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Recap on Bio-sensorial Stress Detection Methods and Technology

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Abstract: Mental stress consist in a biological condition that allows reaction to a demand or unknow situation, it is a necessary aspect for survivable, but, in a big among can turn into acute stress and if acute or common stress is not treated can become chronic stress a very dangerous health condition which can also be trigger for several cardiac disorders like heart attack or even strokes, for the las 20 years stress has increase severely due to our new lifestyle, this document gives a complete recap of stress detection by showing characteristics, health consequences and types of stress, as well as, recollect a background of previous research from methodologies like machine learning implementation to complex sensorial analysis, impacts and advances in stress detection, it also contain general concepts needed to obtain a full compression of stress detection, explanations of EDA (Electrodermal activity), cardiovascular activity, muscular activity, respiratory response, etc. follow by an explanation of devices capable of read such signals using GSR (Galvanic skin reflection), PPG(Photo plethysmography), EMG(Electromyogram), ECG(Electrocardiogram), etc. in addition, the proposed of a comparative table between all the common stress detection techniques, emphasizing parts of the body in which a lecture can be obtain, advantage and disadvantages of each signal and common application, equally important a new classification for stress detection methods.

Keywords: Mental stress, GSR, PPG, EMG, BSN, EDA, bio-signal and stress detection.

1. Introduction

Monitoring biological signals from human body has become a necessity to ensure individual and health, therefore, in recent years such monitoring has received special attention in scientific and technological development [1]. In terms of healthcare is well accepted that some psychological conditions can be “Triggers” for adverse cardiac conditions, one common and harmful condition is mental stress more specific “chronic stress”; it consequent biomarkers are to be found in hypertension, showing us a direct relation between stress and cardiovascular diseases [2]. Stress was definite by Chen et al. [3] as “stress represents an imbalanced state of an individual and is triggered when environmental demands exceed the regulatory capacity of the individual”, as mentioned environment demands represent a great part in the origin of stress, modern world demands more and more of us, even something as simple as tablet of smartphone screen’s resolution [4] can turn into a trigger for stress and consequential conditions. If acute stress is not treated, it can become chronic stress, taking part in the origin of hypertension and coronary atherogenesis, in addition, short-term chronic mental stress can act as a detonator for abnormal heart read and spontaneous dead on people with pre-existences cardiac conditions [2]. This health conditions have increase in late years, requiring a long-term solution but mainly an improve diagnostic methods to promote prevention and pre-care.

Consequences of uncared stress are well known and its treatment as a sickness has become a common medical practice [2], even with all the measures taken from medical authorities, spontaneous illness or even death are common health risk until these days. To reduce this risk several actions have been taken, the introduction of wearable body sensor networks has increased reliability of quick diagnosis and treatments, this has only be improve by the

technology available now [5], this has allow the incorporation of simple sensors on smartphones and cars, however, even with the existing evidence in the detection of stress, these new techniques are faced with a traditional reading model, which does not provide the necessary results for a fast, constant and correct diagnosis, even then concept of "emotions" is unclear and difficult to categorize by a person with traditional methods, requiring time and complexity. Stress detection and treatment have been done by psychological and medical experts for years but using a combination of invasive and disturbing technology with long diagnosis methods has create a slant between real conditions and perceive lectures or diagnostic. The use of technology have shown to be a high reliable way (accuracy rages of 96.6%) to detect biological conditions like emotions or stress [6], taking what mention before into account is imperative de deploy of an actual stress detector with a medical level reliability that also allows us to prove anti stress techniques by comparing lecture values.

