THE DEVELOPMENT OF THE DIGITAL SKIN MOISTURE SENSOR

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2017

ENDORSEMENT

I hereby acknowledge that I have read this report and I find that its contents meet the Requirements in terms of scope and quality for the award of the Bachelor Of Electronic Engineering Technology (Medical Electronic) With Honours

Signature : ....

Name of Supervisor : WAN ROSEMEHAH BT WAN OMAR Pensyarah Jabatan Kejuruteraan Elektrik Politeknik Sultan Salahuddin Abdul Aziz Shah

Date : 7/7/2017

DECLARATION

I hereby declare that the final year project book is an authentic record of my own work carried out of one year Final Year Project for the award of Bachelor Of Electronic Engineering Technology (Medical Electronic) With Honours, Under the guidance of Pn. Rosemehah Bt Wan Omar from 6 September 2016 to 15 May 2017.

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ABSTRACT

The observation of skin changes has long been conducted with an emphasis on the visually identifiable and palpable lesions. However, because of the limitation of sensory evaluation, efforts have been made during the last 30 years toward the introduction of various types of instrumental measurement. Skin conditions that have conventionally been categorized as normal can now be classified to 3 level of skin moisture. There are normal, dry and moist. Such studies are widely utilized in the treatment of diseases, and cosmetics field. Skin moisture sensor device are used to recognize the skin moisture. Many people didn't know about the skin problem in the moisture situation. Moisturizes generally do not add moisture to the skin, but they do keep your skin's natural moisture. The capacitive sensor indicate the measurements of moisture value. Eventhough, the capacitance method treats the water content in the skin as a dielectric material. Thus, for a capacitance measuring device, the increase in capacitance is proportional to the quantity of water in the skin. As a result, by using the capacitance method ability to produce results with high accuracy. As a conclusion, this method is very simple to understand the reading for declare the result compare with BIA method.

Keywords—skin moisture, dielectric material, bia method

ABSTRAK

Pemerhatian perubahan kulit telah lama dijalankan dengan penekanan kepada luka-luka visual dikenal pasti dan dirasai. Walau bagaimanapun, kerana had penilaian deria, usaha telah dibuat dalam tempoh 30 tahun yang lalu ke arah pengenalan pelbagai jenis pengukuran instrumental. keadaan kulit yang konvensional telah dikategorikan sebagai normal kini boleh diklasifikasikan ke tahap 3 kelembapan kulit. Terdapat normal, kering dan lembap. Kajian sedemikian secara meluas digunakan dalam rawatan penyakit, dan bidang kosmetik. Kulit peranti sensor kelembapan digunakan untuk mengenali kelembapan kulit. Ramai orang tidak tahu tentang masalah kulit dalam keadaan kelembapan. Melembapkan umumnya tidak menambah kelembapan pada kulit, tetapi mereka menjaga kelembapan semulajadi kulit anda. Sensor kapasitif menunjukkan ukuran nilai kelembapan. Walaupun, kaedah kemuatan merawat kandungan air dalam kulit sebagai bahan dielektrik. Oleh itu, untuk peranti kapasitan mengukur, peningkatan dalam kemuatan adalah berkadar dengan kuantiti air dalam kulit. Hasilnya, dengan menggunakan keupayaan kaedah kapasitan untuk menghasilkan keputusan dengan ketepatan yang tinggi. Kesimpulannya, kaedah ini adalah sangat mudah untuk memahami bacaan untuk mengisytiharkan keputusan perbandingan dengan kaedah BIA.

Kata kunci*— *kelembapan kulit, bahan dielektrik, kaedah bia

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The skin is much more than an outer surface for the world to see. It protects from bacteria, dirt and other foreign objects and the ultraviolet rays of the sun, and contains the nerve endings that let you know if something is hot or cold, soft or hard, sharp or dull. The skin also plays an important role in regulating your body's fluids and temperature [1]. Moisture can be quantified in a number of ways, but the most important measurement for maintaining atmospheric quality is relative humidity. This is the ratio of actual water vapor present in air to the amount of water vapor that would be present in air at saturation when the air cannot absorb any more moisture. Absolute moisture, on the other hand, is defined as the mass of water vapor dissolved in a total volume of moist air at a given temperature and pressure [2].

The New Digital Skin Moisture is the right tool for measuring humidity in skin. As a result, this instrument utilizes the latest Bioelectric Impedance Analysis (BIA) technology, a nondestructive measuring approach in providing accurate reading to help monitor skin hydration to maintain a young and healthy looking skin [2]. It so easy to use, just turn it on, touch the probe on the skin and see the skin condition with real figure on its easy-to-read LCD display. This analyzer lets to know how good or how bad skin condition is. This is so compact that you can even place it in your pocket. In a global, have many type of digital moisture of skin device but this project which suitable with our environment humidity.

1.2 Problem Statement

The Digital Moisture Sensor device are help to maintain a young and healthy looking skin. Many people didn't know about the skin problem in the moisture situation. Moisturizes generally do not add moisture to the skin, but they do keep your skin's natural moisture. This device can help to control the quantity of moisturize on the skin face. There is no wrong time to start taking care of the skin, and depending the treatment undergo, can see great results in short time spans. But, it do not think the effect at the future time. Skin moisturizers for men and women differ, as men and women have different types of skin by nature. So this device can help to care the skin with take reading are fix at the suitable parameter for men and women. Most people recommend putting skin moisturizers at night and there really is some science to that. During the night, bodies lose a lot of water, so wearing a good product will ensure that your body does not lose too much water. However, generally the skin type should be an important factor. People with dry skin should probably moisturize more often than people with regular or rather oily skin. So this device can declare the skin in good or bad conditions. Skin moisture is commonly thought of as a qualitative measure; one might argue that skin is only described as varying levels of moist and dry. The project approaches the problem of skin moisture as a quantitative one, putting a number to the amount of moisture.

1.3 Objective

The main objective of the project is to testing of skin moisture sensor which is one of the biomedical instrument. There are four requirements of the project to achieve that objective:

i. To identify the sensor of skin moisturize detector device.
ii. To design the circuit of sensor of skin moisture.
iii. To test the circuit of skin moisture.

iv. To validate the result based on LCD display analysis by using the percentage of skin moisturizer.

1.4 Scope of the Project

This purpose of this project is to testing skin moisture sensor. The device to detect the skin moisture by using digital moisture sensor to collect the data based on the respondent's type of skin. The result from the display device know that dry or moist. According to the specification of digital moisture sensor for skin, the device can operate in 5˚C until 40˚C and the device will display the result on LCD with percentage. The data of this observation for 27 persons in BEU6, JKE. To collect the data must to enactive the temperature of surrounding at 22˚C until 30˚C and the experiment was held at MA001. The type of sensor to use for the detect skin moisture that are inter digital sensor and temperature sensor uses a polyimide film to detect changes in humidity.

1.5 Importance of Research

The observation that people can know about their reading moisturize on the skin and can take the action to treat and prevent dry skin. What patients and clinicians perceive as skin "dryness" is not in reality a specific cutaneous symptom. Rather, as one researcher explains, dry skin "is characterized by differences in chemistry and morphology in the epidermis depending on the internal and external stressors of the skin.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The observation of skin changes has long been conducted with an emphasis on the visually identifiable and palpable lesions. However, because of the limitation of sensory evaluation, efforts have been made during the last 30 years toward the introduction of various types of instrumental measurement. Skin conditions that have conventionally been categorized as normal can now be classified into various types on the basis of numerical values. Achievements from such studies are widely utilized not only for the treatment of diseases, but also in the field of cosmetics [3]. Of particular importance is the measurement of the barrier function of the stratum corneum in the outermost layer of the skin, as well as its water content. Capacitive sensors can directly sense a variety of things motion, chemical composition, electric field and indirectly, sense many other variables which can be converted into motion or dielectric constant, such as pressure, acceleration, fluid level, and fluid composition [4]. They are built with conductive sensing electrodes in a dielectric, with excitation voltages on the order of five volts and detection circuits which turn a capacitance variation into a voltage, frequency, or pulse width variation. The range of application of capacitive sensors is extraordinary.

