e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 13, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

Stress Detection Using EEG Signal in Machine Learning

K. Indhumathi[1] , D.Umamaheswari[2], N.Nisha[3], S.Janani [4]

Assistant Professor, Department of Computer Science and Engineering, Shree Venkateshwara Hi Tech Engineering College, Gobichettipalayam, Tamil Nadu, India[1]

Student, Department of Computer Science and Engineering, Shree Venkateshwara Hi Tech Engineering College, Tamil Nadu, India[2,3,4]

ABSTRACT: The mind is more delicate to stretch than different organs, so extreme pressure can cause numerous sicknesses. Utilizing multi-channel electroencephalogram (EEG) signals, we fostered a technique to work on the accuracy of near and dear tension affirmation in this survey. To learn worldwide data and long-range conditions, a gated self-consideration instrument block then catches conspicuous data from every recurrence band. The last attentional depiction for stress acknowledgment shows that comparing features are created by partner vectors from different repeat bunches utilizing repeat band arranging. The proposed technique beats other customary strategies in profound pressure acknowledgment tests directed on three benchmark datasets. EEG configuration assessment's ability to definitively perceive the state of strain from human psyche activity is attested by the show examination of proposed procedures.

KEYWORDS: Stress recognition, EEG signal, machine learning.

I. INTRODUCTION

Stress proposes testing updates that can cause mental, physical, and precious strain in people. Constant pressure can adversely affect one's wellbeing and lead to conditions like a sleeping disorder, stroke, cardiovascular sickness, mental issues, and wretchedness, notwithstanding the way that a solid degree of stress can expand one's physical and mental imperativeness. Thus, it is fundamental to recognize mental pressure before it becomes persistent. Different strategies for deciding the underlying degrees of stress have been created to achieve this. Noting close to home self-report surveys like mental strain scales is the most notable method for managing pressure appraisal. Be that as it may, this strategy might consume a large chunk of the day and yield off base outcomes relying upon the client's understanding of the survey. Chemicals taken from pee or blood can be utilized to gauge pressure, yet these costly strategies don't show the degree of stress immediately.

A. *STRESS RECOGNITION*

The troublesome errand of stress location includes deciding an individual's psychological state by breaking down different physiological and conduct signals. Simulated intelligence and significant learning are astonishing resources that can help in this task by acquiring from data and making figures considering models and features. We will momentarily talk about a portion of the AI based strategies and uses of pressure identification in this text.

The assortment and preprocessing of information from different sources, for example, wearable sensors, virtual entertainment posts, discourse, looks, etc, is one of the essential moves toward utilizing AI to recognize pressure. The singular's pulse, circulatory strain, skin conductance, breath, temperature, feeling, mind-set, and different boundaries can be gathered from these information. Be that as it may, prior to being utilized for examination, these information should be cleaned, standardized, sectioned, and synchronized in light of the fact that they may likewise be boisterous, deficient, or conflicting.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

B. *EEG SIGNAL*

EEG signal is a term that suggests the electrical activity of the psyche that can be assessed by cathodes associated with the scalp. The most common way of extricating helpful data from EEG signals, like the condition of the cerebrum, mental capability, or the presence of neurological problems, is known as EEG signal examination. There are various advances engaged with EEG signal examination, for example,

- Planning: From the crude EEG signals, clamor, relics, and undesirable parts like electrical cable obstruction, eye developments, muscle action, or cathode impedance are taken out in this step.
- Extraction of elements: This step incorporates changing the preprocessed EEG signals into a lot of components that can address the characteristics of the signs, similar to repeat, adequacy, stage, power reach, entropy, or unpredictability.
- Classification: In view of the extricated highlights, this step includes marking or classifying the EEG signals, like typical or unusual, conscious or snoozing, mindful or occupied, or epileptic or non-epileptic.

The high changeability, non-stationarity, and intricacy of EEG signals make investigation of these signs troublesome. Be that as it may, it is likewise a valuable instrument for diagnosing different cerebrum problems and concentrating on mind capability.

