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Measurements of galvanic skin response with accelerometer glove

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Abstract. The purpose of this study is to measure the response of galvanic skin with the accelerometer glove. In this paper, we focus on detecting the level of stress using GSR sensor data and testing the possibility of using the accelerometer glove (own implementation) on a large number of people. The experimental part of this study involved interviews with 15 people. The case study was conducted using a proposed questionnaire about stress at work and, in the same time each person was connected to the glove of the accelerometer. Occupational stress is an enemy of society and, in my view, every future direction of stress identification is a good start to discovering the best way to reduce it.
Keywords: *accelerometer, glove, GSR, stress, measurements*.

1. State of the art

Reviewing the literature, we have found a lot of questionnaire about stress at work, such us: Holmes and Rahe Stress Scale Questionnaire to determine stress factors[1], Cohen Williamson Questionnaire to determine stress level[2], General Questionnaire on Working Environment and Health Status to determine the effects of stress and so on. [3]

GSR is a method of measuring the electrical conductance of the skin, because the emotion can cause more sweat. GSR device allows you to spot strong emotions by attaching electrodes to two fingers on one hand for right prediction of stress level percentage. [4]

Galvanic skin response measurement and analysis is used to measure skin resistance, skin conductance and stress level of people. With GSR device you can observe and record changes in respiratory rate, heart rate and skin resistance associated with cognitive behavior and emotion. [5]

There are several studies which propose different methods of detecting stress levels by measuring skin conductance and skin resistance. [6]

2. Experimental

The research was performed with accelerometer glove. The description of components are presented below.

The circuit consists of a three-stage transistor amplifier which are directly connected.

Each of the transistors being connected to the next by a conductive connection. So, this amounts to a DC voltage amplifier. The last transistor T3 has an LED diode which should detect the skin conductance. When this transistor receives a base current from its predecessor T2, it transmits it and the LED lights up. The second transistor is connected in series with T1 that supplies T2 with base current.

This input transistor T1 receives a base current when the sensors are subjected to conductive overpressure. The high impedance resistance of dry skin is sufficient for this. If the fingertips are wet, the resistance descend to a few Kilo Ohms. The input potentiometer is used to adjust the sensitivity and it is turn to the left to make it insensitive and to the right for the highest sensitivity.

To activate the LED diode, the pair of transistors T2 / T3 must be between 5 and 10 mA as soon as the base of T2 receives between 5 and 10 μA. When the potentiometer is turned completely to the right (maximum sensitivity), a resistance of 5 to 10 m Ohm at input and in this way T1 can arrived to the diode with 0.7V.

It is necessary to turn the potentiometer in the other direction in order to obtain an result on the resistance of the changing skin. The capacitor parallel to the base, emitter segment of T1 prevents the high impedance input parasitic signal from being absorbed. [7]

The glove detects changes in skin resistance (skin wetness) and displays the slightest changes in skin resistance on an LED diode display.

For the experimental part we take in consideration the following tools:

• The questionnaire about the stress at work

We elaborate an online survey which are presented below:

The questionaire about the stress at work

1) Did you feel stressed by the job tasks?
   a) Yes; b) No
2) Interaction (physical, online) with people will make the activity worse?
   a) Yes; b) No
3) Technology and changes regarding how to work will affect you?
   a) Yes; b) No
4) Do you have time for your lunch break?
   a) Yes; b) No
5) Usually do you make overtime work?
   a) Yes; b) No

Interpretation of questionnaire:

If positive answer (yes = 1) are more then 30 – considered high stress level at work.

If negative answer (no = 0) are less then 30 – considered normal stress level (no affect the health).

• The accelerometer glove to detect stress under GSR sensors presented in figure 1.

