

## Stress And Bio Signals: A Review of State of Art Techniques

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**Abstract**— Irrespective of internal or external factors when a person feels excessive pressure it reflects in his facial expression, speech and physiological behaviour signals. Instead of traditional questioner method of stress evaluation, researchers now a day's take various audiovisual and bio-signals, like heartbeat rate, muscle activity, blood pressure (BP) and skin conductivity. Electroencephalogram (EEG), Electrocardiogram (ECG), Electromyogram (EMG), Respiration (RSP) and Skin Conductivity (SC) are highly used bio-sensors for capturing bio signals. ECG signal gives heart-beat rate, inter-beat interval, and heart rate variability (HRV). EMG sensor when fit at upper trapezius gives the reading of muscle contraction which may be correlated with emotional state. SC sensors provide conductance and resistance of the skin which can also be used as a feature of importance. A wide range of physiological features from various analysis domains, including time/frequency, entropy, geometric analysis, sub-band spectra, multi-scale entropy, etc. along with audiovisual feature, got research attention in the process to find the best stress-relevant features and to correlate them with stress level. This article makes a detailed discussion of effectiveness of various bio signals for stress level and emotional state detection.

**Keywords**— Bio signals, cognitive computing, automated emotion detection.

### I. INTRODUCTION

Human emotion is a very composite psycho-physiological experience resulting from the interaction of internal and environmental factors. The emotional state of an individual reflects in audiovisual signals i.e voice and facial expression and physiological signals. Happiness of an individual depends upon healthier internal emotional lives. However stress is a very common problem in modern life. Stress is primarily a physical response. When stressed, the body thinks it is under attack and switches to 'fight or flight' mode, releasing a complex mix of hormones and chemicals such as adrenaline, cortisol and norepinephrine to prepare the body for physical action. This causes a number of reactions, from blood being diverted to muscles to shutting down unnecessary bodily functions such as digestion. In modern lifestyle people experience stress is day-to-day life in different ways. When a person's body goes into a state of stress, he may feel agitated and aggressive towards others. The manifestation of stress varies from person to person. Physical, cognitive, emotional and behavioural changes occur to a stressed person. Chest pain, Rapid Heartbeat, Aches and Pains, Frequent Colds, Skin Complaints, Indigestion, High Blood Pressure, Memory related Problems, Poor Judgmental ability, low level Concentration, Self doubt, Depression, Moodiness, Irritability, Fatalistic Thinking, Anxiety, Frustration, Increase Intake in Alcohol,

Cigarettes and Caffeine to Relax, Loss of sense of humour etc are some of the common problems encountered by people in stress. Table 1 show various common problems categorized in Physical, cognitive, emotional and behavioural.

These problems may affect his personal and professional life, resulting in reduced efficiency of the person. So, before the person's mental health is disturbed because of stress, it is very much necessary to detect the stress at an early stage and take corrective measures. Stress may be calculated and evaluated out of perceptual, behavioural and biological responses. The traditional method for physicians to evaluate stress is by use of questionnaires, which is a subjective approach. Because of this even though stress can do a lot of harm to an individual, people often hesitate to visit counsellors or psychiatrist. There are a lot of reasons in Indian society, which further boosts this behaviour, ignorance is one of them. Most of the people don't even know what stress or disturbance means. They have no idea how this stress can manifest itself with different symptoms. Another reason is Stigma. If someone approaches a counsellor, he or she is seen in a different way in the society. Because the person is seen as mad, entire neighbourhood bursts into gossip orgasms. Family is another big factor which keeps someone away from counsellor. Most of the cases the family members are more worried about what

neighbours may think about if someone from the family visits a counsellor. One more important aspect is that the number of counsellors is also very less in India and it may not be affordable for all. Good news is that today scientists are doing research to develop automated system where people don't have to meet any counsellor and feel embarrassed about it. Machine learning is playing a big role everywhere [1]. Other than stress bio signals are also used highly in other emotional state detection. Because of this possibility of classification of brain signals it is getting a huge application in brain computer interfacing. Figure 1 shows a simulink model that works on physiological signal like blood pressure, SCR, ECG and respiration flow as presented by Raphael Zimmermann et al.