C. *MACHINE LEARNING*

The focal point of the field of study known as AI (ML) is the investigation of strategies that "learn," or techniques that utilization information to further develop execution on a specific arrangement of undertakings. Being a piece of man-made consciousness is accepted.

Man-made consciousness calculations fabricate a model thinking about test information, known as preparing information, to pursue measures or choices without being expressly different to do in that limit. At the point when conventional estimations can't or challenging to complete the essential errands, artificial intelligence computations are utilized in a large number of uses, for example, medication, email filtering, talk acknowledgment, cultivating, and PC vision.

Different methodologies are used in the field of AI to educate PCs on the best way to get done with jobs for which there is no completely agreeable calculation. At the point when there are a great deal of potential responses, one procedure is to name a portion of the right responses as legitimate. The PC can then involve this as planning information for the algorithm(s) it utilizations to choose proper reactions. For example, the MNIST dataset of digits composed by hand has much of the time been utilized to prepare a framework for computerized character acknowledgment. The field changed its fair from accomplishing man-made scholarly ability to dealing with conceivable issues of an objective sort. It directed its concentration toward the models and strategies for measurements instead of computer based intelligence's representative methodologies.

II. RELATED WORK

As per Chung-Yen Liao et al., Brainwave mirrors the change in electrical likely achieved by the connection of thousands of mind neurons. At the point when adequate energy is collected, a neuron starts the cyclic release response, which can get signals from different neurons. That is moreover the inspiration driving why people consistently emanate brainwaves[1].Junhyung Moon et.al says It is practical to recollect one's strain state before the tension causes a couple of ailments. Utilizing different physiological signs that change when one is worried, different works have distinguished the condition of pressure — regardless of whether one is anxious. They enjoy taken benefit of the exploratory data accumulated from pressure inducing investigates various roads with respect to verbal periods, for instance, the socio-evaluative stressor[2]. As indicated by Frédéric Mérienne et al., this article proposes a wavelet change and-brain network-based way to deal with relating understudy conduct to mental pressure. The proposed strategy was tried by recording student measurement and electrodermal movement during a driving reproduction [3]. Steptoe, Andrew, et al. guarantee that ""Impeded recuperation of SBP (P 0.001), DBP (P = 0.009), and pulse changeability during assignments (P = 0.002) anticipated three-year expansions in diastolic tension" [4] to decide if variety in the pace of cardiovascular

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

recuperation following openness to intense mental pressure predicts changes in circulatory strain longitudinally, autonomous of pulse at standard and other covariates.. As per Rateb Katmah et al., mental pressure is one of the serious aims of various medical problems. Different instruments have been created by analysts and clinical experts to decide the underlying degree of mental stress[5]. As indicated by Yun Liu et al., this paper presents a strategy for deciding degrees of mental pressure. It intends to explore the believability of using a single physiological sign to make a more sensible choice for perceiving strain in people than current various physiological signs approaches incorporate [6].According to Sara Pourmohammadi et al., close to home prosperity and stress have as of late been viewed as huge generally concerns. A typical technique is to recognize pressure by utilizing physiological signs like the electrocardiogram (ECG), skin conductance (SC), electromyogram (EMG), and electroencephalogram (EEG)[7]. This meta-assessment plans to investigate the relationship between cortisol responses to mental stressors and despairing. Seven examinations (N=196) differentiating the plasma or cortisol responses of people with clinical debilitation (MDD) and those without misery (ND) to mental stressors: 98 MDD, 98 ND; 83 men and 113 ladies; As per Nandita Sharma et al., " Pressure is a critical creating stress in our day and mature unfavorably influencing the two people and society." [8] Zhe Wang et al. guarantee that, the spatial information of Electroencephalography (EEG) is central for feeling affirmation model to learn discriminative part. The advantages of pressure research are various, going from individual improvement to learning and expanded work efficiency to cultural advantage. 9] The most generally perceived methods for learning complex spatial circumstances through different anodes and frontal cortex locale are convolutional and monotonous associations. [10]

D. *EXISTING SYSTEM*

Since mind waves vibrate in exceptionally complex examples, power range examination, which groups waves as per their recurrence, is every now and again used to notice them. To produce more precise manufactured highlights, it is important to separate the sign into recurrence groups, extricate include data from each band, and interface it to all of the recurrence groups. The utilization of a direct relapse calculation goes through the recurrence and band disintegration. With less featured limits, the result is low accuracy. Straight backslide is a simulated intelligence computation that considers something like one free element to foresee the worth of a reliant variable. It expects a straight connection between the factors and searches for the best line that fits the information. In any case, there are a couple of obstructions to the show and tangibility of straight backslide.

