for smart, wearable, and non-invasive health monitoring systems has increased dramatically. Stress detection, in particular, has emerged as a key area of interest in both healthcare and personal wellness. With the availability of low-cost microcontrollers and sensors, it is now possible to build compact systems capable of monitoring human physiological signals and interpreting them to detect stress levels. This project aims to develop such a system using Arduino, a popular open-source electronics platform that is widely used for prototyping and educational purposes.

Objective of the Project

The main goal of this project, titled "Stress Detection System using Arduino," is to design and implement a functional prototype that can detect and display a user's stress level in real time. The system will be based on physiological signals collected from the human body using biometric sensors. These include:

- Galvanic Skin Response (GSR) Sensor – measures the skin's electrical conductivity, which increases with sweat gland activity, a common indicator of stress.
- Heart Rate Sensor – detects changes in pulse rate, which typically increase under stress.
- Temperature Sensor – measures body temperature, which may vary slightly due to stress-induced physiological changes.

These sensors are interfaced with an Arduino UNO microcontroller, which acts as the core processing unit. The Arduino collects data from the sensors, processes it based on predefined threshold values, and determines whether the user is in a "relaxed" or "stressed" state. The results are then displayed on an LCD screen in real time. Optionally, the system can be enhanced to include data logging features or wireless modules such as Bluetooth or Wi-Fi to transmit data to a smartphone or computer for extended monitoring.

Future Scope of the Project

The project focuses on the integration of embedded systems and biometric data analysis to create a user-friendly, portable, and affordable stress monitoring device. The scope includes:

- Selection and interfacing of appropriate sensors with the Arduino.
- Development of software (Arduino code) to process and interpret sensor data.
- Designing a display interface to communicate the results to the user.
- Calibrating the sensors to work accurately with human biological signals.
- Testing the system on sample users and observing variations in output.
- Exploring the possibility of extending the system for future enhancements like mobile app connectivity or cloud-based data storage.

Importance and Applications

The significance of this project lies in its practical application in day-to-day life. By enabling individuals to monitor their stress levels in real-time, the system helps in promoting mental well-being and early intervention. It can be useful in several scenarios, such as:

- Educational institutions – Students facing examination stress or academic pressure.
- Workplaces – Employees working under tight deadlines or in high-pressure environments.
- Healthcare – Patients with conditions aggravated by stress, such as hypertension or anxiety.
- Personal wellness – Individuals practicing mindfulness, yoga, or meditation who want to track their stress levels.

The system can serve as a stepping stone for more advanced health monitoring systems that incorporate artificial intelligence and machine learning to provide personalized and adaptive feedback.

Relevance of Arduino In The Project

Arduino was chosen as the primary microcontroller platform for this project due to its open-source nature, ease of use, extensive online support community, and compatibility with a wide range of sensors and modules. Its simple programming environment allows for fast development and testing, making it ideal for both beginners and experienced developers working on embedded systems applications. By using Arduino, the project demonstrates how modern microcontrollers can be employed to create practical solutions for real-world health problems without the need for expensive equipment or advanced medical tools.

COMPONENTS DESCRIPTION

1. Arduino UNO Microcontroller

The Arduino UNO is the central microcontroller board that serves as the brain of the stress detection system. It processes data from the sensors, compares it to threshold values, and provides output feedback. Arduino is an open-source platform based on easy-to-use hardware and software, making it ideal for prototyping and development of embedded systems. It operates at 5V, has 14 digital input/output pins, 6 analog inputs, and is programmed using the Arduino IDE.

2. Galvanic Skin Response (GSR) Sensor

The GSR sensor measures the electrical conductance of the skin, which varies depending on the amount of sweat produced. When a person is under stress, the body's sympathetic nervous system is activated, causing an increase in sweat production, which in turn increases the skin's conductivity. This sensor detects this change in conductivity to estimate the level of stress.

3. Heart Rate Sensor

The heart rate sensor detects the user's pulse rate (heartbeats per minute). When a person experiences stress, the heart rate typically increases. The heart rate sensor uses optical sensors or infrared light to detect changes in blood flow, which correspond to heartbeats.

4. Temperature Sensor (LM35)

The LM35 is a temperature sensor that measures the ambient temperature in degrees Celsius. Under stress, body temperature may rise slightly due to physiological changes. The LM35 provides accurate temperature measurements with a low output voltage and is easy to interface with Arduino.

