

A Review of Physiological Signal Processing via Machine Learning (ML) for Personal Stress Detection

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Abstract - Personal stress is maintained and measured by Machine learning. The device which is wearable has been used for the monitoring of personal self stress and data collection. In this research, it has been talked about the factors by which the physiological signal of the stress has been assessed. On the other hand, different type of technology has been used for the detection of the personal stress such as Electrocardiography (ECG) and many other devices. The observation and difficulties has been seen in this research by using this device and the technology. Stress disorder or ailment is one of the most common ailments in all individuals around the world. Stress and anxiety can greatly influence the life, emotion, behavioural pattern and thinking attributes of individuals. It is important to address this issue sooner or later. Psychological signal processing through machine learning effectively assists to detect the stress disorder at an early stage. The general system often considers some variables to detect stress. They are electrocardiogram, galvanic response, heart rate, respiration and many other elements. The ML tend to use algorithms to compare and contrast data to fetch effective e results. The paper has also carried out a statistical analysis based on three variables to fetch a proper result that provided the study group to comprehend a better understanding of the scenario. The researchers have taken the “percentage of stress rate” cases” are considered independent variables whereas “usage of a machine learning system” is considered a dependant variable. The study group has fetched and collected numerous data related to these three variables to get a better understanding.

Keywords: Machine learning, Signal processing, GSR, Heart rate, Stress.

I. INTRODUCTION

Stress or anxiety is a very paradoxical psychic retaliation and behavioural conduct that effectively occurred from the premonition of an unwanted scenario. It can be perceived or it can be virtual at the same time. It can influence an individual systematically and it can be very much harmful to an individual as well. Stress and anxiety operate in a similar domain. A systemic manifestation of stress can effectively put forward psychological ailment. It can efficiently cause depression at the same it can formulate stress disorder as

well. It is discovered that systematic exposure in the face of stress can effectively put forward psychological malformation. It includes insomnia, weakened cognitive attributes, cardiovascular ailment and many other diseases [1].

According to a research, many kinds of research was put forward in this particular domain. The aim of that research was to evoke stress and detect them at the same time. Most of the research tried to fetch or record psychological information in an automation method during a scenario that causes stress or anxiety. The researchers demonstrate that these kinds of monitoring can efficiently assist to identify stress effectively. That research also demonstrates that different types of machine learning tools and deep-learning tools can bring forward some positive results to fight against this ailment. The study groups also show that early detection can also cure the ailment to a certain degree as the researchers claim that it can effectively tell whether a person is stressed or unstressed. An effective example can be put forward in this particular domain as a group of researchers has conducted a study by employing the “Wearable stress and affect detection”(WESAD) database while transforming the pieces of information to fixed variables to formulate machine and deep learning compartmentalisation techniques. The researchers claim that it assists them to explore and formulate distinct classification techniques while pitting them against each other to record the stress meter. They claim that they have gathered pieces of information from respiration, heart rate, electromyography (EMG), GSR foot and hand in a different scenario to gain a broader perspective on the stress meter [2].

It can be effectively said that stress is generally regarded as a global psychological ailment influencing people irrespective of their age group. Data effectively demonstrates that around fifteen to twenty per cent of the adults vehemently suffer from anxiety while it is seen that around twenty to forty per cent of people tend to suffer from stress. The maximization of awareness of stress and its prevailing malicious influence among adults is a testament to the

seriousness of this particular disease. A scenario can be stressful when a psychological premonition strikes suddenly such as fear about sacking from the job, approaching deadline and many others [3]. Researches show that stress can also occur because of loneliness among adults. It is seen that signals of the changes are systematic during the stressed phase. During this phase, certain bio-signals flow from the body and these signals systematically assist to measure stress by assessing the psychological rendering of that individual. District sensors were put forward by different researchers for the purpose of stress detection automatically.

The aim of this research is to put forward a comprehensive outlook on the influence of machine learning to detect stress efficiently while assisting to mitigate them systematically.

II. LITERATURE REVIEW

The physiological signals are commonly used in the stress detection factors contains some important factors that are the checking of the Heart Rate, changeability of the rate of the heart

Checking the temperature of the patient related to the skin. Machine learning technology is a system by which the stress of the human body can be measured. The stress can be detected by using ECG. Stress can be related to the working environment, academic environment and many other things [4].

