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A Review on the Performance of Various Stress Detection Models under Different Situations

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ABSTRACT

Stress is a physiological and psychological response that individuals experience when they encounter challenges, or situations that they perceive as threatening, overwhelming, or beyond their ability to cope effectively. It triggers a cascade of physiological changes in the body, including the release of stress hormones like cortisol and adrenaline, and can have both short-term and long-term effects on physical and mental health. Over the years, a number of experts have analyzed stress through physiological signals like Electrocardiography (ECG) and Electrodermal Activity (EDA) provides insights into an individual's stress response. This study has been undertaken to analyze the different stress models using intelligent techniques under different situations. Machine learning and deep learning models enables the precise classification of stress patterns using a wide array of physiological signals and behavioral data.

Index Terms - Electrocardiography (ECG), Electrodermal Activity (EDA), Wearable Sensors, Skin Potential Response (SPR)

INTRODUCTION

Stress, one of the most pervasive and multi-faceted aspects of modern life, is a complex combination of complex physiological and psychological reactions that people faced when they have to confront with various obstacles or challenges.

The perception of stress can differ vastly among individuals, as it is contingent on their unique life circumstances, coping mechanisms, and resilience. While some may thrive under pressure, others might succumb to the deleterious effects of chronic stress.

Thus, stress analysis becomes imperative, not only for understanding its manifestations but also for devising strategies to manage and mitigate its impact (Gedam & Paul, 2021). Moreover, stress can erode the quality of life, strain relationships, and hinder productivity. Recognizing and managing stress is thus essential for preserving health, enhancing overall life satisfaction, and preventing stress-related ailments.

With the advancement of technology, various methods are designed for analyzing stress in human beings. Many scientists are using physiological signals to measure stress to get a better understanding of an individual’s stress response. These include: Breath rate, Blood pressure, Body temperature, Cortisol and Muscle tension. Body temperature variations and thermal imaging can highlight stress-related alterations in skin temperature regulation.

Cortisol, a stress hormone, can be measured in saliva, blood, or urine, providing insights into chronic stress levels.

Additionally, electromyography (EMG) can detect muscle tension and contraction patterns associated with stress.

While these signals are valuable in stress analysis, they often provide specific, context-dependent information (Chen et al., 2021).

As soon as stress begins to feel adaptable and manageable, people are capable to cope with it. They fail to see how their health is being negatively impacted by extended exposure to stress, even at modest levels. Being aware of the typical warning symptoms and indications of stress overload is therefore important.

The warning signs and symptoms of stress overload are listed in Table 1. In those who are predisposed, a stress overload can cause serious depression. In general, persistently stressful living circumstances can raise the likelihood of getting depression.

Table 1 Signs and symptoms of stress overload

Cognitive Symptoms	Constant worrying, Anxious thoughts, Forgetfulness, Disorganization, Inability to focus, Money problem, being pessimistic (seeing only the negative side), Poor concentration, Poor Judgment.
Physical Symptoms	Aches and pains, Nausea and Dizziness, Frequent cold and flu, Diarrhea or constipation, Chest pain, Rapid heart rate, loosening of bowel, Stiff or tense muscles, Grinding teeth, Frequency and urgency of urination, Tiredness, Weight loss or gain.
Emotional Symptoms	Feeling of tension, Irritability or Anger, Restlessness, Worries, Inability to relax, Depression, General unhappiness, Anxiety and Agitation, Moodiness, Loneliness and Isolation, Other mental and emotional health problems.
Behavioral Symptoms	Sleep problems, Difficulty in completing work assignments, Changes in appetite-either not eating or eating too much, Procrastinating and avoiding responsibilities, Increased use of alcohol, drugs or cigarettes, Exhibiting more nervous behaviors such as nail biting, fidgeting and pacing.

APPLICATIONS OF STRESS DETECTION SYSTEM

Systems for detecting stress have many uses in numerous industries. Here are a few typical examples:

- Mental Health and Well-being**:** Systems for detecting stress can be utilized in assessments and treatments related to mental health. They can assist in identifying those who are under a great deal of stress, enabling early support and intervention. Clinical settings, businesses, educational institutions, as well as private electronics including smartphones and wearable's, can all make use of these technologies (Cecchi et al. 2020).

