

IoT-Based Real-Time Emotional State Detection System

Dharshini S, Harini T, Manjushree Magesh, Dr.S.Velmurugan

U.G. Student, Department of Information Technology, R.M.D Engineering College, Kavaraipettai, Tamil Nadu, India

U.G. Student, Department of Information Technology, R.M.D Engineering College, Kavaraipettai, Tamil Nadu, India

U.G. Student, Department of Information Technology, R.M.D Engineering College, Kavaraipettai, Tamil Nadu, India

Professor, Department of Information Technology, R.M.D Engineering College, Kavaraipettai, Tamil Nadu, India

ABSTRACT: Emotional dysregulation is a significant challenge for individuals experiencing conditions such as ADHD, anxiety disorders, and substance use disorders. Traditional approaches to emotional monitoring primarily rely on self-reporting and periodic clinical evaluations, which are subjective and often fail to capture real-time fluctuations in emotional states. This paper presents the design and implementation of an IoT-enabled emotional state detection system that provides continuous, objective monitoring based on physiological signals. The proposed system measures key physiological parameters, including skin temperature, galvanic skin response (GSR), and body movement patterns, which are associated with emotional arousal and stress. These signals are acquired and pre-processed using an ESP32 microcontroller and transmitted securely to a cloud-based IoT platform. Cloud-level analytics and pattern recognition techniques are applied to identify deviations from baseline patterns and detect potential emotional instability. When significant variations are observed, the system generates alerts and provides visual feedback through a monitoring interface. By shifting from subjective self-assessment to sensor-driven data acquisition, the system enables more reliable and consistent emotional monitoring. Cloud integration supports real-time access, long-term trend analysis, and remote supervision when required. Data security is ensured through encrypted communication protocols and controlled access mechanisms to protect sensitive information. The proposed architecture establishes a scalable framework for real-time emotional state assessment using embedded systems and IoT technologies. This approach contributes to the growing field of technology-assisted mental health monitoring by promoting early detection, improved self-awareness, and proactive emotional regulation.

KEYWORDS: IOT Technology; Emotional State Detection; Real-Time Monitoring; Physiological Signal Processing; Galvanic Skin Response (GSR); Skin Temperature Monitoring; ESP32 Microcontroller; Cloud-Based Analytics; Pattern Recognition

I. INTRODUCTION

The primary objective of this project is to design and implement an IoT-enabled system capable of detecting and analyzing emotional states based on physiological parameters. The system aims to provide continuous, real-time monitoring of users' emotional fluctuations by capturing data such as skin temperature, perspiration levels, and movement patterns through integrated sensors. This information will be processed by an ESP32 microcontroller, which serves as the central unit for data acquisition and transmission to a cloud-based platform. On the cloud, advanced data analysis techniques and pattern recognition algorithms will be applied to interpret the physiological signals and identify mood-related trends or anomalies. The goal is to enable early detection of emotional dysregulation, allowing users, caregivers, or therapists to take timely and appropriate actions. Additionally, the project seeks to enhance self-awareness among individuals by providing feedback on their emotional states, thereby supporting behavioural regulation and mental well-being. This system contributes to the growing field of technology-assisted emotional health monitoring.

II. LITERATURE SURVEY

The use of IoT-integrated sensing and machine learning for emotion and stress detection has gained increasing attention across healthcare, wellbeing, and adaptive learning environments. This section reviews five key studies that collectively

