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A Review on Stress type Analysis using Machine Learning

Hemangi Y. Rane[1], Harshali B. Patil[2]

Assistant Professor, Department of Computer Application, Indira College of Commerce and Science, Pune, India[1]

Assistant Professor, Department of Computer Science, Dr. Annasaheb G. D. Bendale Mahila Mahavdyalaya, Jalgoan, India[2]

Abstract: In this modern era, most of the peoples are working under stress regularly, however serious health issues like heart disease, asthma, migraines, depression, and anxiety can be causes by stress. Stress can be causes by a number of factors, such as being accepted into prestigious universities or colleges, lacking motivation, performing poorly academically, receiving low marks on exams, having high parental expectations, and not knowing if one will be able to find employment after graduating from college. This paper provides an overview of the methods for identifying, tracking, and controlling stress using both supervised and unsupervised learning strategies. This review paper also covers the method for identifying and categorizing stress.

Keywords: Stress detection parameters, psychological stress, physiological stress and method of stress detection

I. INTRODUCTION

Stress is a tense or worried state arrived by a challenging circumstance. Stress can occasionally be beneficial or negative. People behave differently when they are under stress. Stress is the body's response to any form of danger [18, 32]. Stress eventually has an impact on social, familial, and personal life. Stress is detected using various factors like heartrate, temperature, humidity, speech, blood pressure, happiness, sadness, anger, fear, surprise, etc. [31]. A stressor is anything that causes the release of stress hormones.

There are two broad categories of stressors: Physiological stressors and Psychological Stressors. Stressors cause a variety of biological responses and these physiological reactions can be measured using biomarkers including heart rate variability (HRV), Electroencephalogram (EEG), Electrocardiogram (ECG), Blood Volume Pulse (BVP), electromyogram (EMG), and electro dermal activity (EDA) etc. [17]. A variety of supervised and unsupervised machine learning algorithms can use for effectively and efficiently identifying stress in a large population [13]. Adolescent depression and other mental health issues have detrimental impacts on the child, family, and society. Determining the factors that contribute to this mental illness is essential. It is critical to recognize the warning signs of mental illness. Stress can be automatically detected that will use to reduce the chance of health problems and enhance social health.

II. STRESS AND TYPES OF STRESS

There are two different types of stress: acute stress and chronic stress [36].

A. ACUTE STRESS

The most common type of stress is called as acute stress, and it arises from the everyday demands and pressures. Acute stress passes quickly after it occurs. It is one of the most prevalent forms of stress with most people encountering it a few times every day. These threats can be psychological, emotional, or physical, and they can be imagined or real [36]. An acute stress response triggers the autonomic nervous system. Blood pressure, respiration, and heart rate all rise because of increased levels of adrenaline, cortisol, and other hormones. Another name for this is the fight-or-flight response.

B. CHRONIC STRESS

This type of stress persists for a longer amount of time. If you are having trouble at work, in your marriage, or with money, you may be experiencing chronic stress. Chronic stress is any kind of stress that lasts for more than a few weeks or months. A prolonged period of time during which one consistently feels under pressure and overwhelmed. Chronic stress is detrimental to health and can result in issues with mental health, digestive problems, and insomnia. It is also linked to a number of medical disorders, such as diabetes and heart disease.

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III. STRESS DETECTION METHODOLOGY

Automated stress detection methods are capable of accurately detecting stress and informing the user for better management of stress. Some of the available approaches depend on the use of questionnaires, which are often not accurate because of individual differences.[18,35] In this modern era, some other approaches are used for detecting stress, that includes the use of measuring devices such as mobile, remote, or wearable sensing devices to collect physiological signals. Valuable features can be extracted from these devices signals and then analyzed to identify stressed states [28]. Generally unsupervised and supervised learning is use to learn information generated by these devices signals [22, 35]. In unsupervised learning, the machine finds a pattern in the unlabeled input data [27, 37]. In supervised learning, the machine develops and trains the predictive model by using labeled data to predict future output by learning from a known set of input and output data [4,39]. There are varieties of machine learning algorithms like Logistic regression, Support vector machine, Decision tree, Random Forest, Naïve Bayes, K-nearest neighbor etc. that are suitable for stress detection[4,34]. In this review, we summarize the various approaches available in the literature that aim at detecting type of stress.