2. Previous work

The development of technologies such as tactile sensors offer an option to acquire data from various systems, including, but not limited to, the human body [7], consequently health care changed [8], this is due to development of body sensor networks (BSN) and portable sensors [5]. The portable sensors offer a practical option for multiple disciplines from medicine to leisure [9]. Haag et al made an analysis of which statically method works better to prove reliable on a bio-sensor (specifying bio signal) base system, this have allow us to develop more efficient sensorial systems based on bio signals [6]. According to Sioni et al. measuring stress depends greatly of psychological signals obtain by sensors of electrodermal activity and heart rate [1], an example of this was seen when Das et al. show a 99.44% of accuracy reading between opposite emotions using electrocardiography and electrodermal activity together [10] and as later proved Muaremi et al. by using these new technologies to monitory sleep patterns on peregrines and its effect on their health [11], most of sensorial technology have been orientated to improve sensor and lecture methods as mentioned by Yang et al [7], Konijnenburg et al for example used a five channel multisensory acquisition system in a wristband he prove that a multisensorial versatile and portable device can be make, focusing more in a general propose multi lecture than a specific condition high reliable system [12], while all the devices and studies mention before had focus in the acquisition of bio signal using external no invasive sensorial methods some others base on improving or adapting to an existing technology as Sano et al. proposed when used a single sensor supported by smartphone machine learning to detect stress, mood and sleep but with some low accuracy [13] something similar was pull by Warnick et al show in Figure 1, but using electrocardiography to detect heart attacks [14].

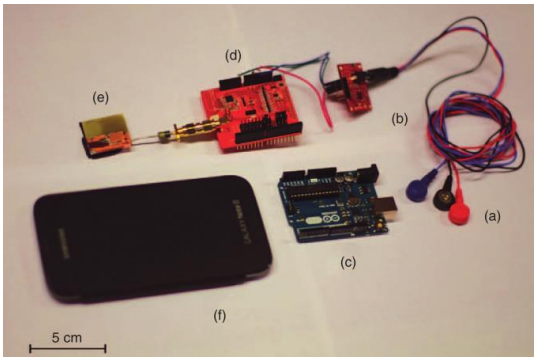

Figure 1. Warnick et al. Wireless Body Area Network for Heart Attack Detection. 2016 [14].

It is also well know that some tendencies have approach to improve cellphone and general lecture by using fuzzy logic and machine learning as shown by Chiang with his implementation to improve single signal biometric lectures[15].

If a device or technique has a high reliability either by having multiple lectures from different signal or a complete machine leaning code this technology oriented to stress or emotional detection have been use on hard environments, in order to make it safer or help the user to overcome such environment, one example of this is the implementation of such system in a car in order to improve the environment by knowing how does the driver feels [16], as well apply in a more safety oriented manner like show by Lee et al, by making a biometrical glove which detects drowsiness on drivers and sounds an alarm to awake them, he as well use multiple signals (GSR and PPG) in order to improve reliability.

Most of current biological detection systems depends of sensorial technologies and it capability to become a wearable item as an example of a use of a sensorial wearable device we have Liu et al. and it sweat monitoring witch control remote fans [17] other example of this is Sim and Cho sweat detector using only one sensorial base of conductivity in skin [18]. The new biometrical detection systems will depend greatly of the sensorial tool, current developed trends to sensors base on tactile technologies, demands self-power, biocompatible, biodegradable, skin merge and not invasive devices, as show in Figure 2 [5]. As conclude [7] advances on tactile sensor like wearable electronic patch and electrochromic polymer has the capacity to perceive way beyond any human common check, having the potential to replace a human medical diagnostics entirely.

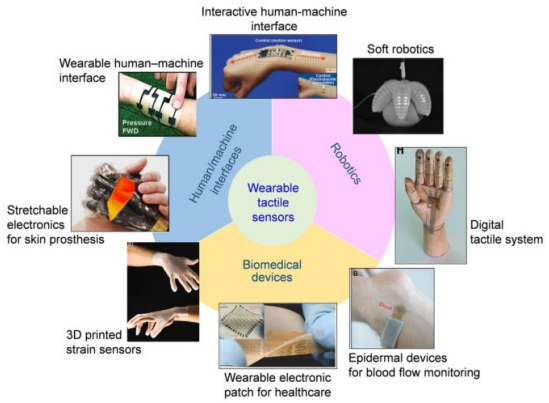

Figure 2. T. Yang et al. Materials Science and Engineering 2017 [7].