highlight advances in physiological sensing, deep-learning-based affect recognition, and the challenges of deploying these systems in real-world contexts. A. K. Tripathi et al. [1] propose a hierarchical deep neural network that processes multimodal physiological data—heart rate, respiration, and electrodermal activity—collected through wrist and chest wearables. Their model classifies baseline, amusement, and stress states with an accuracy of roughly 87%, demonstrating the value of fusing multiple biomarker streams. However, the study's dependence on controlled datasets raises concerns regarding generalizability beyond laboratory conditions. Similarly, P. G. López et al. [2] introduce EmotIoT, an IoT-based emotional wellbeing platform that blends sensor-derived physiological metrics with user-submitted self-reports. The system predicts emotional states with over 80% accuracy and provides adaptive recommendations to support stress reduction. Despite its integrative design, the framework's reliance on self-reported inputs limits full automation and may introduce inconsistency in emotional labeling. Expanding on IoT-centric affect monitoring, M. A. Khan et al. [3] implement a Long Short-Term Memory (LSTM) model to classify emotions using pulse rate, skin temperature, and electrodermal activity. Their findings show strong classification performance and highlight potential applications in remote healthcare and distance-learning contexts—particularly relevant during the COVID-19 period. Nevertheless, the computational demands of LSTM networks pose challenges for real-time deployment on low-power edge devices. A different perspective is offered by A. Gupta et al. [4], who explore aggression detection in children with ADHD via accelerometer-based activity monitoring. Using a Random Forest classifier trained on triaxial motion data, the system achieves an F1 score of 82%. The study underscores the usefulness of motion-derived behavioral cues for affect assessment. Still, its exclusive reliance on physical activity signals—without incorporating physiological factors such as temperature or sweat response—limits its scope in capturing complex emotional states. Finally, S. Chatterjee et al. [5] examine the use of galvanic skin response (GSR) as a standalone indicator of mental stress. Their analysis demonstrates that fluctuations in skin conductance correlate reliably with stress intensity, validating GSR as a practical modality for real-time emotional monitoring. However, the work does not extend to multi-sensor fusion or IoT-enabled architectures, which limits its applicability for more comprehensive and scalable stress-detection frameworks. Collectively, these studies show that IoT-based physiological sensing paired with machine learning holds strong potential for emotional and stress detection. Yet challenges remain—particularly related to real-world generalization, multi-modal integration, computational efficiency, and minimizing user burden.

III. EXISTING SYSTEM

Currently, emotional state detection and mental health monitoring largely rely on self-reporting methods and periodic clinical assessments. Individuals are often required to communicate their emotional experiences through questionnaires, therapy sessions, or mobile applications designed for mood tracking. While these tools provide useful subjective insights, they depend heavily on user input and consistency, which can be unreliable, especially for individuals experiencing ADHD, anxiety, or substance use disorders. Some existing wearable devices, such as smartwatches and fitness trackers, measure limited physiological parameters like heart rate or activity level, but they do not provide comprehensive emotional state analysis or real-time alert mechanisms. Moreover, these devices typically focus on physical fitness rather than psychological well-being. The lack of continuous, automated, and accurate emotion detection limits the ability to identify early signs of emotional distress or behavioral relapse. Hence, there is a growing need for an integrated, sensor-based IoT solution that can objectively monitor physiological indicators and support proactive emotional regulation and mental health management.

IV. PROPOSED SYSTEM

The proposed system introduces an IoT-integrated emotional state detection device designed to overcome the limitations of existing manual and subjective methods. This system utilizes multiple physiological sensors to measure key indicators such as skin temperature, galvanic skin response (perspiration levels), and body movement patterns, all of which are correlated with emotional variations. The collected data is processed by an ESP32 microcontroller, which acts as the core computational unit for signal acquisition and preliminary filtering. The processed information is then transmitted securely to an IoT cloud platform using Wi-Fi connectivity, where it undergoes further analysis through pattern recognition algorithms and data visualization dashboards.

The system can identify significant deviations from normal emotional patterns and generate real-time alerts to notify users, caregivers, or therapists. This enables timely intervention in cases of emotional distress or potential relapse. Furthermore, the cloud integration allows for long-term data storage and trend analysis, supporting better

understanding of emotional behavior over time. Overall, the proposed system provides a non-invasive, continuous, and intelligent monitoring solution that bridges the gap between physiological signals and emotional awareness, promoting improved self-regulation and mental health outcomes. The various advantages are listed below:

A. Real-Time Monitoring

Continuous tracking of physiological parameters enables instant detection of emotional fluctuations, allowing for timely interventions.

B. Objective Data Collection

Unlike self-assessment methods, the system relies on sensor-based physiological data, minimizing bias and improving accuracy.

C. Early Detection and Intervention

By identifying unusual emotional patterns early, the system supports preventive care and reduces the risk of emotional outbursts, anxiety attacks, or relapse.

D. Remote Accessibility

The integration with cloud platforms allows caregivers and therapists to access emotional data remotely, promoting effective monitoring and support.

E. User Awareness and Self-Regulation

Providing real-time feedback helps users understand their emotional responses better and develop coping strategies.

F. Scalability and Integration

The system can be expanded with additional sensors or integrated with mobile and wearable applications for enhanced usability.

Overall, the proposed solution delivers a smart, data-driven approach to emotional health management, combining IoT technology and physiological sensing for improved mental well-being.

