Scientific Journal Impact Factor (SJIF): 1.711

e-ISSN: 2349-9745
p-ISSN: 2393-8161

International Journal of Modern Trends in Engineering and Research
www.ijmter.com

# Real-Time Estimation of Human Skin Elasticity and Skin Hydration Measurement Using LPC 2148

Dr. V.A.Wankhede[1], Akshay A. Ghorpade[2]

[1,2]*E&TC, SNJB's COE Chandwad*

**Abstract**— Furrowed skin and flaccid skin are closely related to both quantity and quality of collagen inside the dermis. In developed countries skin aging play a vital role therefore Quantitative measurement of human skin elasticity is important. [1] Skin provides many functions critical to the human body such as regulation of body temperature and protection from water loss. The things of skin related to these functions, primarily elasticity, hardness and hydration of skin are directly affected by chronological aging and photo-aging and vary among locations on the body. The ability to quantify these properties is important so the aged status of skin can be characterized for patients and skin healing therapies can be evaluated. Therefore, the intention of this paper is to study the stretching and indentation resistance of skin at various rates and size scales. This result provides a deeper sympathetic of the favorable effect of moisturizers in treatment of dry skin conditions and challenges the view that moisturizers, like glycerol and urea [2], are advantageous for skin health by simply increasing the SC hydration.

**Keywords**-CCS Circuitry, Humidity Sensor, LPC2148, Multiplexer, Negative Pressure, Pressure Sensor.

## I. INTRODUCTION

Skin of the human body is a boundary organ between the inside and outside of the body, as well as it supports, contains and sustains the organs in the body [4]. The mechanical properties of the skin play a key role in one crucial function of the skin: its shielding function of the underlying tissues [6]. In aging people, many humanities are interested in skin aging. In skin aging, it is important to reveal elasticity of skin [1]. An important balance between the water content of the stratum corneum and skin surface lipids are maintain the proper functioning and the appearance of the skin. This balance is disrupted by exposure to external factors like: UV radiation, temperature and hormones, air humidity [5]. Cancer and scleroderma are diagnosed by skin's mechanical properties which provide valuable information for medical treatments, and for understanding of physiological process like aging [3]. There are various methods to diagnose these diseases such as Acoustic Radiation Force, Data Acquisition Setup[9], Measurement Object, Strain Imaging, Instrumental Setup (An electric impulse was generated by a high speed switching semiconductor), Image Processing[9], Sebum Level of the Skin Surface, Skin Visco-elasticity Measurement[1-2], Optical micrograph of an epidermal hydration mapping system [9]. High resolution ultrasound imaging is available by high frequency ultrasound because both wavelength and beam width are inversely proportional to the ultrasonic frequency [2,7] and also measured using Single Frequency-Susceptance Measuring Method [8] example Magnetic Resonance Elastography (MRE) which measures the tissue particle disarticulation and velocity through MR imaging [3]. Vibro-acoustography, on the other hand, tracks the similar information through ultrasound. Optical Coherence Elastography (OCE) uses light interference to register the speckle position from frame to frame in order to monitor tissue elasticity at different regions [3].

 

The skin analyzer technology includes various kinds of skin sensibility. It is a compact technology featuring touch screen operation making daily use easy and natural. Skin analyzer easily integrates into the daily work routine, where it may provide supplementary scientific evidence in support of visual assessment of skin conditions, whether it is in a beauty clinic or salon. As such, the device is ideal for evaluating photo aging and the collagen improvement as a result of refreshing procedures as well as the recommendation of specific skin care products. It is based on our long-term experience in developing and manufacturing scientific skin instrumentation.

