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Study the Changes of Bioelectrical Skin Impedance of Human body Associated with Different Physiological Parameters

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A B S T R A C T

Bioelectrical Impedance Plethysmography, in other hand Galvanic Skin Response (GSR) of living system specially for human body is deal with great importance as it changes with different physiological parameters and help to predict the different kind of disease like diabetes mellitus, human mental stress etc. This changing pattern also varies with the human ages and life styles. In this study we have collected the GSR values of two groups of people one is young generation under 20-25 years old and group is middle age under 40-50 years old. The GSR values were collected by using Grove-GSR Sensor with Arduino Uno. The individual's data was analysed in Mat-lab and the statistical parameters like standard deviation and mean of the extracted datasets was calculated respectively and documented. The statistical parameters from the changing pattern of GSR clearly indicate that this changing is fully associated with the different physiological parameters and different ages which indirectly deal with great significance for pre identification of human diseases.

Keywords: Impedance Plethysmography ,GSR, Arduino Uno. Mat-lab, Diseases Prediction

I. INTRODUCTION

The galvanic skin response (GSR) points to the changes in sweat gland activity which influences our emotional state, subject to different conditions faced with, otherwise known as emotional arousal. Skin conductance is indirectly regulated by the Autonomic Nervous System (ANS).The autonomic activation of sweat glands in the skin influences increased production of sweat and thus higher skin conduction. Our emotional stimulation triggers the sweating of our hands and feet: Whenever we are emotionally induced, the GSR data shows distinctive patterns which are visible conspicuously and also which can be quantified statistically. Our body has about three million sweat glands. The density of sweat glands varies throughout the human body. The highest densities are generally found in the forehead, cheeks, the palms, fingers as well as on the sole of the feet.Whenever we try to trigger up the sweat glands and they get activated, they start to secrete moisture through the pores towards the surface of the skin. By changing the balance of positive and negative ions in the secreted fluid, there is a steady flow of electric current, resulting in measurable changes in skin conductance, and with the increase of skin conductance, skin resistance gradually recedes.This change in skin conductance is known as Galvanic Skin Response (GSR).As GSR holds a very close connection to stress, measure of emotional state, mental state, it has been used in many researches to study different human activities and neurological conditions.For our study, we selected 8 volunteers equally divided on the basis of age. While collecting the data, the recorded room temperature was 25^0 C. The data was recorded through an arduino based GSR sensor, with a constant current source. After processing the data, and analysing it, we found that besides the variation of skin conductance value with age and environmental factors, it also depends upon physiological factors to a great extent.

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II. LITERATURE REVIEW

The GSR can be defined as a change in the electrical resistance or properties of the skin. One of the uses of GSR can be capturing the responses of Autonomous nervous system through sweat glands. The change of electrical resistance of the skin is also known as psychogalvanic reflex (PGR). This produces a stimulation which in turn produces an emotional response that draws the subject's attention, which actually calls for the alert. As the electrical conductance of the skin increases, the resistance of the skin decreases in areas such as, around the palms of hands and soles of feet [1]. GSR can be used for analysis of sentiment and generating signal spectrogram. GSR has also been used for sentiment analysis through MDSTC (Multimodal Dataset for Sentiment Classification) and generating signal spectrogram [2]. GSR can be used to measure psychological stress of the operating room (OR) team professionals [3]. The GSR can be a great device for detecting stress. The signals of galvanic response of each student's skin were shown by a study and a classification of 100% stress detection was achieved. Students were stressed due to academics during the pandemic [4]. A study has also been conducted to show that GSR can be used to measure mental difficulty of traffic events while driving a rural test route [5]. GSR is a neurophysiological measurement shown by sweat glands. It comprises of change in skin potential or decrease in skin impedance or resistance to an alerting stimulus.GSR can be used to measure subjective mental condition to provide a better indication of the level of concentration during meditation [6]. The GSR has shown how the increase of relaxation and decrease in stress level increase the skin conductance. There is increase in GSR values with the relaxation of neurophysiological factors. It has been studied, how there is rise in GSR value as a consequence of prayer and meditation [7]. GSR can be also used to analyze the intensity of emotion and the level of attention in an individual. The variation in attention level and emotionalpotency can be measured. Skin conductance can show the difference or variation in the emotional potency and the attention level of the adolescents and young adult instagram users towards the exposed body images and endorsements made by influencers according to their preferences through GSR [8, 9]. So far the conducted studies have not covered the relation between skin conductance and age also with any physiological condition. So, this paper focuses on varying electro dermal response depending on various physiological factors [10, 11], on the basis of age.

