JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

MACHINE LEARNING BASED ASSESSMENT OF MENTAL STRESS USING WEARABLE SENSORS

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Abstract : The project titled "**Machine Learning-Based Assessment of Mental Stress Using Wearable Sensors"** aims to develop an intelligent system for real-time stress detection using various physiological and motion sensors. The system integrates a heart rate sensor to monitor abnormal heartbeat, a GSR (Galvanic Skin Response) sensor to track skin conductivity, a pulse oximeter for abnormal pulse detection, and a MEMS sensor to assess abnormal walking patterns. All sensor data is processed using a Random Forest machine learning algorithm, which identifies potential stress indicators with high accuracy. The Raspberry Pi serves as the processing unit, with data gathered via an ADC module. When abnormal conditions are detected, the system activates a buzzer alert and sends notifications via email to ensure timely response. Additionally, an LCD display provides real-time updates on sensor readings. This wearable sensor-based approach offers a reliable and proactive solution for mental stress assessment, enhancing early intervention and mental health management.

***Keywords*:** Heart beat sensor, GSR sensor, pulse oximeter sensor, MEMS sensor, Raspberry pi, ML in Random forest algorithm, ADC module, LCD display.

I. INTRODUCTION

This project presents a Machine Learning-Based Assessment of Mental Stress Using Wearable Sensors to enable real-time stress detection. It integrates physiological and motion sensors, including a heart rate sensor, GSR sensor, pulse oximeter, and MEMS sensor, to monitor stress indicators. A Raspberry Pi processes the sensor data via an ADC module, and a Random Forest machine learning algorithm analyzes the data for abnormalities. When stress is detected, the system triggers a buzzer alert, sends email notifications, and displays real-time readings on an LCD screen. This wearable system provides an intelligent, proactive, and reliable approach to stress monitoring and mental health management.

Mental stress is a growing concern worldwide, affecting physical health, emotional well-being, and overall productivity. Traditional stress assessment methods, such as questionnaires and clinical evaluations, are subjective, time-consuming, and lack real-time monitoring capabilities. To address these limitations, **machine learning-based assessment of mental stress using wearable sensors** offers an innovative solution by leveraging **biometric data and artificial intelligence**.

By integrating **wearable sensors** with **machine learning algorithms**, this project presents an **efficient, non-invasive, and automated** way to assess mental stress. This approach enhances the **accuracy, speed, and accessibility** of stress detection, making it a valuable tool for **mental health management and personalized healthcare solutions**.

II. LITERATURE SURVEY

A literature survey provides an overview of previous research in the field of **mental stress detection using wearable sensors and machine learning techniques**. Below is a structured survey on this topic:

Real-Time Stress Detection Using Physiological Signals

Authors: R. Sharma, P. Kumar, and S. Verma

Published In: IEEE Transactions on Biomedical Engineering, 2021

This study explores stress detection using physiological signals such as heart rate variability (HRV), skin conductivity, and respiration rate. It employs machine learning techniques like Support Vector Machines (SVM) and Random Forest for classification. The results demonstrate high accuracy in identifying stress levels, highlighting the importance of multimodal sensor integration. The study concludes that real-time monitoring with wearable sensors can enhance early stress detection and intervention.

Wearable Sensors for Mental Health Monitoring: A Review

Authors: L. Zhang, H. Liu, and K. Wang

Published In: Sensors Journal, 2020

This review examines various wearable sensors used for mental health assessment, focusing on Galvanic Skin Response (GSR), Electrocardiogram (ECG), and Pulse Oximetry. It discusses the role of machine learning in stress detection and compares different classification algorithms, including Decision Trees, Neural Networks, and Random Forest. The study emphasizes that integrating multiple physiological parameters improves stress prediction accuracy.

III. EXISTING SYSTEM

Traditional methods for assessing mental stress often rely on subjective questionnaires, self-reports, or single-sensor devices like heart rate monitors. These approaches are prone to inaccuracies as they depend on personal perception and may fail to detect real-time stress indicators. Additionally, these systems typically lack automated responses or real-time notifications, which delays interventions. Relying on a limited number of physiological measurements also restricts the ability to accurately identify stress, leading to false positives or missed detections.