Motion detectors can detect 10-14 m displacements with good stability, high speed, and wide extremes of environment, and capacitive sensors with large electrodes can detect an automobile and measure its speed. Capacitive technology is displacing piezo resistance in silicon implementations of accelerometers and pressure sensors, and innovative applications like fingerprint detectors and infrared detectors are appearing on silicon with sensor dimensions in the microns and electrode capacitance of 10 fF, with resolution to 5 aF (10-18 F). Capacitive sensors in oil refineries measure the percent of water in oil, and sensors in grain storage facilities measure the moisture content of wheat.

2.2 Stratum Corneum

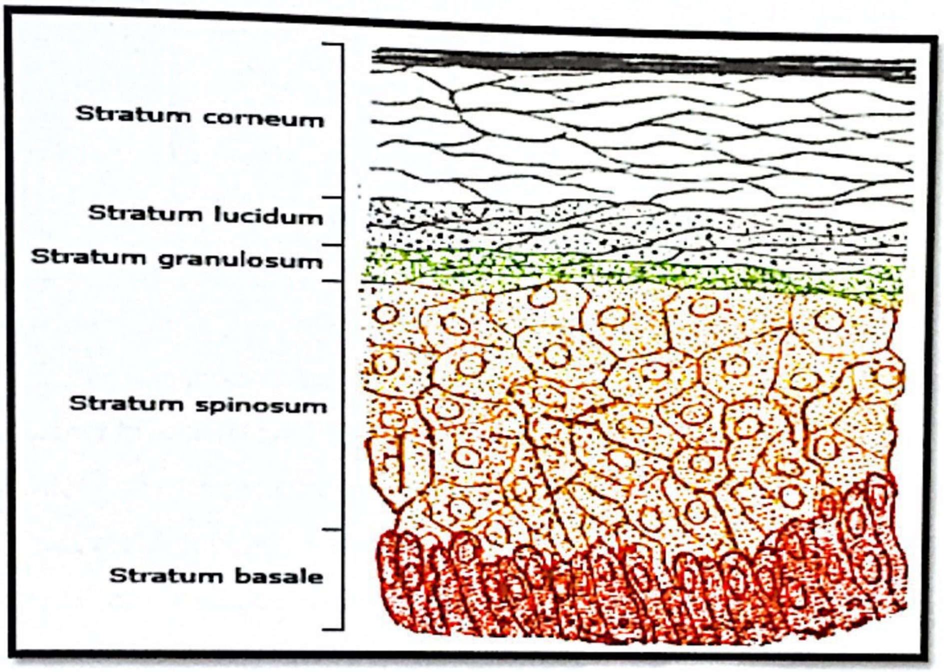


Figure 2.1: Stratum Corneum

The stratum corneum is the outermost layer of the skin. It is composed of dead skin cells, which eventually slough off and are replaced by the layer below, and a protein called Keratin. Keratin is responsible for the prevention of water evaporation and the attraction/absorption of water to the skin. The hydration of the skin in relation to this project refers specifically to the water content found in the stratum corneum layer of the skin. Adequate skin hydration is vital to the prevention of dry skin. A top the stratum corneum is the layer of dead skin cells and the body's naturally secreted oils. The oils in combination with the stratum corneum are the body's first defense against foreign invaders such as allergens. Dry skin exhibits a lack of oils and/or inadequate hydration, which results in cracking of the stratum corneum. Dry cracked skin, especially in cases of eczema, leaves the body susceptible to an attack [5]. Figure 2.1 shows the position of the stratum corneum in relation to the other layers of the skin.

2.2.1 Anatomy of Skin

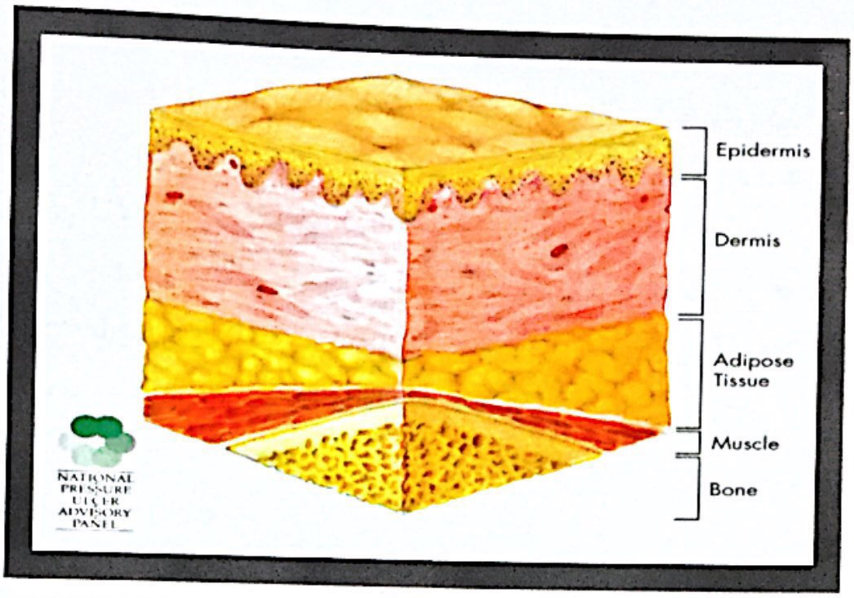


Figure 2.2: Layer of Skin

The skin protects the body and its internal organs from injury and is a barrier to bacteria and infection. It keeps moisture inside the body and also regulates body temperature by cooling mechanisms such as perspiration. In addition, the skin provides sensation, allowing us to feel heat, cold, pain and touch. Glands within the skin secrete oil and sweat for lubrication, helping it stay moist and healthy. There are three primary layers of the skin. That have epidermis. It is dry, outermost layer which provides protection. Then for dermis. It is moist, inner layer which provides strength and support. For hypodermis. It is adipose tissue or fatty layer which provides insulation and cushioning. The illustration shows a cross-section of the skin, muscle and bone. The three primary layers of the skin are the epidermis, dermis and hypodermis. The epidermis is the dry, outermost layer. Underneath the epidermis is the dermis, a moist inner layer which provides strength and support. The dermis contains blood vessels, lymph vessels, sweat glands and hair follicles. This layer also contains the pain and touch receptors. When the epidermis is injured, the dermis is exposed [6]. This type of injury can hurt because pain receptors are exposed. The hypodermis or adipose fatty layer is the deepest layer of skin.

2.2.2 Essential skin Facts

As we know, the skin are largest organ in human body. Besides that, it is accounts for 15% body weight. After that, the organ of the body that is most exposed to bacteria, UV light, toxins dust and other environmental stressors. Every for 24 hours the surface of skin sheds dead layer of cells, and on average 40 kg of skin is shed during lifetime. Then, dead skin cells can become a components of household dust [7].

2.2.3 Epidermis Layer Skin

Figure 2.3: Epidermis skin layer

From the figure 2.3, as shown the epidermis is on average about 0.2 mm thick, and 95% of the cells composing it are epidermal keratinocytes that proliferate and divide in the epidermal basal layer and move up to the upper layers as they mature (to form cornified cells). In the epidermis, epidermal keratinocytes at different stages of maturation are arranged in layers that can be divided into four levels. The period between the production of daughter epidermal cells and their exfoliation from the outer surface of the epidermis is called the turnover time, which is approximately 28 days in normal skin [8].

