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Designing Prototype of Electronic Sudometer for Qualitative Analysis of Hyperhidrosis

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Abstract: Skin of a human has different afflictions in the form of chronic and acute illness. Most are only cosmetic diseases that are not life-threatening but can impair mental health and interrupt daily activities. Hyperhidrosis is one of those cosmetic disorders that can or can be inherited from diabetes, infections or thyroid hyperactivity. There are a few tests for hyperhidrosis, for example mild starch-iodine tests and gravimetric. There are a few instruments capable of measuring sweat, but not explicitly used or really designed for hyperhidrosis use. A non-invasive prototype device called Electronic Sudometer is designed using the concept of calculating electrical impedance. The sensor injects electrical current and measures the resulting voltage proportional to the sweat impedance on the skin during hyperhidrosis. The sensor injects electrical current and measures the resulting voltage proportional to the sweat impedance on the skin in hyperhidrosis. The electrode device is designed for this experiment and then the following signal is transmitted wirelessly to the laptop using near-radio frequency. Results of impedance can also be converted into sweat level, as impedance during hyperhidrosis decreases with increased sweat. The Sudometer was also calibrated using fixed precision resistors over its working range. The device output seems to be well correlated to sweat level. The proposed device successfully tested on human palms and the results look quite promising.

I. INTRODUCTION

Human skin is the body's biggest organ and has multiple acute and chronic disease pathologies. Some are just not very damaging cosmetic illnesses, but they can impact mental health and interfere with daily operations. Some conditions can lead to hyperhidrosis (HH), such as diabetes, certain infections, or hyperactivity of the thyroid [1]. Some HH tests, e.g. gravimetric and minor starch-iodine tests, are available. Some instruments also measure sweat, but owing to constraints addressed later in this section, they are not much used for HH

HH indicates excessive sweat secretion [2]. Even in a cool setting or in a rest situation, a patient can sweat [3]. It's not a rare issue, but most people don't know about it [4]. Report of Statisticians state that 1% of the population has this type of illness [5]. In the United States, 2.8% of the population has focal HH, of which only 38% consult with health professionals [6]. Patients usually feel social embarrassment and significant burden from extreme sweating in their operations. [4,5-8].

Gravimetric test needs a filter paper that is put on the skin for 60 seconds after weighing in dry condition, Sufficient to absorb the skin's sweat.

The weight of the document is then evaluated again. You can calculate the sweat level as mg / min / cm^2 [9].

Minor Starch-Iodine testing is also a sweat quantification technique. 1-5% iodine solution is applied to the target region in this experiment and left to dry. Starch is powdered over the dry iodine solution after a few seconds [10]. Due to the complex of iodine and starch, sweat shifts color from brown to purple.

Then it is possible to take serial photographs for documentation.

Transepidermal water loss technique (TEWL) utilizes passive water diffusion from the surface of the stratum corneum (SC) through the skin leaves. Evaporimeter EPI (Servomed AB, Kinna, Sweden) or comparable devices can be used to measure it. It is mainly used to quantify the status of the skin barrier. The EPI measures the evaporation of water vapor from the skin through a perpendicular open chamber, like a chimney.

After the level is stable, readings after 30-60s can be done [11,12].

In this work we have developed a prototype capable of measuring sweat levels on human skin using the method of electrical bioimpedance (EBI). A sensor designed specially was intended to provide convenience to the subject. The prototype instrument is called Electronic Sudometer that uses the principle of electrical impedance measurement to diagnose patients of HH. The proposed prototype is interfaced wirelessly with a laptop using near radio frequency and the experimental results are demonstrated.

II. PROPOSED DEVICE WORKING MECHANISM

A non-invasive prototype tool called Electronic Sudometer was created using the concept of measuring electrical impedance. The philosophy behind this prototype is to create an instrument capable of detecting hyperhidrosis in both homeostasis and pathology. The instrument injects an electrical current and detects the resulting voltage proportional to the sweat impedance on the skin during hyperhidrosis. In the electronic assembly, this signal is then processed, and the output is then sent via a wireless channel to the Arduino connected to laptop using com/usb port as shown in Fig. 1

