

Real-Time Stress Monitoring Using Multi-Parameter Physiological Signals with IoT-Based Data Processing

Kalpna Pardeshi¹, Riya Bendke², Parth Bhamare³, Yash Baheti⁴
Department of Engineering, Instrumentation and Control Engineering,
Vishwakarma Institute of Technology, Pune

Abstract — Stress is something that we all deal with every day. We usually do not notice it until it starts to make us sick or affects our work. If we keep an eye on our body's signals all the time we can find out when we are stressed before it gets bad. In this project a system that is not too expensive was made to check for stress as it happens using sensors.

The system uses a sensor to check our heart rate, a GSR sensor to see how our skin is doing and a DHT11 sensor to check the temperature and humidity. These sensors are connected to an ESP32 microcontroller, which gathers all the information and makes sense of it before sending it to a website using Wi-Fi.

We use a website to see what is going on with our body in time and to get an idea of how stressed we are based on what the sensors are saying. We tried this system in situations and we saw that our body's signals changed a lot when we were stressed. The system we made is simple. Does not cost too much and it can be used to keep an eye on our basic health.

I. INTRODUCTION

Stress affects our mental health in a big way. Many of us do not realize we are stressed until we start to feel symptoms. If stress goes on for long it can cause problems like anxiety, tiredness or even heart issues.

Traditional ways to check for stress include questionnaires or doctor evaluations. These methods are helpful but not good for monitoring and rely on how we feel. Physiological signs like heart rate and skin conductivity give signs of stress.

With IoT technology advancing it's now easier to keep track of these signs using sensors and microcontrollers. The data can be accessed from in real-time.

In this project we developed a low-cost system that uses physiological signals to monitor stress. This approach is more reliable, than using one sign and keeps the system simple and affordable.

II. LITERATURE REVIEW

Previous studies have explored different approaches to stress detection using physiological signals.

Villarejo et al. [1] proposed a stress detection system using Galvanic Skin Response (GSR) with wireless communication. Their work demonstrated that skin conductivity is a useful indicator of stress, but it relied on only one parameter.

Kyriakou et al. [2] developed a wearable system that uses multiple physiological signals to detect stress. Their findings showed improved accuracy when combining signals, although the system involved complex processing.

Gedam and Paul [3] reviewed various stress detection techniques using wearable sensors and machine learning. They emphasized the benefits of multi-sensor systems but also highlighted challenges such as cost and implementation complexity.

Hernández-Rodríguez et al. [4] designed a low-cost Arduino-based data logging system for multiple parameters. However, their work did not specifically focus on stress detection or real-time cloud visualization.

The proposed system in this project aims to combine multiple sensors with IoT technology to create a simple, efficient, and affordable stress monitoring solution.

III. METHODOLOGY/EXPERIMENTAL

A. Components

The system works by collecting information about our body using sensors that are connected to the ESP32 microcontroller.

The MAX30102 sensor checks our heart rate by seeing how our blood flow changes when light is shone on it.

The GSR sensor looks at how our skin resists electricity, which changes when we are stressed because we sweat more.

The DHT11 sensor also checks the temperature and humidity around us which can slightly affect what our body is doing.

All the information that is collected is looked at by the ESP32. Sent to a database on the internet using Wi-Fi.

Then a website is used to show this information as it happens.

The system looks at how the sensor information's changing and guesses how stressed we are putting it into categories like normal stress, moderate stress or high stress and the stress levels are estimated based on the physiological data from the ESP32 microcontroller and the sensors, like the MAX30102 sensor and the GSR sensor.

B. Working principle

- [1] The system keeps collecting data from the MAX30102, GSR and DHT11 sensors.
- [2] The data is checked against ranges.
- [3] If everything looks normal it just says so. Does nothing else.
- [4] If there are some changes it says there is some stress.
- [5] If things are off it says there is a lot of stress and might send a warning.
- [6] The data is sent to the cloud every often.
- [7] This keeps happening over to keep an eye on things in real time.
- [8] The ESP32 starts up. Connects to Wi-Fi.