One of the drawbacks of straight backslide is that it is leaned to underfitting, and that suggests that it fails to get the multifaceted nature and vacillation of the data. Despite the fact that non-direct examples in the information can't be addressed by a straight line in some genuine circumstances, direct relapse can demonstrate straight connections. An individual's pay, for example, may not ascent in an orderly fashion with age yet rather in a bended example. Straight relapse might have to add polynomial or association terms to tackle this issue, which can make the model more troublesome and confounded.

E. *PROPOSED METHODS*

Cerebrum waves are every now and again noticed utilizing power range examination, which arranges waves as per their recurrence since they vibrate in profoundly complex examples. To additionally foster tension affirmation rate, it is critical to segment the sign into repeat gatherings, eliminate feature information from each band, and partner it to entire repeat gatherings to make more exact fabricated features. With the got EEG signal dataset, the SVM calculation accomplishes an elevated degree of exactness of 99.9%.

F. *ABOUT THE SVC ALGORITHM*

A help vector machine (SVM) calculation known as the SVC calculation can be applied to order and relapse issues. The objective of the SVC calculation is to find the best hyperplane with the best edge for arranging the pieces of information. The edge is the distance between the hyperplane and the closest information of interest, which are called help vectors. By utilizing different parts, for example, direct, polynomial, spiral premise capability (RBF, etc, the SVC calculation can manage both straight and non-straight information. The choice of part depends upon the properties of the data and the issue. Albeit the SVC calculation is a strong and versatile AI device, it has a few disadvantages, for

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

example, being delicate to exceptions, requiring cautious boundary tuning, and being computationally costly for enormous datasets.

Various bits, for example, direct, polynomial, outspread premise capability (RBF), or sigmoid, can be utilized to deal with straight and non-straight information.

Utilizing the part stunt to plan the information into a higher-layered space where it turns out to be straightly divisible, it can manage high-layered information in any event, when the quantity of elements surpasses the quantity of tests.

Utilizing the class_weight boundary to dole out various loads to different classes or the "adjusted" mode to consequently change the loads in a manner that is contrarily corresponding to the class frequencies, it can perform well on informational indexes that are imbalanced.

- It can give probability appraisals to the assumptions, by defining the probability limit to Substantial, which enables the use of 5-overlay cross-endorsement to discover the probabilities.

- It can manage anomalies and clamor by controlling the compromise between expanding the edge and limiting the order blunder with the C boundary.

G. *INPUT DATASET*

An info dataset is an assortment of information that is utilized to prepare or fit an AI model. From the elements or factors in the info dataset, the model plans to anticipate or characterize the ideal result or name. The amount and nature of the info dataset straightforwardly affect the presentation and exactness of the AI model. The test, approval, and preparing sets of the information dataset are normally isolated. The model's presentation on inconspicuous information is assessed utilizing the test set, hyperparameters are adjusted utilizing the approval set, and boundaries are fitted utilizing the preparation set. The info dataset, which should incorporate every one of the potential situations that the model could experience in genuine applications, should act as a portrayal of the issue space.

H. *PREPROCESSING*

Preprocessing the crude information for building and preparing AI models is a fundamental stage in AI. To make the information reasonable and justifiable for the calculations, it involves cleaning, arranging, changing, and enhancing it. In AI, preprocessing can lessen the intricacy and computational expense of the growing experience while additionally expanding the quality, precision, and effectiveness of the models.

- Taking care of void strings: The legitimacy and execution of the models can be influenced by absent or invalid qualities. Contingent upon the unique circumstance and extent of the information, they can be managed by dropping, placing them in, or not tending to them.