**Table 1:** Common problems with category

Physical	Cognitive	Emotional	Behavioural
Chest Pain	Memory Problems	Depression	Increase Intake in Alcohol
Rapid Heartbeat	Poor Judgments	Moodiness	Isolate from Others
Aches and Pains	Inability to Concentrate	Panic	Sleeping too little
Frequent Colds	Brain Fog'	Cynicism	Sleeping too much
Skin Complaints	Indecision	Anxiety	Loss of sense of humour
Indigestion	Starting many tasks but achieving little	Irritability	Intake Cigarettes and Caffeine to Relax
High Blood Pressure	Self doubt	Frustration	De-motivated

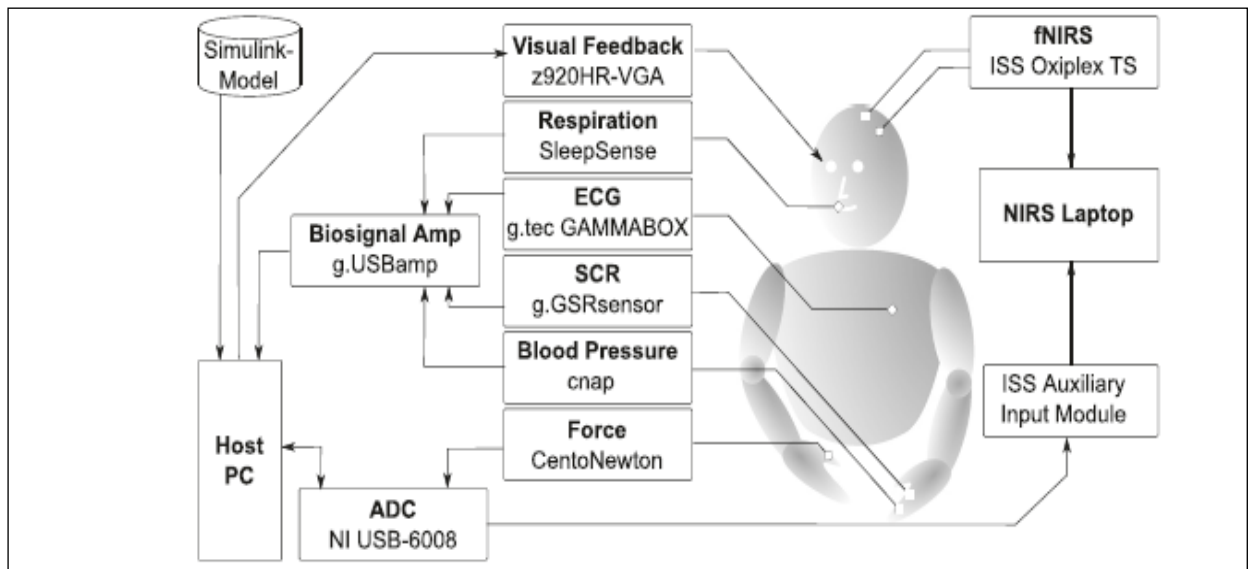
## II. RELATED WORK

The primary problem in this field is to investigate the effectiveness of audio-visual and physiological signals in determining the stress level of an individual. Analysing audio visual signals and automating the emotional state detection has got a huge attention from the research community. Such an effort for detecting human behaviour from facial feature with SURF feature descriptor is done by M.U.Nagrak et. al [2]. J.A. Healey et al. [3] presented an approach to collect and analyze the data generated by physiological signals in a real world driving work and correlate it with the stress level at different point of time. Four bio-signals electrocardiogram, electromyogram, skin conductance and respiration were considered for continuous monitoring while the subject was driving the car and recorded accordingly. Figure 2 shows stress and biosignal