2.2.4 Basal cell layer

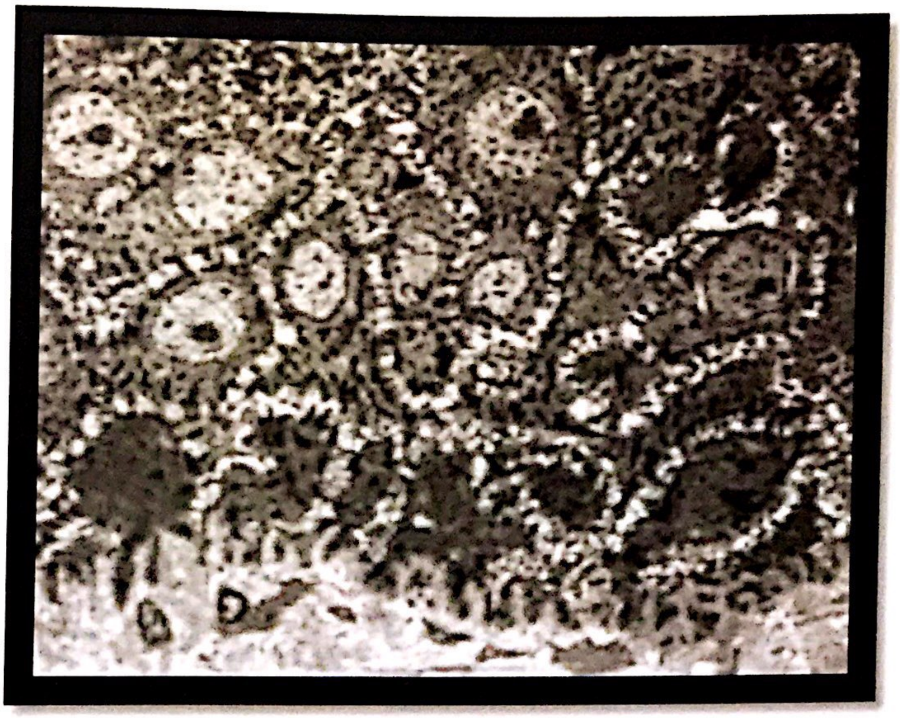


Figure 2.4: Ultra structural anatomy of the epidermis

The basal cell layer is a single layer consisting of basal cells including the epidermal stem cell subpopulation. Basal cells vary in shape from cubic to columnar. They contain basophilic (or darkly staining) cytoplasm and an elliptical nucleus that is rich in chromatin. The basal cells have desmosomes (for cell cell attachment), gap junctions (for cell communication), and hemidesmosomes (for connection with the extracellular matrix and underlying basal membrane). Cell cytokeratins (keratin filaments, tonofilaments) are abundant in the cytoplasm of many epidermal keratinocytes and are distributed in bundles at the periphery of the nucleus, from where they distally connect with hemidesmosomes and desmosomes to form a rigid and robust cellular cytoskeleton [8].

2.2.5 Suprabasal cell layer

The suprabasal cell layer is composed of five to ten layers that appear connected to each other by prickle-like structures. Suprabasal (prickle) cells are polygonal in the lower layer and flattened in the upper layers. They are larger than basal cells and contain a small amount of chromatin in their circular nucleus. The part that gives the appearance of a prickle corresponds to the desmosome (a form of intercellular bridge) [8].

2.2.6 Granular cell layer

The granular cell layer is composed of two or three layers of cells containing basophilic keratohyalin granules. The cells and nuclei in the granular cell layers are even flatter than those in the suprabasal layer. Spherical lamellar granules, each with a diameter of approximately 300 nm (also known as Odland bodies or ketatosomes), can be observed in the granular cell layers by electron microscopy. The main component of lamellar granules is released into the intercellular space of horny cells as stratum corneum lipid [8].

2.2.7 Horny cell layer

The horny cell layer, also called the stratum corneum, is composed of about ten sub-layers. Enucleated dead keratinocytes become membranous and multilayered, resembling fallen leaves, and exfoliate sequentially, beginning with the outer layer, in what is commonly called grime. The horny cell layer is very thick in the palms and soles. Horny cells are flat, and their cytoplasm is filled with aggregated keratin fibers. Directly above the granular cell layer, the horny cell structure appears as an eosinophilic layer. The horny cells gradually change into membranous structures in the upper layers. By electron microscopy, the contrast between electron-dense interfibrous substance and the low-electron-dense keratin fibers is clear; this contrast is called the keratin pattern. The cell membranes are thicker in the horny cell layer than in the other layers. The lining structure is called a cornified cell envelope or a marginal band. The protein, component of the cornified cell envelope, is extremely stable against physicochemical degradation [8].

2.3 The Biochemistry of Dry Skin

Dry skin is also called xerosis. The complex factors contributing to dry, flaky skin are just beginning to be understood. Some of these relate to the environment and some relate to the particular individual involved. There are individual and genetic factors, which make some persons more susceptible than others to this problem. The structure of the epidermis, the outermost layer of skin and the stratum corneum, and the outermost layer of the epidermis are of greatest importance in determining who develops dry skin and when it develops. The epidermis is composed of 4 layers. The cells of the inner layer migrate upward from the basal layer to the granular layer until they reach the outer layer of the stratum corneum. Through this migration, the cells change, losing their nuclei (inner portion containing DNA) and becoming keratinized, thus forming the outer protective keratin layer of the stratum corneum. This outer layer provides a barrier function; it keeps important substances such as cellular fluids and blood within the body and it helps keep out too much water, invading micro-organisms, and toxins that might harm the inner organism if allowed to pass through the skin. When no longer functional, cells of the outer stratum corneum are shed in a process called desquamation. Junctional bridges called desmosomes hold all cells, including those of the stratum corneum, together. When the cells are no longer functional, the desmosomes break down so the cells are no longer held together and can be shed from skin surface. Desmosomes that are "too tight" do not allow for proper shedding of discarded cells. Several enzymes degrade the desmosomes and allow nonfunctional cells to detach from each other and desquamate (shed). Genetic differences in the amount or efficiency of these enzymes also determines the efficiency of this process. If the desmosomes are not degraded properly and the outer nonfunctional cells are held together longer than optimal, dry flaky sheets of skin develop in which the cells are still attached to one another. In a normal process, friction causes very tiny clumps of nonfunctional cells to be shed; in an abnormal process, these clumps are larger since the cells cannot dis-attach from each other, causing them to be more visible, flaky and unattractive. The spaces between these cells and around the bridges are filled with a substance that provides the primary barrier to water loss. The composition of this substance is very important in protecting against excessive skin dryness. This substance has a very high fat content and such is called lipid-rich [9].

There are primarily 3 critical compounds in this substance — ceramide, cholesterol, and fatty acids. The total amounts of these 3 compounds as well as their proportions to each other are all very important in healthy function of the skin barrier. Ceramide, cholesterol, and fatty acids are further classified as to type. For example, there are 9 different chemical classes of ceramides, each doing something a little different from the others. We actually do not understand the exact roles of all of these subtypes as yet and much more research needs to be done in this area. We do know that the ceramides present as longer chains provide a better water barrier than the short-chain ceramides. People with dry skin (and with diseased skin) have too much of the short-chain ceramides and not enough of the long-chain ceramides. Linoleic acid, an essential fatty acid that must be provided in the diet, is especially important in the synthesis of long-chain ceramides. Essential fatty acids are found in the omega-3 and the omega-6 group, found in cold-water fish (salmon, herring, and mackerel) and in nuts, avocados, flax seed oil. Some shapes of fats (lipids) in the skin act as better barriers than others. The "packing" of these molecules against and around each other determine how much water is let through. The amount of water allowed through a barrier is referred to as the barrier's permeability; high permeability means a lot of water is let through and low permeability means less water is allowed through. As the cells of the epidermis migrate upward, the substance between them composed of these lipids changes configuration so that the barrier is weaker at the outermost layers of the stratum corneum. The deeper layers contain lipids that are more tightly packed against each other and less permeable to water; the outer layers have more loosely packed lipids and are more permeable to water. The more tightly packed lipids have rhomboid shapes (looking like a slightly squashed rectangle) and the loosely packed lipids have hexagonal shapes [10].

2.4 The Biochemistry of Moist Skin

The moisture skin is defined as being caused by urine and/or faeces and perspiration which is in continuous contact with intact skin of the perineum, buttocks, groins, inner thighs, natal cleft, and skin folds and where skin is in contact with skin. Moisture cause superficial loss of epidermis and/or dermis, which may be preceded by areas of erythema on intact skin. They will usually cause pain. The skin will either be excoriated which presents as superficial broken skin which is red and dry, or macerated presenting as red and white, wet, soggy and shiny. The pattern of skin damage is uneven apart from on the natal cleft when the damage presents as a linear vertical split in the skin. In the case of kissing lesions the damage usually presents on either side of a skin fold [11].