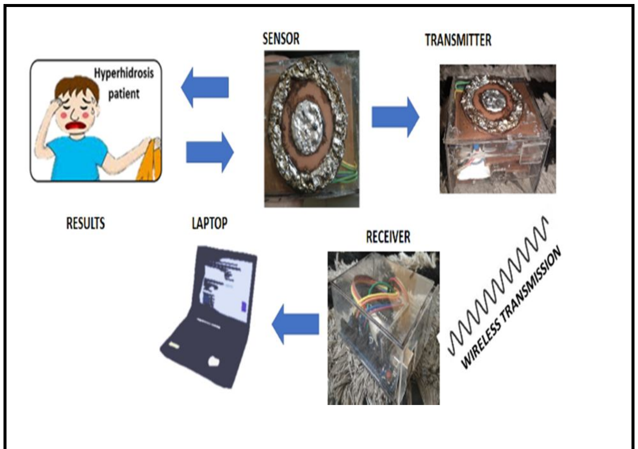

Figure 1: Block diagram of proposed device.

Until designing the new probe, various skin surface electrode designs were studied. Barnett developed a three-electrode device in 1937[]. Yamamato et al. used a two-electrode bipolar system, the larger electrode area is 10 times bigger than the smaller electrode [].To minimize deeper tissue contact affecting series impedance, Martinsen et al. added a third current carrying electrode within the same geometry[].Unlike the present purpose, the above techniques were used to make sensors for measuring skin impedance to a certain depth in the skin. In this work, a geometric arrangement was used to detect a sweat layer on top of the skin, i.e. two concentrated rings of 10 mm and 30 mm diameter respectively. To avoid interfering with the construction of a sweat layer, the outer end of the hollow cylinder sensor is open as show in Fig 2

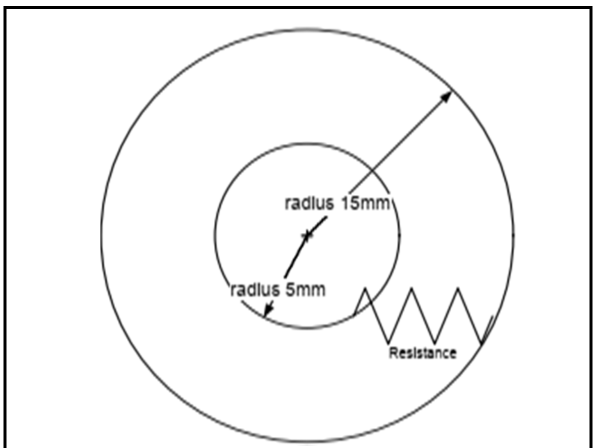

Figure 2: Surface Sensor Dimensions.

The device Electronic Sudometer is made for measuring sweat level using electrical impedance measurement. For this purpose, the device has to be calibrated according to known values of resistances to make sure readings are accurate. Fixed resistors declared to be within 1% accuracy was measured to relate the output of the Electronic Sudometer to a known physical reality

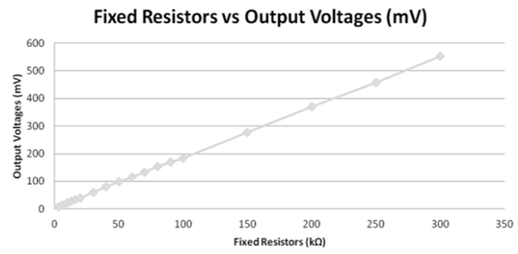

Figure 4: Electronic Sudometer Output Voltages vs. Fixed resistors.

The Electronic Sudometer output for different fixed resistors is shown in Figure 4. It shows unit linearity. The living strata of human skin has a high-water content and the water level present on the skin surface is increased during sweating, especially in HH

Figure 5: Wettex Cloth

To understand the water level relationship with EBI, as shown in Figure 5, WTX cloth was used as an "human skin model". To monitor the impedance at different levels of "physiological" water content, saline solution was added. Different amounts have been added to physiological saline solution. WTX, a spongy cloth, is composed of 35% cotton and 65% cellulose. A Sartorius balance (TE1535- DS) was used for weighing of the WTX sample along with a plastic bag. WTX fabric of 17 x 20 cm size was cut to 4 equal pieces, i.e. 8.5 x 10 cm per piece. One reason to choose WTX is its ability to absorb. Weighed one piece of WTX along with a plastic bag, see Table 1. Plastic over the WTX is intended to prevent evaporation during experiments. The Sartorius scale TARE button was used to save that original dry weight. Known quantities of the saline solution have been added to various samples. Wetted sample weights and pipette quantities are given in Table 1. Time of moist spread in the WTX samples was also controlled. Two hours of spreading humidity in the samples is permitted. Figure 6 shows bags of plastic samples

Samples of data given in Table 1 are shown in Figure 7 graphically. This graph shows the simple and monotonous variability in Electronic Sudometer output voltages with increasing saline solution level but is not linear. the voltage drop is because of lower electrical impedance. Two hours of equilibrium allowed time to enable homogeneous saline propagation within the WTX sample. The Electronic Sudometer's real-time output is shown in Figure 8.