- Workplace Safety and Productivity**:** In order to track employee stress levels, workplaces can use stress detection systems. Employers can put strategies in place to lessen stress, improve working conditions, and increase general productivity by detecting stressed employees. These systems can be used into campaigns for occupational health and wellness among employees.

- Educational Settings: Systems for detecting stress can be used in schools to keep track of how stressed out their kids are. Educators and counselors can detect students who are really stressed and offer them the right assistance and solutions. The well-being of students can be enhanced and the learning environment made more favorable with the aid of these solutions.

- Sports Performance: Sports performance evaluation and training can make use of stress detection technologies. During practice and contests, athletes' stress levels can be measured to have a better understanding of how they're feeling mentally and to spot potential performance-impairing pressures. With the use of this knowledge, coaches and trainers can improve their training plans and put stress-reduction measures into action (Bobade & Vani, 2020).

- Human-Computer Interaction: Computers and other gadgets can adjust to users' stress levels thanks to stress detection technologies, which can improve human-computer interaction. On the basis of the user's measured levels of stress, a computer can modify its interface or recommend stress-relieving activities. When using technology, this programme can make the user experience and general wellbeing better.

- Healthcare and Chronic Disease Management: The stress levels of individuals with chronic diseases like cardiovascular problems, diabetes, or chronic pain can be monitored by integrating stress detection technologies into healthcare facilities. By measuring patients' levels of stress, healthcare professionals can offer individualized therapies along with assistance for handling stress, possibly enhancing the patient's overall health results.

LITERATURE REVIEW

Traditionally, psychological experts analysis the stress using questionnaires and then they determine the person and their stress level. But now different advanced stress analysis models have been designed which are capable to determine the stress level automatically in humans. A. A. S. et al**.**, 2020, build an electrodermal activity (EDA)-based automatic pre-surgery stress detection method. Additionally, A wrist wearable is used in the measuring setup to continuously and unobtrusively monitor an individual's EDA. At the Sri Ramakrishna Hospital in Coimbatore, India, data were gathered from 41 subjects 17 females and 24 males who later underwent various surgical operations.

Moreover, A supervised machine learning system was created to find motion artifacts' in the recorded EDA data. On a brand-new user dataset, it produced an accuracy of 97.83%.To define low, moderate, and high degrees of stress, additional analysis of the clean EDA data was performed. Being under constant stress from looking after a family member who has autism spectrum disorder (ASD) might affect bodily homeostasis. The autonomic nervous system's sympathetic activity, which was associated with emotions and homeostasis, was measured by electrodermal activity (EDA).Parents of individuals with (n = 30) and without (n = 34) ASD (carers and non-caregivers, correspondingly) were tested for their EDA in reaction to acute stress in a laboratory setting. In reaction to acute stress, carers had lower EDA than non-caregivers. Compared to non-caregivers, carers displayed decreased EDA in response to acute stress.

Only in care givers was a higher EDA correlate with a lower mood and more intense physical complaints. These findings might be an adaptive adaptation to stress and show that the health of carers affects how much EDA they produce in reaction to acute stress (Ruiz-Robledillo, et al., 2015)

Zontone, P. and Affanni, 2020 **,** offered a system that used EDA Skin Potential Response (SPR) data and a straightforward, low-complexity classification method to determine a person's level of stress while they were operating a motor vehicle. The motion artefacts caused by the hand movements caused by steering the wheel and by vibrations were removed from the captured SPR signal using an adaptive filter that used the steering wheel signal as an indicator signal. In order to accurately capture the emotional and stress components of the SPR signal, statistical characteristics were then derived from the resultant signal. In order to identify the presence of stress during a specified time period, these features were provided as input to a Support Vector Machine (SVM) classifier. Furthermore, Data were gathered from studies conducted on several participants in which stress was created at random moments by loud noises, with a metronome frequency ticking sound providing the tempo for the motion of the steering wheel. **L.** The purpose of this study was to determine whether it was possible to identify stress in people by using Electrodermal Activity (EDA) data obtained through wearable technology. By analyzing the amount of perspiration that the sweat glands generate, EDA could calculate variations in sympathetic dynamics. Only a few manufacturers have EDA sensors integrated into their smartwatches at this time, and the use of EDA sensors in commercially available, off-the-shelf smart watches remains in its early stages. The datasets containing the EDA signals gathered from wearable devices were necessary to support the feasibility research (Zhu et al. 2021).