V. OVERVIEW OF THE SYSTEM

The proposed IoT-enabled emotional state detection system is designed to monitor, analyze, and provide feedback on users' emotional fluctuations in real time. The system integrates wearable physiological sensors that measure key parameters such as skin temperature, perspiration levels (galvanic skin response), and movement patterns, which are strongly correlated with emotional states. These sensors are connected to an ESP32 microcontroller, serving as the central processing unit responsible for acquiring, filtering, and temporarily storing the data before transmission.

The collected physiological signals are transmitted via Wi-Fi to an IoT cloud platform, where advanced data analysis algorithms detect patterns, trends, and significant deviations from normal emotional states. Based on this analysis, the system can generate instant notifications for the user or designated caregivers, enabling timely interventions during episodes of anxiety, emotional dysregulation, or stress. The system also provides long-term data storage and visualization, allowing users and therapists to monitor emotional trends over time. By combining real-time monitoring, intelligent analysis, and cloud connectivity, this system offers a non-invasive, continuous, and proactive approach to emotional health management, supporting self-awareness, behavioral regulation, and improved mental well-being.

The hardware design of the proposed emotional state detection system focuses on seamless integration between physiological sensors and the ESP32 microcontroller for efficient data acquisition and transmission. The system incorporates sensors that measure skin temperature, galvanic skin response (GSR), and motion activity. These sensors are strategically placed to ensure accurate and consistent readings from the user's body.

The ESP32 microcontroller serves as the central node, featuring built-in Wi-Fi and Bluetooth capabilities for IoT communication. Each sensor is interfaced with the ESP32 through its analog or digital input pins, where the collected signals are first filtered and digitized for preprocessing. For example, the GSR sensor measures changes in skin

conductivity due to perspiration, while the temperature sensor tracks thermal variations associated with emotional arousal. The accelerometer detects movement patterns that may correspond to agitation or restlessness.

Once the signals are processed, the ESP32 formats the data and transmits it securely to the IoT cloud platform for storage and analysis. The modular hardware configuration allows flexibility in adding or modifying sensors based on the user’s requirements. Overall, the hardware design ensures real-time data capture, low power consumption, and reliable communication between the sensing layer and the cloud infrastructure.

VI. WORKFLOW

The workflow of the IoT-enabled emotional state detection system follows a structured sequence, beginning with data acquisition, followed by processing, cloud transmission, analysis, and feedback generation. The process starts when the wearable sensors continuously collect physiological signals such as skin temperature, perspiration levels, and movement activity. These raw analog signals are fed into the ESP32 microcontroller, which performs initial preprocessing, including noise filtering and analog-to-digital conversion. After preprocessing, the ESP32 transmits the formatted data to the IoT cloud platform using secure Wi-Fi communication protocols such as MQTT or HTTP. On the cloud, data analytics modules and pattern recognition algorithms analyze the incoming streams to detect variations that may indicate emotional changes such as stress, anxiety, or agitation. The processed information is then visualized on a dashboard interface, where users or caregivers can observe emotional trends in real time. If the system identifies a significant deviation from normal patterns, it triggers a real-time alert or notification, enabling prompt intervention or self-regulation. The workflow thus ensures a continuous loop of sensing, analysis, and feedback, providing a responsive and intelligent emotional monitoring system that promotes early detection and proactive mental health management.

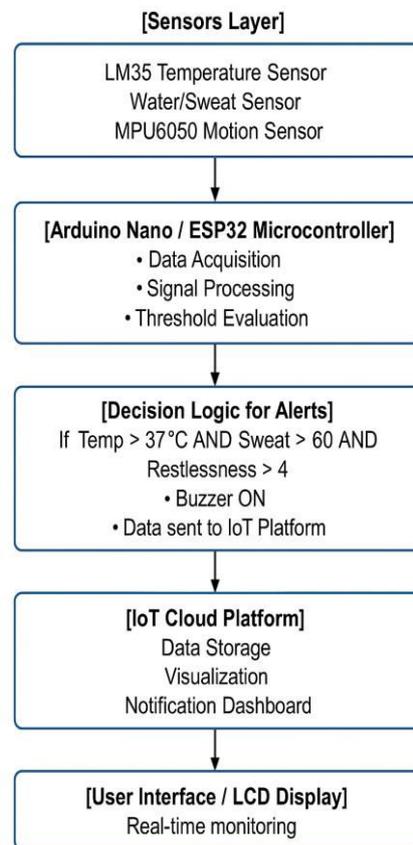


Fig 1: Workflow Diagram

VII. HARDWARE AND SOFTWARE REQUIREMENTS

The hardware components form the foundation of the IoT-based emotional state detection system, enabling the collection, processing, and display of physiological data. Each element plays a specific role in ensuring accurate sensing, reliable communication, and effective user feedback.