2.5 Skin Moisture Sensor

The most common methods in quantitatively measuring the skin moisture content in humans are the Bio impedance Analysis (BIA) method and the Capacitance method. The BIA and Capacitance method each have their own advantages and disadvantages. The focus of skin moisture sensors lies in the upper most layer of the skin. The capacitance method are more effective than Bio impedance Analysis (BIA). A direct assessment as to which method is better is not fair because the commercially available devices using each method are toward cosmetic application. When one considers the application of this project toward moist or dry skin, a medical condition, it becomes clear that cost becomes less of an issue and accuracy increases in importance. Medical devices and other medical related items tend to be quite costly and as such we might expect that consumers might be willing to pay more for a device with applications toward the incurable condition, moist or dry skin. With these facts in mind, this project should take on the approach of designing the skin moisture sensor using the capacitance method [5]. The capacitance method might be more difficult to design because devices using the method are not quite as available as those that use the BIA method. Therefore, there is less research to work from in taking the capacitance direction.

2.5.1 Capacitance Method

The capacitance method refers to an idea applied specifically toward the measuring of skin moisture. A typical capacitor consists of two parallel plates and is capable of holding charge. Between the plates exists an electric field. At the edges of the plates this electric field exhibits a scattering of the field known as the "scatterfield effect". Between the plates, a dielectric material can be placed to increase the capacity of the capacitor to hold charge. A dielectric material is usually a material with insulating properties but it can be any material with a relative static permittivity greater than '1'. Under the right conditions, materials with a relative static permittivity greater than 1 can concentrate electrostatic lines of flux.[12] Material's with this ability act as effective dielectrics by increasing capacitance. With this definition in mind, water is a dielectric.

2.5.2 Bioelectrical Impedance Analysis

A normal balance of body fat to lean body mass is associated with good health and longevity. Excess fat in relation to lean body mass, a condition known as altered body composition, can greatly increase your risk of cardiovascular disease, diabetes, and more. Bioelectrical impedance analysis (BIA) is a valuable tool for measuring your body composition the measurement of body fat in relation to lean body mass [13]. It is an important part of any comprehensive health and nutrition assessment. BIA also provides the measurement of fluid and body mass that can be critical assessment tool for your current state of health.

2.6 Capacitive Sensor Theory, Operation, and Optimization

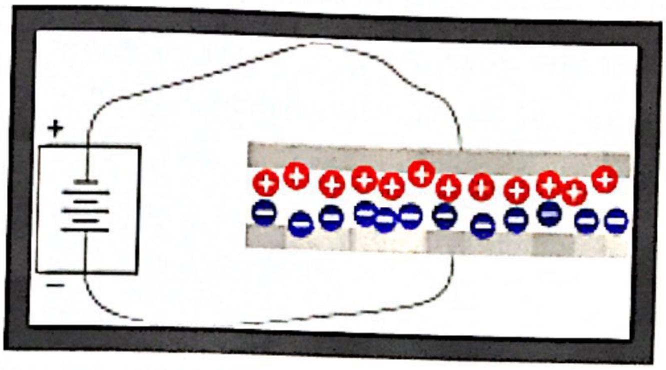


Figure 2.5: Conductive objects

Figure 2.5 shows how the applying a voltage to conductive objects causes positive and negative charges to collect one each object. This creates an electric field in the space between the objects.

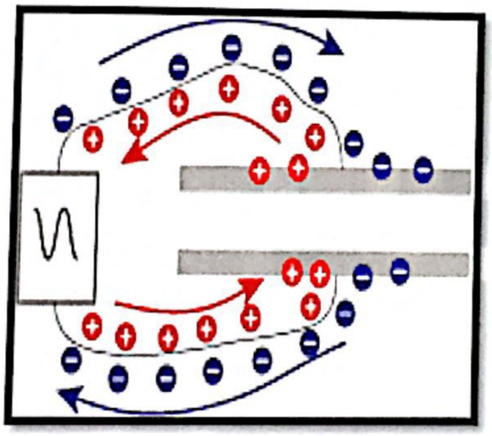


Figure 2.6: Noncontact capacitive sensor

Figure 2.6 shows how the noncontact capacitive sensors work by measuring changes in an electrical property called capacitance. Capacitance describes how two conductive objects with a space between them respond to a voltage difference applied to them. When a voltage is applied to the conductors, an electric field is created between them causing positive and negative charges to collect on each object. If the polarity of the voltage is reversed, the charges will also reverse [14].

Applying an alternating voltage causes the charges to move back and forth between the objects, creating an alternating current which is detected by the sensor. Capacitive sensors use an alternating voltage which causes the charges to continually reverse their positions. The moving of the charges creates an alternating electric current which is detected by the sensor. The amount of current flow is determined by the capacitance, and the capacitance is determined by the area and proximity of the conductive objects. Larger and closer objects cause greater current than smaller and more distant objects. The capacitance is also affected by the type of nonconductive material in the gap between the objects.

2.6.1 Focusing the Electric Field

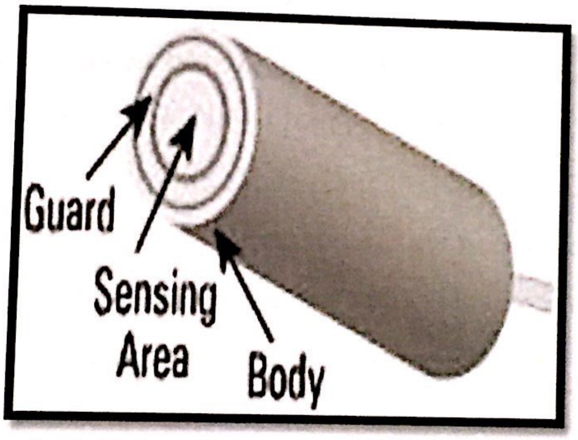


Figure 2.7: Capacitive sensor probe components

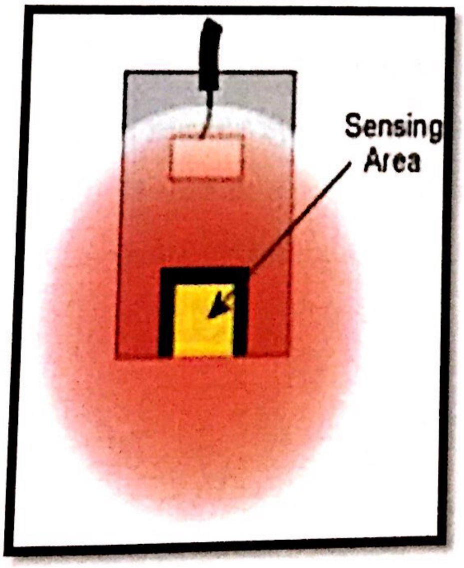


Figure 2.8: Cutaway view

From the figure 2.8 that shows the cutaway view showing an unguarded sensing cutaway showing the guard field shaping the sensing area electric field. When a voltage is applied to a conductor, the electric field emanates from every surface. In a capacitive sensor, the sensing voltage is applied to the sensing area of the probe. For accurate measurements, the electric field from the sensing area needs to be contained within the space between the probe and the target. If the electric field is allowed to spread to other items or other areas on the target then a change in the position of the other item will be measured as a change in the position of the target [15].

From the figure 2.7 as shows a technique called "guarding" is used to prevent this from happening. To create a guard, the back and sides of the sensing area are surrounded by another conductor that is kept at the same voltage as the sensing area itself when the voltage is applied to the sensing area, a separate circuit applies the exact same voltage to the guard. Because there is no difference in voltage between the sensing area and the guard, there is no electric field between them [16]. Any other conductors beside or behind the probe form an electric field with the guard instead of the sensing area. Only the unguarded front of the sensing area is allowed to form an electric field with the target [17].