- Harmonization: A strategy for scaling the information to have a mean of nothing and a standard deviation of one is called normalization. It supports the standardization of the information and limits the effect of anomalies and different units of estimation.

Instructions to manage downright factors: Orientation, variety, or type are instances of unmitigated factors that have a limited arrangement of discrete qualities. Contingent upon the nature and relationship of the classifications, they can be dealt with by encoding them into mathematical qualities, for example, name encoding or one-hot encoding.

- One-hot encoding: A technique for encoding downright factors without an ordinal relationship, like nation, language, or sort, is one-hot encoding. For every classification, it makes a double vector with only one component being one and the rest being zero. A can be encoded as [1, 0, 0], B as [0, 1, 0], and C as [0, 0, 1] in the event that there are three classifications, for example.

Numerous collinearities: Multicollinearity is a condition where at least two elements have a serious level of relationship with each other. This can be dangerous for straight relapse and other AI calculations. Techniques like the connection framework and the fluctuation expansion factor (VIF) can be utilized to track down it. Regularization techniques or eliminating or consolidating the associated highlights can be utilized to address it.

I. *SVC CLASSIFICATION*

An order and relapse critical thinking directed AI calculation known as SVC is a kind of SVM. It works by finding a hyperplane that effectively isolates the data of interest into different classes. The quantity of elements in the

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

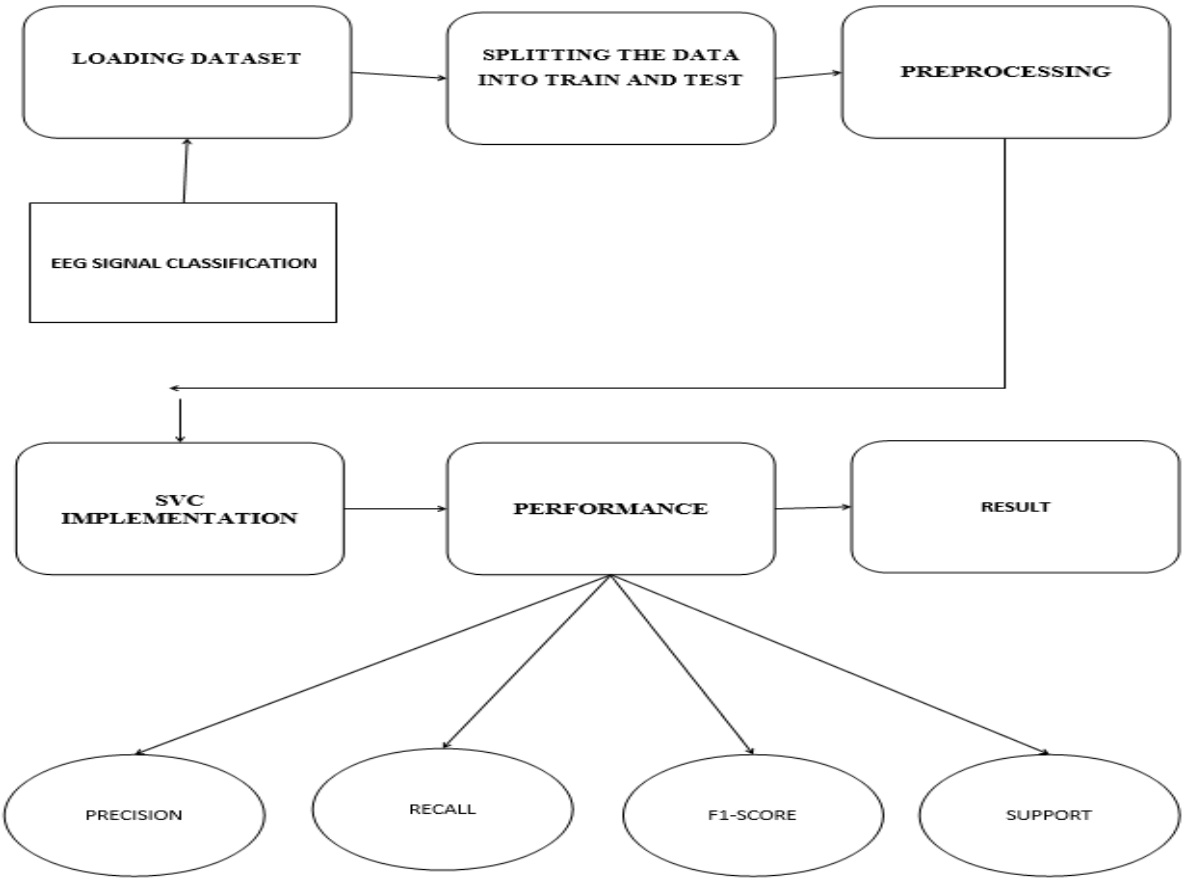
Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