Arduino Nano: Used for initial prototyping and sensor interfacing. It provides easy connectivity and efficient analog signal processing for small-scale testing.

- A. NodeMCU (ESP8266): Serves as the primary IoT controller with built-in Wi-Fi capabilities. It collects processed sensor data and transmits it to the cloud for analysis and visualization.
 - B. General Purpose Board (Breadboard/PCB): Provides a platform for circuit assembly and testing connections among the components.
 - C. Buzzer: Acts as an alert mechanism to indicate abnormal emotional readings or threshold breaches.
 - D. 16x2 LCD Display: Displays real-time sensor readings such as temperature, motion, or moisture levels directly to the user.
 - E. LM35 Temperature Sensor: Measures the user's skin temperature, which varies with emotional arousal or stress.
 - F. MPU6050 Sensor: Detects movement and acceleration, helping identify agitation or hyperactivity.
 - G. Water Sensor: Used to approximate perspiration levels, correlating with galvanic skin response.
 - H. Connecting Wires: Enable stable electrical connections between sensors, controllers, and output devices.
- Collectively, these components establish an efficient and scalable hardware foundation for emotional state detection.

The software requirements define the development environment, programming tools, and cloud services necessary for implementing and monitoring the IoT-based emotional state detection system. Both embedded and web-based software platforms are used to ensure seamless data flow from sensors to user interfaces.

- A. Arduino IDE: Used for programming the Arduino Nano and NodeMCU microcontrollers. It supports C/C++ coding and provides essential libraries for sensor integration, Wi-Fi communication, and LCD display control.
- B. ThingSpeak IoT Platform: Acts as the cloud server for real-time data storage, processing, and visualization. The NodeMCU transmits sensor readings to ThingSpeak using the MQTT or HTTP protocol. ThingSpeak's analytics tools, such as MATLAB integration, allow for graphical plotting of emotional trends and detection of abnormal readings over time.
- C. Visual Studio Code (VS Code): Employed for developing the web interface using HTML, CSS, and JavaScript. The web page fetches data from the ThingSpeak API and renders it dynamically, enabling users and caregivers to view real-time updates and emotional statistics in a browser.
- D. Embedded Libraries and Drivers: Libraries like ESP8266WiFi.h, Wire.h, and LiquidCrystal.h enable sensor interfacing and cloud communication, while USB drivers support hardware–software interaction.

Together, these tools provide an integrated environment for data acquisition, processing, visualization, and user interaction across both embedded and web platforms.

VIII. ALERT LOGIC

The microcontroller continuously monitors the collected signals. An alert is triggered only when all three conditions are satisfied: body temperature exceeds 37 °C, sweat level is above 60, and restlessness count is greater than 4. Once these thresholds are met, the buzzer sounds, and the event is logged to the cloud platform, ensuring immediate and accurate notification. This hardware design ensures real-time monitoring, efficient processing, and reliable alert generation while maintaining simplicity and low power consumption.

IX. ARCHITECTURE DESIGN

The overall architecture of the IoT-enabled emotional state detection system is designed to ensure seamless interaction between hardware, software, and cloud components, providing a comprehensive solution for real-time emotional monitoring. At the hardware level, wearable sensors such as the LM35 temperature sensor, water/sweat sensor, and MPU6050 motion sensor collect physiological data, which is preprocessed by the Arduino Nano and transmitted to the NodeMCU (ESP8266) for further handling. The microcontroller evaluates the sensor readings against predefined thresholds and triggers the buzzer alert when all conditions are met, while simultaneously sending the data to the ThingSpeak IoT platform for storage, analysis, and visualization. The architecture supports modular scalability, allowing additional sensors or user interfaces to be integrated without significant redesign. The system also includes a web-based dashboard, developed using HTML, CSS, and JavaScript in Visual Studio Code, which fetches real-time data from the IoT cloud for user and caregiver access. By combining a robust hardware layer with cloud computing and a responsive web interface, the architecture enables continuous monitoring, intelligent alerting, and long-term trend analysis, ensuring both reliability and usability in managing emotional well-being.

X. SYSTEM DESIGN AND SCREENSHOTS

This section includes images and screenshots of sensor readings, dashboard visualizations, and alert notifications. The images illustrate data acquisition, real-time updates on the web interface, and buzzer alerts, providing a clear representation of system performance and user interaction.