2.1. Patents

Scientific interest in monitoring physiological and physiological conditions have drove to the design of several devices and methodologies to improve healthcare base on stress. As so patens as shown in Table 1., trend to create an advantage by improving it technologic briefcase and allowing more continuous development, next we present a chart with some patents related to a stress lectures or detection.

Table 1. Patens table.

Patent Name	Patent Number
Physiological stress detector device and system [19].	US7171251B2
Methods and systems for detecting, measuring, and monitoring stress in speech [20].	US7283962B2
Method and device for measuring stress [21].	US7160253B2
Voice, lip-reading, face and emotion stress analysis, fuzzy logic intelligent camera system [22].	US7999857B2
Procedure for detection of stress by segmentation and analyzing a heartbeat signal [23].	US20050256414A1
Advanced patient management for identifying, displaying and assisting with correlating health-related data [24].	US20090105554A1
Methods and apparatus for profiling cardiovascular vulnerability to mental stress [25].	US20080081963A1
Wearable computing apparatus and method [26].	US20140347265A1
System and method for physiological monitoring [27].	US20120071731A1
Method and apparatus for analysis of psychiatric and physical conditions [28].	US20090292180A1
Real-time monitoring and control of physical and arousal status of individual organisms [29].	US20090312998A1
Assessing subject's reactivity to psychological stress using fmri [30].	US20090253982A1
Method for analyzing stress based on multi-measured bio-signals [31].	US20090069641A1
Methods and devices for relieving stress [24].	US20070056582A1
Data capable strapband for sleep monitoring, coaching, and avoidance [32].	US20150186609A1
Mental state analysis using wearable-camera devices [33].	US20130245396A1
Method and apparatus for determining heart rate variability using wavelet transformation [34].	US20120123232A1
Portable psychological monitoring device [35].	US20110151418A1
A method and apparatus for measuring and reducing mental stress [36].	WO2009138923A1
Metabolic monitoring, a method and apparatus for indicating a health-related condition of a subject [37].	US20070060803A1
Physiological signal detecting device and system [38].	US20150031964A1
The method and system, as well as their use for the physiological and psychological / physiological monitoring [39].	JP2008532587A
System and method for pain monitoring using a multidimensional analysis of physiological signals [40].	US8512240B1
Continuous monitoring of stress using environmental data [41].	US20120289789A1
Mental state analysis using web services [42].	US20110301433A1
Method, system and software product for the measurement of heart rate variability [43].	US20100174205A1
Continuous monitoring of stress using accelerometer data [41].	US20120289793A1
Continuous monitoring of stress using self-reported psychological or behavioral data [44].	US20120289790A1
Physiological and environmental monitoring systems and methods [45].	US8204786B2
Vehicle driver monitor and a method for monitoring a driver [46].	US20130070043A1
Washable wearable biosensor [47].	US 8140143 B2
Detection of cardiac arrhythmias using a photoplethysmograph [48]	US 7794406 B2

2.2. Stress detection

Stress diagnostic and psychological changes in general, can be improved with the use and more extensive application of sensory technology as demonstrated by [10] in its analysis of application of electrodermal activity and electrocardiogram, demonstrating that the use of sensory technologies is vastly superior to traditional models of emotional detection. This has led to sensor-based biometric systems becoming safe measures for disease and accident prevention, as posteriorly prove [49] and [50], these systems are a valuable asset for a safe and healthy between human and environment interaction, in other hand, [18] designed a portable sweat detector to control a house fan, while [51] developed a biometric human-machine interface controller, demonstrating that these technologies are not limited to healthcare instead having multiple applications.

3. Collection of data

Modern technology has proven to be able to read biological changes and condition without recurring to complex analysis and unprecise diagnosis, stress detection depends totally of the biological conditions that comes with it, biological condition of stress allows us to possible detect other medical condition as show by [52] or [53], but as mention before in order to detect and measure biological conditions in a proper way is needed a comprehension of the biological reaction in analysis.