IV. STRESS RELATED FACTORS

Stress is an action in which body reacts to any kind of threat. Stress is detected using various factors like Heart rate, Temperature, Humidity, Speech, Blood pressure [21].

A. Heart Rate: Heart rate variability (HRV) can be used to identify stress. The beat-to-beat interval is the foundation of HRV. Every person's HRV is unique and depends on their health. An individual is considered fit and healthy if their HRV value is greater than 50. A person is classified as slightly tense if their HRV value is between 14 and 25, and hypertension if it is between 2 and 15.

B. Temperature: A person's body temperature can be used to gauge their level of stress. Vasodilation warms blood circulation during relaxation, but it typically does not do so to the same degree as the body's core temperature.

C. Humidity: Using Galvanic Skin Response (GSR), skin temperature provides an accurate representation of an individual's stress level. The GSR electrodes gather perspiration from the user and send a signal to the associated device. The computer or device will store the gathered data. When there are significant GSR peaks in the data, it is considered that the individual is depressed. A person is considered to be in a relaxed state if their GSR peak is at its lowest.

D. Speech: One of the most common forms of human communication is the vocal signal, which conveys the understood paralinguistic information about the speaker and the clear semantic content.

E. Blood Pressure: High blood pressure can result from stressful circumstances. Systolic and diastolic pressures (BPs and BPd) can be used to calculate stress. We can quickly ascertain that an individual is under stress if their systolic and diastolic blood pressures are both higher than 130 and 110, respectively.

V. STRESS DETECTION SENSORS

Stress can be detected by using various physiological sensors namely: heart rate (HR) sensor, Galvanic Skin Response (GSR)sensor, Electrocardiogram(ECG),Electromyogram(EMG),Respiration (RESP), Finger Temperature (FT),Skin Temperature (ST),blood volume pulse (BVP),heart rate variability (HRV),electroencephalogram (EEG),skin conductance (SC),three axis acceleration (ACC),electro dermal activity (EDA) etc.[17].

A. Heart Rate (HR) Sensor:
The primary purpose of the heart rate sensor is to identify stress based on the photo plethysmography (PPG) rule. An optical technique is used to detect the change in blood volume, and it applies the same principle found in pulse oximeters.

B. Galvanic Skin Response (GSR) Sensor:
GSR measures a person's sweat, electrical conductance of the skin, and fluctuating moisture content [33]. GSR sensors can detect an increase in an individual's electrical skin conductance when they begin to perspire. Emotions such as happiness, sadness, frustration, stress, shock, depression, and other related ones can alter a person's skin conductance.

C. Electrocardiogram(ECG) :
An ECG is a non-invasive, painless method of diagnosing a number of common cardiac conditions. A medical professional to identify or detect use an ECG: Arrhythmias, or irregular heartbeats. If you have previously experienced a heart attack, whether chest pain or a heart attack is being caused by narrowed or blocked heart arteries (coronary artery

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disease). An electrocardiogram (ECG) is a quick test that measures the electrical activity and rhythm of your heart. Your skin contains sensors that are used to pick up the electrical signals your heart produces with each beat.

D. Electromyogram(EMG):
A diagnostic technique called electromyography (EMG) is used to evaluate the condition of the motor neurons, the nerve cells that control the muscles. The results of an EMG can show issues with nerve-to-muscle signal transmission, muscle dysfunction, or both.

E. Blood Volume Pulse (BVP):
By measuring the volume of blood, that passes the sensor in either red or infrared light. BVP is a technique for detecting heartbeats. Heart rate and heart rate variability (HRV) can be computed from BVP. Attached to the tip of a finger (but not the thumb), the BVP sensor is a tiny clip. This clip has an infrared light and an LED that shine light into the skin. A sensor then determines the blood volume by measuring the intensity of the reflected light.

F. Heart Rate Variability (HRV):
Simply put, HRV is a measurement of the difference in heartbeat duration. The autonomic nervous system (ANS), a primitive component of the nervous system, is in charge of this variation. It functions in the background, among other important functions, by automatically controlling our blood pressure, respiration, digestion, and heart rate. The sympathetic and parasympathetic nervous systems commonly referred to as the fight-or-flight response and the relaxation response, make up the two main parts of the autonomic nervous system (ANS).