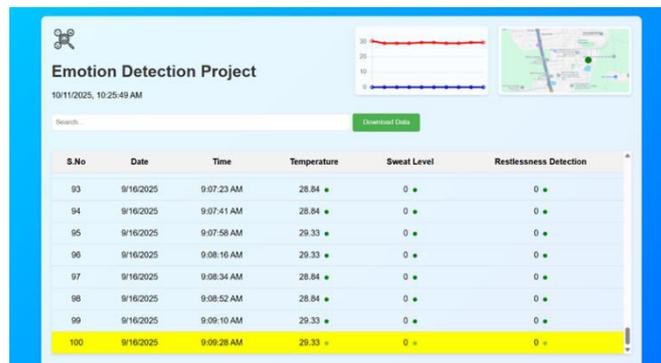


Fig 3: Screenshot of the website

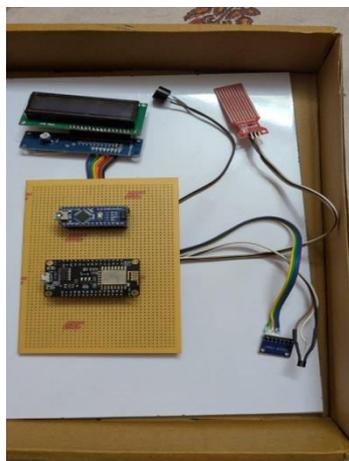


Fig 4: Hardware Setup

XI. FUTURE ENHANCEMENTS

Several enhancements can be implemented to expand the system's capabilities and improve its efficiency. Advanced machine learning algorithms can be integrated on the cloud platform to detect subtle emotional patterns and predict potential stress or anxiety events before threshold conditions are reached. Additional sensors, such as heart rate monitors or blood pressure sensors, could be incorporated to provide a more comprehensive physiological profile.

Moreover, the current design is a basic prototype intended to demonstrate feasibility. To make it practical and user-friendly, the device needs to be miniaturized and ergonomically designed, allowing it to be worn comfortably without constant manual intervention. This would make the system more intuitive and convenient, enabling continuous monitoring without disrupting daily activities.

The system could also be extended into a mobile application, offering push notifications, personalized recommendations, and trend analysis for multiple users. Integration with wearable devices and healthcare platforms could enable remote monitoring by professionals. Enhancements to the dashboard interface, including interactive visualizations and customizable alert thresholds, would further increase usability and intelligence, making the system suitable for real-world deployment and long-term mental health management.

XII. CONCLUSION

The IoT-enabled emotional state detection system demonstrates an effective integration of hardware, software, and cloud technologies to monitor and manage emotional well-being in real time. By leveraging physiological sensors such as temperature, sweat, and motion detectors, the system can identify significant changes in emotional states and provide immediate alerts via a buzzer while simultaneously logging data to the cloud. The integration of Arduino Nano, NodeMCU, and the ThingSpeak platform ensures reliable data acquisition, processing, and visualization.

The project highlights the importance of continuous monitoring for individuals at risk of emotional dysregulation, anxiety, or stress-related conditions. The system's modular design and responsive web dashboard make it accessible, scalable, and user-friendly. Through real-time feedback, threshold-based alerts, and long-term data visualization, the solution fosters self-awareness, timely intervention, and better mental health outcomes. Overall, the project validates the feasibility of combining IoT and embedded systems to create a proactive, intelligent, and practical tool for emotional state management.

REFERENCES

- [1] A. K. Tripathi et al., "Hierarchical Deep Neural Network for Mental Stress State Detection Using IoT-Based Biomarkers," *Pattern Recognition Letters*, vol. 145, pp. 55–61, 2021.
- [2] P. G. López et al., "EmotIoT: An IoT System to Improve Users' Wellbeing," *Applied Sciences*, vol. 12, no. 12, p. 5925, 2022.
- [3] M. A. Khan et al., "LSTM-Based Emotion Detection Using Physiological Signals: IoT Framework for Healthcare and Distance Learning in COVID-19," *Computers, Materials & Continua*, vol. 72, no. 3, pp. 5669–5685, 2022.
- [4] A. Gupta et al., "Machine Learning-Based Aggression Detection in Children with ADHD Using Sensor-Based Physical Activity Monitoring," *Sensors*, vol. 23, no. 10, p. 4949, 2023.
- [5] S. Chatterjee et al., "Functional Analysis of Mental Stress Based on Physiological Data of GSR Sensor," in *Proceedings of the International Conference on Computational Intelligence and Communication Networks (CICN)*, Springer, 2015, pp. 121–130.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details