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Design and Implementation of Arduino based Stress Sensor using Galvanic Skin Response (GSR)

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***Abstract* - Sometimes the need to manage different emotional situations can lead people to dangerous situations in both the medium and short term, with research showing that stress increases the risk of heart problems. Design and build a galvanic skin response (GSR) strain sensor.**

***Index Terms* - Strain, GSR, Resistance of skin.**

1.INTRODUCTION

In psychology, stress can be a feeling of tension and pressure. People experience stress or see things as a threat if they do not believe that their resources to overcome obstacles (incentives, people, situations, etc.) require a scene. However, excessive stress can be harmful to the body, in some cases it is necessary to collect feedback to correct this symptom, as in certain situations it can become dangerous, because we need to create a tool for detecting stress. We have developed a Galvanic Skin Response (GSR) device to detect different skin expressions under stress. It uses only two electrodes placed on the fingers and acts as if they are energized. 2 outputs, 1 resistor each. This device sends various data to the mobile phone via Bluetooth. We can also send this data to a computer. The ultimate goal is to implement this GSR in an application that can be used in any organization to know the stress levels of the people working in it. It also sends stress level information to the specified contacts. Figure 1 shows the interaction of the final application

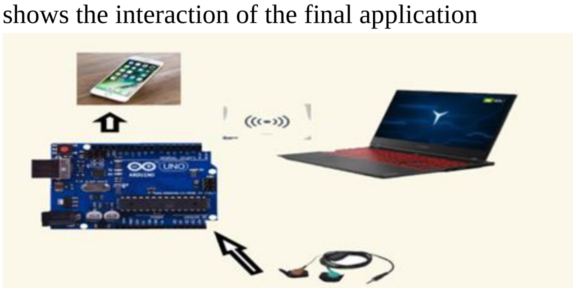


Figure 1 the final implementation of the GSR system

2. DEVELOPING THE PROJECT

The project is divided into two parts: the Arduino board and the other part - the Android application. Thus, the system consists of two subsystems; The first subsystem includes an Arduino microcontroller and two sensors (i.e. PPG and GSR sensors), while the second includes an Android monitoring app. Typically, all signal acquisition will be done in the Arduino microcontroller subsystem. Android (4.3+) is a platform that will not design a device, and an Android device is just a receiver and a sender. Get readings from PPG and GSR sensors in Android app, then plot the corresponding waveforms and process them to extract the corresponding parameters. Communication between the Arduino microcontroller and thus the Android device is established via a BLE connection. The two sensors are connected to a Grove shield mounted on top of the Arduino microcontroller. The GSR sensor used has Grove connectors, so a Grove shield is required to pair it with the Arduino microcontroller. The Grove shield identifies the corresponding pins on the Arduino microcontroller and allows you to connect additional sensors and / or other shields.

3. RESEARCH METHODS

a. Hardware

For this purpose, we have developed a Galvanic Skin Response (GSR) device to measure the varying electrical conductivity of the skin when a person is under stress. 2]. It uses only two electrodes placed on the finger and acts as if they were two leads of a resistor. This GSR manages various medical devices in one application. Users can use the load cell anywhere in their home up to 10 meters away. Below is the block for the system.

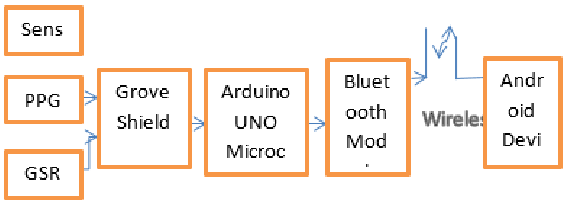


Figure 2. System block diagram

a. GSR (Galvanic Skin Response Sensor) -Galvanic Skin Response is a method of measuring the electrical conductivity of the skin. Being contingent on the moisture content of the sweat on the skin, this value varies. It can be correlated with psychological stress, and thus GSR cutaneous conduction can be used to detect this stress.

b. Grove Shield -Grove - Base Shield is designed to help you get rid of the breadboard and patch cables. Thanks to the large number of ports on the motherboard, you can very conveniently add all cluttered modules to the Arduino Uno.

c. Arduino UNO- Microcontroller the Arduino Uno is an ATmega328P based microcontroller board. Arduino UNO is a widely used open-source microcontroller board based on Microchip ATmega328P developed by Arduino. The UNO is the most frequently used and recognized board in the Arduino family.

d. Bluetooth Module - A Bluetooth module is usually a piece of hardware that you provide. A wireless product to work with a mobile phone or, in some cases, Bluetooth as an accessory or peripheral, or a wireless computer or other product (such as a headset).