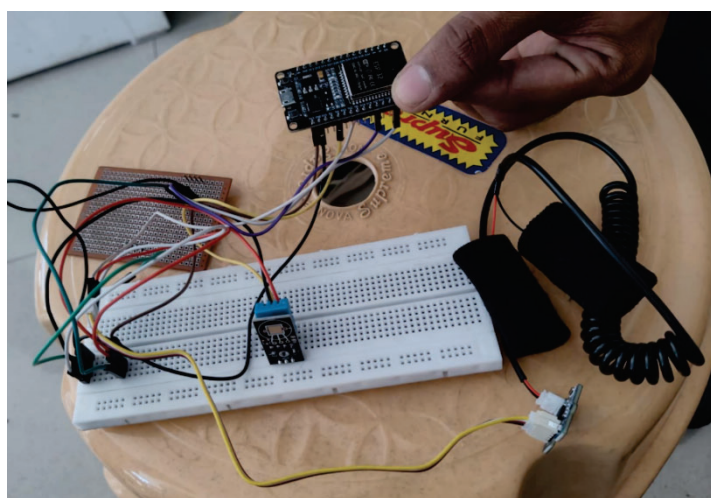


Fig.1. System Design

C. System algorithm

- [1] Initialise ESP32 and establish Wi-Fi connection.
- [2] The system continuously reads data from the MAX30102, GSR, and DHT11 sensors.(heart rate,GSR,temperature)
- [3] The collected sensor values are processed and compared with predefined threshold ranges.
- [4] If all parameters are within normal range, the system indicates a normal condition and updates the data without triggering any alert.
- [5] If moderate variation is detected, the system indicates a moderate stress condition and updates the values accordingly.
- [6] If significant variation is observed, the system indicates a high stress condition and can trigger an alert on the monitoring interface.
- [7] The processed data is transmitted to the cloud database at regular intervals.
- [8] All operations are executed continuously in a loop to ensure real-time monitoring and quick response to changes in physiological parameters.



