Analysis of Mental Health using Galvanic Skin Reflectance

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Abstract: Our skin gives away a lot of information on how we feel when we're exposed to emotions. Sometimes, one has to control different emotional situations which may lead the person suffering them to dangerous situations, in both the medium and short term. There are studies which indicate that stress increases the chance of cardiac problems. Stress detector classifies a stressed individual from a standard one by acquiring his/her physiological signals through appropriate sensors like Electrocardiogram (ECG), Galvanic Skin Response (GSR) etc,. These signals are pre-processed to extract the specified features which depicts the stress level in working individuals. The signal are often used for capturing the autonomic nerve responses as a parameter of the sweat gland function. The response appears as a rise within the electrical conductance of the skin (a decrease in resistance) across the palms of the hands or soles of the feet. Galvanic Skin Response (GSR) is defined as a change within the electrical properties of the skin. It is used to measure skin resistance, skin conductance and stress level of human being. The mathematical manipulation is implemented to measure these parameters skin resistance, skin conductance and stress level at various situations(i.e. listening music, mathematical calculations, breathing, etc.,). The present state of sensor technology allows to develop systems measuring physical symptoms reflecting the stress level. The problem of stress identification and categorization from the sensor data stream mining perspective, consider a reductionist approach for arousal identification as a drift detection task, highlight the foremost problems of managing with GSR data, and propose simple approaches the way to them.

Keywords—LabVIEW, Galvanic Skin Response (GSR), EDR, Conductance and stress , Biomedical Workbench, Arduino.

1. Introduction:

Stress may be a common problem that is experienced by people. Stress is how the body reacts when a person is involved in a threatening situation, and when the body reacts in way if the situation isn't real or that would protect him from harm which is usually called stress response. Once we perceive a threat, our nervous system responds by releasing a flood of stress hormones. These hormones rouse the body for emergency action. In some cases it is necessary to gather feedback so as to regulate this symptom because it can become dangerous in certain situations. The Stress management Society defines stress as a situation where demands placed on someone exceeds the person's resources or the flexibility to cope. It is one of the biggest issues that modern man has to deal with and biggest cause of illness some of which even lead to death.

Stress detection has been considered from many alternative views and approaches. These views and approaches had considered the following stress detection devices with any or a combination of any of the following inputs, namely: behavioral manifestations, physical features, physiological manifestations, emotional manifestations and others. It is impossible to avoid stress in a working environment. In spite of whether we are stressed, nervous, fearful, baffled, or surprised, whenever we are emotionally aroused, the electrical conductivity of our skin subtly changes. Therefore, it is necessary to create a tool to detect stress.

It is the property of the human body that causes continious variation in the electrical characteristics of the skin. The theory of EDA holds that skin resistance varies with the state of sweat glands in the skin. Sweating is controlled by the sympathetic nervous system and skin conductance is an indication of physiological arousal. If the sympathetic branch of the autonomic nervous system is extremely aroused, then sweat gland activity also increases, which successively increases skin conductance. In this way, skin conductance can be measure of emotional and sympathetic responses. EDA is extremely conscious of emotions in some people. Fear, anger, orienting response are among the reactions that may be reflected in EDA [14]. Fig1 shows the schematic representation of GSR Signal.

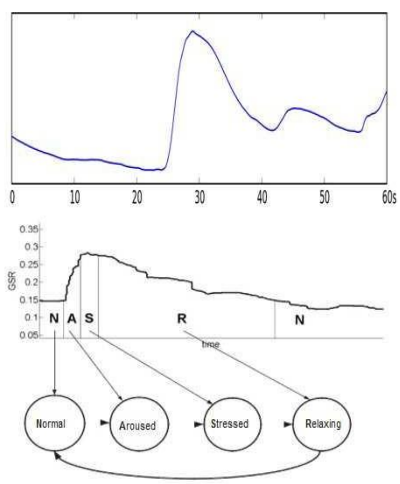

Fig1: Schematic representation of GSR Signal

2. System Design Overview

This Complete GSR System will be understood by simple block diagram having different stages. The Block Diagram of the planned system is shown in **Fig2.** The physiological parameter of the patient are measured using GSR Sensor Module (CJMCU-6701) and Ag electrodes and their output is processed through a microcontroller. The Microcontroller performs the function of a DAQ and easily serves the signals to LabVIEW. The Signal is processed through the LabVIEW VIs. The output is displayed within the front panel of LabVIEW.