3.1. Stress

To detect and measure stress using technology or any traditional method it is necessary to know what stress is and how many kinds are, all this information will help us to realize what kind of signal are we looking for and how are we going to measure them, according to [54] mental stress consist in “a body or mental tension resulting from factors that tend to alter an existing balance", this is presented as a natural reaction to an unexpected change, also stress can be seen as a defensive process to protect a person against possible injuries or treats to emotional well-being [1]. In this research, we definite stress as a biological condition of the autonomic nervous system (ANS) that allows reaction to a demand or unknow situation. All physiological responses related to stress are controlled in the autonomic nervous system (ANS). The latter is divided into sympathetic (SNS) and parasympathetic nervous system (PNS), the former controls activities that are detonated during emergency or unknown situations and the latter controls the rest and restoration functions of energy.

3.1.1. Types of stress

There is a wide variety of conditions under the name stress, and as mentioned before it is a very natural reaction, based on [55], there are three different types of stress, Eustress, Neustress and Distress. Not all kind of stress are bad or health prejudicial and it is needed to know which kind of stress is useful and which demands immediate detection and treatment. Eustress consist on good stress, it is call good stress because it increases in moments of inspiration, joy or motivation. Neustress is a neutral kind of stress and it comes to presence when a stimulus does not trigger a biological response and at last Distress, this final type of stress is the one considered harmful and is commonly known as “stress”, Distress is detonating by an unexpected event or circumstance, this is the type of stress that required constant monitoring because chronic phycological distress can have harmful cardiovascular consequences [2].

Distress is divided into two different kinds, acute stress and chronic stress. Acute stress comes from intense and strong stimulus, but with a short duration, it is also a common stress and in big quantities triggers chronic stress. Most of population is exposed to develop acute stress in any point of his/her life. Chronic stress is not as strong as acute stress but it can last days, weeks and even months [55].

3.2. Biological signals

All new methods of stress or emotional detection depends heavily on been able to monitor biological changes and translate them into readable signals. Biological signals fulfill that purpose, according to Kaniusas [56] a biological signal describes a physiological phenomenon, there is almost an unlimited quantity of biometrical markers, these markers are apply in the analysis, study and prediction of biological phenomenon, there are three bio-signals classification:

1. First classification is base on it “existence”.
   - Permanent bio-signals. Permanent bio-signals are those that “exist” without need of impact, arousal or external trigger and can be measure anytime.
   - Induced bio-signals. Consisting on those signals exhibit only when external artificial triggers activate them.

2. Second class. This classification is based on the dynamic nature of the signal.
   - Static bio-signals. Are those that suffer slow changes in long periods, these carry information on static state, for example body temperature.
   - Dynamic bio-signals. These bio-signals changes considerably over short periods of time

3. Third and last classification is base in the bio-signal origin, which include the next bio-signals:
   - Electrics.
   - Magnetics.

- Mechanics.
- Optics.
- Acoustics.
- Chemicals.
- Thermals.

3.2.1. Signals and tools for stress detection

Next, we present most common signals use for stress detection, each signal is follow by a hardware to read such signal, many of them are sensor other are more complex devices integrating sensors, filter, etc. and all of them are explain in each section, also, Figure 3 shows a visual summary of every signal and hardware use to measure them.

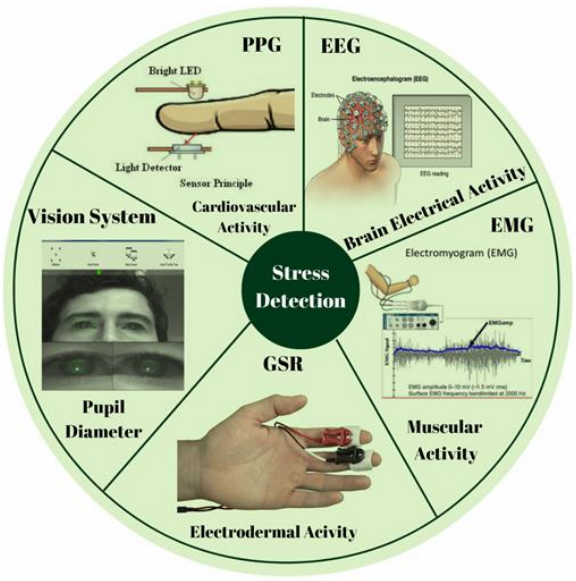

Figure 3. Stress detection methods (own image).