Fig.2 Real-time data

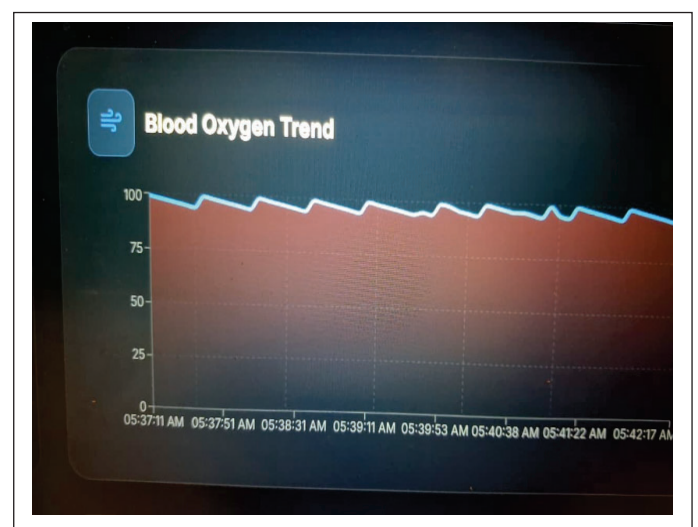


Fig.3 Real-time data

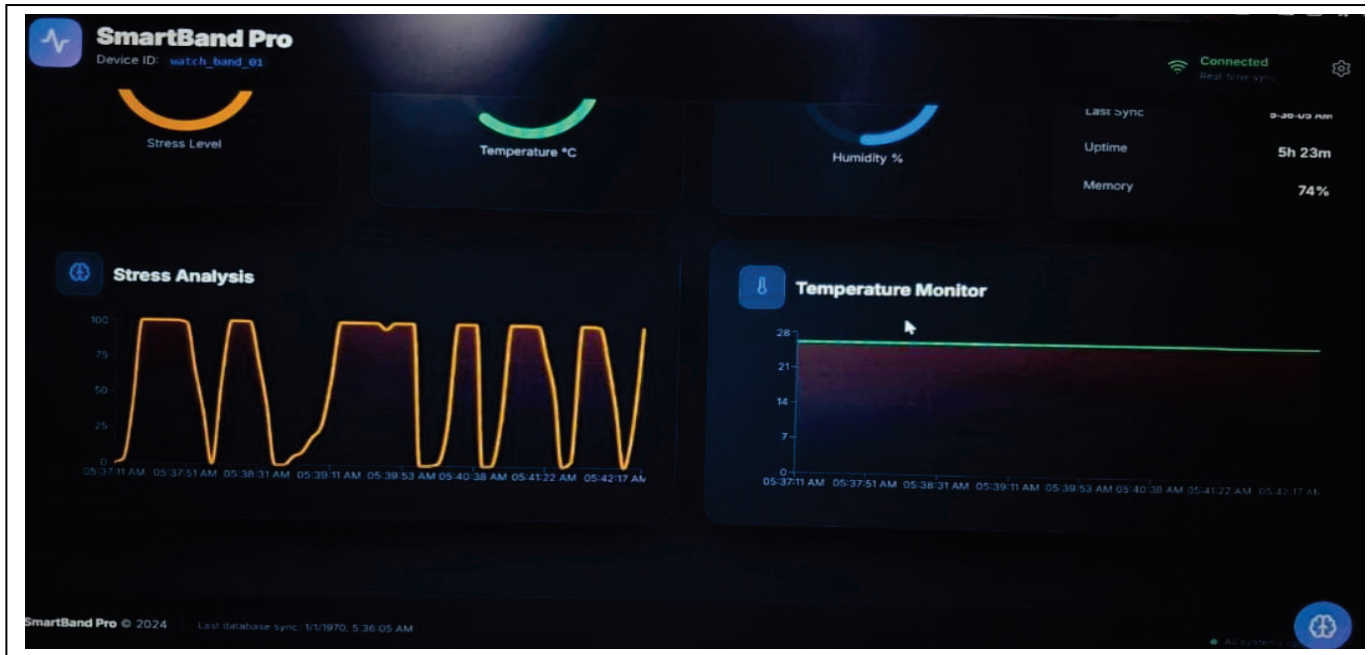


Fig.5.System Res

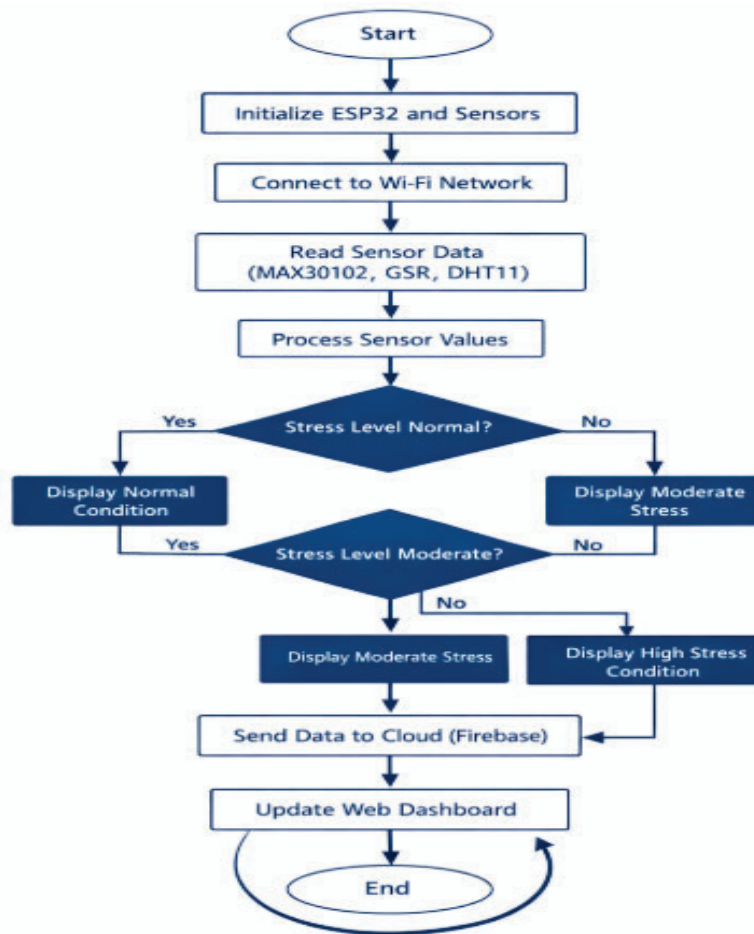


Fig.6.workin

IV. RESULTS AND DISCUSSIONS

The system was tested in situations like when I was relaxed doing some light activity and under stress to see how my physiological parameters changed.

The sensors were hooked up to the ESP32 and data was sent to the cloud in time and shown on a dashboard.

* When I was relaxed my heart rate was normal.

But when I was active it went up and when I was stressed it increased more.

The GSR sensor also showed resistance when I was relaxed and lower resistance when I was stressed.

This makes sense because when I'm stressed my skin gets more conductive. Temperature changes were small. It did go up a bit when I was stressed. The system sent data to the cloud quickly. The dashboard updated in real-time. Overall the system worked well. Gave consistent readings from the sensors. Using parameters like heart rate and GSR made stress detection more reliable than using just one parameter.