## II. BLOCK DIAGRAM

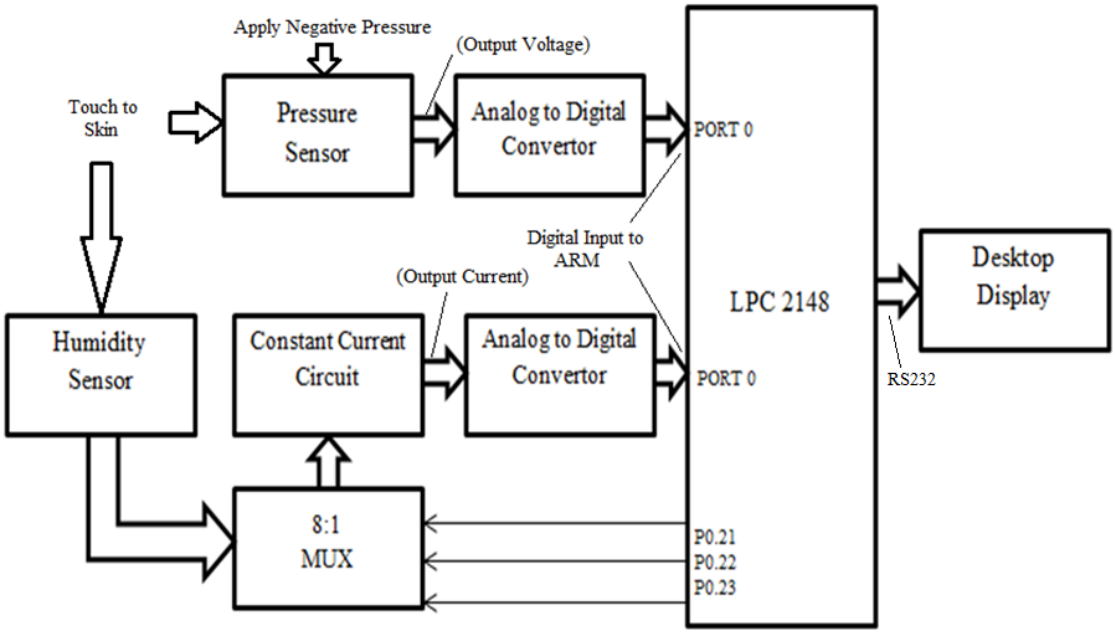


***Figure1. Skin Elasticity and Hydration measurement system Block Diagram***

The skin analyzer is simple: to incorporate working in the field of dermatological instrumentation for almost three decades in one platform, which is fully configurable just by connecting application probes as needed. Figure 1. Show total working of skin analyzer with the help of pressure and humidity sensors to measure the elasticity and hydration respectively.

### 2.1. Skin Elasticity

#### 2.1.1. Principle

The elasticity measurement of the Combo unit is based on suction applied to the skin surface. The probe provides a vacuum chamber and uses adhesive tape to prevent creeping and folding of the skin under the edge surrounding the measurement chamber.

]

The suction method features an elevation phase and a retraction phase. Young and smooth delicate skin, which is well moisturized, will normally be relatively easy to elevate by applying suction, and it will retract rapidly. Old and loose skin will also be easy to elevate, however, it will retract slowly.

It measures the skin retraction time as an indicator for the skin elasticity. The retraction time is defined as the time it takes for the skin to retract 1.5 mm from full elevation. Where a high score is represents a very elastic skin with a short retraction time.

If skin is lifted there is a time lag when the skin retracts to its former position with the help of pressure sensor by applying negative pressure. Retraction time is defined as the time in seconds it

 

takes for the skin to retract 1.5mm from full elevation. This is represented as a Retraction Score in the range 0-99 using the Elasticity Probe. Measurements are taken prior and following anti-ageing treatments, which can measure accurately that over-used phrase "take back 10 years".

### 2.1.2. Pressure Sensor

This pressure sensor has an amplified analogue output. Via internal settings the sensor is compensated for offset, sensitivity, temperature drift and nonlinearity. The sensor has a range of 2 PSI FS and the output is ratio metric to the power supply voltage. Other pressure ranges (from 0.3 to 100 psi) on request.

***Figure2. SPD002GAsiL Pressure Sensor***

The suction cup consists of a light plastic probe that forms a closed chamber when attached to the skin surface using double-sided sticky tape. Within the probe chamber there are two narrow beams of light that are run at different heights parallel to the skin surface and serve as elevation detectors. A computer-controlled vacuum pump is used to progressively increase the suction within the chamber. Since the time at which each of the beams is blocked can be electronically detected, the amount of suction in kilopascals (kPa) required to lift the skin to that point can be easily determined and electronically recorded by the computer.

Below Figure shows a schematic diagram consisting of four panels that portray the sequence of events that occurs during a measurement procedure. When the probe is first placed on the skin, its surface will be flush across the opening of the suction chamber, as shown in Figure a. The progressive increa.se in suction will cause the skin to be drawn into the chamber (Figure b), and eventually be drawn into the chamber (Figure b), and eventually the skin will be lifted to the point where the light beam of the lower elevation detector (level I) will be blocked, as shown in Figure c. When this occurs, the vacuum at that point will be electronically recorded. If the pump is allowed to continue, sufficient suction will be created to additionally lift the skin to the point where the light beam of the upper elevation detector (level 2) is blocked as well, as shown in (Figure d). The amount of suction required to achieve this higher level is also electronically recovered.

### 2.1.3. Negative Pressure

The amount of pressure expressed in atmosphere and which is below 1 atmospheric pressure then it known as Negative Pressure which will be useful in this system.

