# A REVIEW ON ASSESSING STRESS METHODS USING MACHINE LEARNING AND WEARABLE SENSORS

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**Abstract**

*Stress is one kind of response to pressure. It can be good according to the situation. Stress management is a very important criterion now because it keeps up one's stress level low, and health at risk. There can have several reasons that affect stress levels such as social reasons, environmental reasons and so on. If we can detect stress levels before risk, it will be a good chance to prevent sudden health issues. Because if someone has stressed for a long period of time it will be affected badly not only mental health but also physical health. This paper, tries to examine and review various ways to detect stress levels, and also aims to give a systematic survey for a more efficient way to detect stress among different ways.*
***Keywords***: *machine learning, stress detection, wearable sensors*

## 1 Introduction

People's health and wellbeing status have been weakened with the technological advancement, the busy schedule and the lifestyle of the human being. The health and wellbeing include both the physical and mental health. In today's fast-paced world, mental health is a known thing and which is popular at this contemporary era. According to the World Health Organization (WHO),[1] identified the major diseases that affect peoples' mental health such as depression, anxiety, stress, and eating disorders, etc. Mental health conditions are increasing worldwide. Mainly because of demographic changes, there has been a 13% rise in mental health conditions and substance use disorders in the last decade (to 2017). Mental health disorders exist 1 in 5 and around 20% of the world's children and adolescents have a mental health condition, with suicidal death among 15-29-year-olds. Approximately one in five people in post-conflict settings have a mental health disorders.

According to the World Health Organization, [1] there are 3 types of stress, acute stress, episodic acute stress, and chronic stress. Chronic stress is a very harmful stress type for a normal person. Stress can be detected by measuring physiological and physical measures in a body. Physiological measures such as heart rate variability, heart rate, and skin conductance etc. and physical measures such as skin temperature, blood pressure, and pulse rate are the major indicators of success. Stress is one way of reacting to abnormal pressure in humans managing the hard situations for a long period of time and hence it will become as depression. This could affect either in a good or bad way according to the threshold of the person and the situation handled by the person. Stress can also help to motivate in a good way and it helps us to be more careful about things. Environmental reasons such as huge noises, bad smells, rain, and personal reasons such as the funeral of a family member, or divorce can be affected by the stress level of a person. Stress can differ from person to person with their capacity and attitudes for different kinds of reasons.

There can have several reasons that affect stress levels such as social reasons, environmental reasons so on. If we can detect stress levels before risk, it will be a good chance to prevent sudden health issues. Because if someone has stressed for a long period of time it will be affected badly not only mental health but also physical health. At present several researchers [2] [3]focused on finding the mechanism to reduce the stress levels while analyzing the collected data through different machine learning tools and techniques [4]and also by inventing the wearable devices that could be able to find out the stress levels with body condition factors. This paper, tries to examine and review various ways to detect stress levels, and also aims to give a systematic survey for a more efficient way to detect stress among different ways.

## 2 Related Works

There are several researchers show their interest towards the stress detection through several mechanisms. This paper review a certain papers which dealt with the identification of stress. The ways of identification are categorized and are discussed separately.

### *2.1 Stress detection using Electrocardiogram (ECG)*

Electrocardiogram (ECG) is a test that records the electrical activity of the heart. It helps to detect the manners of the heartbeats as slow, fast and regular. The electrical activity of the heartbeat is measured by an electrocardiogram which is called as ECG. For the purpose of identifying mental stress, Heart Rate Variability (HRV) parameters are frequently calculated from ECG data. These parameters are then separated into the Time domain and Frequency domain for additional research [2][4].

In [3] baseline drift and noise were eliminated from the ECG readings without changing the features of the waveform. The discrete wavelet transform approach was used to do feature excision. Additionally, classification was carried out on real-time data from 20 participants using Support Vector Machine (SVM), Artificial Neural Network (ANN), Bayesian network, and decision tree in order to obtain more accurate findings. Support Vector Machine (SVM) provides the results with more accuracy of 84.4% in a 10-fold cross validation method. The minimal redundancy maximum relevance (MRMR) selection process was used to choose the useful features. These techniques are appropriate since they can be easily used through wearable devices in everyday routine thanks to the scientific community's focus on the use of a single ECG channel.

### *2.2 Stress detection while driving*

Driving under stressful circumstances, such as maintaining the speed limit or driving in hazardous conditions, may result in traffic violations and auto accidents because the driver was not paying attention. The issue of a car driver's stress level being automatically detected is becoming more and more important because it directly affects passengers' safety and health. Researchers [5] have created a few stress detection techniques that can assist a person in determining both their bodily and psychological well-being so that appropriate precautions can be taken. A technique to detect stress via a wearable ECG sensor in drivers of cars while they are experiencing various levels of environmental stress brought on by driving conditions was developed by N. Keshan et al. [6]. The MIT-BIH PhysioNet Multiparameter Database provided a dataset of 17 drivers. Using the NetBeans Java Platform, 14 distinct features were retrieved from the ECG signal. This method detected three levels of stress with 88. 24% accuracy using machine learning algorithms as low, medium, and high.