Figure 1. Accelerometer glove

3. Measurement results

To analyze the results, I used GSR package software [8] presented below:

```
// save pin numbers to variables
int sensorPin = A0;
int ledPin1 = 2;
int ledPin2 = 3;
int ledPin3 = 4;
int ledPin4 = 5;
void setup() {
   // define which pins are used for input and output
   pinMode(sensorPin, INPUT);
   pinMode(ledPin1, OUTPUT);
   pinMode(ledPin2, OUTPUT);
   pinMode(ledPin3, OUTPUT);
   pinMode(ledPin4, OUTPUT);
   // open a serial port connection to computer
   Serial.begin(9600);
}
void loop() {
   // read data from appropriate pin and assign value to variable
   int sensorVal = analogRead(sensorPin);
   // print sensor reading to the the computer via serial port
   Serial.println(sensorVal);
   // set all leds to off
   digitalWrite(ledPin1, LOW);
   digitalWrite(ledPin2, LOW);
   digitalWrite(ledPin3, LOW);
   digitalWrite(ledPin4, LOW);
   // turn on leds based on value from sensor
   if (sensorVal >= 20) {
      digitalWrite(ledPin1, HIGH);
   }
   if (sensorVal >= 40) {
      digitalWrite(ledPin2, HIGH);
   }
   if (sensorVal >= 60) {
      digitalWrite(ledPin3, HIGH);
   }
   if (sensorVal >= 80) {
      digitalWrite(ledPin4, HIGH);
   }
   // wait for 20 milliseconds before reading sensor again
   delay (20);
 }
```

The experiment involved 15 subjects from different institution of Romania.

The result obtained after answered of questionnaire and GSR measurements with accelerometer glove are related in the table 1 from bellow.

Table 1. Results of GSR data collection

Respondent	Q1	Q2	Q3	Q4	Q5	GSR
1	1	1	1	1	0	4.13
2	1	0	1	0	1	4.99
3	1	1	1	0	1	3.11
4	1	0	1	0	1	4.99
5	1	1	1	0	1	4.56
6	1	1	1	1	0	6.93
7	1	1	1	0	1	3.17
8	1	1	1	0	1	3.97
9	1	1	1	0	1	5.27
10	1	1	1	0	1	6.01
11	1	0	1	0	1	5.76
12	1	0	1	0	1	3.99
13	1	1	1	1	0	4.03
14	1	0	1	0	1	6.37
15	1	0	1	1	0	6.12

The questionnaire puts the brain in motion and after that, during a 5 minute screening respondents are seated with accelerometer glove in front of the monitor and we can detect changes in stress level from the GSR sensor.

The result obtained just with accelerometer glove, without survey, are related in the table 2 from bellow.

Table 2. Results of GSR without survey

Respondent	GSR measurements
1	2.99
2	3.11
3	2.73
4	4.32
5	3.00
6	5.71
7	1.97
8	2.87
9	4.07
10	4.59
11	3.99
12	3.61
13	2.91
14	5.16
15	4.84

The GSR device generates the graphics which are showing the variation of stress.

The results indicate that the stress level is high after they answer to the questionnaire. Analyzing the below figures (fig.2, fig.3, fig.4 and fig.5) we can see that the results for GSR screening are lower in case when the accelerometer glove was applied without survey than measurements GSR after they complete the survey (the brain processes the memory of different situations).

