International Journal of
DATA SCIENCE AND IOT MANAGEMENT SYSTEM
ISSN: 3068-272X www.ijdim.com Original Research Paper

REAL TIME PERSONALIZED PHYSIOLOGICALLY BASED STRESS DETECTION FOR HAZARDOUS OPERATIONS

RACHANA POTHARAJU
SARITHA PALLE
DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS
VAAGESWARI COLLEGE OF ENGINEERING
(Affiliated to JNTUH, Approved by AICTE, New Delhi & Accredited by **NAAC** with '**A+**' Grade)
Karimnagar, Telangana, India – 505 527

ABSTRACT

In hazardous working environments such as construction sites, mining operations, firefighting, or chemical industries, stress can significantly impair human performance, leading to reduced safety and increased accident risks. This project focuses on **real-time personalized, physiologically based stress detection** to enhance safety and decision-making during hazardous operations. The proposed system utilizes **wearable biosensors** to continuously monitor physiological signals such as **heart rate, skin temperature, electrodermal activity (EDA), and oxygen saturation (SpO_2)**. These signals are processed and analyzed using **machine learning algorithms** to detect variations that indicate stress levels specific to each individual.

By implementing **personalized models**, the system adapts to each worker's physiological baseline, improving the accuracy of stress detection compared to generalized models. The collected data are transmitted in real time to a **central monitoring unit**, where supervisors can observe the stress status of workers and receive **alerts** during critical conditions. The proposed solution ensures **early identification of stress**, enabling timely interventions to prevent fatigue-related errors or accidents.

This research contributes to **occupational safety** by integrating **IoT-based sensing, real-time data analytics, and adaptive stress modeling**. The system can be extended to other domains such as **military missions, healthcare, and transportation**, where real-time stress monitoring is essential for performance and safety.

Keywords: Stress Detection, Physiological Signals, Wearable Sensors, Hazardous Operations, Machine Learning, Real-Time Monitoring, IoT.

Received: 17-09-2025 Accepted: 20-10-2025 Published: 28-10-2025

INTRODUCTION

In hazardous working environments such as firefighting, chemical plants, construction sites, mining operations, and military missions, workers are often exposed to high physical and psychological stress. Prolonged or extreme stress can negatively affect cognitive performance, decision-making ability, and overall safety. Stress can lead to fatigue, slower reaction times, and even serious accidents, making it crucial to monitor and manage stress levels in real time. Traditional stress evaluation methods, such as surveys and self-reporting, are subjective, time-consuming, and not suitable for dynamic work environments.

To address this issue, **real-time physiologically based stress detection systems** have emerged as an effective solution. These systems utilize **wearable biosensors** to collect physiological signals such as **heart rate (HR), heart rate variability (HRV), electrodermal activity (EDA), skin temperature, and blood oxygen levels (SpO_2)**. By continuously monitoring these parameters, the system can detect stress responses as they occur.

Unlike conventional approaches, the proposed system adopts a **personalized detection model**, recognizing that stress responses vary significantly among individuals. Each person's physiological baseline is established during normal conditions, and deviations from this baseline are analyzed using **machine learning algorithms** to determine the stress level. The system operates through **IoT-enabled devices** that transmit data in real time to a

International Journal of
DATA SCIENCE AND IOT MANAGEMENT SYSTEM
ISSN: 3068-272X www.ijdim.com Original Research Paper

centralized monitoring platform, enabling immediate analysis and response.

The integration of **artificial intelligence (AI), Internet of Things (IoT), and wearable technologies** provides a comprehensive and intelligent approach to enhancing worker safety in hazardous environments. Through early detection and timely intervention, this system helps prevent accidents, improve operational efficiency, and promote overall well-being among workers engaged in high-risk occupations.

Overall, real-time personalized physiologically based stress detection represents a major step forward in **occupational health monitoring**, combining technology and human-centered design to create safer and smarter workplaces.

LITERATURE REVIEW

Several studies have explored stress detection using physiological signals to improve safety and performance in critical environments. Early research identified key physiological indicators of stress such as **heart rate (HR)**, **heart rate variability (HRV)**, **electrodermal activity (EDA)**, **skin temperature**, and **respiration rate**. These parameters reflect changes in the autonomic nervous system during stressful conditions.

With advancements in **wearable sensor technology**, continuous monitoring has become feasible using devices like smartwatches, chest straps, and biosensors. Researchers have shown that combining multiple physiological signals (multimodal sensing) improves detection accuracy compared to single-signal systems.

Machine learning algorithms such as **Support Vector Machines (SVM)**, **Random Forest (RF)**, and **Neural Networks** are widely used to classify stress levels based on extracted features. Recent studies emphasize **personalized models**, as stress responses vary from person to person. Personalized systems that learn an individual's baseline provide more reliable and accurate results. Furthermore, **IoT-based real-time systems** enable remote monitoring of workers in hazardous environments, transmitting stress data to centralized dashboards for timely action. However, challenges such as signal noise, power efficiency, and data privacy remain.