In this study by A. Hasanbasic, et al 2019, ten students were tracked using wearable sensors to determine how stressed they were during exams. Various classification techniques were applied using characteristics of the ECG and electro dermal activity signals. Findings obtained showed that for three classes relax state, written exam, and oral exam recognition accuracy ranges between 86 and 91%. Some advanced stress analysis models are tabulated in below table 2.

Table 2 Review of various Stress detection Techniques

Subjects	Signal Sensor	Stress Procedure	ML Technique	Result	Author
40	EDA	Subjects were put under relaxation, arousal and stress conditions	Linear SVM, LDA and Coarse tree classifiers	Accuracy 94.1% for test phase and 60.5 to 72.2% for stress and arousal	[10]
41	EDA	Hemicolectomy, or open appendectomy	Supervised ML algorithm	Accuracy of 97.83%	[5]
147	EDA	Watched videos depicting calm and stressed situations	SVM and Deep SVM	D-SVM and SVM classifiers achieved accuracy of 92% and 83% respectively	[11]
NA	EDA, PPG, Spare	Put subjects under 12-minute experiment with 6 minute baseline and 6 minute stressed	SVM and RF	Attained an accuracy of 80% for HRV features	[12]
20	EDA	Under three stress conditions	SVM	Attained accuracy of 88.52%	[13]
16	EDA	Controlled environment	SVM	Attains 87.7% accuracy	[14]

Stress Detection using Wearable Sensors In modern medical applications, sensors are absolutely essential. These are typically employed for the detection, assessment, and level-setting of a variety of disorders. One of the main elements contributing to a variety of health issues is typically acknowledged to be stress. In order to identify any indicators of stress before it results in health issues, those who are at a high risk of becoming stressed should be regularly observed. In order to identify the amount of stress, wearable sensors and mobile computing advancements allow for the continuous recording of a number of physical and physiological signs. In addition, The majority of wearable sensor devices, such as smart bands and chest belts, are employed to collect data. Some researchers collected data using sensors and identified the amount of stress using hardware and software, correspondingly.

STRESS DETECTION THROUGH PHYSIOLOGICAL SIGNALS

a. Stress detection using Electrocardiogram (ECG): The electrical activity of the heartbeat is quantified by an electrocardiogram (ECG). The cardiovascular system is just one of the many ways that stress has an impact on the body. A person's sympathetic nervous system becomes activated during stress, changing their heart rate and other ECG characteristics. Insights concerning a person's stress levels can be gained by examining these alterations, according to experts and medical specialists. For the purpose of identifying mental stress, Heart Rate Variability (HRV) parameters are typically extracted from ECG data. Additionally, these parameters are then separated into Time domain and Frequency domain for additional research. Baseline drift and noise were eliminated from the ECG data during pre-processing without changing the features of the ECG waveform. The discrete wavelet transform approach was used to do feature excision. Additionally, classification was carried out on real-time data using SVM, ANN, Bayesian network, and decision tree in order to obtain more accurate findings.

b. Stress detection using Electroencephalography (EEG):Stress has the power to alter the brain's normal state and have an impact on cognitive function. To assess brain cognitive change, electroencephalography (EEG) is performed. Due to its affordability, portability, and suitability for online projects, the EmotivEpoc device is frequently employed in EEG-related research to collect raw EEG information. EEG Theta and Alpha band alterations can be used to detect stress. Alpha wave power decreases while theta wave power increases indicating that the brain is experiencing stress. Stroop color-word test and mental arithmetic test stressors are used in an automated EEG-based stress identification system.

c. Blood Volume Pressure based Stress Detection: BVP is a technique for calculating the pressure placed on the blood vessels. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) are the two numbers that are obtained while evaluating blood pressure. Blood pressure is a good metric for measuring stress since the human body releases a lot of stress chemicals when under stress, which causes blood pressure to rise. According to a 3-year study, people who are under stress at work likely to have greater SBP and DBP, but they also have higher SBP while they are sleeping. It has been noted that SBP and DBP are increased when performing a mental stressor task.