 

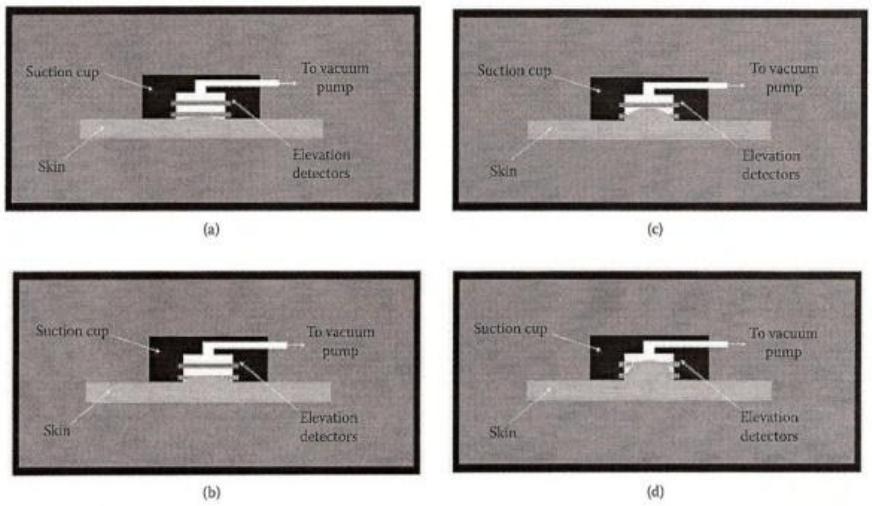


***Figure3. Operating principles of the suction cup chamber***

### 2.1.4. Elasticity Measurement Equation

$$\Delta x = \Psi * p * (r^4 / (E * S^3)) \quad (1)$$

Where: Δx- Deviation, Middle of surface

Ψ- Constant

p- Surface Pressure

E- Elasticity Module

r- Radius of the Surface

s- Thickness of the Surface (Skin thickness Set to 1.00 mm)

## 2.2. Skin Hydration

### 2.2.1. Principle

The Moisture Module provides information about the hydration state by measuring the conducting properties of the very upper layers of the skin, when subjected to an alternating voltage. Accordingly, the method is referred to as a conductance measurement and the output is presented in the unit of micro-Siemens (µS).

### 2.2.2. Humidity Sensor

The pin probe features eight contact pins and superior performance in dry skin applications, on uneven skin surfaces and on the scalp. Further, the pins and the ventilated design reduce occlusion, when applying the probe, thereby minimizing water accumulation in the skin covered by the probe. The probe has a spring-loaded action, which will initiate a measurement, when the probe is pressed against the skin.

Humidity Sensor with conductance measurement principle, 8 pin electrodes, Pin Probe with ventilating spacer etc.

### 2.2.3. Pin probe with ventilating spacer

The pin probe comes with a ventilating spacer to facilitate application of constant measurement pressure and reduce accumulation of water in the measurement area.

 


*(a)* *(b)* *(c)*

***Figure.4 (a) Humidity Sensor, (B) Operation, (c) Hydration and Conductance Measurement Principle***

### 2.2.4. Measurement of hydration

- This Hydration sensor measures the stratum corneum hydration state.
- This measurement is based on differences in dielectric constants of water and other substance where the capacitor would show the capacitance changes based on moisture content of samples measures.
- During the measurement, there will be an electric scatter field penetrating the skin and the dielectricity will be determined.
- Useful for evaluating moisturizers and cleansers.

To obtain measurements of skin surface impedance to determine electro conductivity of the treatment sites. This meter provides a relative measure of the retained water content of the skin as a function of the skin's dielectric value. Skin impedance is recorded automatically when equilibrium is achieved.

### 2.2.5. 8:1 MUX

Using this HEF4051B IC as 8:1 MUX to multiplex the output signals of the Hydration sensor and which again fed to CCS (Constant Current Source) Circuitry to generate appropriate output to measure the conductance in the form of current to know the hydration of the human skin. This MUX IC helps in selection of hydration sensors outputs using Select lines (S1, S2, and S3) which are controlled by programmable LPC2148.

### 2.2.6. CCS

Constant Current Source Circuitry with Low Power Consumption, Low Input Bias Current, Low Input Offset Current and High Input Impedance will fed the input from multiplexer which is hydration sensors output and with the help of some transistorised circuitry, it converts this signals into the appropriate current output which will be fed to ADC to convert in digital form.

### 2.3. LPC2148

It acts as controller of whole system and it is fully assembled with 16/32-bit ARM7TDMI-S microcontroller, 8 to 40 kB of on-chip static RAM, 32 to 512 kB of on-chip ash program memory, two 10-bit A/D converters provide a total of 6/14 analog inputs, Single 10-bit D/A converter provides variable analog output, Multiple serial interfaces including two UARTs ,two Fast I2C-bus, 60 MHz maximum CPU clock available from programmable on-chip and outcome of these sensors will connected to PC Desktop by RS232.