EXISTING SYSTEM

In the existing stress detection systems, most approaches rely on **manual observation**, **questionnaires**, or **periodic assessments** to evaluate a worker's mental and physical state. These traditional methods are **subjective**, time-consuming, and unsuitable for continuous monitoring in hazardous environments. Some systems use **non-personalized models** that analyze physiological data such as heart rate and skin temperature, but they often fail to adapt to individual differences, resulting in **low accuracy and false alarms**.

Existing wearable-based systems collect physiological data but typically perform **offline analysis**, meaning stress levels are determined after data collection rather than in real time. Moreover, these systems often focus on laboratory settings rather than real-world hazardous operations, where environmental conditions, motion artifacts, and physical exertion affect signal quality.

Additionally, many current solutions lack **IoT integration** and **real-time alert mechanisms**, limiting their ability to provide immediate feedback or preventive actions. Data privacy and limited energy efficiency in wearable sensors also pose challenges for long-term use.

Thus, the existing systems provide only partial monitoring and are not efficient enough for continuous, **real-time, personalized stress detection** required in high-risk operational environments.

PROPOSED SYSTEM

The proposed system introduces a **real-time, personalized, physiologically based stress detection model** specifically designed for hazardous operations. It uses **wearable biosensors** to continuously monitor key physiological parameters such as **heart rate, heart rate variability, electrodermal activity (EDA), skin temperature, and oxygen saturation (SpO_2)**. These signals are processed using advanced **machine learning algorithms** to accurately identify stress levels as they occur.

Unlike traditional systems, this model is **personalized** — it establishes an individual's

International Journal of
DATA SCIENCE AND IOT MANAGEMENT SYSTEM
ISSN: 3068-272X www.ijdim.com Original Research Paper

physiological baseline under normal conditions and detects stress based on deviations from this baseline. This personalization improves detection accuracy and minimizes false alarms.

The system is built on an **IoT-enabled platform**, where real-time data from sensors are transmitted wirelessly to a **central monitoring unit**. The data are analyzed instantly, and if high stress is detected, **immediate alerts** are sent to supervisors or safety systems, enabling timely intervention.

The proposed solution emphasizes **edge computing** for fast processing, **secure data handling**, and **energy-efficient sensor operation** to ensure reliability in field environments. It can be integrated into safety helmets, wristbands, or wearable garments for continuous monitoring without disrupting worker comfort.

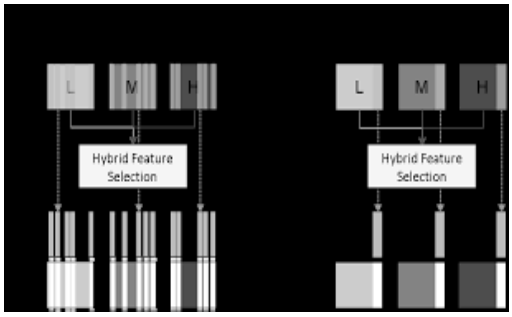
METHODOLOGY

The proposed system employs a systematic approach to detect stress in real time using physiological signals. Initially, **wearable biosensors** are used to collect data such as heart rate, skin temperature, electrodermal activity (EDA), and oxygen saturation (SpO_2) from individuals working in hazardous environments. These sensors are connected through **IoT technology**, enabling continuous and wireless data transmission. The collected signals often contain noise caused by body movement or external factors; therefore, **data preprocessing techniques** like filtering and normalization are applied to remove artifacts and improve signal accuracy.

After preprocessing, key **features** that represent the worker's physiological state—such as heart rate variability and skin conductance levels—are extracted. These features are then used to train **machine learning models** like Support Vector Machine (SVM), Random Forest (RF), or Neural Networks. Each worker's **personal baseline** is first recorded under normal conditions, and the system compares real-time data with this baseline to detect any deviation that indicates stress. When stress is detected, an **alert** is automatically sent to the monitoring system or supervisor through the IoT network for timely action.