Figure 6: Wet samples marked with time and weight in their plastic bags.

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Plastic Bag + Wettex Cloth Weight (g)	Saline Weight (mg)	Sudometer Output (mV)
4.165	940	8
3.920	800	12
3.994	780	22
4.204	700	30
3.917	500	45
4.05	450	50
3.876	350	62

As mentioned above, Table 3 describes huge variations in the output voltage proportional to the WTX level of the saline solution. This voltage deviation indicates that the device operates within the given saline level range. Table 1 used liquid samples ranging from 30µL to 100µL applied to the WTX pieces. WTX cloth poured with saline solution acted as a basic skin model, see Table 1. The graph in figure 7 shows linear relationship between salinity and voltage output. Contact artifacts between the WTX cloth and the probe electrodes may explain the non-linearity, and the existing trajectories in the fairly thin WTX cloth differ, which isn't easy to calculate if at all possible.
The Electronic Sudometer was tried on two volunteer subjects acording to experimental setup shown in Fig.

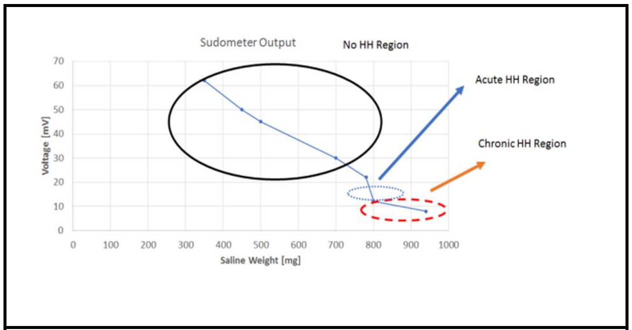


Figure 7: Variation of Output Voltages with amount of saline solution .

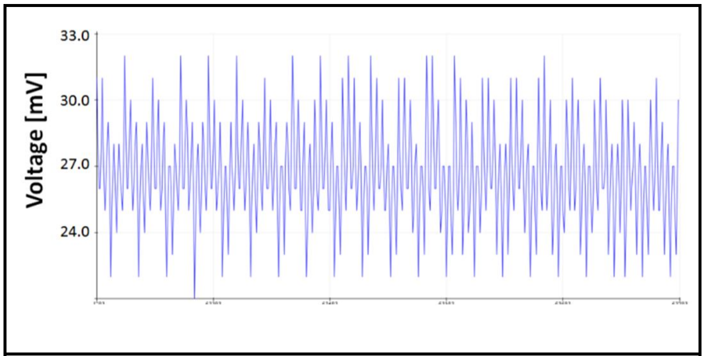


Figure 8: Real time Electronic Sudometer output voltage sample.

In the first case, the device was applied on the subject one that is not diagnosed with HH and a recorded reading is shown in Figure 10. The high level level of voltage indicated no sweat present on the palm, according.

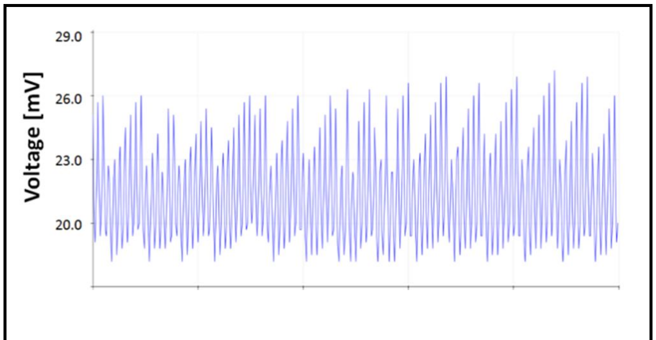


Figure 10: Real time Electronic Sudometer output voltage sample of subject not diagnosed with HH

In the second case, the device was tried on another test person having chronic HH and the result is depicted in Figure 10. It is possible to see low level voltage (high impedance) that shows that the sweat level present on this test person's hand is higher using the simple model of constant resistivity.