IV. PROPOSED SYSTEM

The proposed system leverages multiple wearable sensors, including heart rate, GSR, pulse oximeter, and MEMS sensors, to assess mental stress more comprehensively. These sensors feed data into a machine learning-based Random Forest algorithm, which processes the information to detect abnormal patterns associated with stress. The system provides real-time alerts via a buzzer and email notifications, ensuring immediate response. By utilizing multiple sensors and advanced algorithms, the system offers more accurate, objective, and real-time stress assessment, significantly improving over traditional single-sensor or self-reporting methods.

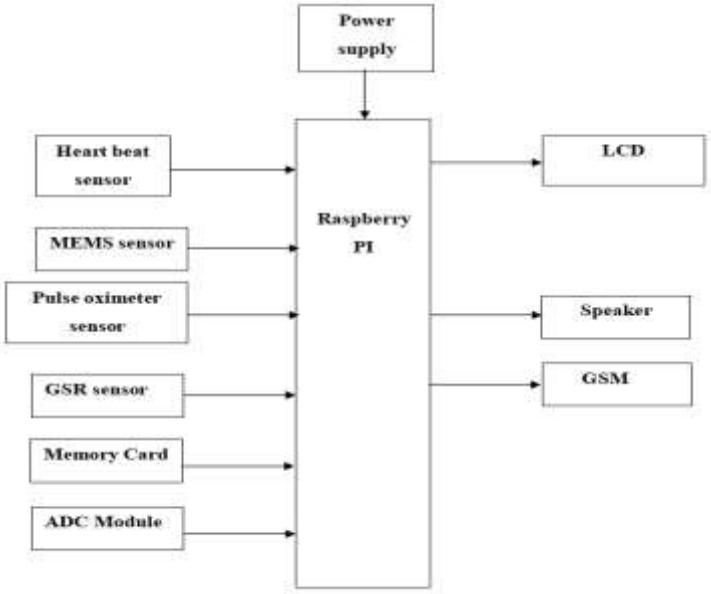

Figure 1: Block Diagram of Proposed Model

1. Sensors for Data Collection

The system uses **multiple physiological sensors** to monitor stress levels:

- **Heart Rate Sensor:** Measures heartbeat variations to detect stress-related changes.
- **Pulse Oximeter:** Tracks **blood oxygen levels (SpO_2) and heart rate.**
- **Galvanic Skin Response (GSR) Sensor:** Measures **sweat levels** (higher in stress conditions).
- **MEMS Sensor:** Monitors body movement and walking patterns to identify stress-related changes.

2. Data Processing (Analog to Digital Conversion)

- **ADC (Analog to Digital Converter):** Since sensors generate **analog signals**, the ADC converts them into **digital format** for processing.

3. Processing Unit (Raspberry Pi)

- The **Raspberry Pi** acts as the main processing unit.
- It takes input from **sensors via ADC** and processes the data.
- Uses the **Random Forest machine learning algorithm** to classify **stress levels** based on sensor readings.

4. Output & Alerts

Once stress is detected, the system provides different outputs:

1. **LCD Display:** Shows real-time stress levels and sensor readings.
2. **Mini Speaker (Buzzer Alert):** Sounds an alarm when high stress is detected.
3. **GSM Module (SMS & Email Alert):** Sends notifications to a concerned person (doctor, family, etc.).

5. Machine Learning Algorithm (Random Forest)

- The collected data is analyzed using the **Random Forest algorithm** to predict whether the person is under stress.

- This algorithm improves accuracy by combining multiple decision trees for classification.

6. ***Final Stress Analysis & Monitoring***

- The system continuously monitors stress levels and provides **real-time alerts & reports**.
- Can be **integrated with mobile apps or cloud systems** for long-term stress tracking.