III.EXPERIMENTATION AND MATERIALS

In the study reported, we have taken data form 8 individuals between 20 to 50 years of age. The data samples were taken in a balanced form on the basis of age. The samples were segregated into two groups, a younger group represented the age above 20 years and the other group contained data above the age of 40 years. The recorded room temperature was 25oC

The data was collected from the participants using arduino, in voltage form with based on constant current source. For every participant, the data samples were continuously recorded for 1.5 minutes using arduino based Grove-GSR sensor and the circuit depicted in Fig-1. While recording the analog values, distinct changes in the voltage levels were noted with time, which represented the change in skin conductance. Initially the normal was recorded, without skin conductance and then the participants were made to wear the gloves attached with electrodes, to record their skin conductance values. 8 data samples were collected and stored.In the pre-processing part, the collected data was processed using MATLAB software and a stable part of the recorded data sample was extracted for every sample of data. The standard deviation and mean of the extracted datasets was calculated respectively and documented. On the basis of the results, analysis was drawn.

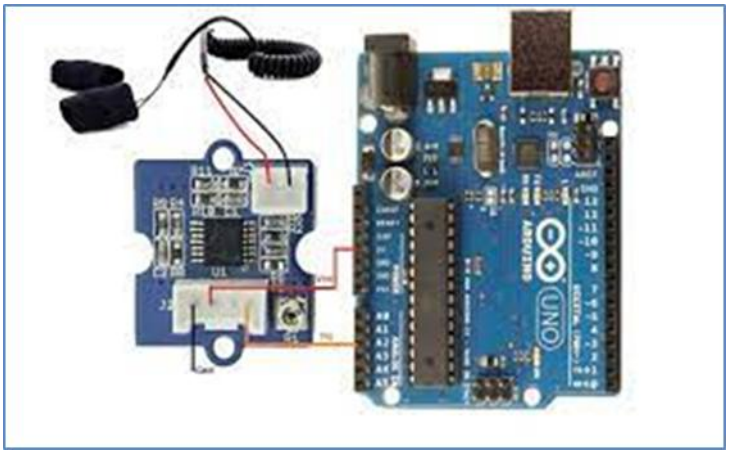

FIG- 1: CIRCUIT DIAGRAM OF ARDUINO BASED GROVE GSR SENSOR

IV. RESULTS AND ANALYSIS

GSR reportedly depends on different parameters like stress, sweating, environmental conditions and many others.In our study, as we processed the recorded data sample and compared them, a distinct variation among the standard deviation and mean of the 8 participants was noted. The following graphs depict the results obtained