G. Electroencephalogram (EEG):
When diagnosing brain disorders, particularly epilepsy or another seizure disorder, an EEG can detect changes in brain activity. Electrodes, which are tiny metal discs with thin wires attached to them, are applied to your scalp during the procedure. Your brain cells' activity produces minute electrical charges, which are detected by the electrodes. The charges are enlarged and show up as a recording that can be printed out on paper or as a graph on a computer screen. Your healthcare provider then interprets the reading.

H. Electro dermal activity (EDA):
The changes in conductivity brought about by an increase in sweat gland activity are measured by the electro dermal activity (EDA). Three distinct parameters have been used to measure EDA: skin potential, skin DC conductance, and skin AC admittance. The palms of hands and the soles of feet are the recommended locations for EDA measures.

VI. RELATED RESEARCH WORKS

Many studies are conducted to identify tension or depression among the individuals. Table-1 shows some research work carried out about the stress detection.

TABLE 1- Stress detection mechanisms reported in literature

Ref No.	Type of stress	Data collection method	Dataset	Wearable device
[1][38]	perceived stress	questionnaires	Private Dataset	Smartphone[38]
[2]	work stress	Questionnaire	website, articles from agazines, newspapers	Physiological sensor
[3]	Environmental stress	Questionnaires	Twenty healthy participants	imec Necklacewireless (ECG) sensor, NeXus 10 – MK II
[5][6]	environmental stress-driver's stress	ECG signals	physionet(2010)	Physiological sensor
[7]	social media stress	collect a set of datasets using different labeling	Sina Weibo	Physiological sensor
[8]	Academic level stress	heart rate variability	biomedical lab student	Physiological sensor

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[9][12] [15] [40]	Mental stress	EEG,SC,ECG	Universiti Sains Malaysia (HUSM), Malaysia[9], smartphone app SESAME[12]	MindWave Mobile Headset[15]
[10]	environmental stress	human facial expressions	Enterprise05	Physiological sensor
[11][14] [30]	work stress	physiological signals	SWELL-KW dataset,image	Physiological sensor
[16]	work stress	Survey method	OSMI mental health survey 2017	
[19]	emotional stress	real-world dataset	real-world dataset	Physiological sensor
[20]	Mental stress	questionnaire	Jaypee Institute of Information Technology(206 student)	Physiological sensor
[23][24] [26]	Mental stress	Physiological signal	WESAD dataset, PRESAGE training center[26]	chest-worn RespiBAN Professional and Empatica E4 on the chest and on the wrist
[25]	Work-related stress	ECG-sensors	Linkura Company	

VII. CONCLUSION

It is evident from the approaches discussed above that physiological sensor signals, when collected by physiological sensing devices, can be used to determine an individual's stress level. In order to extract meaningful features from the collected signals, signal pre-processing needs to be put into place. The machine learning algorithms can then be used to construct the classification model after the features have been identified. The purpose of this paper is to provide information about stress detection methodology, stress detection sensors, and stress related factors as per the literature survey. The literature survey revels that many modern studies used several types of sensors and machine learning algorithms for detecting stress. In future, we will try to detect stress using machine-learning algorithms.

REFERENCES

[1]. Gjoreski M, Gjoreski H (2015) Automatic detection of perceived stress in campus students using smartphones. In: 2015 International conference on intelligent environments, pp 132–135. https://doi.org/10.1109/IE.2015.27.
[2]. Das, P., & Srivastav, A. K. (2015). A study on stress among employees of public sector banks in Asansol, West Bengal. International Journal of Science and Research, 4(7), 108-113.
[3]. Elena Smets, Comparison of ML Techniques for Psychophysiological Stress detection." International Sym. On Pervasive Comp. Paradigms for Mental-Health, (2015).
[4]. Wade, B. S., Joshi, S. H., Pirnia, T., Leaver, A. M., Woods, R. P., Thompson, P. M., ... & Narr, K. L. (2015, April). Random forest classification of depression status based on subcortical brain morphometry following electroconvulsive therapy. In 2015 IEEE 12th International Symposium on Biomedical Imaging (ISBI) (pp. 92-96). IEEE.
[5]. Keshan, N., Parimi, P. V., & Bichindaritz, I. (2015, October). Machine learning for stress detection from ECG signals in automobile drivers. In 2015 IEEE International conference on big data (Big Data) (pp. 2661-2669). IEEE.
[6]. Ghaderi, A., Frounchi, J., & Farnam, A. (2015, November). Machine learning-based signal processing using physiological signals for stress detection. In 2015 22nd Iranian Conference on Biomedical Engineering (ICBME) (pp. 93-98). IEEE.
[7]. Lin, H., Jia, J., Qiu, J., Zhang, Y., Shen, G., Xie, L., ... & Chua, T. S. (2017). Detecting stress based on social