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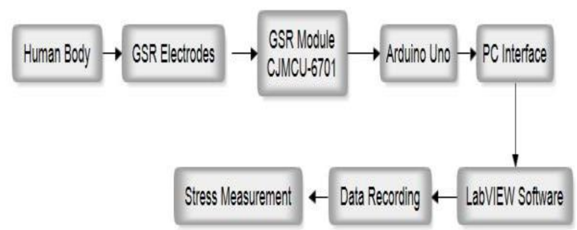

Fig.2: System Model of the proposed work

The objective of this work is to extract the GSR signal from different subjects and the raw GSR signal fed into the GSR sensor module which filters and amplifies it in presence of noisy conditions. The output of the sensor module is fed into a computer having LabVIEW using Arudino Uno. Using LabVIEW, proper analysis of the extracted signal is done. Various real time data from different subjects are taken in order to analyse them by comparing them with an ideal data [15]. The Schematic diagram of the proposed system is shown in **Fig3**.

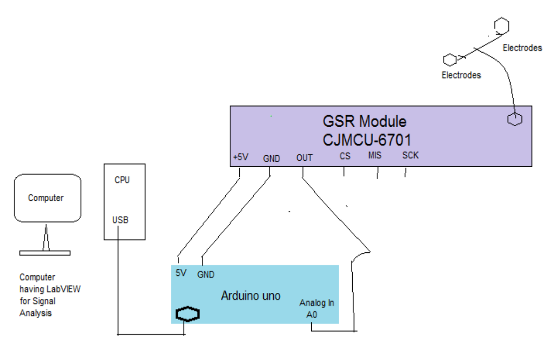

Fig3: Schematic diagram of the analysis of GSR signal Using LabVIEW

3 .Hardware Required

3.1. Arduino UNO

The Arduino Uno may be a commonly used microcontroller board supported the ATmega328 IC. It has 14 digital input/output pins - 6 analog inputs, a 16 MHz oscillator, a USB connection, a power jack, an ICSP header, and a reset button, out of which 6 pins is used as PWM outputs [16].

Fig 4: Arduino Uno microcontroller

Arduino is simply used as a DAQ (Data Acquisition) to communicate the input signals to the LabVIEW. The Signals are manipulated using the LabVIEW VIs and not the controller.

3.2. GSR Sensor

The body that can be used to measure the electrical activity of the skin (EDA), also known as the GSR . EDA is truly a characteristic of the human body that leads to continuous changes within the electrical properties of the skin. EDA monitoring is typically combined with monitoring of heart rate, respiratory rate and vital sign to completely understand some parameters of the human autonomic nervous system. EDA measurements are an integral a part of modern lie detectors and are often used as lie detectors. GSR clicks are ideally suited as an experimental tool for research, as well as for establishing effective test applications based on EDA reactions - such as polygraphs. The clicking features a precise 12bit AD converter so that the measured data are often digitally processed by the MCU via the SPI, it also outputs buffered analog signal for further processing (analog or digital) [17]. Fig5 shows the GSR Sensor Module.

Fig5:GSR Sensor Module (CJMCU-6701)

4. Software Platform Implementation

4.1 LabVIEW

LabVIEW - *Laboratory Virtual Instrument Engineering Workbench*, is an interactive programming environment in which programs can be created using a graphical notation.The programming language employed in LabVIEW could be a dataflow programming language within which the execution is set by the structure of a graphical block diagram. The programmer can connect different function-nodes by drawing wires. These wires propagate data as variables and a node can execute when all its input file is obtainable. This graphical is highly advantageous as it allows the nonprogrammers to build programs by dragging and dropping virtual representations of lab equipment in LabVIEW. One of the additional features of LabVIEW is that, it includes extensive support for interfacing various devices, instruments and even cameras. LabVIEW also includes built-in support for NI hardware platforms like Compact DAQ and Compact RIO, with a large number of device-specific blocks for such hardwares similar to the *Measurement and Automation eXplorer* (MAX) and *Virtual Instrument Software Architecture* (VISA) toolsets [18].