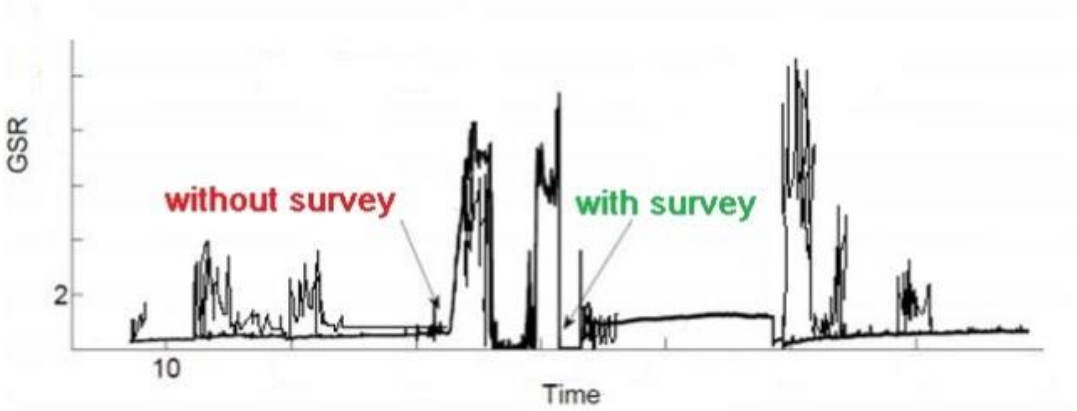

Figure 2. GSR stress level

Figure 3. GSR measurements

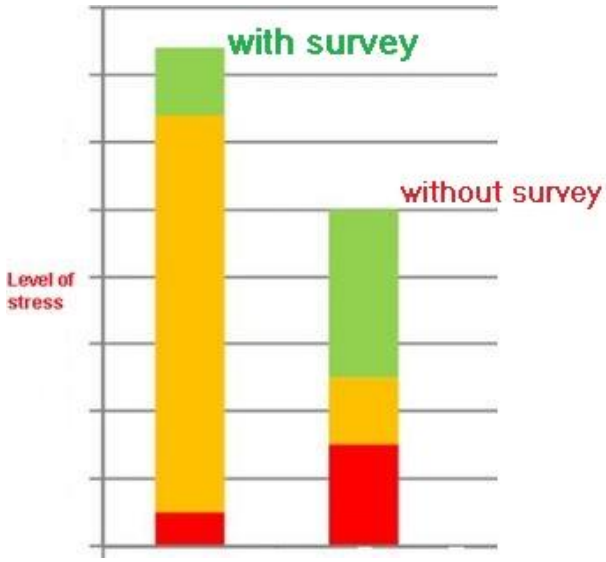

Figure 4. Results of average for the survey

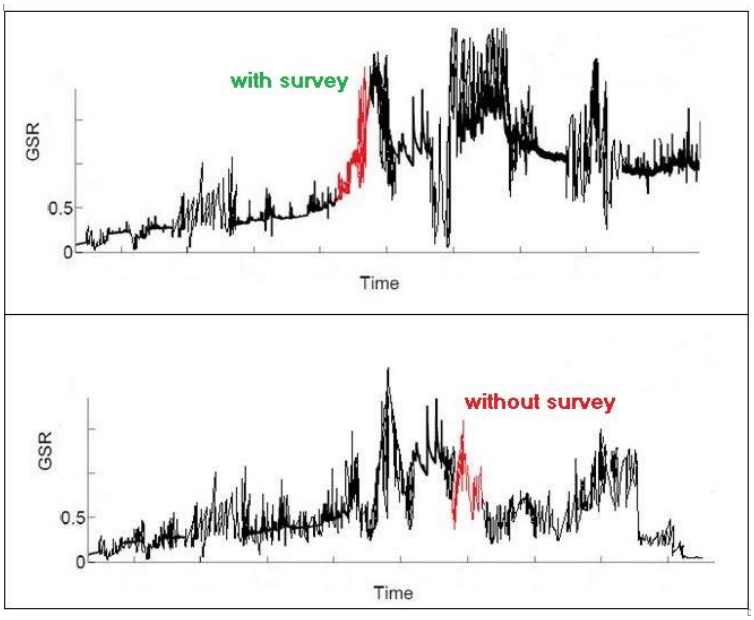

Figure 5. Results of GSR screening

4. Conclusion

The conclusions for the results obtained in the research are presented below:

• figure 2- GSR level showed a high variation of stress in case of respondents who complete the survey, but the GSR level for respondents without survey it is low.

• figure 3 - GSR measurements denote that the stress level is low if the respondents do not remember things from the past with the help of the questionnaire.

• figure 4 - as per average results, the questionnaire "stress at work" prove that the level of stress is very high if we make the screening after the survey.

• figure 5 - the results of GSR screening for respondents who complete the survey compared to respondents without survey are high as per red signal showed in the picture and variation of black lines.

This study is the first step in conducting scientific research with an accelerometer glove to determine the level of stress of workers from the perspective of skin galvanization.

Research in this area is extensive and future directions for this article will be to continue research based on the accelerometer glove, improve glove functions and expand the sample.

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