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interactions in social networks. IEEE Transactions on Knowledge and Data Engineering, 29(9), 1820-1833.

[8]. Ramteke R, Thool V (2017) Stress detection of students at academic level. In: International conference on energy, communication, data analytics and soft computing (ICECDS-2017), pp 2154–2157.

[9]. Subhani, A. R., Mumtaz, W., Saad, M. N. B. M., Kamel, N., & Malik, A. S. (2017). Machine learning framework for the detection of mental stress at multiple levels. IEEE Access, 5, 13545-13556.

[10]. Raichur, N., Lonakadi, N., & Mural, P. (2017). Detection of Stress Using Image Processing and Machine Learning Techniques. International journal of engineering and technology, 9, 1-8.

[11]. Sriramprakash, S., Prasanna, V. D., & Murthy, O. R. (2017). Stress detection in working people. Procedia computer science, 115, 359-366.

[12]. Huysmans, D., Smets, E., De Raedt, W., Van Hoof, C., Bogaerts, K., Van Diest, I., & Helic, D. (2018). Unsupervised learning for mental stress detection-exploration of self-organizing maps. Proc. of Biosignals 2018, 4, 26-35.

[13]. Yadav, S. K., & Hashmi, A. (2018). An Investigation of Occupational stress Classification by using Machine Learning Techniques. International Journal of Computer Sciences and Engineering, 6(6), 842-850.

[14]. Burman, R., & Goswami, T. G. (2018). A systematic literature review of work stress. International Journal of Management Studies, 3(9), 112-132.

[15]. Vuppalapati, C., Raghu, N., Veluru, P., & Khursheed, S. (2018, July). A system to detect mental stress using machine learning and mobile development. In 2018 International Conference on Machine Learning and Cybernetics (ICMLC) (Vol. 1, pp. 161-166). IEEE.

[16]. Reddy, U. S., Thota, A. V., & Dharun, A. (2018, December). Machine learning techniques for stress prediction in working employees. In 2018 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC) (pp. 1-4). IEEE.

[17]. Elzeiny, S., & Qaraqe, M. (2018, October). Machine learning approaches to automatic stress detection: A review. In 2018 IEEE/ACS 15th International Conference on Computer Systems and Applications (AICCSA) (pp. 1-6). IEEE.

[18]. Tappler, M., Aichernig, B. K., & Bloem, R. (2018, March). Model-based testing IoT communication via active automata learning. In 2018 IEEE International conference on software testing, verification and validation (ICST) (pp. 276-287). IEEE.

[19]. Mounika SN (2019) Detection of stress levels in students using social media feed. In: Proceedings of the international conference on intelligent computing and control systems (ICICCS 2019), no Iciccs, pp 1178–1183.

[20]. Ahuja, R., & Banga, A. (2019). Mental stress detection in university students using machine learning algorithms. Procedia Computer Science, 152, 349-353.

[21]. Shanmugasundaram, G., Yazhini, S., Hemapratha, E., & Nithya, S. (2019, March). A comprehensive review on stress detection techniques. In 2019 IEEE International Conference on System, Computation, Automation and Networking (ICSCAN) (pp. 1-6). IEEE..

[22]. Cho, G., Yim, J., Choi, Y., Ko, J., & Lee, S. H. (2019). Review of machine learning algorithms for diagnosing mental illness. Psychiatry investigation, 16(4), 262.