3.2.2. Electrodermal Activity (EDA)

One of the most common bio signal use to read stress on humans is electrodermal activity, this may be the most use bio signal to detect chronic stress, and many researchers considered the ideal stress signal. Human skin consist on an electrical conductor, in case of a cognitive, emotional or physical stressor, skin glands will produce ionic sweat [57]. This change on a physical condition can be measure and analyzed to obtain information about a person's condition. According to Johnson and Lubin (1966) cite by Boucsein [58] electrodermal activity (EDA) is definite as a common term for all electrical phenomenon and properties (passive or active) present or traceable to the skin. electrodermal activity is divided in two, EDL (Electrodermal Level) and EDR (electrodermal reaction) [58].

3.2.2.1. Galvanic Skin Reflection (GSR)

Considering that EDA as a bio signal, is still need to be obtain and translate into a readable unit in order to interpreter and understand what this signal is telling us about our body, Galvanic Skin Reflection is an indicator of electrical conductivity in skin or SC (Skin Conductivity), this conductivity increases linearly in presence of external or internal stimulus [59].) The changes in the electrodermal activity are created by physical and emotional stimuli on the autonomic nervous system (ANS) generating variations in the activity of the sweat glands (increasing the conductivity of the skin) [1] and [60], also GSR detects a wide rate of emotions and it has become a standard stress measurer. An example of a GSR process (noise reduction) signal is shown on Figure 4.

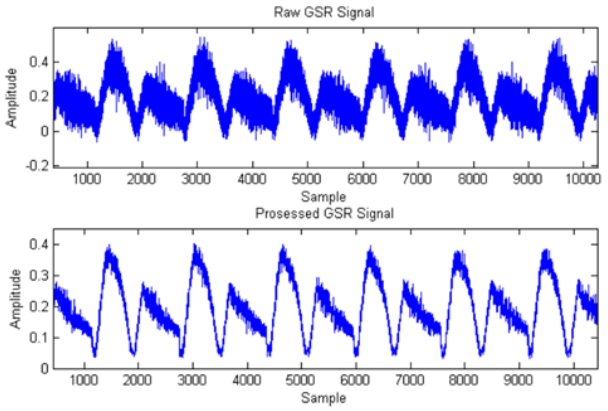

Figure 4. P.Das et al. Design and Development of Portable Galvanic Skin Response Acquisition and Analysis System. 2016 [60].

3.2.3. Cardiovascular activity

Cardiovascular activity refers to any measure that involve hearth and blood vessels, this bio signal provides a wide range of lectures for different physical and psychological conditions, cardiovascular activity can be measure throughout several different physiological signals, most common and use signals are blood volume pulse (BVP), electrocardiography (ECG). Blood volume pulse is related with the amount of blood that flows into the peripheral vessels and is generally measure using plethysmograph (PPG) [1].

3.2.3.1. Photoplesthysmography (PPG)

In order to translate cardiovascular signals several devices have been create, one of them is the plethysmograph, Photoplethysmography (PPG) has been used for the development of small and portable pulse sensors. These devices consist of infrared (LED) and light emitting diode photodetector; the infrared LED crosses the skin giving a reflex, this reflex is detected by the photodetector, detecting changes in the volume blood volume flow using changes in light intensity through reflection microvascular tissue (Figure 5). This is a reliable and economical method to monitor heart rate in a non-invasive and portable way [61].

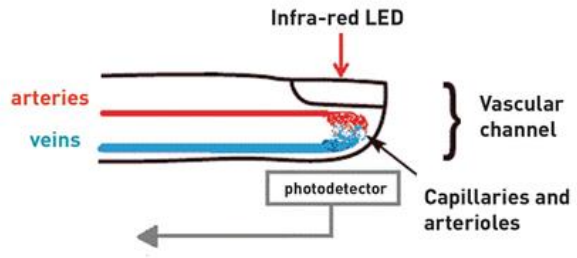

Figure 5. PPG operation by Scott Wilkes et al. Br J Gen Pract. 2015. 65 (635): 323-324.