information decides the n-layered hyperplane. Support vectors are the information focuses that impact the hyperplane's situation and are nearest to

it. Various portions, for example, direct, polynomial, outspread premise capability, etc, make it workable for the SVM calculation to think about information that can be isolated straightly or non-straightly. The SVM calculation enjoys many benefits, including the capacity to utilize an assortment of closeness gauges, its viability in high-layered spaces, and its protection from exceptions.

J. *ARCHITECTURE DIAGRAM*



III. RESULT

When contrasted with the current framework and different calculations, the SVC calculation creates a superior and more dependable result. The SVC calculation is enhanced to improve eeg signals to accomplish a high level exactness rate. Accuracy, review, f1-score, and backing are totally determined with a high measure of large scale normal, high exactness, and high weighted normal.

PARAMETERS	PRECISION	RECALL	F1-SCORE	SUPPORT
interruption	100	100	100	117.82
no stress	100	100	100	221.58
time pressure	100	100	100	70.93
accuracy	99.9	100	100	410.33
macro avg	100	100	100	410.33
weighted avg	100	100	100	410.33

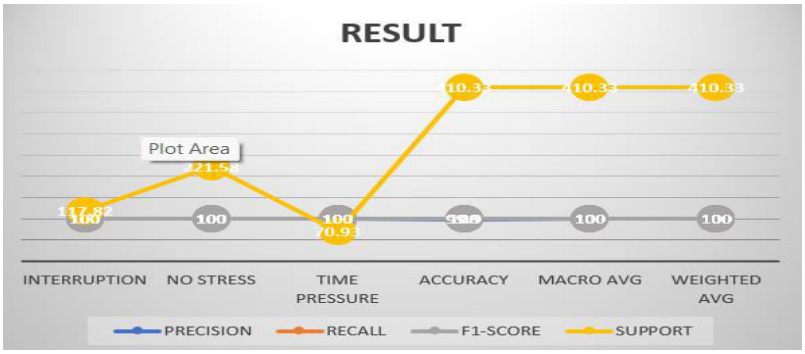
| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

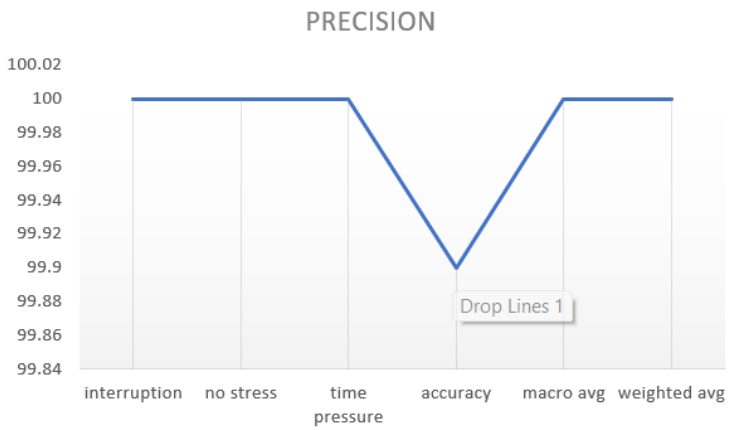
Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India



A. *PRECISION*

Accuracy is a measurement in AI that actions a model's exactness in foreseeing the positive class. Not entirely set in stone by isolating the quantity of genuine up-sides (TP) by the all out number of bogus up-sides (FP). A low accuracy model has a high pace of phony problems, though a high accuracy model has a low pace of deceptions. Accuracy is the proportion of the absolute number of positive expectations (TP + FP) to the quantity of genuine up-sides (TP), where FP is the quantity of bogus up-sides. It shows the number of the model's positive expectations were right.