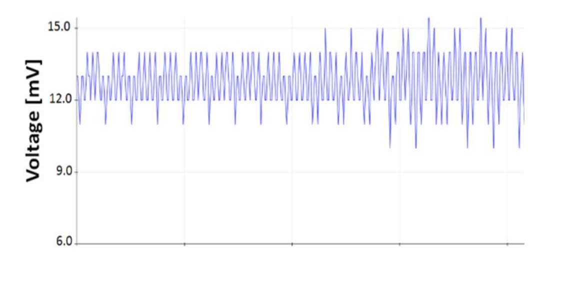


Figure 11: Real time Electronic Sudometer output voltage sample of subject diagnosed with HH

The tests conducted on various Subjects show relation between electrical impedance and saline hydration amount. Given a lack of volunteers with HH, the tests on WTX cloth and yeast and two volunteers are assumed to be sufficient to say that this system can be used to measure sweat levels in HH patients. Two examples, which are volunteers with HH property, demonstrate that the aim of developing a sweat meter has been accomplished, and the overall results seem positive. The experimental Electronic Sudometer could be used for research purposes with the laptop computer or Smart Phone as it is, as long as the system is completely disconnected during measurements from the 230V mains. More design and testing is needed for a commercial product, and the device must meet MDD requirements. Ethical approval would be required before clinical trials. Because sweat salinity can differ over time and between individuals, an additional sensor should be added for the sweat composition

III. CONCLUSION

In the form of acute and chronic diseases, human skin has different pathologies. Some are only cosmetic illnesses that are not life-threatening but can impact mental health and interfere with everyday operations. Hyperhidrosis is one of these cosmetic illnesses that can or can be inherited from diabetes, infections, or thyroid hyperactivity. Some tests for hyperhidrosis, such as gravimetric and minor starch-iodine tests, are available. Some instruments can measure sweat but are not specifically used or even used for hyperhidrosis. Experiments carried out using the Electronic Sudometer show that this device is capable of measuring sweat level in HH. Although it was only tested in palmar regions, it is assumed that it would operate on any surface associated with the sample. After industrial design, along with a sensor of sweat composition, and further research, this could be a tool for clinical support tracking treatment effectiveness and also quantifying hyperhidrosis severity

REFERENCES

[1] Baker CR, Reese G, Teo JH, Rapid Surgery, Wiley-Blackwell, Sec. Ed. 2010, p. 29

[2] Harth W, Gieler U, Kusnir D, Tausk FA, Clinical Management in Psycho Dermatology, Springer, 2009, p.102

[3] "Health Guide." The New York Times, (March 19 2013).

[4] Hornberger J, Grimes K et al. "Recognition, diagnosis and treatment of primary focal hyperhidrosis." J Am Acad Dermatol , vol.51, pp. 274-86, Aug. 2004.

[5] Adar R, Kurchin A, Zweig A, Mozes M. "Palmar hyperhidrosis and its surgical treatment: a report of 100 cases." Annals of Surgery, vol.186, pp. 34-41, Jul. 1977.

[6] Strutton DR, Kowalski JW, Glaser DA, Stang PE. "US prevalence of hyperhidrosis and impact on individuals with axillary hyperhidrosis: Results from a national survey." J Am Acad Dermatol, vol.51, pp. 241-8, Aug. 2004

[7] Strutton D, Kowalski J, Glaser D, Stang D. "Impact of hyperhidrosis on daily life and leisure activities in the US for individuals with auxiliary hyperhidrosis: results from a national consumer panel.", Scientific Poster, Am Acad Dematol Meeting, 2003