2.6.2 Effects of Target Size

The target size is a primary consideration when selecting a probe for a specific application. When the sensing electric field is focused by guarding, it creates a slightly conical field that is a projection of the sensing area. The minimum target diameter for standard calibration is 130% of the diameter of the sensing area [18].

2.6.3 Range of Measurement

In general, the maximum gap at which a probe is useful is approximately 40% of the sensor diameter. Standard calibrations usually keep the gap considerably less than that.

The range in which a probe is useful is a function of the size of the sensing area. The greater the area, the larger the range. The driver electronics are designed for a certain amount of capacitance at the probe. Therefore, a smaller probe must be considerably closer to the target to achieve the desired amount of capacitance. The electronics are adjustable during calibration but there is a limit to the range of adjustment. In general, the maximum gap at which a probe is useful is approximately 40% of the sensing area diameter. Standard calibrations usually keep the gap considerably less than that [19].

Capacitive sensors (capacitive linear displacement sensors) are noncontact devices capable of high-resolution position measurement and/or position change - displacement measurement - of any conductive target. The nanometer resolution of high-performance capacitive sensors makes them indispensable in today's nanotechnology world. They can also be used to measure the position or other properties of nonconductive targets [20].

2.6.4 A Capacitive Sensor System

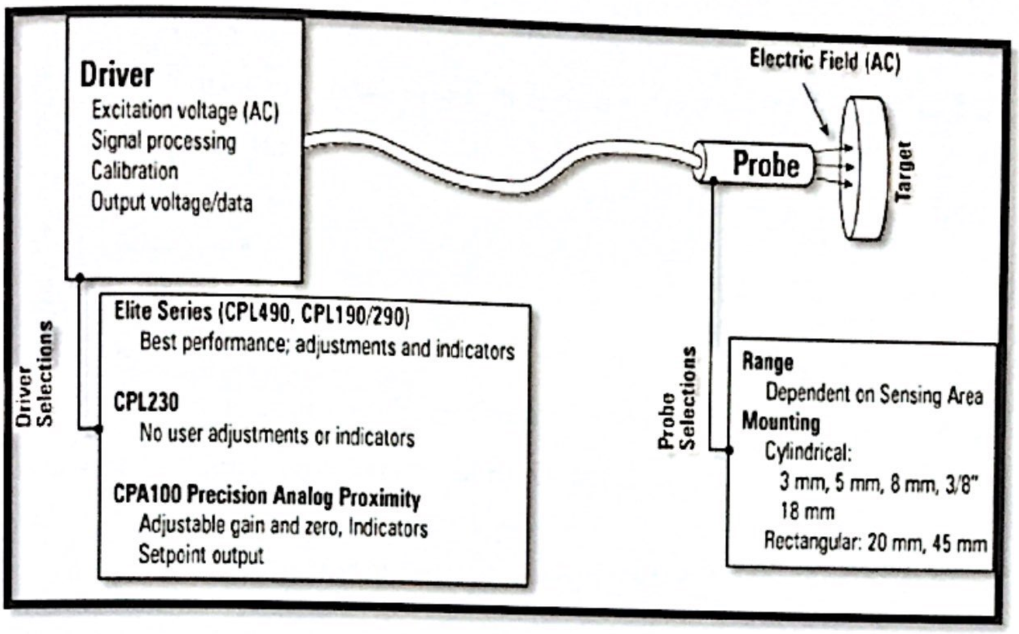


Figure: 2.9: Capacitive System

Capacitive sensors use the electrical property of "capacitance" to make measurements. Capacitance is a property that exists between any two conductive surfaces within some reasonable proximity. Changes in the distance between the surfaces changes the capacitance. It is this change of capacitance that capacitive sensors use to indicate changes in position of a target. High-performance displacement sensors use small sensing surfaces and as result are positioned close to the targets (0.25-2 mm) [21].

2.6.5 Capacitive Sensor Advantages

Compared to other noncontact sensing technologies such as optical, laser, eddy-current, and inductive, high-performance capacitive sensors have some distinct advantages.

I. Higher resolutions including sub nanometer resolutions
II. Not sensitive to material changes: Capacitive sensors respond equally to all conductors
III. Less expensive and much smaller than laser interferometers.

2.6.6 Capacitive sensors are not a good choice in these conditions

I. Dirty or wet environment (eddy-current sensors are ideal)

II. Large gap between sensor and target is required (optical and laser are better)

2.6.7 Applications

Capacitive sensors are useful in any application requiring the measurement or monitoring of the position of a conductive target. They can also be used with nonconductive targets in many applications.

2.6.8 Position Measurement/Sensing, Displacement Measurement

Capacitive sensors are basically position measuring devices. Their outputs always indicate the size of the gap between the sensor's sensing surface and the target. When the probe is stationary, any changes in the output are directly interpreted as changes in position of the target. This is useful in

I. Automation requiring precise location

II. Semiconductor processing

III. Final assembly of precision equipment such as disk drives

IV. Precision stage positioning ion

2.6.9 Specifications of Capacitive Sensor

I. Flow- Many types of flow meters convert flow to pressure or displacement, using an orifice for volume flow or Coriolis effect force for mass flow. Capacitive sensors can then measure the displacement.

II. Pressure- A diaphragm with stable deflection properties can measure pressure with a spacing-sensitive detector.

III. Liquid level - Capacitive liquid level detectors sense the liquid level in a reservoir by measuring changes in capacitance between conducting plates which are immersed in the liquid, or applied to the outside of a non-conducting tank.

IV. Spacing- If a metal object is near a capacitor electrode, the mutual capacitance is a very sensitive measure of spacing.

V. Scanned multiplate sensor- The single-plate spacing measurement can be extended to contour measurement by using many plates, each separately addressed. Both conductive and dielectric surfaces can be measured.

VI. Thickness measurement- Two plates in contact with an insulator will measure the insulator thickness if its dielectric constant is known, or the dielectric constant if the thickness is known.

VII. Ice detector- Airplane wing icing can be detected using insulated metal strips in wing leading edges.

VIII. Shaft angle or linear position--Capacitive sensors can measure angle or position with a multiplate scheme giving high accuracy and digital output, or with an analog output with less absolute accuracy but faster response and simpler circuitry.

IX. Lamp dimmer switch- The common metal-plate soft-touch lamp dimmer uses 60 Hz excitation and senses the capacitance to a human body.

X. Keyswitch- Capacitive keyswitches use the shielding effect of a nearby finger or a moving conductive plunger to interrupt the coupling between two small plates.

XI. Limit switch- Limit switches can detect the proximity of a metal machine component as an increase in capacitance, or the proximity of a plastic component by virtue of its increased dielectric constant over air.

XII. X-Y tablet- Capacitive graphic input tablets of different sizes can replace the computer mouse as an x-y coordinate input device. Finger-touch-sensitive, z-axis-sensitive and stylus-activated devices are available.

XIII. Accelerometers- Analog Devices has introduced integrated accelerometer ICs with a sensitivity of 1.5g. With this sensitivity, the device can be used as a tilt meter.

2.7 Dielectric Constant for Capacitive Sensor

This term means a material property which is characteristic of the behavior in the electrical field. This characteristic shows e.g. when material is placed between the plates of a capacitor. Nonconductive material is meant here, otherwise there would be a short circuit between the plates. The following term will help clarify this background. As mentioned above, matter consisting of elementary particles such as electrons is electrically neutral. The electric charges which are bound to the elementary particles are balanced. At this point we want to recall the structure of matter. The smallest parts are atoms (at this point we do not want to ask in detail what they consist of). It is only in inert gas that they are isolated, usually they combine to form molecules. Looking at this structure in more detail you will see that there are materials in whose molecules the charges are not arranged completely symmetrically. A well-known example is water. A water molecule is electrically neutral. However, it is easy to imagine that for example a .left-hand. Side is slightly positive and the .right-hand. Side is slightly negative. This is the cause of some properties of the water, e.g. the good solubility of salts. Usually this is hardly noticed because the water molecules are oriented completely irregularly. However, if you place them into an electrical field, e.g. between the plates of a capacitor, they orient themselves. The positive side will point to the negative plate and accordingly the negative side to the positive plate [22].