B. *RECALL*

An estimation used to evaluate computer based intelligence models' show is survey. It gives a gauge of the quantity of critical data centers that the model accurately distinguished. The particular meaning of review is the extent of genuine positive class tests that the model distinguished. It shows missed positive expectations and gives some knowledge into the inclusion of the positive class. The amount of excused models influences audit. The extent of certified up-sides (TP) to amount to truly up-sides (TP + FN), where FN is the amount of deluding negatives, is known as audit. It tells the number of positive class tests in the information the model accurately distinguished.

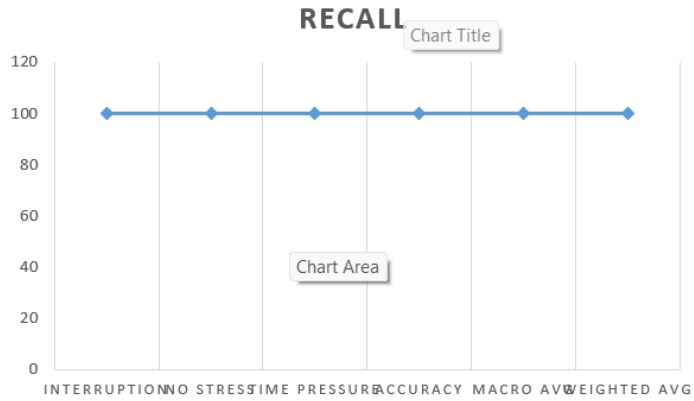
| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

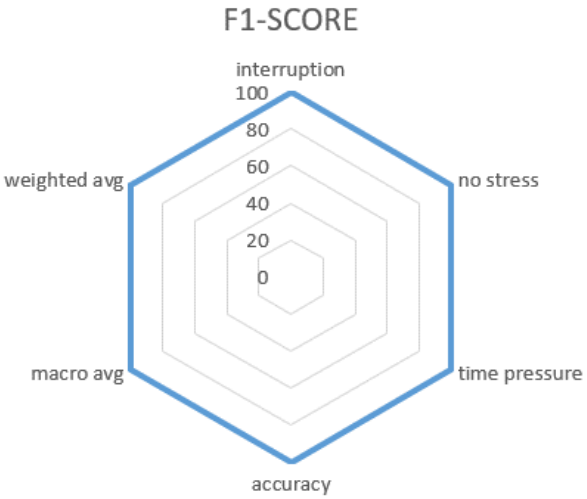
Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India



C. *F1-SCORE*

The F1 score, which is an AI assessment metric, is utilized to assess the presentation of an order model. It joins a model's exactness and survey scores, two estimations that activity different pieces of the accuracy of the model. Accuracy is the means by which the model's positive expectations are estimated, and review is the way exact the model is at accurately recognizing the positive class tests in the dataset. Bad qualities are given more weight when the F1 still up in the air as the symphonious mean of exactness and survey. Consequently, a low F1 score shows a low motivator for either precision or survey. A high F1 score, then again, shows a high incentive for both. Nonetheless, the sklearn.metrics.precision_score and sklearn.metrics.recall_score capacities can likewise be utilized to autonomously work out the exactness and survey scores, and the recipe can then be utilized to genuinely enroll the F1 score: F1 is equivalent to 2 x (survey x exactness)/(audit x precision).



D. *ACCURACY*

One of the most widely recognized measurements used to assess an AI model's exhibition is precision. The proportion of accurately anticipated occurrences to the all out number of cases is the way things are characterized. Accuracy not set in stone as follows:

exactness is equivalent to (TP + TN)/(TP + TN + FP + FN), where TP addresses the quantity of genuine up-sides, the quantity of genuine negatives, the quantity of bogus up-sides, and the quantity of misleading negatives are completely addressed by TN, FP, and FN, separately.