However there were some issues, like changes in GSR readings due, to the environment and using fixed thresholds that might not work for everyone. The system can be improved by addressing these limitations. Stress detection is important. This system is a good start. The ESP32 and cloud data transmission are components. The system is not perfect. It shows promise.

More work is needed to make it better.



Output 1



Output 2

V. CONCLUSION AND FUTURE SCOPE

A low-cost stress monitoring system has been developed using multiple sensors and IoT technology. The system enables real-time monitoring and provides a basic indication of stress levels. It is simple, reliable, and suitable for general applications. The system can be further improved by integrating machine learning algorithms to replace fixed threshold-based classification. This would allow the system to adapt to individual variations. Additional sensors such as ECG and SpO₂ can be included for more accurate analysis. The system can also be converted into a wearable device for continuous monitoring. A mobile application can be developed to provide alerts and long-term data tracking. Integration with healthcare platforms can enable remote monitoring by professionals.

VI. REFERENCES

- [1] M. V. Villarejo, B. G. Zapirain, and A. M. Zorrilla, "A stress sensor based on galvanic skin response (GSR) controlled by ZigBee," *Sensors*, vol. 12, no. 5, pp. 6075–6101, 2012.
- [2] K. Kyriakou, S. Chatzis, M. S. Pattichis, and C. S. Pattichis, "Detecting moments of stress from measurements of wearable physiological sensors," *Sensors*, vol. 19, no. 17, p. 3805, 2019.
- [3] N. Gedam and S. Paul, "A review on mental stress detection using wearable sensors and machine learning techniques," *IEEE Access*, vol. 9, pp. 84045–84066, 2021.
- [4] A. Hernández-Rodríguez, M. Rodríguez-Reséndiz, J. A. Salinas, and R. Soto, "Reliability testing of a low-cost, multi-purpose Arduino-based data logger deployed in several applications," *Sensors*, vol. 23, no. 17, p. 7412, 2023.

- [5] S. Cohen, D. Janicki-Deverts, and G. E. Miller,
“Psychological stress and disease,”
JAMA, vol. 298, no. 14, pp. 1685–1687, 2007.
- [6] T. Iqbal, M. Hossain, and M. S. Islam,
“Stress monitoring using wearable sensors: A pilot study and dataset,”
Sensors, vol. 22, no. 21, p. 8135, 2022.
- [7] J. A. Healey and R. W. Picard,
“Detecting stress during real-world driving tasks using physiological sensors,”
IEEE Transactions on Intelligent Transportation Systems, vol. 6, no. 2, pp. 156–166, 2005.
- [8] R. W. Picard,
“Affective computing: Challenges,”
International Journal of Human-Computer Studies, vol. 59, no. 1–2, pp. 55–64, 2003.
- [9] A. Sano and R. W. Picard,
“Stress recognition using wearable sensors and mobile phones,”
in Proc. IEEE Int. Conf. Affective Computing and Intelligent Interaction, 2013.
- [10] S. Gjoreski, H. Gjoreski, M. Luštrek, and M. Gams,
“Continuous stress detection using a wrist device: In laboratory and real life,”
in Proc. ACM Int. Joint Conf. Pervasive and Ubiquitous Computing (UbiComp), 2016, pp. 1185–1193.
- [11] E. Jovanov, A. Milenkovic, C. Otto, and P. C. de Groen,
“A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation,”
J. NeuroEngineering Rehabil., vol. 2, no. 6, 2005.
- [12] H. Fatmaryanti, F. Febriani, and S. Rahman,
“Smart tools for smart learning: IoT-based landslide early warning system with tilt sensors and apps,”
E3S Web of Conferences, vol. 400, 2025.
- [13] R. Jain and T. Gupta,
“Integration of ADAS technologies for low-cost vehicles in developing countries,”
IEEE Access, vol. 10, pp. 47258–47270, 2022.
- [14] S. M. Lee and H. J. Kim,
“Development of a real-time steering angle monitoring system using MEMS sensors,”
IEEE Sensors Journal, vol. 21, no. 12, pp. 13454–13462, 2021.
- [15] X. Li, J. Hu, and Y. Zhou,
“Stress detection using deep neural networks and wearable sensors,”
IEEE Access, vol. 7, pp. 70920–70929, 2019.