5. LCD Display (16x2 LCD)

The 16x2 LCD display is a commonly used graphical display module that can show 2 lines of text, each with 16 characters. It is an ideal choice for displaying short pieces of information such as system status, stress levels, and error messages.

6. Jumper Wires and Breadboard

Jumper wires are used to make electrical connections between components, while a breadboard provides a platform for assembling the system without the need for soldering. Both components are essential for prototyping and testing the circuit before final assembly.

7. Power Supply (5V DC Adapter or USB Cable)

The power supply for the Arduino is typically a 5V DC adapter or can be powered via the USB port from a computer. The system requires a stable 5V DC supply to function correctly.

PROPOSED WORK

The proposed work of the project “Stress Detection System using Arduino” focuses on designing and building a reliable, affordable, and standalone system that detects stress levels in individuals using biometric sensor data and provides immediate, visible feedback through an LCD screen and colored LEDs. The system is grounded in the principle that stress causes physiological changes in the human body—such as increased heart rate, altered skin conductivity, and fluctuations in body temperature. The device will use a combination of three primary sensors: a GSR (Galvanic Skin Response) sensor, which measures the skin's resistance and is directly affected by sweat gland activity; a heart rate sensor that monitors pulse and cardiovascular activity; and an LM35 temperature sensor that detects subtle changes in body temperature. These sensors will be connected to the Arduino UNO, which serves as the core processor for collecting and analyzing the incoming data. Each parameter will be processed in real time, and the microcontroller will apply simple decision-making logic based on pre-calibrated thresholds to classify the user’s state as “Relaxed,” “Normal,” or “Stressed.”

The LCD display (16x2) will show the current status clearly, while LED indicators (green, yellow, and red) will offer an immediate, visual representation of the result, helping users recognize their stress levels at a glance. The proposed system will begin with a comprehensive analysis of existing stress detection techniques, leading to the selection of suitable hardware components and sensors. The system will be designed and tested first on a breadboard setup, followed by developing the Arduino code to handle sensor integration, noise filtering, signal conditioning, and decision-making. A key focus of the work is to ensure simplicity and robustness, avoiding complex setups like Bluetooth modules or mobile interfaces, making the system energy-efficient and more reliable for environments where wireless signals might not be necessary or ideal.

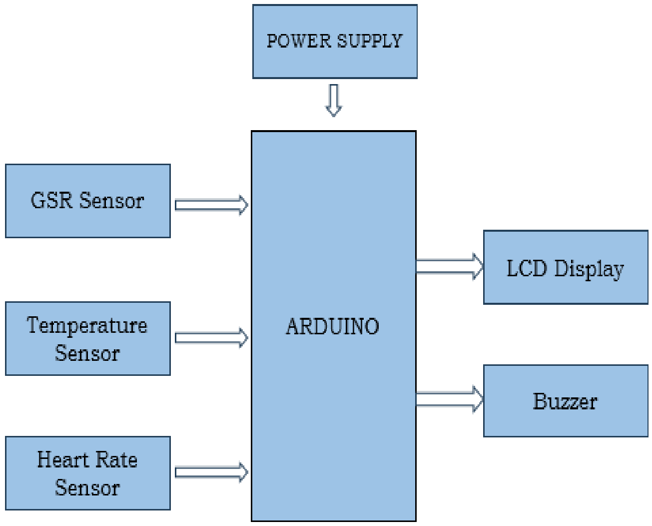
Once the components are fully integrated and the circuit stabilized, the team will proceed with extensive testing on multiple users under different conditions—during relaxation, after physical exertion, and while engaging in mentally demanding tasks. These tests will allow fine-tuning of the sensor thresholds for improved accuracy and consistency. The final prototype will be enclosed in a compact casing for protection and ease of handling. Optional enhancements may include a buzzer to alert users when stress levels are critically high or a manual reset button to restart the system easily. The absence of wireless modules not only simplifies the design but also ensures that data remains within the local device, enhancing privacy and reducing potential technical issues.

The final outcome of this project is a self-contained, user-friendly stress detection system that requires no external software or app to function. It serves as an effective tool for educational demonstrations, personal health monitoring, and basic clinical use, especially in places where access to advanced digital systems is limited. This solution emphasizes practicality, ease of use, and awareness, allowing users to identify their stress levels in real-time and encouraging healthier lifestyle habits through timely self-observation.