If you enter a material which is not polarised into an electric field, it can slightly stretch these charges. Even if before the charge distribution was symmetrical, there will be a polarisation in the electric field. Especially in connection with capacitors there is an important consequence. Whether the charges orient themselves or whether they stretch, the field is weakened in either case. For example, opposite the negative plate there will be positive charges which partly neutralise the negative charge of the plate. Thus less work is required to apply additional charges to the plates, i.e. the capacitance increases. Formula has to be modified.

2.7.1 Capacitor with dielectric material

This term sounds very scientific and abstract but in fact a dielectric material is nothing special. Each non-conductive material is a dielectric material (we will discuss conductive material further below). This term only points out that in the current context polarisability is the essential property. If there is no matter between the plates (vacuum), then r = 1. With air the difference is so small that r also virtually takes the value 1. With other materials this value can only be > 1. For many materials it is between 1 and 10. With water it is already unusually high, here r 81. This means that the capacitance of a capacitor where there is water between the plates is 81 times higher than in air. r is considerably higher with only some exotic. For example they are used in the production of special capacitors with high capacitances. A special case is of particular importance for the analogue level sensor. It depends on the level. It makes, of course, sense to take the empty capacitor as reference. The capacitance rises to about 81 times when it is filled with water. If it is only filled half, the capacitance will increase by only half the value [22]. To be more precise we can say, the change in capacitance is proportional to the difference in height (for rectangular plates). This relation is used for the signal generation in the analogue level sensor.

2.7.2 Capacitor half-filled

In metals (by the way likewise in other electrical conductors such as graphite) charges (more precisely: charge carriers) move relatively freely. As already said this does not mean completely filled because otherwise the capacitor would be short-circuited. There must remain a small gap on both sides. If the capacitor is charged, an electrical field is generated between the plates. It acts on the electric charges which move freely in the metal. So the positive charges will accumulate opposite the negative plate and vice versa. The movement of the charges will continue until the electrical field inside the metal has been compensated. Here the term polarisation is stripped of its meaning, however. R cannot be indicated for conductors. Can easily understand the effect of the charge distribution if you imagine that this arrangement is replaced by two capacitors [22].

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter is to describe development of skin moisture sensor and identifying the suitable sensor for skin moisture detector that use a capacitor sensor that can achieve maximum performance. By achieving maximum performance in the hardware, the capacitive touch software library can perform the capacitive touch measurements with the lowest power consumption. The capacitance method treats the water content in the skin as a dielectric material.

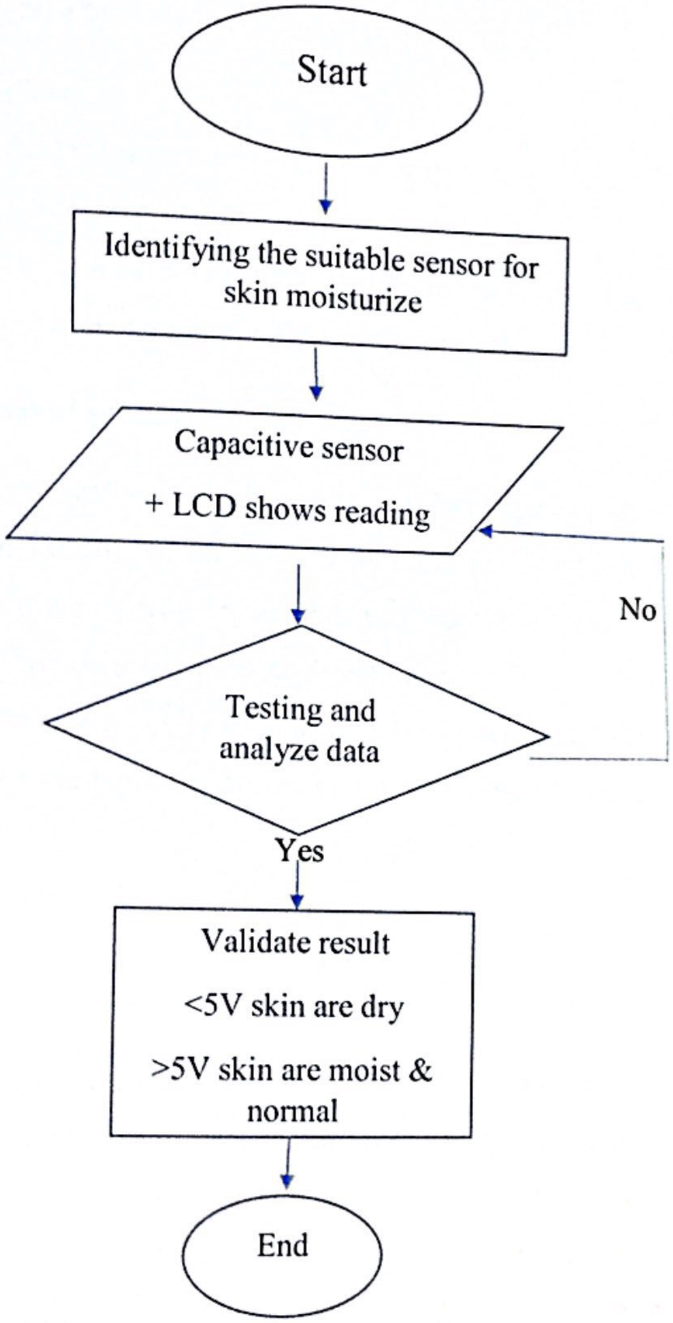
Thus, for a capacitance measuring device, the increase in capacitance is proportional to the quantity of water in the skin. The exact type of transducer used for capacitance measuring devices in relation to skin moisture is called an "Inter digital Capacitor". The exact details including design, theory, and application are discussed in section. Devices for measuring skin moisture using the capacitance method come in various shapes and sizes [23].

A commercialized device might be found at about the same size as its BIA counterpart. A commercialized device for measuring skin moisture using the capacitance method is quite accurate for its purposes as opposed to it BIA counterpart. The application for this device currently is towards cosmetics. For research purposes, one might invest in the corneometer, which consists of a probe about the size of a highlighter marker connected to a larger unit. At the tip of the probe is an inter digital capacitor

The larger unit would be approximately the same size as a small laptop. The probe is connected to the larger unit through leads. The corneometer is considered the gold standard in skin moisture sensors. It is by far the most accurate device for its purpose. It is generally used for research purposes only.

The main advantage of using the capacitance method is its ability to produce results with high accuracy. The capacitance method also offers devices on extremes of the financial spectrum. A relatively inexpensive device for consumers and a highly accurate option for those who can afford it. The disadvantages include the difficulty in producing the device, its cost, and limited availability. A device using the capacitance method is quite difficult to find. There are very few companies that produce the device for public consumption.

3.2 Flowchart



3.3 Design

To develop this project, few phase must be set up so that the project will go smoothly like the way we want it according to plan. Like before, there are a few important steps that must be done to finish this project:

i. Planning.

ii. Build structure and programming of the project.

iii. Write a report.

iv. Block diagram or steps taken to finish the project.

v. Flowchart about the flow of the project.

3.3.1 Process of product

The first, for the production of the product must be looking for some info about the functionality of the product, in other words what we want from the product. When we already know what you want, must examine the nature of human skin. The methods used to detect whether the skin is dry or in humid conditions. Electronic device used to detect the inter digital skin sensor. We are required to list the types of sensors that are suitable for detecting human skin moisture.

3.4 Hardware

This project used hardware component to detect the skin moisturize either dry or moist. The main component used in this project is Breadboard , Inter digital Capacitor, Resistors, capacitors, diodes, Hex Schmitt chip, Capacitance meter, Silicone pen , Battery holder + 9 V battery , AVR Butterfly Microcontroller kit, Serial-to-USB cable , Printed Circuit Board AVR Butterfly Microcontroller kit accessories [5].