5. Experimental Details

5.1. Electrode Placement

The electrode which is used in GSR are attached to the index and middle finger of the subject as shown in **Fig6**. It is also possible to place the electrodes in other locations (such as the shoulders, or even feet).The electrodes should be placed on the proximal part of the finger (i.e. not the joint), with the electrodes placed on the palm side of the hand.

Fig6: Placement of Electrodes

5.2. <u>Signal Conditioning and Processing using LabVIEW</u>

After the signal is extracted from a particular subject using Ag electrode, the signal is interfaced to the PC with LabVIEW using Arduino Uno where it will be further processed. **Fig.7**. shows the flowchart for the detection of the subject is relax or stress.

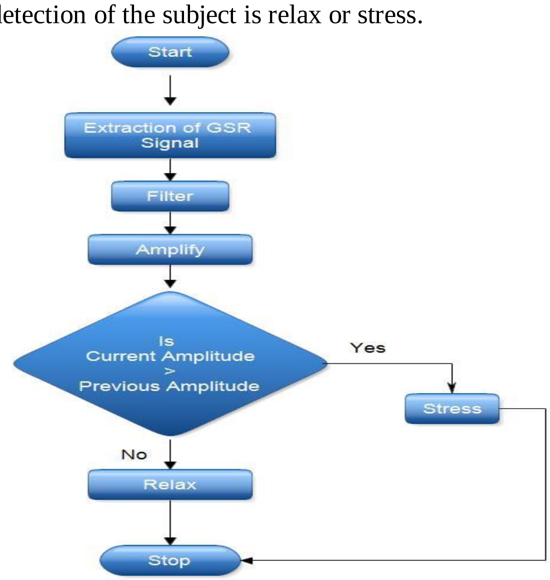

Fig7: Algorithm for the detection of the subject is stressed or relax

Fig.8 shows the back panel of LabVIEW for the detection of the subject is relax or stress. **Fig.9** shows the front panel of LabVIEW for the detection of the subject is stress or relax.

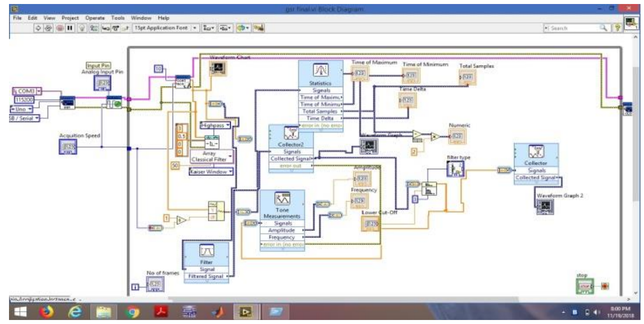

Fig8: The back panel of LabVIEW for the detection of the subject is stress or relax

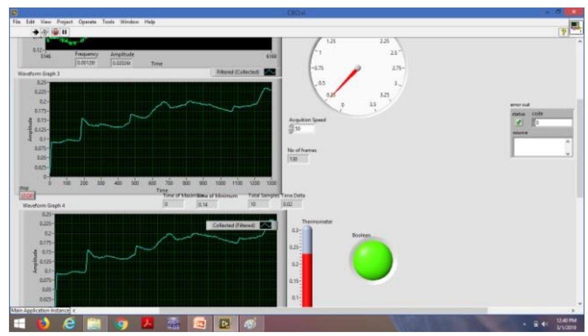

Fig9: The front panel of LabVIEW for the detection of the subject is stress or relax

5.3. <u>Experimental Results</u>

An experimental set-up has been shown in the **Fig10** while extracting the GSR signal from a subject.