3.2.4. Muscular Activity (EMG) and Respiratory Response

Tension in muscles is a common indicator of an external stimulus, as consequence it is possible to found certain emotional changes using muscular signals, muscular activity can be measure by EMG which stands for Electromyogram. EMG uses electrodes on the skin muscles to detect electrical discharger during muscles fiber contractions, [1], is need to be notice that the electrodes most be stick or insert using needles , is because of this that EMG is traditionally considered an invasive technique. Even so, new technologies have made possible to use EMG in a more practical way reducing invasively and improving lecture.

Continuing with stress detection signals, there is a well know relationship between stress and respiration, SNS and PNS have a close relation with berating patterns [62], inhalation and exaltation length turn into biomarkers for stress, during stress respiration becomes irregular. This respiration unbalance affects different body phenomenon such as HRV and EDA, this is since almost all physiological activities in human body depends on respiration. Respiratory response is usually measure by using a related bio signal, an example the relation between breathing and HRV in sleep patterns [11], or by measuring air flow and quantities.

3.2.5. Analysis by Vision Systems

A relative new technique to measure stress and emotional changes is by using vision system, as shown by Chen et al the use of Hyperspectral Imaging which uses oxygen saturation and temperature in order to detect emotional changes, also small movements in the face [3]. Another implementation of vision system is in the use of pupil, Torres et al. using a cam detected stress by measuring the changes on the pupil using different stimulus [63], showing many of the possibilities using this technology.

3.2.6. Other tools and signals

Some other signals have been used to determine the presence of stress, electroencephalography or EEG is a common tool for diagnosis for several psychological conditions, it consist of a big amount of electrodes place on the user head measuring the electrical activity on the brain. This technique has been used successfully to read stress by clustering results [64],[65]. Another signal also use for stress detection is electrocardiogram or ECG, this consist of an interpretation of electrical activity in heart [66] this allow a wide variety of lectures and it has been use to monitoring heart conditions including but not limiting to heart attacks or sudden death.

3.2.7. Comparative Chart

Next, we show a descriptive chart (Table 2), first mentioning all the common ways to detect and measure stress and where its commonly measure (body part), second its characteristics and benefices or disadvantages.

Table 2. Comparative chart.

Stress Detection Comparative Chart					
Bio-signal	**Devices to read signals**	**Body part for recollection of data**	**Beneficies**	**Disadvantage**	**Applications**
Electrodermal activity.	GSR	Any soft skin tissues. (Hand fingers, hand palm, foot plant.)	Noninvasive, detects a wide range of emotional changes.	Hard to interpreter, requires signal conditioners and post processing techniques.	Commonly use to stress detection or emotional detection [67], [68], [60], [69].
Cardiovascular activity. -	PPG, Polygraph, etc.	Wrist, finger tips, lobule, chest, etc.	Detects a wide variety of biological conditions and	Sensible to movement. Sensible to internal biological conditions and cardiac diseases.	Its application varies [61] from detecting emotions and stress [70], [6] to cardiac conditions like heart attacks [5].
Muscular activity	EMG	Any muscular section, is recommended upper arm.	Clear lectures and reliable.	Very invasive. Sensible to movement	EMG are usually use to interface machines with human body [71], [51], but can also been used to detect psychological stimulus in human body [64].