metrics [4]. Dataset consisted of a collection of 24 different drives, each with at least 50 minutes duration. The analysis of data was carried out in two different ways. While one analysis used features from every five minute interval of data, the second analysis used continuous data every second throughout the duration of driving. Experimental results showed that for most of the subjects the bio-signals skin conductivity and heart rate metrics are dominant features for deciding stress level of the subject. The research considered rest, highway and city driving conditions to distinguish three levels of driver stress within accuracy of over 97% across multiple drivers and driving days. The results of this research point towards the possibility of physiological signals to provide a metric of stress level of the driver in cars which brings the hope of monitoring of driver stress level in future. S. Sager et al.[5] explored for the first time the classification's performance of acoustic concepts pairs. Research shows that audio signals are able to provide extensive information about the content of the surroundings. In previous research the content of audio has been investigated at the semantic level using acoustic concepts. However the author in this work had explored the content using pairs, for example happy crowd and angry crowd.

As a part of the research the researchers developed a corpora named AudioSentiBank corpus, which is a large-scale folkology containing over 1,123 adjective and verb-noun pairs. The basic objective of this research was to contribute by providing the research corpus, the benchmark for classification of acoustic concept pairs, and an analysis on the pairs.

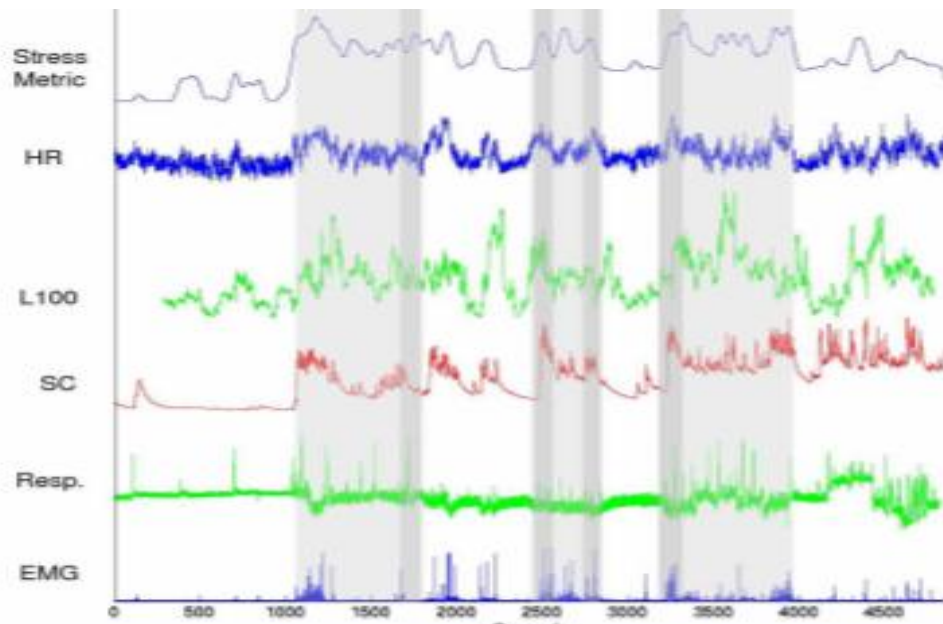
Study shows that mental stress as one of the chief contributing reasons that leads to a variety of sickness such as stroke, depression etc. According to them an accurate stress assessment technique would be of great significance for clinical intervention. Motivated by this fact, FARES AL-SHARGIE et al. carried out a research to assess mental stress by using EEG or fNIRS [6]. They considered 22 persons aged between 22-30 years. For real time data and avoid unwanted influence they conducted the experiment between 3-4.30 p.m. Eating or chewing of gums were prohibited for participants two hours prior to the experiment. They suggested that combination of EEG (frontal alpha rhythm) and fNIRS (concentration change of oxygenated hemoglobin) could be a possible means to assess mental stress objectively They proposed an approach based on joint independent component analysis (jICA) to combine simultaneous measurement of EEG and fNIRS on the PFC as a way of stress assessment.