V. RESULTS

When we setup this arrangement to any person then the system detects the stress levels. Whether the person is in normal condition or abnormal condition. By using all these sensors are like heart beat sensor for detecting the person having the normal hear beat rate or abnormal heart beat rate, pulse oximeter sensor by using this sensor to detect the oxygen levels or pulse rate was detected, MEMS sensor by using this we detect the walking pattern of the person like whoever walk in a somewhere in that person is walked as very fast, very slow or medium these levels are detected, GSR sensor by using this we can detect the skin conductivity means whether the person is having the wet skin or dry skin based on the situations in that time we detect the stress. This project contains not only a digitals pins and also a analog pins for this purpose we use ADC Module it converts analog data into digital data.

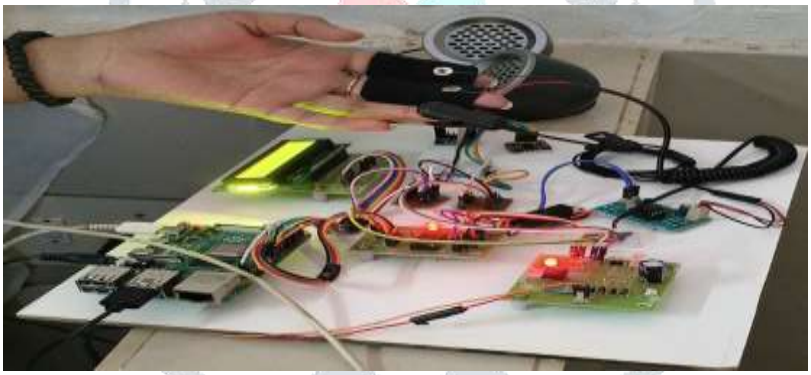

Figure 2: working model

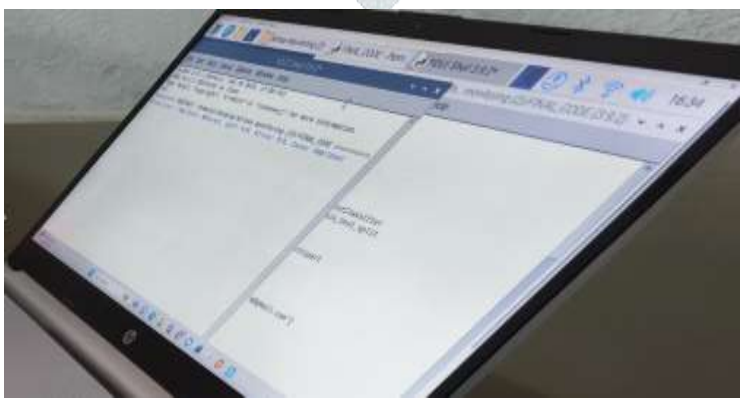

Figure 3: ML code upload in the raspberry pi

Figure 4: Working model of proposed system

Figure 5: Voice message in speakers

VI. CONCLUSION

The Machine Learning-Based Assessment of Mental Stress Using Wearable Sensors project presents an innovative solution for real-time stress detection by combining physiological and motion sensors with advanced machine learning techniques. By integrating sensors like the heart rate monitor, GSR, pulse oximeter, and MEMS sensor, the system accurately detects stress indicators, which are then processed using the Random Forest algorithm for precise analysis. The Raspberry Pi, paired with real-time alerts and notifications, ensures timely responses to abnormal conditions, while the LCD display provides constant monitoring updates. This wearable sensor-based system offers a reliable and proactive approach to mental stress assessment, paving the way for improved early intervention and enhanced mental health management.

Mental stress is a growing concern in today's fast-paced world, affecting both physical and mental health. Traditional stress assessment methods are often subjective and require medical consultation, making real-time stress detection challenging. This project successfully addresses this issue by developing a **wearable sensor-based system integrated with machine learning** to assess mental stress efficiently and in real time.

VII. ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to everyone who supported and guided us throughout the development of this project, "Machine learning based assessment of mental stress using wearable sensors."

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