Working

The working of the “Stress Detection System using Arduino” revolves around sensing and interpreting key physiological signals that change in response to stress. The system uses a GSR (Galvanic Skin Response) sensor to measure skin conductivity, which increases when a person sweats due to stress; a heart rate sensor to detect changes in pulse rate, as stress typically causes the heart to beat faster; and an LM35 temperature sensor to monitor slight variations in body temperature, which can drop when blood vessels constrict under stress. All three sensors are connected to an Arduino UNO microcontroller, which reads the sensor data through its analog input pins. The microcontroller runs a program that filters and analyzes the data in real time, comparing each reading with calibrated threshold values based on normal and stressed conditions. If the GSR indicates high conductivity, the heart rate is elevated, and the temperature shows deviation, the system concludes that the user is under stress. Depending on the analysis, the Arduino classifies the user's condition as “Relaxed,” “Normal,” or “Stressed” and displays this status on a 16x2 LCD screen. Simultaneously, an LED indicator lights up—green for relaxed, yellow for normal, and red for stressed—to provide a quick visual cue. The system continuously monitors changes in the sensors and updates the output in real time. Designed as a fully standalone and offline system, it operates without any wireless modules, making it simple, reliable, and cost-effective. This device is especially useful for individuals seeking to monitor their stress levels regularly and can also be utilized in educational environments to demonstrate biofeedback and emotional health monitoring.

Block Diagram



Block diagram of the proposed system

RESULT AND CONCLUSION

The Stress Detection System using Arduino successfully detects and classifies stress levels by monitoring physiological signals such as skin conductivity, heart rate, and body temperature using sensors like the GSR sensor, heart rate sensor, and LM35 temperature sensor. The Arduino UNO microcontroller processes the real-time data, comparing it to predefined thresholds to assess whether the user is “Relaxed,” “Normal,” or “Stressed.” The results are displayed on a 16x2 LCD screen and visually represented through LED indicators (green, yellow, or red). The system was tested under various conditions and accurately identified stress levels in real-time, providing immediate feedback to the user. It successfully demonstrated its potential as a low-cost, standalone solution for stress monitoring, offering an easy-to-understand, non-invasive method for tracking emotional health. While simple and offline, the system proved reliable, making it an effective tool for personal wellness, educational use, and preliminary health monitoring. Future developments could enhance the system's functionality, but the current version already meets its goal of raising awareness and providing users with real-time insights into their stress levels.

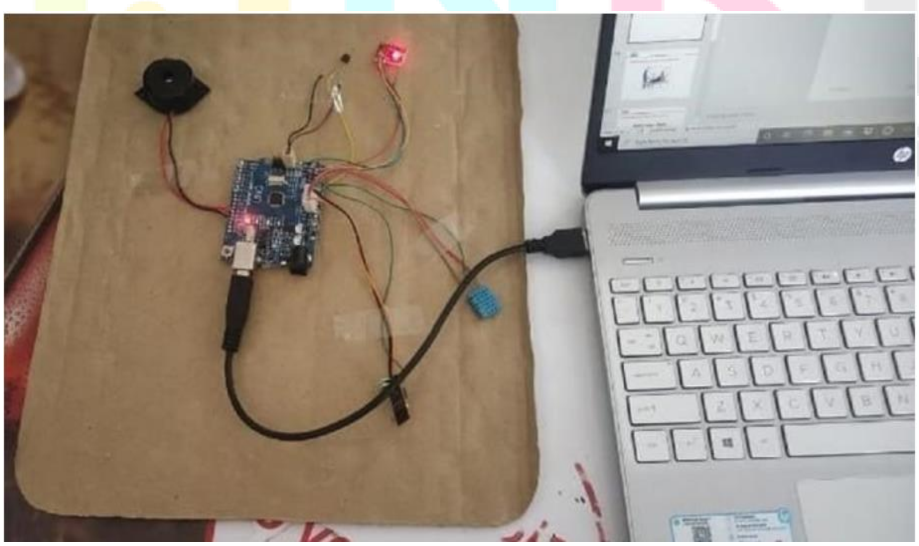


Image of the final project

OUTPUT

Table for the results obtained in the project

Time	Heart Rate (BPM)	GSR Value (Conductance)	Body Temp (°C)	Stress Level
10:00:01	75	520	36.5	Normal
10:00:05	85	580	36.8	Mild Stress
10:00:10	95	640	37.2	High Stress
10:00:15	72	500	36.3	Normal
10:00:20	80	560	36.7	Mild Stress
10:00:25	100	700	37.5	High Stress
10:00:30	78	530	36.6	Normal

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