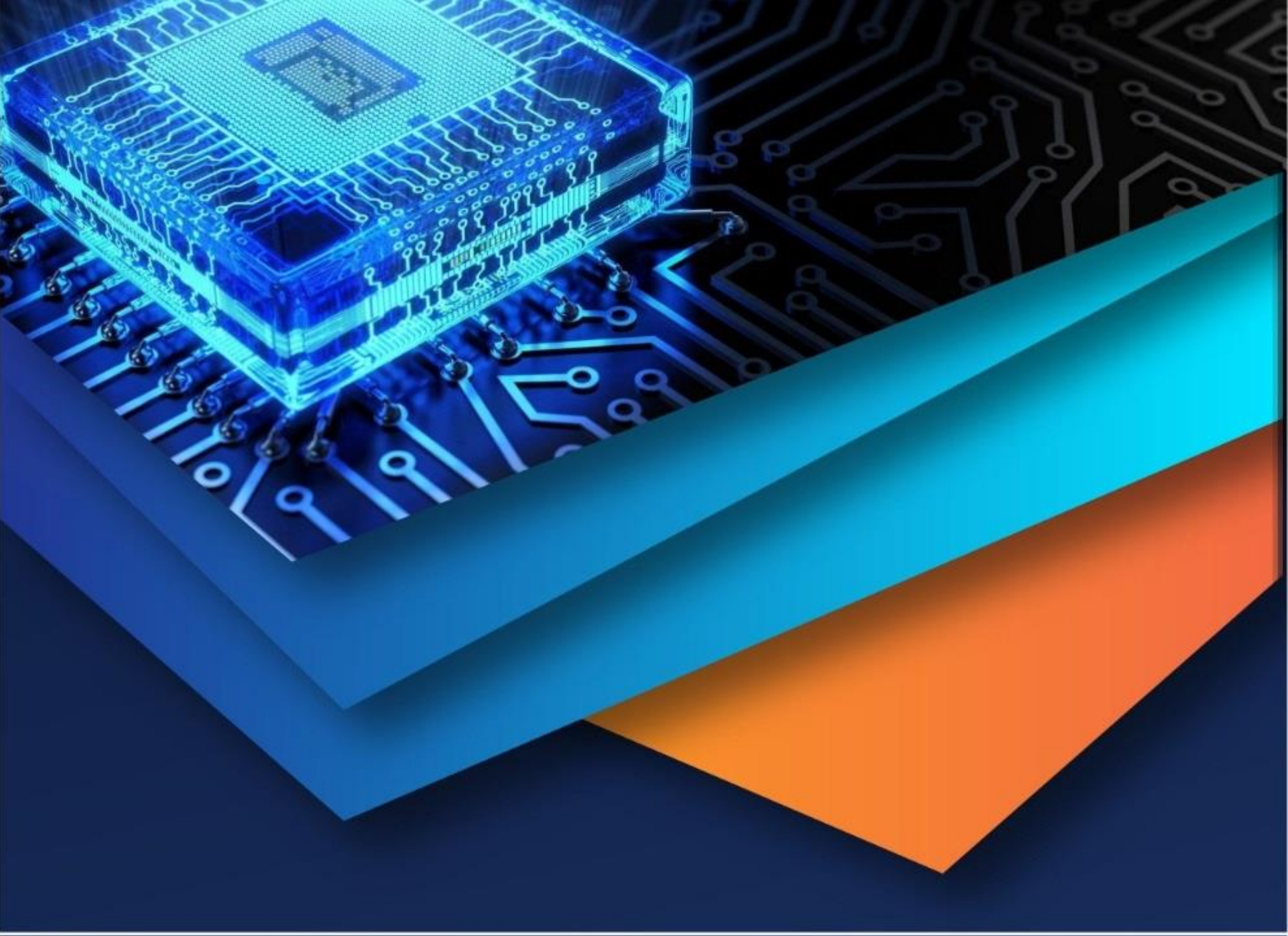
[8] Amir M, Arish A, Weinstein Y, Pfeffer M, Levy Y. "Impairment in quality of life among patients seeking surgery for hyperhidrosis (excessive sweating): preliminary results."Isr J Psychiatry Relat Sci, vol.37, pp. 25-31, 2000.

[9] Kathani A. Amin, MD , "Primary Focal Hyperhidrosis." DermatologyReview.com Journal, p. 3, February 2007

[10] Maillard H, Bara C. "Hyperhidrosis and hypohidrosis." Internet: http://www.therapeutiquedermatologique.org/spip.php?article1549, [1 Feb 2013].

[11] Blickmann CW, Serup J, "Reproducibility and variability of transepidermal water loss measurement: studies on the Servomed Evaporimeter." Acta Derm Venereol, vol.67, pp. 206-210, 1987.

[12] Nicander I, "Electrical impedance related to experimentally induced changes of human skin and oral mucosa." (PhD-thesis) Karolinska Institutet, Stockholm 1998



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