In [7], Skin Potential Response SPR signals from EDA devices were utilized to detect the presence of stress in car drivers. Three wearable devices were employed for the data collection, including an ECG on the chest and an EDA device on each hand. A professional driving simulator that mimics the movements and accelerations of an automobile was used in the experimental setting. Driving down a roadway where some unexpected things were happening at certain points was the stressor test. Support vector machine and artificial neural network accuracy for the events under consideration were balanced at 79.58% and 79.94%, respectively.

A stress detection system using ECG signals with the features RR interval (the duration of conduction through the AV node), QT interval (the duration of ventricular depolarization to repolarization), and EDR (End Point Detection and Response) was 3 developed by Md. Fahim Rizwan et al. [8]. 15 healthy volunteers were given an ECG signal for five minutes while they were at rest and while they were driving in heavy traffic, which were regarded to be no stressful and stressful situations, respectively. By altering the feature number and kernel type, the system validated various SVM model types. The most accurate model to identify stress was the Cubic SVM, which had a 98.6% accuracy level with a Gaussian kernel function and all features. This methodology demonstrated how adding additional characteristics can improve model accuracy.

### *2.3 Stress detection using wearable sensors*

To recognize stressful situations, [9] uses a wrist device. In order to distinguish between stress and other situations that cause physiological arousal similar to stress, activity identification classifier employs accelerometer data to detect user activities. A web application was developed to collect data in a lab setting where participants had to complete mental arithmetic activities within a predetermined period of time while being pressured. The information for 2[10] comes from three sources: Use of my phone for messages, locations, and calls survey results on general health, mood, and stress, as well as accelerometer and skin conductance data from wrist sensors. The classification establishes whether or not the individual is under stress. To start the trial, three questionnaires must be filled out. A wearable sensor records information from the accelerometer and skin conductance Wearable sensors and data from mobile phones both have useful components to identify stress, according to the method's accuracy rate of 75%. The mean and standard deviation of the mobility radius are these properties. The authors will compile a broader data collection in order to better understand the dynamic influence of the long-term data.

In order to identify mental stress in real-time, the authors of [11] capture the individuals' body temperature, Galvanic skin response (GSR), and Rhythm to rhythm (RR) interval as they solve the Hanoi Tower. The answers to the questionnaires that the subjects completed before and after the studies were used to validate the data that had been collected. From the gathered signals, the author retrieved 27 features, and the 10 with the highest mutual information were utilized to train the K-nearest neighbor (KNN) classifier. Stress prediction is 89.8% accurate.

The authors of [12] created a smart bracelet that can determine whether a person is under stress or not. The device has two electrodes, a skin conductance sensor, a tri-axis accelerometer, Bluetooth, and a microcontroller to evaluate the data from the 12 participants' recorded skin conductance and other pentameters. Small electrical currents are applied to the skin by the electrodes and are recorded via Bluetooth and transmitted to the smartphone. These type of similar smart wearable bands can be used to measure the stress of a person [13].

### *2.4 Stress detection by blinking*

In [13], a computer vision-based system was suggested for identifying stress by automatic blinking patterns in video recordings of discussions. Their method uses a face tracker to locate the eye region and adjust these areas' color look. Additionally, it makes advantage of Shannon's entropy, offset characteristics, and in-between blinking time lapses. The suggested system demonstrates a connection between the patterns of eye blinking and perceived stress.

### *2.5 Stress detection through the behavior of typing*

The study [14] describes a potential method for monitoring keyboard interactions to identify changes in older persons' physical and cognitive status as well as to discriminate between tense and calm states. After completing physical and mental challenge tasks, study participants compose a sample sentence. The method examines the resulting text's keystrokes and textual characteristics. The three-fold cross-validation method was combined with a step-wise logistic regression algorithm. Before using machine learning on the data, Z-scores standardized it. Compared to the control settings, cognitive and physical stress may be classified with 75% and 66% accuracy, respectively. VI. Stress detection by human voice On the basis of a subject's Galvanic Skin Response (GSR) and speech, a classification approach to identify his acute stress period was developed in [15]. By employing HD handy-cam camcorders, facial expressions, GSR, and speech are recorded and classified using the Support vector machine (SVM) classifiers, K-means clustering, and decision trees, whereas, SVM achieved 92% and 70% accuracy by employing GSR and speech characteristics.

## 3 DISCUSSIONS AND CONCLUSION

In recent years, the term stress has become a very common topic in society because of competitive lives. The pre-analysis and the identification of the stress will be a useful at this period as stress can harm a person's physical and mental health. As a result of a challenging and competitive life, mental stress is now quite prevalent across all age groups.

One's level of stress can be determined by blood tests. One of the most often performed blood tests is a cortisol test to verify the stress level. When someone is under stress, their adrenal glands release a hormone called cortisol. Higher cortisol levels would suggest more stress [16].

Physiological sensor signals can be used to gauge a person's degree of stress, and physiological sensing devices are employed to gather the data. Signal pre-processing must be used to choose useful features from the collected signals. After the features have been identified, the classification model can be constructed using machine learning algorithms. In addition, wearable sensors can be utilized to detect stress. In the above-mentioned methods, they are used several ways to detect stress. The features were initially extracted by each built system using different approaches, and then machine learning algorithms were used to create classification models.

However, the stress levels varies with the persons and the situations handled, according to the above-mentioned methods, it is vividly seen that detecting stress level using ECG signals, with support vector machine and Gaussian kernel method is the best way detect stress more accurately. Other methods also can be used to take some idea about stress level.

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