3.4.1 Breadboard

A breadboard is a device used as a construction base in developing an electronic circuit. Breadboards can be solderless, which allows them to be reusable. A solderless breadboard is made of plastic and perforated with numerous holes. Small tin-plated bronze or nickel alloy clips are located under the perforations and provide contact points or "nodes" to attach electronic pieces to create a circuit. A breadboard is used for multiple functions to create a variety of products using electricity.

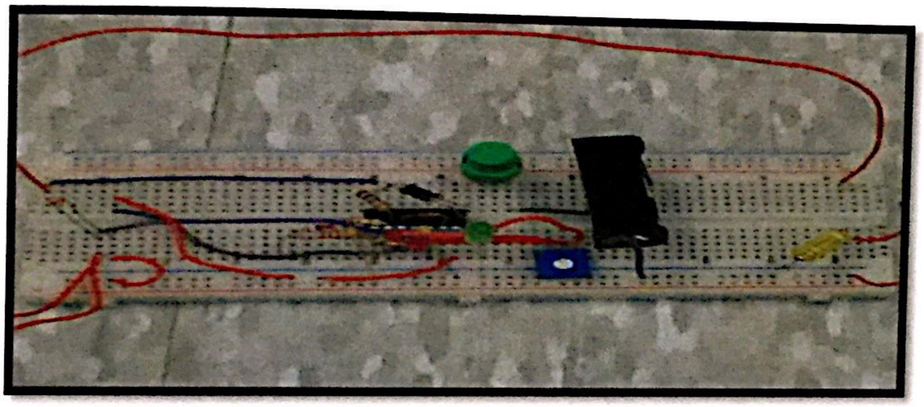


Figure 3.1: Breadboard

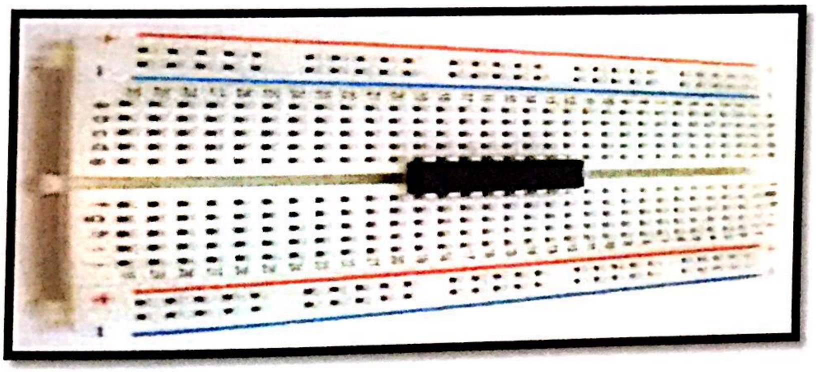


Figure 3.2: Breadboard with component

3.4.2 Inter digital Capacitor

The 74HC14 74HCT14 is a hex inverter with Schmitt-trigger inputs. This device features reduced input threshold levels to allow interfacing to TTL logic levels. Inputs also include clamp diodes, this enables the use of current limiting resistors to interface inputs to voltages in excess of VCC. Schmitt trigger inputs transform slowly changing input signals into sharply defined jitter-free output signals.

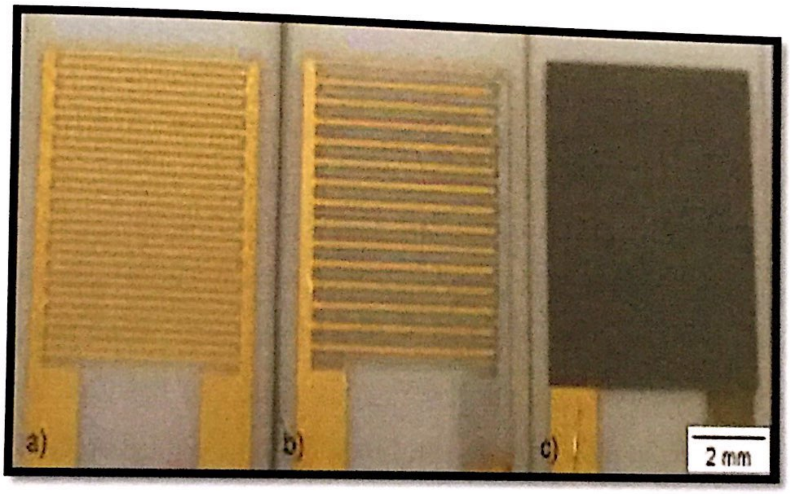


Figure 3.3: Inter digital sensor (IDC)

3.4.3 Capacitance Meter

This Digital Capacitance Meter give a direct reading of capacitance on a 3 1/2 digits LCD display. Nine ranges give precision readings from 0.1 pF to 20,000 uF, which includes virtually all capacitors used in electronic engineering labs, production, service shops, and schools. It can be used to check tolerance, sort values, select precision values, measure unmarked capacitors, and select matched sets, and measure cable, switch or PCB LAYOUT capacitance. Its battery operation, light weight, and small size make it a truly portable instrument.

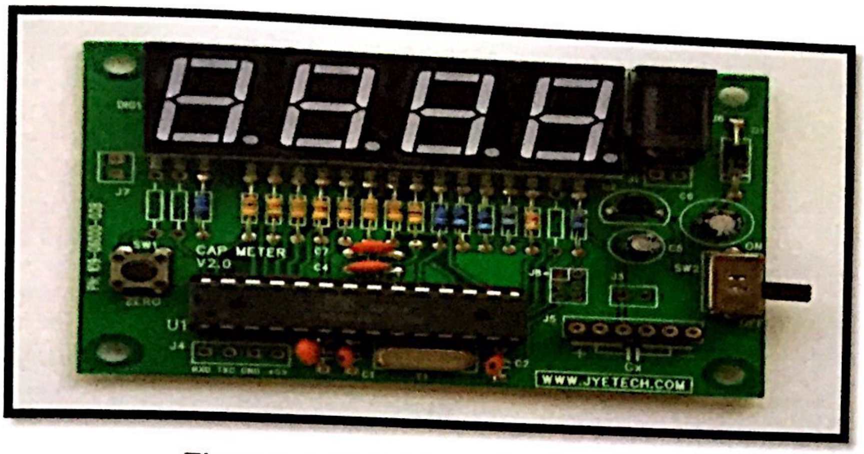


Figure 3.4: Digital Capacitance Meter

3.4.4 AVR Butterfly Microcontroller kit

The AVR Butterfly evaluation kit is designed to demonstrate the benefits and key features of the AVR microcontrollers. It is a stand alone microprocessor module that can be used in numerous applications, the AVR architecture in general and the AT mega169 in particular, low power design, the MLF package type peripherals.

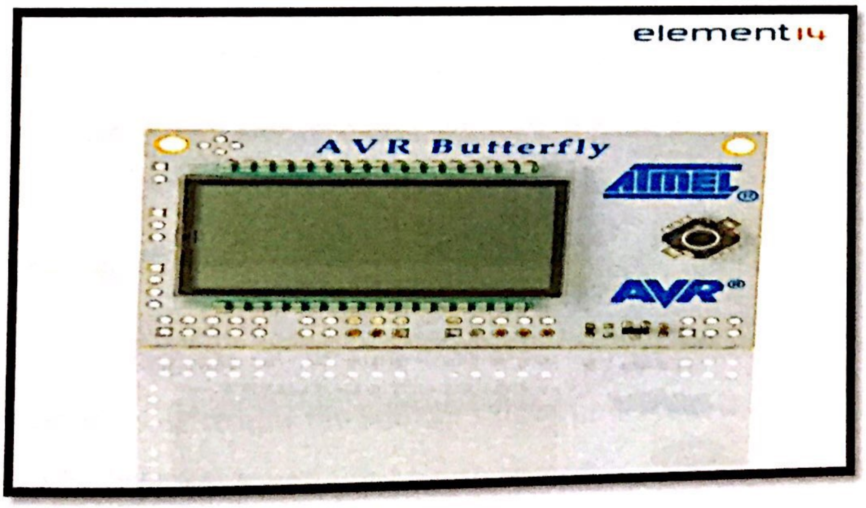


Figure 3.5: AVR Butterfly Kit

3.5 Block Diagram

The project can be viewed by breaking it into a few basic modules a transducer, capacitance measuring circuit, signal processor, microcontroller, and display. The transducer is the IDC, which converts the quantity of skin moisture into a proportional increase in capacitance. A circuit to measure this increase in capacitance is thus required. The circuit we use to measure the capacitance will have an output. The process signal can then be connected to a microcontroller to drive a display.