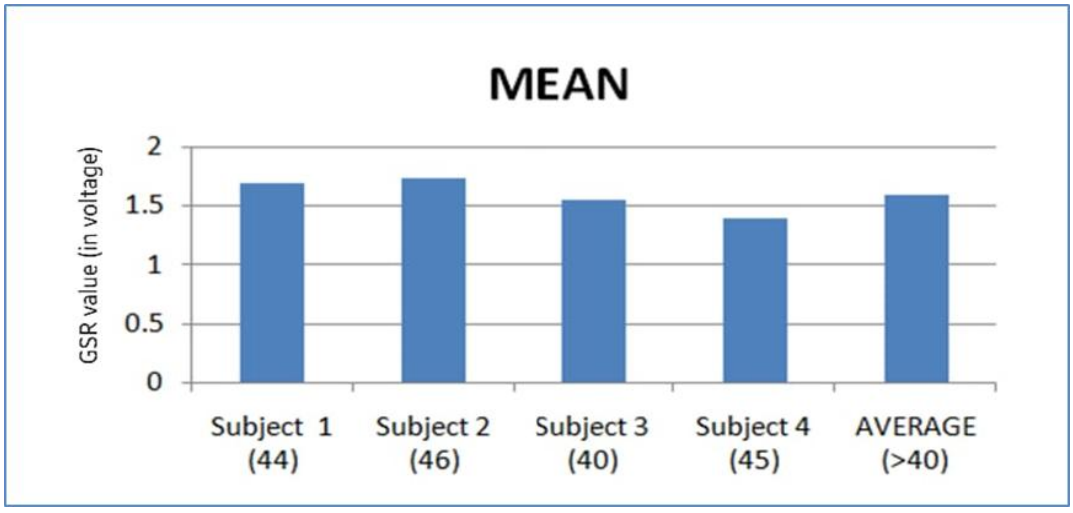

FIG-II: MEAN GSR VALUES (AGES 40-50)

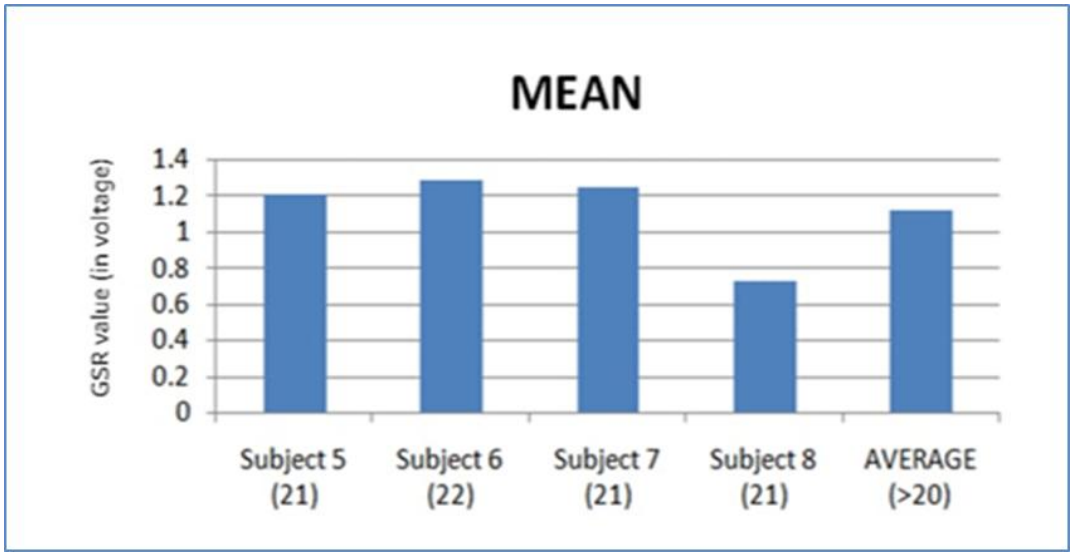

FIG-III: MEAN GSR VALUES (AGES 20-25)