E. *MACRO AVERAGE*

In AI, we should register the normal of a measurement across different classes or gatherings to compute the large scale normal. For example, in the event that we really want to sort out the full scale ordinary precision for a multi-

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

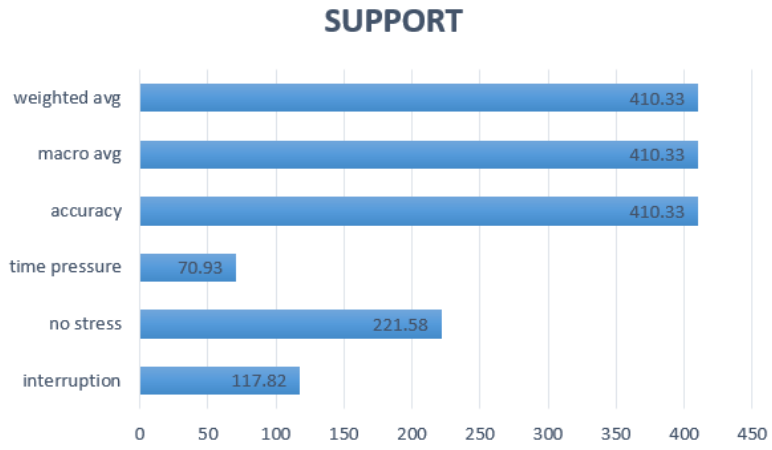
Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

class portrayal issue, we truly need to process the exactness for each class and a short time later take the number related mean of them. No matter what their size or recurrence, each class gets equivalent load from the large scale normal. At the point when we need to look at a model's presentation across all classes without inclining toward any one, this technique is useful.

F. *SUPPORT*

In AI, support esteem is the recurrence with which a component or blend of elements shows up in the ideal choice principles for a specific issue. It tends to be utilized to diminish the dimensionality and intricacy of the element space and to distinguish the highlights that are generally helpful and pertinent to a specific undertaking. Different methodologies, including affiliation rule mining, choice tree acceptance, and Bayesian organization learning, can be used to work out help esteem. In AI pipelines, support worth can likewise be deciphered as a type of element significance or component determination.



IV. CONCLUSION AND FUTURE WORK

The accuracy review F1 score and backing an incentive for interference stress and no pressure are gotten by utilizing the help vector classifier's AI calculation from the drawn outcome. With the informational index acquired from kaggle, this accomplishes the ideal aftereffect of more noteworthy than almost 100%. It is proposed that pressure state acknowledgment execution can be gotten to the next level. Multichannel EEG signals are initial separated into four distinct recurrence groups utilizing 3DCGSA, then corresponding data is learned through interfrequency planning. Utilizing EEG SIGNAL DATASET, tests, the proposed strategy beat customary methodologies in its capacity to recognize pressure states. Nevertheless, our procedure has some cutoff.

REFERENCES

1. Sharma, N.; Gedeon, T. Objective measures, sensors and computational techniques for stress recognition: A survey. Comput. Meth. Programs Biomed. 2012, 108, 1287–1301. [CrossRef] [PubMed]
2. Burke, H.M.; Davis, M.C.; Otte, C.; Mohr, D.C. Depression and cortisol responses to psychological stress: A meta-analysis. Psychoneuroendocrinology 2005, 30, 846–856. [CrossRef] [PubMed]
3. Ahn, M.H. Analysis on The Reflection Degree of Worker's Stress by Brain-waves based Anti-Stress Quotient. J. Korea Acad.-Ind. Coop. Soc. 2010, 11, 3833–3838.
4. Pourmohammadi, S.; Maleki, A. Stress detection using ECG and EMG signals: A comprehensive study. Comput. Meth. Programs Biomed. 2020, 193, 105482. [CrossRef]
5. Liu, Y.; Du, S. Psychological stress level detection based on electrodermal activity. Behav. Brain Res. 2018, 341, 50–53. [CrossRef]
6. Katmah, R.; Al-Shargie, F.; Tariq, U.; Babiloni, F.; Al-Mughairbi, F.; Al-Nashash, H. A Review on Mental Stress Assessment Methods Using EEG Signals. Sensors 2021, 21, 5043. [CrossRef]