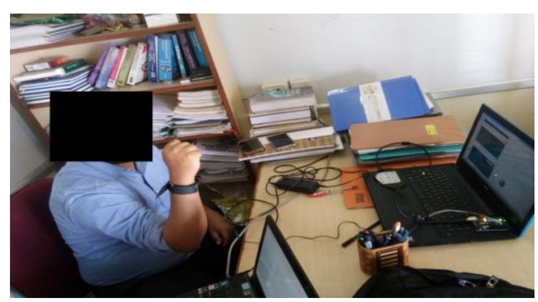

Fig10: Experimental Set-Up

The GSR signals that we have extracted from various subjects with the help of electrodes and then processed them in LabVIEW using Arduino Uno are as follows:

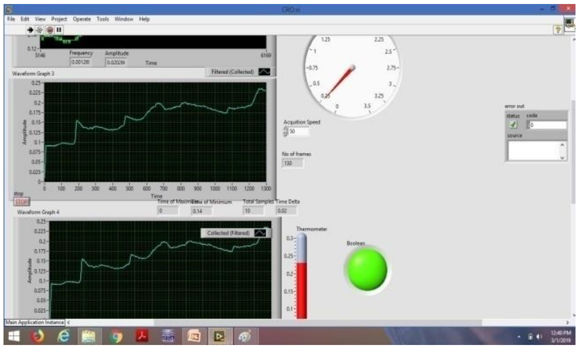

Fig11: Subject-1, Male, Age:24

Comment 1: From the extracted GSR signal as shown in **Fig11**, we have come to a point that the subject-1 is in Stress condition because the amplitude is increased compare to previous amplitude.

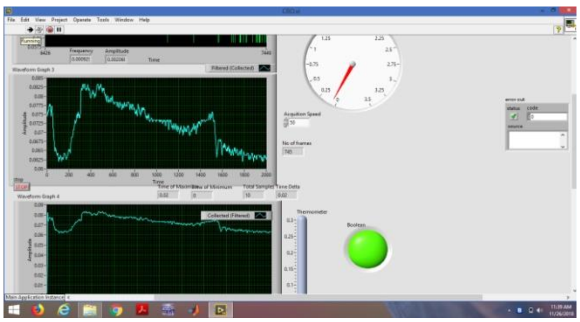

Fig12: Subject-2, Male, Age:24

. **Comment 2:** From the extracted GSR signal as shown in **Fig12**, we have come to a point that the subject-2 is in relax condition because the amplitude is increased compare to previous amplitude.

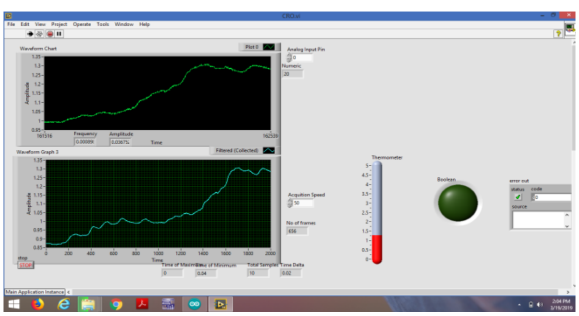

Fig13: Subject-3, Male, Age:24

Comment 3: From the extracted GSR signal as shown in **Fig13**, we have come to a point that the subject-3 is in Stress condition because the amplitude is increased compare to previous amplitude.

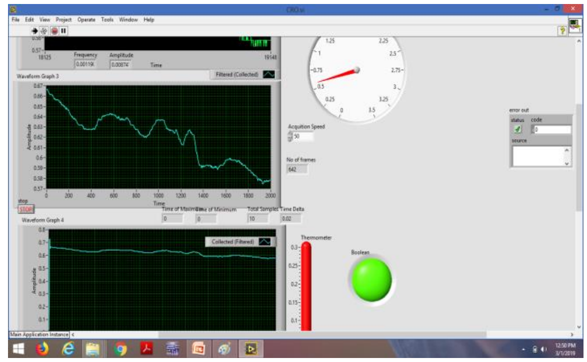

Fig14: Subject-4, Male, Age:24

Comment 4: From the extracted GSR signal as shown in **Fig14**, we have come to a point that the subject-4 is in relax condition because the amplitude is increased compare to previous amplitude.

6. Result

We have conducted several tests so as to vary the emotion of the subjects. Knowing the moments when the person should be stressed and therefore the ones where he should not, we are able to analyze each kind of data separately. We have used 30 subjects aged between 21 and 36 (13 women and 17 men).

All the users have done the following tests:

- Staying relaxed
- Mathematical operations
- During Class Test
- During Interview, etc.