3.1 Implementation

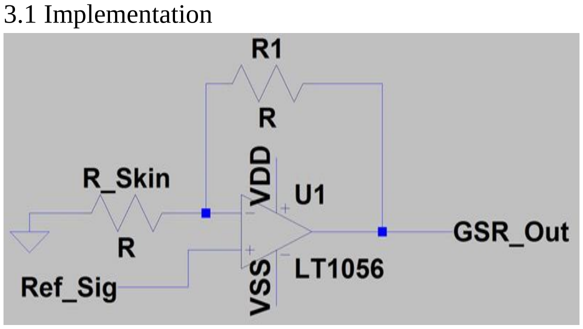


Figure 3 - A Measurement of skin resistance based on the GSR sensor and Op-amp

A GSR sensor allows us to experience the activity of the sweat glands, known as arousal. To measure GSR, we use the electrical properties of the skin. More precisely, how the resistance of the skin changes with the activity of the sweat glands, i.e. the increased activity of the sweat glands. , more sweat and therefore less resistance on the part of the skin. Resistance is the most commonly used measure of a GSR signal it is not conductance. Conductance is the reciprocal of resistance. The measuring unit of it given in Siemens (conductivity = 1/ resistance). The conductance makes it easier to interpret the signal, because the higher the activity of the sweat glands, the higher the conductance of the skin. Measurement of constant voltage is the most communal method of measuring a GSR signal for emotional research. A continuous voltage applied by the GSR sensor which is usually 0.5 V. It is applied at the two electrodes that are attached to the skin are in contact. The circuit also contains a very small resistance compared to the resistance of the skin, which is connected in series with the voltage source and therefore the electrodes. The tenacity of this circuit is to acquire the conductivity of the skin and its variation by applying Ohm's law (voltage = intensity x resistance = intensity / conductivity). Since the voltage (V) is kept constant, conductance (C) of the skin is frequently

Calculated by measuring the current flow (I) through the electrodes. Any fluctuation in the current flow is due to a change in the electrical properties of the skin with this conformation. Thus the activity of the sweat glands also changes. It is imperative to note that the voltage applied to the electrodes is very small and the current that can flow through them is very small and imperceptible. GSR circuit was mainly designed based on the feedback gain through an op amp circuit, when the GSR measures the impedance of the skin across the two leads; the resistance of the skin itself forms one resistor at op amp. Feedback loop which is seen in the previous circuit. As the circuit conducts direct current to the body, it is important to ensure that the current value is low and that all elements of the circuit are isolated when connected to the body. Therefore, a voltage divider is used to get a smaller voltage that goes into the reference signal. This reference signal passes through a voltage buffer before it reaches the non-inverting connection of the GSR operational amplifier. The galvanic response of the skin ranges from 10 kΩ to 10 MΩ as it is often observed in existing studies of skin conductivity in various applications. After the first contact with the test person, we set an input voltage of 1.8 V. We take measurements of our circuit with various resistances that are within the skin resistance range. These values were selected in order to know the theoretical behaviour of the output voltage. Depending on the skin conductivity, the different values of Rs are determined by combining different real resistances.

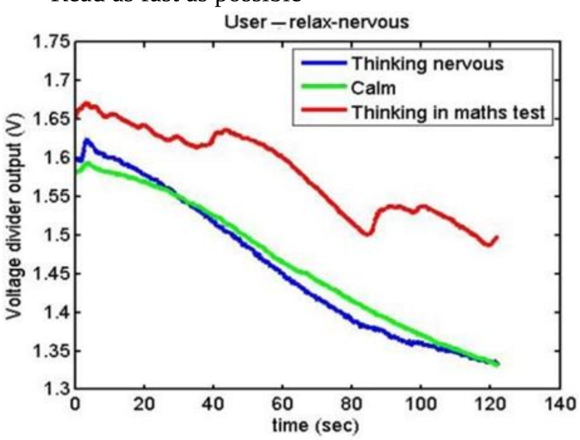
b. Software

The development of the Android application GUI is in progress and the application functionalities are being implemented. In addition, the PPG and GSR signals are displayed in the developed application.

4. RESULTS

we performed several tests to change the subjects' emotional state, knowing the moments when the person needs to be stressed and when the person doesn't, we can analyze each type of data separately. Following tests:

- Remaining relaxed
- Math operations
- Deep breathing
- Read as fast as possible



5. DISCUSSION

The main design of the GSR circuit was compatible with the feedback gain through an operational amplifier circuit. The GSR measures the impedance of the skin across the two wires; the resistance of the skin itself forms one of the resistors in the op-amp feedback circuit. This can be seen in the circuit above. Since the circuit conducts direct current to the body, it is important to ensure that the current value is low and that all elements of the circuit are isolated when connected to the body. Therefore, a voltage divider is used to get a smaller voltage that goes into the reference signal of the operational amplifier. This reference signal passes through a voltage buffer before it reaches the non-inverting connection of the GSR operational amplifier. The galvanic response of the skin ranges from 10 kΩ to 10 MΩ as it is often observed in existing studies of skin conductivity at different applied voltages. After the first contact with the test persons, we determined an input voltage of 1.8 V. We measured our circuit with various resistances that are in the skin resistance range. These values were chosen in order to know the theoretical behaviour of the output.

6. CONCLUSIONS

The GSR device detects whether there has been an attempt or a special situation from being relaxed with a hit rate of 90.97%. It has been observed that participants who had done some trials before obtained the highest difference; so the average could be higher if the user are familiarized with the device. The next stage is to design an algorithm in order to establish the threshold between different emotional situations because this first algorithm does not distinguish between being stressed and making an effort. Two tasks lying ahead of us are:

- Improving the algorithm to establish more reliable thresholds.
- Using different tests for the calibration state: conducting tests that last longer

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