CONCLUSION

Stress is a prevalent and often impactful aspect of modern life, and its timely identification is crucial for effective stress management and overall well-being. Here, stress analysis is poised for remarkable advancements with the integration of advanced artificial intelligence (AI) techniques. These developments promise to transform how we understand, detect, and manage stress. Real-time stress monitoring will become the norm, thanks to wearable devices and smartphone apps powered by AI algorithms, offering immediate feedback and proactive stress management strategies.

REFERENCES

[1]. S. Gedam and S. Paul, "A Review on Mental Stress Detection Using Wearable Sensors and Machine Learning Techniques," in IEEE Access, vol. 9, 2021, pp. 84045-84066.
[2]. Chen, J.; Abbod, M.; Shieh, J.-S. Pain and Stress Detection Using Wearable Sensors and Devices—Review. Sensors 2021, 21, pp. 1030.
[3]. S. Cecchi, A. Piersanti, A. Poli and S. Spinsante, "Physical Stimuli and Emotions: EDA Features Analysis from a Wrist-Worn Measurement Sensor," 2020 IEEE 25th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD), Pisa, 2020, pp. 1-6.
[4]. P. Bobade and M. Vani, "Stress Detection with Machine Learning and Deep Learning using Multimodal Physiological Data," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 51-57.
[5]. A. A. S. et al., "Electrodermal Activity Based Pre-surgery Stress Detection Using a Wrist Wearable," in IEEE Journal of Biomedical and Health Informatics, vol. 24, no. 1, 2020,pp. 92-100.
[6]. Zontone, P., Affanni, A., Bernardini, R., Piras, A., Rinaldo, R., “Low-Complexity Classification Algorithm to Identify Drivers’ Stress Using Electrodermal Activity (EDA) Measurements”, In: Tavares, J., Dey, N., Joshi, A.

(eds) Biomedical Engineering and Computational Intelligence. BIOCOM 2018. Lecture Notes in Computational Vision and Biomechanics, vol 32, 2020

[7]. Ruiz-Robledillo, N., Moya-Albiol, L. Lower Electrodermal Activity to Acute Stress in Caregivers of People with Autism Spectrum Disorder: An Adaptive Habituation to Stress. J Autism Dev Disord, vol. 45, 2015, pp. 576–588

[8]. L. Zhu et al., "Feasibility Study of Stress Detection with Machine Learning through EDA from Wearable Devices," ICC 2021 - IEEE International Conference on Communications, Seoul, Korea, Republic of, 2022, pp. 4800-4805

[9]. A. Hasanbasic, M. Spahic, D. Bosnjic, H. H. adzic, V. Mesic and O. Jahic, "Recognition of stress levels among students with wearable sensors," 2019 18th International Symposium INFOTEH-JAHORINA (INFOTEH), East Sarajevo, Bosnia and Herzegovina, 2019, pp. 1-4

[10]. T. Pakarinen, J. Pietilä and H. Nieminen, "Prediction of Self-Perceived Stress and Arousal Based on Electrodermal Activity," 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Berlin, Germany, 2019, pp. 2191-2195.

[11]. Sánchez-Reolid, Roberto, et al. "Deep support vector machines for the identification of stress condition from electrodermal activity." International Journal of Neural Systems 30.07, 2020, pp. 2050031.

[12]. Lima, Rodrigo, Daniel Faustino de Noronha Osório, and Hugo Gamboa. "Heart Rate Variability and Electrodermal Activity in Mental Stress Aloud: Predicting the Outcome." Biosignals. 2019.

[13]. Lutin, Erika, et al. "Feature Extraction for Stress Detection in Electrodermal Activity." BIOSIGNALS. 2021.

[14]. Sánchez-Reolid, R., Martínez-Rodrigo, A., Fernández-Caballero, A, “Stress Identification from Electrodermal Activity by Support Vector Machines” In: Ferrández Vicente, J., Álvarez-Sánchez, J., de la Paz López, F., Toledo Moreo, J., Adeli, H. (eds) Understanding the Brain Function and Emotions, IWINAC 2019, Lecture Notes in Computer Science, vol 11486, 2019.