**Figure 1:** Schematic representation of the measurement setup [3]

Jun-Uk Chu et al. proposed a new electromyogram (EMG) pattern recognition technique capable of working at real-time for controlling of a multifunction myoelectric hand from EMG signals of four channels [7]. Wavelet packet transformation is used for extraction of features to generate a feature vector. The issue of dimensionality reduction is taken care of by principal component analysis. To deal with non linear mapping of feature, self organizing map is being used.

Self organizing map uses non linear mapping to dimensionally reduced feature into a feature space which has high class separability. As a classifier, they have used Multi-layer perception. From the results observed they have made the conclusion that accuracy of recognition depends mainly on class separability of the features projected.



**Figure 2:** Stress and bio-signal metrics [4]

J.Kim et al. investigated the emotion recognition possibility based on physiological signal generated by an individual [8]. Starting with physiological dataset generation to multiclass classification is being performed by them. They have taken the help of music induction to see change in emotional state of the subject and change in physiological signal at the same time. They used four channel biosensors to measure electromyogram, electrocardiogram, skin conductivity (SC) and respiration changes.

They have also used a wide range of physiological features which include time and frequency domain features, entropy, geometric analysis, sub band spectra, multi scale entropy, etc. The basic objective was to find the best emotion relevant features and to correlate them with emotional states. Four different classes of emotion are considered in this experiment and classification is done by extended linear discriminant analysis (pLDA). They further developed a new scheme of emotion-specific multilevel dichotomous classification with improved accuracy as compared to pLDA. A lot of similar effort is put in India as well. U. Lahiri et al. has made an investigation into technology-assisted intervention for children with autism spectrum disorders [9]. From works done by previous researcher they considered robots to be a feasible way to impart skills to the children with autism spectrum disorders as these children are fascinated by robots. Virtual reality (VR) is a medium that suits for generating interactive intervention paradigms for teaching of skills to these children with ASD. They proposed a design that considers ratings from a Clinical observer with physiological responses indicative of affective states from the participants. The description of the proposed design of the virtual environment system for social interaction is published by them. A. Dutta et al. worked on people with disability occurred because of stroke. Their survey reveals that half the stroke survivor has to face some sort of disability. They proposed post stroke balance rehabilitation under multilevel electrotherapy [10]. They reported that the post stroke brain state can be altered toward improvement of Visio motor task performance. Ashish Panat et al. studied the emotions and the patterns of EEG signals of human brain for utility in the diagnosis of psychosomatic disorders in more simple and economical way with the help of ECG signal in their Analysis of emotion disorders [11] based on EEG signals of Human Brain. R. Agarwal et al. proposed a sleep assisted system where sleep states are recognized base on electroencephalogram (EEG), electromyogram (EMG) and electroculogram (EOG) signals[12].

### III. CONCLUSION

Stress has become a part of our daily life, because of the modern living style. Due to stress an individual suffers from

a variety of problems. Some of the common problems are: headaches, high blood pressure, heart problems, diabetes, skin conditions, asthma, arthritis depression and anxiety. As it is seen, Stress is a silent killer. Stress hinders an individual from performing the task as per expectation. The outcome of the research in this domain will be very helpful to detect a stressed individual and his/her level of severity. Once the level of stress is detected, proper measures will be suggested to the sufferer. The application area of this research field will be any bank, academic institutions, corporate houses where people suffers from stress because of hectic work schedule.

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### **Authors Profile**

Dr. Chandan Jyoti Kumar has done his B.Tech from NIT Silchar, M.Tech from NIT Jalandhar and PhD from Gauhati University. His research interest are Computer Vision, Machine learning, cognitive science and Hyperspectral Image Analysis. He is closely associated with IEEE sponsored International Conference on Computational Intelligence in Data Mining as a Reviewer (2014-2017) for last 4 years and Associated with IEEE sponsored International Conference INDIACom2017 as a Reviewer. He is also a reviewer of "IETE journal of reserach". He has academic experience of more than 5 years as an assistant professor.

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