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| | Monthly Peer Reviewed & Refereed Journal |

|| Volume 7, Issue 13, April 2024 ||

International Conference on Intelligent Computing & Information Technology (ICIT-24)

Organized by

Erode Sengunthar Engineering College, Erode, Tamilnadu, India

7. Steptoe, A.; Marmot, M. Impaired cardiovascular recovery following stress predicts 3-year increases in blood pressure. J. Hypertens. 2005, 23, 529–536. [CrossRef]
8. Pedrotti, M.; Mirzaei, M.A.; Tedesco, A.; Chardonnet, J.R.; Mérienne, F.; Benedetto, S.; Baccino, T. Automatic Stress Classification with Pupil Diameter Analysis. Int. J. Hum.-Comput. Interact. 2014, 30, 220–236. [CrossRef]
9. Lee, M.; Moon, J.; Cheon, D.; Lee, J.; Lee, K. Respiration signal based two layer stress recognition across non-verbal and verbal situations. In Proceedings of the 35th Annual ACM Symposium on Applied Computing, Brno, Czech Republic, 30 March–3 April 2020; pp. 638–645.
10. Liao, C.Y.; Chen, R.C.; Tai, S.K. Emotion stress detection using EEG signal and deep learning technologies. In Proceedings of the 2018 IEEE International Conference on Applied System Invention (ICASI), Chiba, Japan, 13–17 April 2018; pp. 90–93.
11. Jebelli, H.; Khalili, M.M.; Lee, S. Mobile EEG-based workers' stress recognition by applying deep neural network. In Advances in Informatics and Computing in Civil and Construction Engineering; Springer: Cham, Switzerland, 2019; pp. 173–180.
12. Baumgartl, H.; Fezer, E.; Buettner, R. Two-level classification of chronic stress using machine learning on resting-state EEG recordings. In Proceedings of the 25th Americas Conference on Information Systems (AMCIS), Virtual Conference, 12–16 August 2020.
13. Subhani, A.R.; Mumtaz, W.; Saad, M.N.B.M.; Kamel, N.; Malik, A.S. Machine learning framework for the detection of mental stress at multiple levels. IEEE Access 2017, 5, 13545–13556. [CrossRef]
14. Chen, J.X.; Jiang, D.M.; Zhang, Y.N. A hierarchical bidirectional GRU model with attention for EEG-based emotion classification. IEEE Access 2019, 7, 118530–118540. [CrossRef]
15. Wang, Z.; Wang, Y.; Hu, C.; Yin, Z.; Song, Y. Transformers for eeg-based emotion recognition: A hierarchical spatial information learning model. IEEE Sens. J. 2022, 22, 4359–4368. [CrossRef]
16. Vaswani, A.; Shazeer, N.; Parmar, N.; Uszkoreit, J.; Jones, L.; Gomez, A.N.; Kaiser, Ł.; Polosukhin, I. Attention is all you need. In Advances in Neural Information Processing Systems 30 (NIPS 2017); Curran Associates, Inc.: Red Hook, NY, USA, 2017; Volume 30.
17. Li, D.; Xie, L.; Chai, B.; Wang, Z.; Yang, H. Spatial-frequency convolutional self-attention network for EEG emotion recognition. Appl. Soft Comput. 2022, 122, 108740. [CrossRef]
18. Issa, S.; Peng, Q.; You, X.; Shah, W.A. Emotion Assessment Using EEG Brain Signals and Stacked Sparse Autoencoder. J. Inf. Assur. Secur. 2019, 14, 20–29.
19. Song, Y.; Jia, X.; Yang, L.; Xie, L. Transformer-based spatial-temporal feature learning for eeg decoding. arXiv 2021, arXiv:2106.11170.
20. Newson, J.J.; Thiagarajan, T.C. EEG frequency bands in psychiatric disorders: A review of resting state studies. Front. Hum. Neurosci. 2019, 12, 521. [CrossRef]

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com