[23]. DevakunchariRamalingam,Vaibhav Sharma, Priyanka Zar . Study of Depression Analysis using Machine Learning Techniques. ISSN: 2278-3075, Volume-8, Issue-7C2, May 2019.

[24]. Bobade, P., & Vani, M. (2020, July). Stress detection with machine learning and deep learning using multimodal physiological data. In 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA) (pp. 51-57). IEEE.

[25]. Li, R., & Liu, Z. (2020). Stress detection using deep neural networks. BMC Medical Informatics and Decision Making, 20, 1-10..

[26]. Madjar, N., & Lindblom, F. (2020). Machine Learning implementation for Stress-Detection.

[27]. Wu Y, Daoudi M, Amad A, Sparrow L, D'Hondt F (2020) Unsupervised learning method for exploring students' mental stress in medical simulation training. In: ICMI 2020 companion publication of the 2020 international conference multimodal interaction, pp 165–170. https://doi.org/10.1145/3395035.3425191.

[28]. Ding Y, Chen X, Fu Q, Zhong S (2020) A depression recognition method for college students using deep integrated support vector algorithm. IEEE Access 8:75616–75629. https://doi.org/10.1109/ACCESS.2020.2987523.

[29]. Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., ... & Khaledi-Paveh, B. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. Globalization and health, 16(1), 1-11.

[30]. Patil, A., Mangalekar, R., Kupawdekar, N., Chavan, V., Patil, S., & Yadav, A. (2020). Stress detection in IT professionals by image processing and machine learning. International Journal of Research in Engineering, Science and Management, 3(1).

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Impact Factor 8.102 ⁙ Peer-reviewed journal / Refereed journal ⁙ Vol. 12, Issue 10, October 2023
DOI: 10.17148/IJARCCE.2023.121019

[31]. Binny S , Darsana K Lal, Cina Mathew, Jefna Naza (2021). Mental Stress Detection in Students using Machine Learning Algorithms. JETIR July 2021, Volume 8, Issue 7,www.jetir.org (ISSN-2349-5162).

[32]. G.M. Kalatzantonakis-Jullien (2021). Automatic stress detection using speech and advanced machine learning methods of Joint Postgraduate Degree of the Hellenic Open University with the Ionian University.

[33]. Acevedo, C. M. D., Gómez, J. K. C., & Rojas, C. A. A. (2021). Academic stress detection on university students during COVID-19 outbreak by using an electronic nose and the galvanic skin response. Biomedical Signal Processing and Control, 68, 102756.

[34]. Issa, G. (2021). A new two-step ensemble learning model for improving stress prediction of automobile drivers. The International Arab Journal of Information Technology, 18(16).

[35]. Albreiki, B., Zaki, N., & Alashwal, H. (2021). A Systematic Literature Review of Student' Performance Prediction Using Machine Learning Techniques. Education Sciences, 11(9), 552. https://doi.org/10.3390/educsci11090552.

[36]. Sharma, S., Singh, G., & Sharma, M. (2021). A comprehensive review and analysis of supervised-learning and soft computing techniques for stress diagnosis in humans. Computers in Biology and Medicine, 134, 104450.

[37]. S, A. P., Devi, A., Nair, A. S., Suresh, A., & George, N. (2022). Automated Stress Detection using Machine Learning. International Journal of Engineering Research & Technology, 10(4). https://doi.org/10.17577/IJERTCONV10IS04038.

[38]. Aalbers, G., Hendrickson, A. T., Vanden Abeele, M. M., & Keijsers, L. (2023). Smartphone-Tracked Digital Markers of Momentary Subjective Stress in College Students: Idiographic Machine Learning Analysis. JMIR mHealth and uHealth, 11, e37469.

[39]. Ding, C., Zhang, Y., & Ding, T. (2023). A systematic hybrid machine learning approach for stress prediction. PeerJ Computer Science, 9, e1154.

[40]. Gurusamy, D., Chakrabarti, P., Chakrabarti, T., & Jin, X. B. (2023, March). Machine Learning, Wearable, and Smartphones for Student's Mental Health Analysis. In Third Congress on Intelligent Systems: Proceedings of CIS 2022, Volume 1 (pp. 327-341). Singapore: Springer Nature Singapore.