Respiratory Response	Breath sensor (like gas sensor) or a sensorial chest trap.	Chest and mouth.	Detects a wide variety of conditions. Doesn't need much signal preconditioning.	Uncomfortable and some invasive. Sensible to movement.	Applications for this are monitoring for patient in hospital and also can be used to detect stimulus or conditions like apnea or stress [72], [62].
Vision	Camera	Usually monitoring eyes or face muscular changes.	Noninvasive, detects a wide variety of conditions, doesn't require direct contact with the user.	Requires a high level of programing and debugging. Its affected by a lot of noise.	Using vision can detect al emotional range or emotional conditions [63], [3].
Electrocardiogram	ECG	Chest area.	Precise and versatile (proven technology)	Big hardware	Can be used to detect almost any cardiac conditions [66], [52].
Electroencephalography	EEG	Head.	Can read a wide range of signals and conditions derivate from brain activity.	Invasive and require a big hardware	Used on control of devices by human brain and to detect neural illness, but can be used to detect emotions and stress, any brain related condition [73], [49].

4. Stress bio-lecture techniques/methods

To correctly detect biological changes like emotions or stress by bio signals, it is necessary to determine which sensor, method and / or technique work optimally. To do this, first, we must identify which signals are more efficient when reading the stress. Some authors affirm that the EDA (Electrodermal Activity) are "ideal" obtaining psychological signals for stress measurement [60], [1], EDA measure changes in electrical conductivity of the skin and receive data mostly when an unexpected situation occurs or that demands a reaction [1]. Some stress detection have been well done by using only a single or various GSR sensors, an example of this is appreciate in a portable Galvanic Skin Response Acquisition and Analysis System done by Das et al [60], focusing in improving the lecture and analysis of a GSR signal and obtaining good result. Based on previous mentioned, some others studies report using this type of sensor to perform detection and quantification of stress based only on an EDA in form of a GSR (Galvanic Skin Response) sensor [74], [69]. Other often use biological characteristics for optimal stress detection or emotional changes are cardiovascular signals, there are several cardiovascular phenomenon and these conditions are closely linked to stress [53] most common cardiovascular reads/signals used on stress detection according to [1] are BVP (Blood Volume Pressure) which is measured by a plethysmograph (PPG) [57] and ECG (Electrocardiography) [75], [76]. These sensors consist of an infrared emitting diode (LED) and photodetector, which allows to be a reliable, non-invasive and low cost sensor [61], in addition, the PPG sensors are the basis of modern pulse monitoring devices and extensively apply on medical monitoring area [77], however, its performance still can be improved by using noise canceling techniques. As has been noticed EDA and cardiovascular activity tend to be the most accepted way to detect stress and have become a proven method to read emotional changes, even so there is some debate in which sensor is more efficient and if a single sensor is enough, due to this divergence is necessary to stablish a relation between lecture method/sensor/signal approach and benefits or disadvantage respectably.

In this paper, we divided stress's lecture technique into two main classes:

- Unisensor.
- Multisensor.

The first one applies when the user depends of only one sensor/type of signal to obtain the stress lecture, this technique depends greatly from filter, signal conditioning, and hardware (sensor), this method benefits from complete sensor and signals that carry a wide variety of data as cardiovascular or electrodermal activity, being said that, instruments like PPG or GSR sensor can be used to detect a wide variety of biological phenomenon have shown a high efficiency individually apply.

Unisensor lectures carry a disadvantage of needed an advance code and digital and/or analog filters to avoid noises like movement to get mandatory precision, often this technique is very useful when we try to find big changes in data, like detect happiness or sadness, calm or arousal, but it lacks lecture's reliability when we try to read a more precise biological state, some authors have solved this problem by applying to the signal classifiers,

RAF (Rectifier, Amplifier and Filters) and genetic algorithms in a synergistic way (Figure 6).

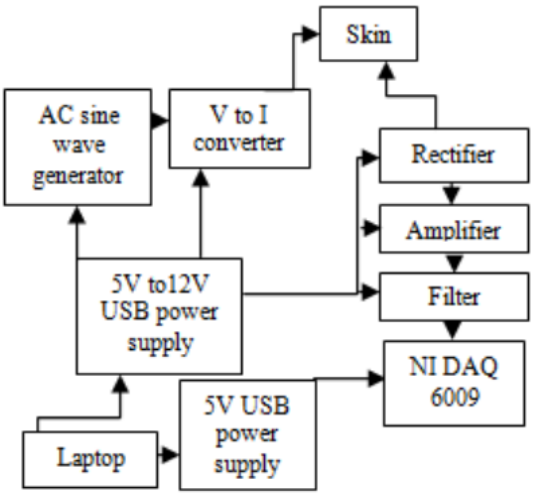

Figure 6. Design and Development of Portable Galvanic Skin Response Acquisition and Analysis System /Schematic block diagram of design methodology/ Das, Priyanka (2016).