System Model

SYSTEM ARCHITECTURE



Results and Discussions

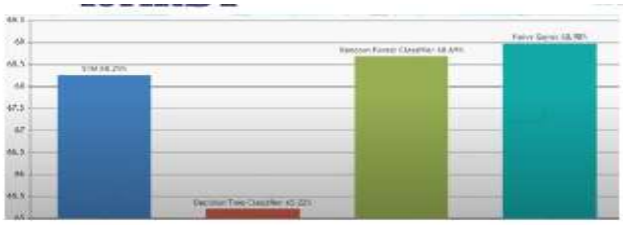


Fig:3 :Accuracy Results

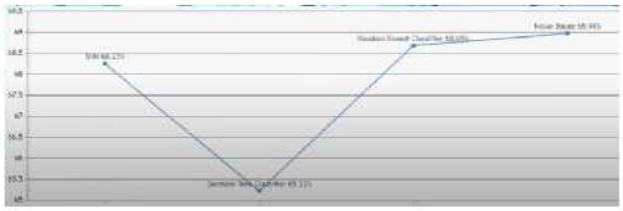


Fig:4 :Accuracy Graph

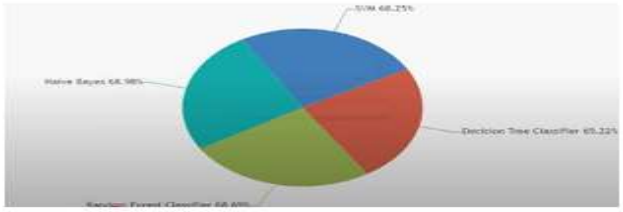


Fig:5 :Pie Chart Accuracy Results

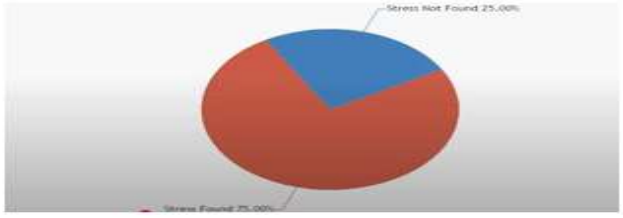


Fig:6 :Pie Chart Stress Found /or not

CONCLUSION

The proposed real-time personalized physiologically based stress detection system provides an effective solution for ensuring safety and well-being in hazardous working environments. By integrating **wearable biosensors**, **IoT technology**, and **machine learning algorithms**, the system continuously

International Journal of
DATA SCIENCE AND IOT MANAGEMENT SYSTEM
ISSN: 3068-272X www.ijdim.com Original Research Paper

monitors physiological parameters and accurately detects stress levels in individuals. Unlike traditional approaches, it adapts to each worker's unique physiological baseline, improving accuracy and minimizing false alerts.

This real-time monitoring allows for **early identification of stress**, enabling supervisors to take timely preventive measures and reduce the likelihood of accidents or performance decline. The system also supports **data analysis and long-term monitoring**, which can be used to improve work schedules, workload distribution, and overall occupational health management.

In conclusion, the proposed system represents a significant advancement in **occupational safety and health monitoring**, offering a reliable, efficient, and intelligent solution to detect and manage stress in hazardous operations, ultimately leading to safer and more productive work environments.

REFERENCES

- Healey, J. A., & Picard, R. W. (2005). *Detecting stress during real-world driving tasks using physiological sensors.* IEEE Transactions on Intelligent Transportation Systems, 6(2), 156–166.
- Gjoreski, M., Gjoreski, H., Luštrek, M., & Gams, M. (2016). *Continuous stress detection using a wrist device: In laboratory and real-life situations.* ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 1(2), 1–20.
- Setz, C., Arnrich, B., Schumm, J., La Marca, R., Tröster, G., & Ehlert, U. (2010). *Discriminating stress from cognitive load using a wearable EDA device.* IEEE Transactions on Information Technology in Biomedicine, 14(2), 410–417.
- Can, Y. S., Chalabianloo, N., Ekiz, D., & Ersoy, C. (2019). *Continuous stress detection using wearable sensors in real life: Algorithmic programming contest case study.* Sensors, 19(8), 1849.
- Sarker, H., Tyburski, M., Rahman, M. M., Hovsepian, K., Sharmin, M., Epstein, D. H., & Choudhury, T. (2016). *Finding significant stress episodes in a discontinuous time series of rapidly sensed data.* Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 1(2), 1–23.
- Wijsman, J., Grundlehner, B., Penders, J., & Hermens, H. (2013). *Trapezius muscle EMG as predictor of mental stress.* In Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 7029–7032.
- Chen, W., & Zhao, L. (2020). *Stress detection using physiological signals based on machine learning: A comprehensive review.* Biomedical Signal Processing and Control, 62, 102099.
- Li, X., & Chung, W. Y. (2021). *Smart wearable systems for personalized stress monitoring using IoT and machine learning.* IEEE Access, 9, 89456–89468.
- Zontone, P., Affanni, A., Pinti, P., & Napoletano, P. (2022). *Real-time stress monitoring through multimodal wearable sensors.* Sensors, 22(15), 5674.
- Al-Shargie, F., Tang, T. B., & Kiguchi, M. (2019). *Stress assessment based on EEG, ECG, and EOG signals in response to cognitive tasks.* Sensors, 19(22), 5199.