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IDENTIFYING THE MENTAL STATUS OF BEDRIDDEN ELDERLY BY THE BODY TEMPERATURE, HEART RATE, AND SKIN CONDUCTIVITY USING AN ARDUINO SENSOR MODULE

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Abstract— Addressing the emotional and mental health of the bedridden elderly is necessary as they are more likely to be depressed being isolated and dependent on a caregiver for a prolonged time. Several studies have been carried out to identify the mental stress of patients through their skin conductivity. The variations in the sympathetic nervous system reflect the emotional state of a person. This is demonstrated by the Galvanic Skin Response and thus can be used as a denotation of psychological or physiological arousal. Such arousal causes the blood capillary dilation, increment of sweat gland activities making the skin further conductive to electricity. In this study we develop a sensor module composed of a Galvanic Skin Response sensor for the bed ridden elderly and identify the relationship between body temperature, heart rate and GSR of them. The experiment is conducted upon 10 bed ridden elderly aged from 60 – 80 years of the Mihinthale region. The observations demonstrate a correlation between the heart rate, body temperature, skin conductivity and the human physiological states.

Keywords— Stress detection, Galvanic Skin Response, Bed ridden elderly mental condition

I. INTRODUCTION

Being bed ridden for a prolonged period of time due to and old age sicknesses limits a person's social interactions, and disrupts the regular routine and makes him isolated. It's important to address emotional and mental stress of such a person to maintain their mental health.

Several studies have revealed that the electrical conductance of the human skin can be taken as a fact that depicts the mental stress as it fluctuates with the mental and emotional conditions of a person.

Galvanic Skin Response (GSR) is a means of quantifying the skin electrical conductance that differs according to the mental

and emotional conditions of a human being. Galvanic skin response refers to changes that occur in electrical resistance through two regions of the skin. The electrical resistance of the skin wavers rapidly during mental, physical, and emotional arousal. Emotional sweating is activated through skin sympathetic nerves [1] and it is influenced from the cerebral cortex [2]. Every time the skin sympathetic nervous system is stimulated, the palmar and plantar sweat glands get completely data filled. This causes reduction in skin resistance which increases the skin conductance. The conductance decreases when the skin resistance gradually decreases with the reabsorption of sweat.

The sweat gland responds according to the sympathetic nerve stimulation while also resulting decrements in skin resistance levels. The galvanic skin response reveals the emotional state as reflected in variations in the sympathetic nervous system. SO this skin conductivity variations can be used as a denotation of psychological or physiological arousal.

In this study we propose a sensor module to collect real-time bio signal data, the skin temperature, skin conductivity, and heart rate of elderly bedridden. The collected are processed and correlated to detect the relationship between the mentioned bio metrics with the mental status.

II. RELATED WORK

The physical and mental stress of a person affects the mundane conduct of an individual and when considering its effect on the patients, it affects their health and the disease they are suffering from. In accessing the stress, the skin conductivity, pulse patterns, blood pressure are the mostly used physiological markers [3].

Therefore continuous perceiving of the affective state of individual is essential to understand and manage the effect of stress. And the measurement of skin conductance of a person is

a simple and a reproducible technique that helps to measure the internal state in regard to mental and physical changes [4].

Using galvanic skin response as the basis for analyzing the human stress, various models and techniques have been invented/ developed to measure the skin conductivity of patients. Fortunately, miniaturized wireless devices are also now available to monitor physiological markers helping to track the levels of stress caused by psycho-physiological activity. Still, a thorough analysis of individual stress is essential in terms of galvanic skin response features [5]. Even sometimes statistical features of other physiological markers together with features of galvanic skin response signals are used and are practical for advanced mental condition analysis and diagnosis.

In [6], a method is proposed which determines the transient impedance change of palm instantaneously. The time domain analysis decides the electrical resistance of the skin while fast Fourier transform (FFT) technique decides the skin resistance of palm during galvanic skin reflex (GSR).

A portable data logger system was designed, prototyped and developed using a PIC microcontroller for recording galvanic skin response data and relaying them to a computer for physiological analysis [7]. Another version of portable transistor based instrument for skin response measurement for pain assessment is presented in [8]. It detects both galvanic skin response and acceleration in synchronal to disambiguate valid galvanic skin response signals from motion artifact.

Since without knowledge of underlying motion of a highly active subject, galvanic skin response signals could be misinterpreted, a wireless sensor, action GSR is developed in [9]. In [10], a stress detection system for computer users is proposed and developed based on the physiological signals.