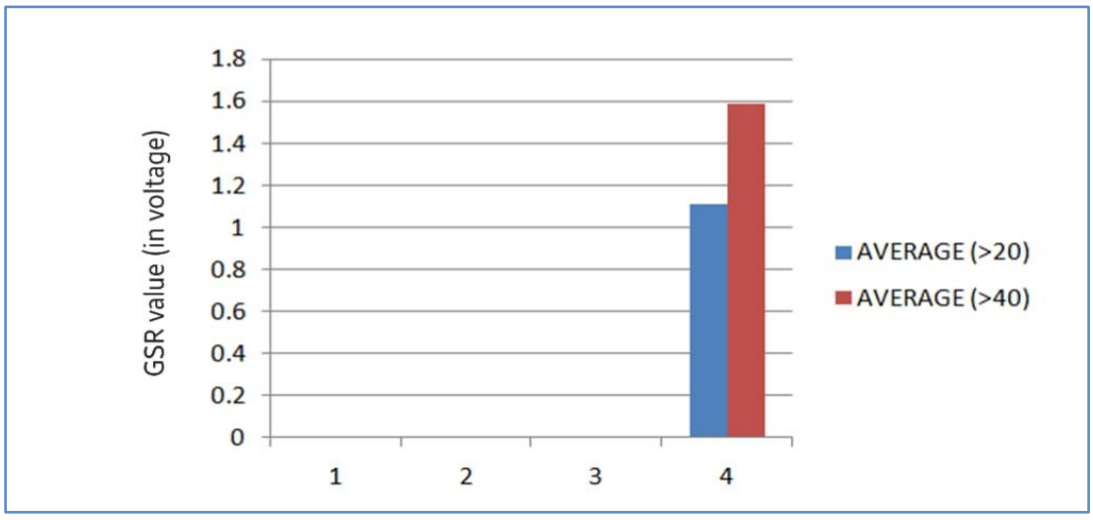

FIG-IV: MEAN GSR VALUE OF TWO AGE GROUPS

Figure II show the mean GSR values and their average of the subjects above 40 years of age. The mean value here is found in the range of 1.4 to 1.8 and the average of the mean GSR values is 1.59115..Figure III shows the mean GSR values and their average of the subjects above 20 years of age. In this case, the mean has been found in the range of 0.05 to 1.3 and the average is 1.117125. Figure IV represents a variance among the mean of younger subjects(>20 years) and the comparatively older age group(>40 years) .The values depict that in case of younger subjects the GSR value stays within a range of 1.3 while for older people the range does not fall below 1.4. Also a variation is found within the GSR values of Subjects 1 to 4.For the age group of Subject 5 to Subject 8 the GSR values show a comparatively lesser range than Subjects 1 to 4. Though the data being recorded under similar environmental conditions and the only different factor being the age group, it lead us to the fact that GSR depends upon the age of a particular individual alongside the stress and environmental factors. But again a notable distinction was found among the group of older subjects (Subject 1, Subject 2, Subject 3 and Subject 4). A clear difference is seen between the mean values of Subject 1, Subject 2, Subject 3 and Subject 4. Within the range of 1.4 to 1.8 mean GSR values, for Subject 1, 2 and 3 it was found a bithigher compared to Subject-4. Now for the Subjects 1 to 4, we know their blood glucose level values.

Subjects	Age	BGL(mg/dL)
Subject 1	44	107
Subject 2	46	114
Subject 3	40	108
Subject 4	45	97

TABLE-1

Subjects 1, 2 and 3 are in the pre-diabetic stage and Subject 4 has normal blood glucose level [Table-1].In spite of being under the same age group (>40) subject 4 with normal BGL, has a GSR value of not more than 1.45. While for Subjects 1,2 and 3, they have a slightly increased BGL value than Subject 4, and a GSR of not less than 1.5. We know that GSR values depend upon the environmental conditions, but from our study, where we have recorded all the values, it may be said that skin conductance associated to GSR may also depend upon their respective health conditions, such as blood glucose level (BGL) or diabetes.

V. CONCLUSION & FUTURE SCOPE:

The study shows that, one of the main reasons of varying GSR besides environmental and stress factors, is age. With increase in age the resistivity of skin increases, thus skin conductance decreases. Also we have noted variation in GSR values depending upon physiological conditions like diabetes. Thus we can conclude that skin conductance, though it depends on stress factors and environmental conditions, age is a very important factor behind variation of resistivity power of skin. Decreased GSR value can also be a result of having diabetes, which is indicated in our study. This can help to a great extent in determination of diabetes in non-invasive way and also pre-identification of diabetes.
In future a hardware module of GSR with constant current source will be design based on tetra-polar method to get a more accurate result. Our goal is to achieve a system, stable enough to record the changes in voltage level with varying skin resistance and a constant current source. This will help is proper recording of data and analyzing them for finding out a strong relation between skin conductance and diabetes and other physiological parameter strongly associated with GSR..

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