Second, we have multisensorial technique as the name subject require several signals and sensor, also biological sensor networks enter in this category, this method requires a high synergic between it sensors to acquire a measure without conflict between them. This method, if is correctly complemented (machine learning or genetic algorithm)[78] can detect and measure almost every known biological phenomenon, as an example by using PPG, EMG, GSR, Vision, etc. to detect stress you can achieve a reliable lecture and proving to be much exact [79].

In both techniques there is a common problem worth to be mention and analyses how each technique deal with it, this is, what if the biological signal which your lectures are taken from is affected for other external or internal conditions ?, this is the divergence where unisensor method seen to be inferior to multisensor, because of his lack of feedback from some other bio-signal meaning that unisensor relays to much in the device making hard to responded to a unpredicted stimulus non readable, explain in another way, if we are taking a cardiovascular lecture and the subject has or had cardiac diseases the lecture is going to be affected because of this conditions or if we are taking a electrodermal measure and the user has some respiratory problems our lecture won make a patron causing doubt in the system. Consequently, this may create false positives and wrong lectures, in cases like stress or heart attacks this kind of errors must never happen due to the dangerous nature of such conditions, many authors claim that the best and only way to measure biological signals is by using multiple bio signal data acquisition [80], [81] to avoid false positives, for example, in case of cardiac previous diseases cardiovascular lectures are supported by electrodermal lectures so if the data show conflict between it different receptors we could discard some conditions depending on which phenomenon are we trying to measure, this is a basic principle of a body sensor network[82], even so, some other claim that a unisensorial method is highly efficient if proper signal treatment and generic algorithm are apply [77], [83], but there still no a unified posture.

5. Future Research

According to what was mention before, stress detection has and will be an important part of our lives, oriented to help to avoid illness in a day a day basis, new technologies allow us to obtain several bio-signals from a single sensor and the develop of biopolymer attach to skin, will make stress detection a future symbiotic aspect of technology in human's healthcare. There is no dough that smaller and complex skin attach sensors will make the future of stress detection and also an integration of these kind of sensors into cars, houses, furniture and industry.

A new use or open field for this kind of devices is in the industry, although some of these devices have been use to monitoring stress in workers, is always in a health perspective, but, the reach of these technologies is far greater than that, a new way of use in industry could be by verifying polities or techniques to improve production and workers efficiency, for example when a company starts to apply anti-fatigue mats, which claim to also reduce stress and improve workers efficiency, how can a company actually know this decision is working, well for all those kinds of decisions a biometric stress detector can be apply, even something as simple as illumination or color use in a plant can affect workers but using of these technologies could lead to an actual improvement.

6. Conclusions

To conclude, stress (distress) has increase greatly in the las 20 years due to a wide variety of life style changes, computer use and work and living conditions have spread and increase the number of people affected by this condition becoming a mass harmful condition, triggering several cardiac terminal afflictions and physical diseases, forcing us to detect and measure stress and its specific varieties to avoid it or reduce it. Previous said, have driven the creation of several methodologies, sensors and devices

which can detect stress in a certain condition, allowing us to actually have a knowledge and control of our mental state, this device opened a door of several possibilities of which we are still trying of fully to take advantage of, to take advantage of there is a wide variety of applications for stress detection and the technology advances only make it more efficient and portable, making possible an integration in home automation, wearable devices, car design, computer interface, phycological diagnosis, healthcare, vision system, etc. Also, all the studies of biological signals use to detect this phenomenon can be applied to detect several conditions phycological and physical, making this kind of technology a continuous study area.

This section is not mandatory but can be added to the manuscript if the discussion is unusually long or complex.

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