A notable observation from the review is seen as the plan of action, which is used for the collection of the data related to the stress detection of the patient, is the *empatica*, *Emotiv* and *Shimmer*. The researchers used very high quality and openly available sets of data that are built on the immediate sets of the data. The most encouraging and popular stress test which is done by the researcher is the SCWT, TSST and a few tests related to arithmetic related to the mental.

The most differentiating and unassuming signals are used for detecting stress [5]. The challenges which have been seen in this observation of the review is Issues related to health such as high blood sugar, faulty sleep patterns, having the habits of the king and smoking are seen as having the most changes in physiology. It is very much needed to pay a lot of attention to the issue for the better treatment of the patient

The most challenging factor that comes in the collection of the data from the patient is the good environment, removal of all the antiquity and the different surrounding noises. The most important difficulty is the accurate data collecting for the treatment. The factor, which has to be seen, is developing a perfect stress detecting Model [6].

The general ideology behind the stress detection framework has a positive influence on the healthcare system to effectively predict the stress meter by employing algorithms related to machine learning and deep learning.

According to some research machine learning plays a significant role in assessing the stress level effectively. She proposed a system in this project where distinct datasets are collected from different social media platforms. They have employed a piece of vector machinery that functions with the ideology of "Naive Bayes Algorithms". This algorithm has the capacity and efficiency to identify the level of stress in an individual. This algorithm is versatile as well. It can also detect depression at the same time. In the data set the study

group gathered from Twitter, the only determinants they employ was depression and stress. A sentimental analysis was put forward in this particular scenario to generalise depression, anxiety and stress. However, it is important to employ more techniques, datasets and algorithms to examine the precision of this particular method as the recall value is very low in this domain. The researchers have employed a *confusion matrix* in this study to gain a proper understanding of the role of machine learning in the early detection of stress disorders. The proposed system suffers vehemently from inaccurate data as the Twitter datasets are not reliable [7].

It has been effectively put forward a process that refers to the safety protocols employed on women. Women are not safe even in the 21st century. They are facing different kinds of sexual assaults in the streets. At the same time, they are often are raped. The device was framed keeping in mind the condition of the women. The devices assist to collect real-time values in this regard. The accelerometer has been employed in this particular domain. The data of body temperature and galvanic body reaction are also gathered in this scenario. Women can effectively wear these tools comfortably. The device assimilates data and stores them in the database. It is not a hidden fact that body signals tend to change dramatically when danger occurs and this device will effectively identify when the women are at risk through the dataset. There is a metric in this device called "threshold value". When the indicator crosses the metrics, it means they are at risk. The researchers employed different devices to fetch the appropriate values. However, results are showing that they are as appreciative as they claim [8].

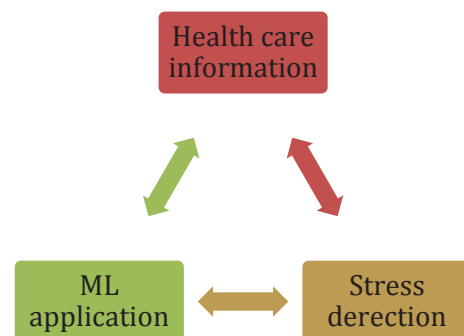


Fig 1: General mechanism of ML to detect stress

(Source: [9])

Wan-young has effectively put forward a system that efficiently records the anxiety and stress parameters of the drivers of different vehicles. The number of accidents occurring in recent times is just unfathomable and most of the time the driver suffers the most in a road accident. The devised system employs a psychological tool to fetch data. This particular gadget employs motion sensor technology to put forward accurate values to measure the stress level of the driver. Skin response and body temperature are also taken into consideration in this scenario. The galvanic response is also collected. The device stored these data based on the parameters. The device can effectively tell when he has a chance to sleep. This response would effectively assist to avert many dangerous accidents on the road. The device will make the driver aware of the health condition before the accident so that he can avert the accident. The psychological devices have been employed in this framework, the

researchers faced some problems regarding calculating the value [9].

A framework for anxiety and stress identification can be used through a machine-learning tool. This particular framework efficiently collects data from heart rate. This tool is also employs and consider electrocardiogram metrics to assess the result. The particular framework also considers age as a metric. Therefore, the value of a stressed person will flicker as per their age. It is an enormous advantage, as the value would change after the changing of the age. It negates the chances of miscalculation and poor data storage. However, this framework effectively suffers from the scarcity of domain expansion. It only predicts the data as per ECG and heart movement. The framework completely ignores other variables [10].