The GSR signal has been extracted by means of Ag electrodes of the subject and it has been processed in the LabVIEW to detect the subject is stress or relax. Front panel visualizes the detection of the stress or relax.

Overview of the Experimental Results

Table 1 shows the output voltage for the different tests in those cases where the differences are better appreciated.

Subject	**Age**	**Sex**	**Occupation**	**Time**				**Comments**
				Morning		**Evening**		
				(If current amplitude > Previous amplitude) Stress	**(If current amplitude <Previous amplitude) Relax**	**(If current amplitude > Previous amplitude) Stress**	**(If current amplitude < Previous amplitude) Relax**	
Subject1	21	F	Student	Yes			Yes	During Class Test
Subject2	21	M	Student		Yes		Yes	During Class Test
Subject3	23	F	Student	Yes		Yes		Trying to be nervous
Subject4	23	M	Student		Yes	Yes		Trying to be nervous
Subject5	23	F	Student	Yes			Yes	Taking in air and expelling it forcefully
Subject6	25	M	Student		Yes		Yes	Sleeping Time
Subject7	21	M	Student	Yes		Yes		College Hour
Subject8	23	M	Student		Yes	Yes		Busy in doing creative thing.
Subject9	23	M	Student	Yes			Yes	Just before the interview
Subject10	21	F	Student		Yes	Yes		College Hour
Subject11	28	M	Warden	Yes			Yes	Meetings
Subject12	35	F	Faculty		Yes		Yes	In calm state
Subject13	24	M	Student	Yes			Yes	Just before the interview

Subject14	23	M	Student		Yes	Yes		Lunch Time
Subject15	23	F	Student		Yes	Yes		Watching Movie
Subject16	23	M	Student	Yes			Yes	Just before the interview
Subject17	24	M	Student		Yes		Yes	In Calm State
Subject18	24	M	Student	Yes		Yes		Assignment work
Subject19	22	M	Student		Yes		Yes	In calm state
Subject20	21	F	Student		Yes		Yes	Sleeping
Subject21	21	F	Student	Yes			Yes	Before Exam
Subject22	21	F	Student	Yes			Yes	After playing tug of war
Subject23	21	F	Student		Yes		Yes	Listening music
Subject24	36	M	Faculty	Yes			Yes	Before Exam
Subject25	21	M	Student	Yes		Yes		Mathematical operation
Subject26	21	M	Student	Yes			Yes	During Assignment
Subject27	21	F	Student		Yes		Yes	During Class Test
Subject28	23	F	Student		Yes		Yes	Watching Movies
Subject29	22	M	Student	Yes			Yes	Project Time
Subject30	23	M	Faculty	Yes			Yes	During office Hour

Table 2 shows the output voltage for the different tests undertaken under different situations shown in Table 1.

Subject	**Age**	**Sex**	**Morning (in)**	**Evening (in)**	**Remark**
Subject 1	21	F	1.23	1.12	At the evening stress is less
Subject 2	21	M	1.02	0.99	At the evening stress is less
Subject 3	23	F	0.56	0.36	At the evening stress is less
Subject 4	**23**	**M**	**0.45**	**0.77**	**Moring stress <Evening stress**
Subject 5	23	F	0.89	0.46	At the evening stress is less
Subject 6	25	M	0.68	0.33	At the evening stress is less
Subject 7	21	M	0.69	0.45	At the evening stress is less
Subject 8	**23**	**M**	**0.67**	**1.30**	**Moring stress <Evening stress**
Subject 9	23	M	0.77	0.59	At the evening stress is less
Subject 10	**21**	**F**	**0.75**	**0.95**	**Moring stress <Evening stress**
Subject 11	28	M	0.80	0.54	At the evening stress is less
Subject 12	**35**	**F**	**0.46**	**1.05**	**Moring stress <Evening stress**
Subject 13	24	M	1.54	0.55	At the evening stress is less
Subject 14	23	M	0.68	0.31	At the evening stress is less
Subject 15	23	F	0.68	0.59	At the evening stress is less
Subject 16	**23**	**M**	**1.06**	**1.32**	**Moring stress <Evening stress**
Subject 17	**24**	**M**	**0.39**	**0.40**	**Moring stress <Evening stress**
Subject 18	**24**	**M**	**0.87**	**1.39**	**Moring stress <Evening stress**
Subject 19	**22**	**M**	**0.82**	**1.24**	**Moring stress <Evening stress**
Subject 20	21	F	0.54	0.51	At the evening stress is less