## III. CONCLUSION

As we seen, this system is very useful to measure the skin elasticity and hydration. This method is applicable for in vivo elasticity measurement and it would provide significant information in human

 

skin aging [1] and numbers of diseases related to elasticity of skin and take some treatments over it. With skin hydration we kwon the hydration of skin and types of the skin whether is it dry, oily, sensitive, combination or normal and based on this we will do the treatment over it. This system can be used in Scientific skin research, Prove efficiency of treatments, Claims substantiation, Ageing studies, Hydration state analysis, Barrier function analysis, Irritancy/allergy testing, Scleroderma/Psoriasis, Pre/Post laser Monitoring etc. this system is very easy to handle, cost efficient, small in size etc.

## REFERENCES

[1] Ryo Nagaoka, Takuya Izumi, Kiyono Kubo, Kazuto Kobayashi, Yoshifumi Saijo, "Elasticity of Artificial Skin by Measuring
Displacement Induced by Acoustic Radiation Force", IEEE International Ultrasonics Symposium Proceedings, pp.1378-1381, 2012.

[2] Kazutoshi Kumagai, Hideyuki Koike, Yukina Kudo, Ryo Nagaoka, Kiyono Kubo, Kazuto Kobayashi, Yoshifumi Saijo, "Imaging of Sebaceous Glands of Human Skin by Three-dimensional Ultrasound Microscopy and Its Relation to Elasticity", 33rd Annual International Conference of the IEEE EMBS Boston, Massachusetts USA,pp.7199-7202, August 30 - September 3, 2011.

[3] Bo Qiang, Xiaoming Zhang, James Greenleaf, "Estimation of Skin Elasticity by Measuring Surface Wave Velocity under Impulse
Stimulus Using Compact Optical Sensors", IEEE International Ultrasonics Symposium Proceedings,pp.185-188,2009.

[4] Xie Chi, Liu Nian, Gao Zhongyou, Lin Daquan, Guo Zuoda, "Investigating Testing Elasticity of Equivalent Material for Human Skin", Proceedings of the 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference Shanghai, China,pp.5862-5864, September 1-4, 2005.

[5] NAVEED AKHTAR, SHAHIQ UZ ZAMAN, BARKAT ALI KHAN, MUHAMMAD NAEEM AMIR and MUHAMMAD ALI
EBRAHIMZADEH, "CALENDULA EXTRACT: EFFECTS ON MECHANICAL PARAMETERS OF HUMAN SKIN", Acta Poloniae Pharmaceutica n Drug Research, Vol. 68 No. 5 pp. 693n701, 2011.

[6] Jean-Luc Gennisson, Th´er`ese Baldeweck, Micka¨el Tanter, Stefan Catheline, Mathias Fink, Laurent Sandrin, C´eline Cornillon, and Bernard Querleux, "Assessment of Elastic Parameters of Human Skin Using Dynamic Elastography", ieee transactions on ultrasonics, ferroelectrics, and frequency control, vol. 51, no. 8, august 2004.

[7] Michael Vogt, Helmut Ermert, "Development and Evaluation of a High-Frequency Ultrasound-Based System for In Vivo Strain Imaging of the Skin", ieee transactions on ultrasonics, ferroelectrics, and frequency control, vol. 52, no. 3, march 2005.

[8] Woo Young Jang, Jeong Je Park, Hye Jin Jeong, Hong Sig Kim, Jae Chan Park, "Time Series Trend of the Water Content on the Different Human Anatomical Sites Using Single Frequency-Susceptance Measuring Method", Proceedings of the 28th IEEE EMBS Annual International Conference New York City, USA, Aug 30-Sept 3, 2006.

[9] Xian Huang, Huanyu Cheng, Kaile Chen, Yilin Zhang, Yihui Zhang, Yuhao Liu, Chenqi Zhu, Shao-chi Ouyang, Gil-Woo Kong, Cunjiang Yu, Yonggang Huang, and John A. Rogers, "Epidermal Impedance Sensing Sheets for Precision Hydration Assessment and Spatial Mapping", IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 60, NO. 10, OCTOBER 2013.

[10] Nadia Magnenat-Thalmann, Prem Kalra, Jean Luc Lévêque, Roland Bazin, Dominique Batisse, and Bernard Querleux, "A Computational Skin Model: Fold and Wrinkle Formation", IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 6, NO. 4, DECEMBER 2002.

 