III. RESEARCH METHODOLOGY

To effectively examine the efficiency as well as the parameters of effectiveness of “psychological signal processing through machine learning to detect stress at an early stage”, a quantitative research outlook has been employed in this particular scenario. A statistical analysis has been put forward in this particular scenario to gain a proper understanding of the situation [10]. The quantitative statistical approach employs 1 independent variable and 2 dependant variables to gather data. It is important to comprehend that percentage of stress rate and implementation of physiological signal processing cases are considered independent variables whereas usage of a machine learning system is considered a dependant variable. The study group has fetched and collected numerous data associated with these three variables to get a better comprehension [11]. The study has collected data of the last five years to maintain the authenticity of the information. Then they have put forward a linear regression analysis framework to pit the data against each other to compare and contrast them to gain a broad perspective on this topic [12].

IV. ANALYSIS AND INTERPRETATION

The statistics related to SPSS has effectively put forward multiple tables of results in the domain of linear regression. It can be seen that three core tables are needed to comprehend results from the framework. It is important to assume that no assumption has been tempered in this due process. It is important to interpret the complete output sets to gain a better understanding of the scenario. Effective scatter plot and histogram have also been deployed in this particular study to gain better comprehension.

TABLE 1: MODEL SUMMARY (SOURCE: CREATED BY THE RESEARCHERS)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. The error of the Estimate
1	.974 ^a	.948	.897	1.1843
a. Predictors: (Constant), Percentage of stress rate, Implementation of Physiological Signal Processing cases				
b. Dependent Variable: Usage of machine learning system				

The first framework to be discussed is the model summary. It plays a vital role to correlate the three distinct variables effectively. The model summary table effectively shows that the value of R is recorded as 0.974. The data also shows that the value of R square is recorded as .984. The adjusted value of R square is recorded as 0.897 and Std. The error of the estimate is recorded as 1.1843. It is important to comprehend that percentage of stress rate and implementation of physiological signal processing cases are considered independent variables whereas usage of a machine learning system is considered a dependant variable. The value of R square demonstrates how much of a gross imbalance is in the domain of dependent variables. As the value of R is recorded as .974, it can be effectively stated that it shows a high degree of correlation. It demonstrates a positive correlation among the variables. That means the usage of machine learning has increased significantly in the last few years.

TABLE 2: ANOVA (SOURCE: CREATED BY THE RESEARCHERS)

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	51.543	2	25.771	18.374	.052 ^b
	Residual	2.805	2	1.403		
	Total	54.348	4			
a. Dependent Variable: Usage of machine learning system						
b. Predictors: (Constant), Percentage of stress rate, Implementation of Physiological Signal Processing cases						

The second framework that must be considered in this domain is ANOVA. It effectively demonstrates how efficient the regression framework fit the fetched pieces of information. Here the sum of the square of regression is recorded as 51.543. It also demonstrates that the sum of squares of residuals is recorded as 2.805. The total sum of squares is recorded in this domain is 54.348. The mean square of the regression is recorded as 25.771. The data also shows that the means square of residual is recorded as 1.403. It is important to comprehend that percentage of stress rate and implementation of physiological signal processing cases are considered independent variables whereas usage of a machine learning system is considered a dependant variable. The SIG table demonstrates the statistical importance of the regression framework that was employed. Here P is greater than 0.05 i.e. 0.052 and it refers to that regression framework statistically effortlessly failed to analyse the outcome variables.

The coefficient table gives the researchers insight into the proper data associated with the employment of machine learning as well as examine whether the usage of machine

learning provides inputs statistically to the framework. The regression equation can be effectively put forward as below:

The usage of machine learning for the first independent variable: $1.684 + 0.009 = 1.693$

The usage of machine learning for the second independent variable: $1.684 - 0.177 = 1.507$

V. DISCUSSION AND FINDINGS

Linear regression framework effectively assists the study group to determine the linear correlation among the variables. Here the variables are “Implementation rate of psychological signal processing”, “the percentage of machine learning technology” and “percentage of stress rate”. Here the researchers have taken the implementation rate of psychological signal processing as independent variables and the other two are considered as dependant variables. linear -regression efficiently assists in examining the size of the correlation among the selected variables. It effectively assists to establish an understanding regarding the employment ML to detect stress in the last five years. The linear regression framework also assists to analyze whether the correlation among selected variables flickers or not when other variables such as heart rate and other variables are incorporated into the discussion [14].