Using only the heart rate signals and the galvanic sin response, real time stress detection mechanism has been developed through the means of fuzzy logic [11]. Measuring the skin conductivity and the heart rate for 10 consecutive seconds provide results with 99.5% accuracy in this approach2 based on statistical classifier – Support Vector Machine (SVM) with various physiological signals like galvanic skin response, electrocardiogram (ECG), skin temperature etc. as inputs and positive-negative responses of emotion as outputs of the classifier.

Emotional reactions are medically proven to cause increase in sweat gland activity in the soles of the feet. A novel e-textile prototype is proposed and validated in [13] for measuring galvanic skin response from the foot using conductive fabric electrodes embedded in the sock. The sock prototype is useful in the sense that it provides meaningful measure of galvanic skin response activity that can be modestly used in routine monitoring.

III. MATERIALS AND METHODS

The preliminary data (about the factors causing stress and the visible indications of a person under stress) for the research were gathered with related literature and interviews with the medical professionals.

A real-time bio metric data monitoring module was implemented with two pre-developed Arduino supporting sensors for measuring pulse and the temperature, and the sensor to capture the galvanic skin response was designed and developed by the team. The sensor module was developed with Arduino Mega 2560.

The status meter is developed on the principle that the resistance of the skin varies in accordance with the emotional states. When an individual's stress level is high, the skin possesses less resistance while the resistance rises with the relaxation of the body.

During high stress state the supply of blood to the skin is increased, decrementing the skin resistance and increasing the skin permeability. These variations result in an increase of the skin conductivity as well. Figure 1 shows the basic circuitry of the developed status meter.

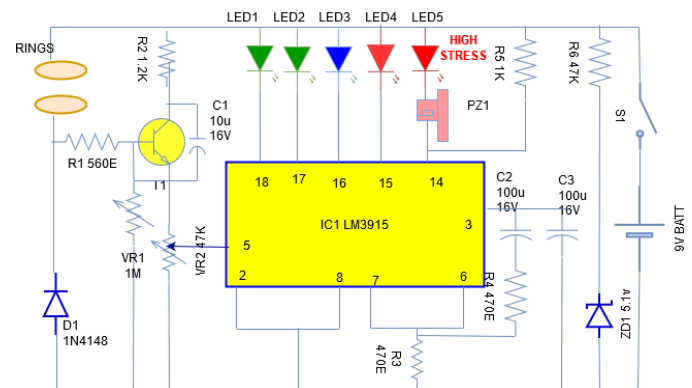


Figure 1: The status meter circuit

The skin conductivity was measured by applying a low, undetectable, and constant voltage to the skin. This was achieved by connecting the circuit to two aluminum rings worn in both thumb and index fingers of the participants. The Galvanic Skin Response was measured in units of Ampere and we depicted the conductivity in a range of 5 LEDs (Light Emitting Diodes)

The sensed collective bio metric data was sent to an LCD screen and was displayed with JFree Chart software. The collected data was analyzed and used to determine the mental status of the patient.

The captured biometrics were integrate with a mobile application to provide a real time feedback of mental stress recognition to the relevant parties and caregivers.



IV. RESULTS AND EVALUATION

The module was tested with 10 bedridden elderly (5 females and 5 males) who aged from 60-80 and resided in the Mihinthale region.

It is apparent that the skin temperature and the conductivity and pulse rate are directly proportional to the mental condition of the patient.

The Table 1 shows the collected biometrics of the selected sample of 10 elderly. The age is depicted in years, the heart rate as BPM – Beats per minute, temperature as Temp and the galvanic skin response as GSR.

Table-1 The collected real-time biometrics of the bed ridden elderly

No	Gender	Age	BPM	Temp	GSR
1	Male	62	59	35	7
2	Male	78	80	35	14
3	Male	60	80	36	30
4	Male	78	72	35	44
5	Male	67	70	36	48
6	Female	56	84	35	42
7	Female	80	68	35	23
8	Female	59	80	35	67
9	Female	65	80	35	4
10	Female	70	59	36	5

More research is needed to clarify any significant interrelationship between changes in skin temperature, skin resistance, and pulse.

V. CONCLUSION

In this work, we propose a sensor module to collect and analyze biometric data, the skin temperature and conductivity, heart rate, in order to detect mental stress condition of the bed ridden elderly, at low cost.

The results that the stress of a bed ridden elderly can be identified through the measurements of person's heartrate, temperature and skin conductivity.

The external and internal factors that affect the condition of the skin such as different skin types, weather changes that affect the skin temperature and conductivity, the time of the day the biometrics are measured, diseases and the illnesses the patient suffers from directly affects the sensor reading of our GSR sensor. To overcome the patients being underrated we can use the minimum calculated GSR as the stress limit. To gain more accurate values the sensor has to be furthered into a sub dermal implant of conductive metal clips.

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