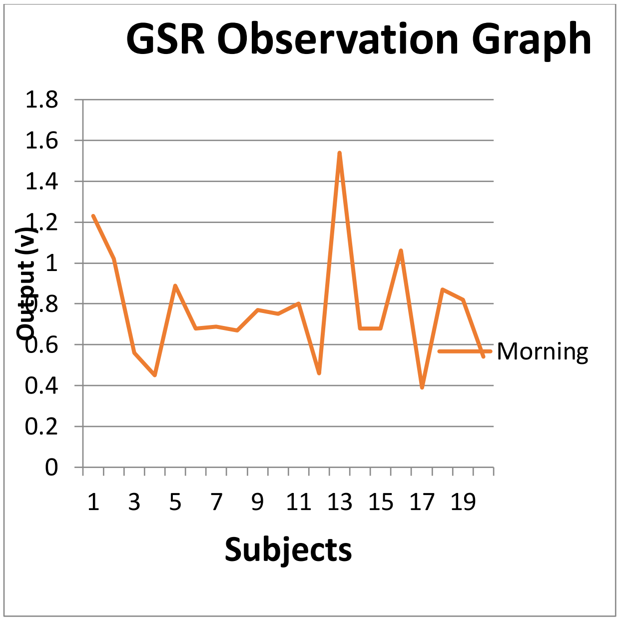

Fig15: Graph comparing output for different subjects(Morning)

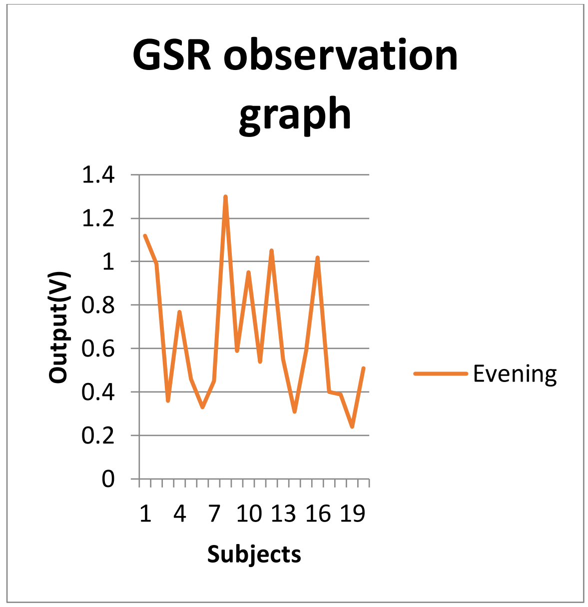

Fig16: Graph comparing output for different subjects (Evening)

7. Discussion

The main part of this study involved the planning of a tool which is ready to detect skin resistance in several situations. It also includes an initial threshold between being stressed and being relaxed. From the observation table we can see that out of 20 subjects, in case of 8 subjects morning stress is more than that of evening stress. With the various graphs, it is observed that signals increase or decrease depending on the trouble or the mental situation of the user.

By measuring the response from different subjects of varying ages and sex, we found out that all the reading fall between 0.30V to 1.54V (for morning) and 0.30V to 1.12V(for evening). Under or after any hyper active or unordinary conditions such as fear, duress or any slightly physical activity the readings are bound to show deflections from the standard.

8. Conclusion

Research was done to decide the best physiological signals to use in stress detection, how these signals can be detected, how these signals are affected by stress and what would be the best model or system to use in stress detection. The measured skin resistance can give us information about a person skin and how how skin reacts under different emotional states. From this research we examine how a simple low cost stress monitor device using GSR is capable of indicating when someone is under stress in real life situation. The aim basically focuses on the design and development a cost-effective and reliable GSR meter that utilizes simple electronics hardware. Despite a variety of sophisticated and hence, high-cost GSR meters already do exist, however, it is undeniable that for developing countries, like India, such a low-cost biofeedback monitoring device can easily find its place in heath care systems.

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