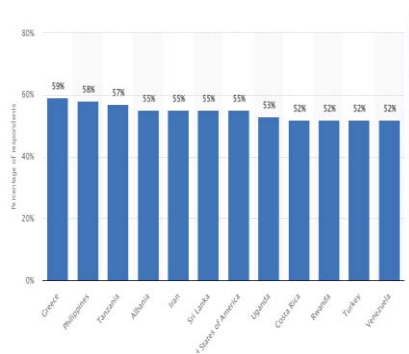


Figure 2: Leading countries based on stress experience

(Source: [13])

It can be seen from the data that EU regions are systematically affected by stress disorder. The data also shows that around sixty per cent of Greek people are suffering from stress disorders. It is not a brainer that the employment of machine learning has maximized significantly in the last five years.

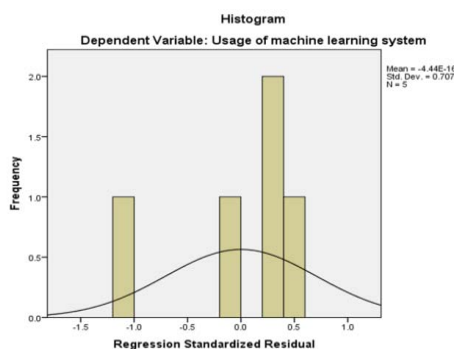


Figure 3: Histogram

From this graph, it can be seen that frequency has been put in one axis and regression standardised residual is put into another. The graph effectively demonstrates a significant pattern in this regard. The graph effectively comments on the employment of machine learning to detect stress. The growth shows a linear progression in the first phase. However, it shows a systematic growth after that. However, it demonstrates a dip in the curve at the end. This graph effectively assists the researchers to comprehend the rates of machine learning that has been employed to reduce in the last couple of years.

Another experimental discussion

The data was collected from 206 Jaypee Institute of Information Technology Noida students. It has been divided the data into two categories: before examinations and stress caused by internet use. The data was gathered for the PSS test, which consists of 14 questions in total, including the complete emotive question. “The questions were graded in five different ways. (a) Never (b) Almost Never (c) Occasionally (d) Fairly Frequently (e) Very Frequently”. The weighted average approach is then employed, with each question being prioritised. Highly pressured, stressed, and typical pupils are separated into three groups.

The information was gathered from college students. They were given basic questions regarding their sentiments and reactions to circumstances they may have experienced in the previous month. Their responses are weighted, and the weights are used to create a score that may be used to assess an individual's anxiety levels. To assess the weights and determine final scores, the dataset was pre-processed. It used K-fold cross-validation to increase the performance of the model.

Proposed approach

In this research, researchers utilised machine learning (ML) to detect rising stress levels in students, anticipate stress ahead of time, and prevent serious harm to their lives before it occurs. During the test, pupils were evaluated in a variety of circumstances. The project performance authorised the amount of stress. “PSS dataset collection, pre-processing, feature extraction, and machine learning algorithms (Random Forest, SVM, NB, KNN)” are all part of the proposed model, which is compared on three performance measures.

Performance Parameters

“The true positive rate is also called as sensitivity. It's the proportion of true positives (TP) to false negatives (FN) (FN). This identifies the model's ability to accurately recognise illnesses”.

$$Sensitivity = \frac{TP}{TP+FN}$$

Specificity

“The true negative rate is also known as specificity. It is the ratio of true negative (TN) to true negative and false positive (FP). This refers to the capacity to appropriately recognise illnesses without them”.

$$Specificity = \frac{TN}{TN+FP}$$

Accuracy

“This is the ratio of true positives plus true negatives to true positives plus true negatives + false positive plus false negative. It determines the percentage of instances that are accurately categorised”.

$$Accuracy = \frac{TP+TN}{TN+FP+TP+FN}$$

VI. CONCLUSION

Stress is regarded as one of the influential elements of an individual. The WHO has efficiently summarised stress as a mental ailment and it should be treated as soon as possible if detected at an early stage. However, early detection is often perceived to be very difficult as individuals sometimes completely ignore their psychological condition. Psychological signal processing through machines has revolutionised the particular domain as it assists to detect stress disorders at an early stage. It is seen that it also assist to minimise certain social malicious act such as rape with the effective use of this gadget. However, this particular method often suffers from different problems as well. Sometimes, it fails to put forward accurate data. This paper has effectively analysed the importance of psychological signal processing machine learning to detect stress from a broad perspective through a statistical analysis called linear regression model. At the same time, the paper has effectively consulted several peer-reviewed articles to gain a better understanding.

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