The display could be either a LED or LCD but this project an LCD screen is used because it was readily available. These modules combine to form a fully functional portable skin moisture sensor (capacitance method). The end result should be a device that reads skin moisture through skin contact with an IDC and the amount of moisture should appear as a voltage value on the LCD screen.

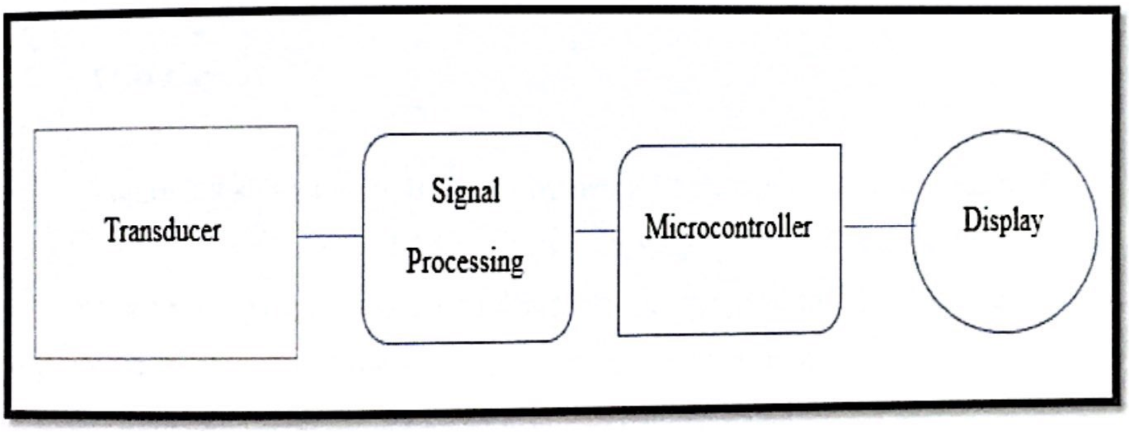


Figure 3.6: Block Diagram Hardware

3.6 Schematic Circuit

Figure 3.7 shows schematic circuit that used to design the digital skin moisture sensor in electronic circuit to determine the voltage value of moisture in skin of human. There is designed by Mitchell circuit and this circuit can used with analog voltmeter to measure capacitance. The circuit designed by Mitchell has an extra functionality by turning a knob on the circuit it can change the correspondence between capacitance and voltage. That means is that the 0 to 10 V scale can correspond to another scale of capacitance (i.e. 10 pF to 1 nF). The "test" LED is used only to indicate to the user when the circuit is being used. A 9 V battery is used and the battery life must be conserved, therefore a push button is used to connect the battery to the circuit only when it is in use. However, it is difficult for the user to hold the push button down while manipulating the transducer to make skin contact. Therefore, the push button in Mitchell's circuit is replaced with an on-off switch for convenience purpose.

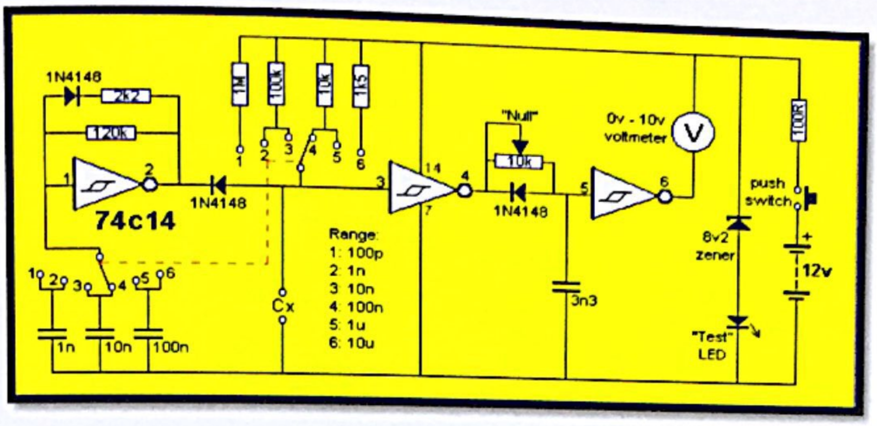


Figure 3.7: Schematic Circuits

3.7 PCB Layout

Figure 3.8 show the PCB layout by using Eagle capacitance schematic. For the output signal from pins 6 and 14 appears as a very messy DC signal. On an analog voltmeter a zero test capacitance would correctly correspond to 0 V but microcontroller may not have as easy a time reading the messy signal as zero. By adding a 15 pF capacitor in parallel with the IDC this problem can be avoided.

The IDC has a capacitance value of only 2.3 pF and one can expect that the capacitance will only increase to maybe 6 pF greater than that value when pressed against human skin. The small increase means that the full 100 pF range of the measuring circuit will not be used. Therefore, the addition of the 15 pF capacitor does not limit the maximum measurement that can be taken with the skin moisture sensor.

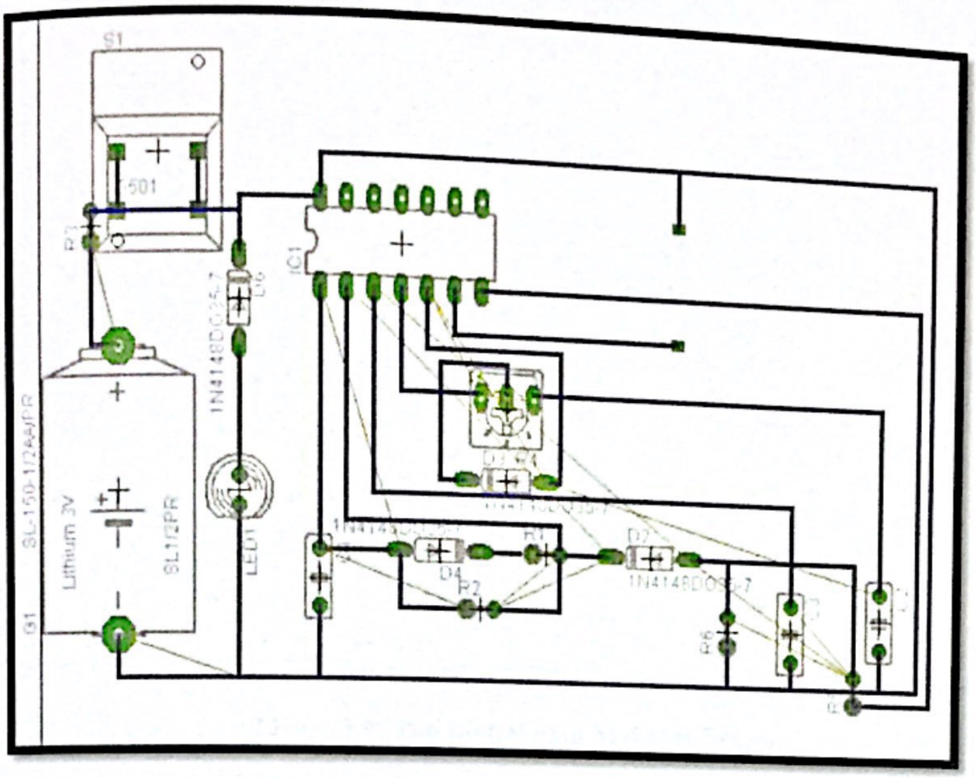


Figure 3.8: PCB Layout

3.8 Hardware Design

Figure 3.9 shows the completed of this project which is the Digital Skin Moisture Sensor. This hardware include capacitive sensor which is used to transmit the moisture of part skin from the human, sensor that is used to detect voltage value of skin moisture then the capacitive circuit to greatly recognize the skin either moist or dry.

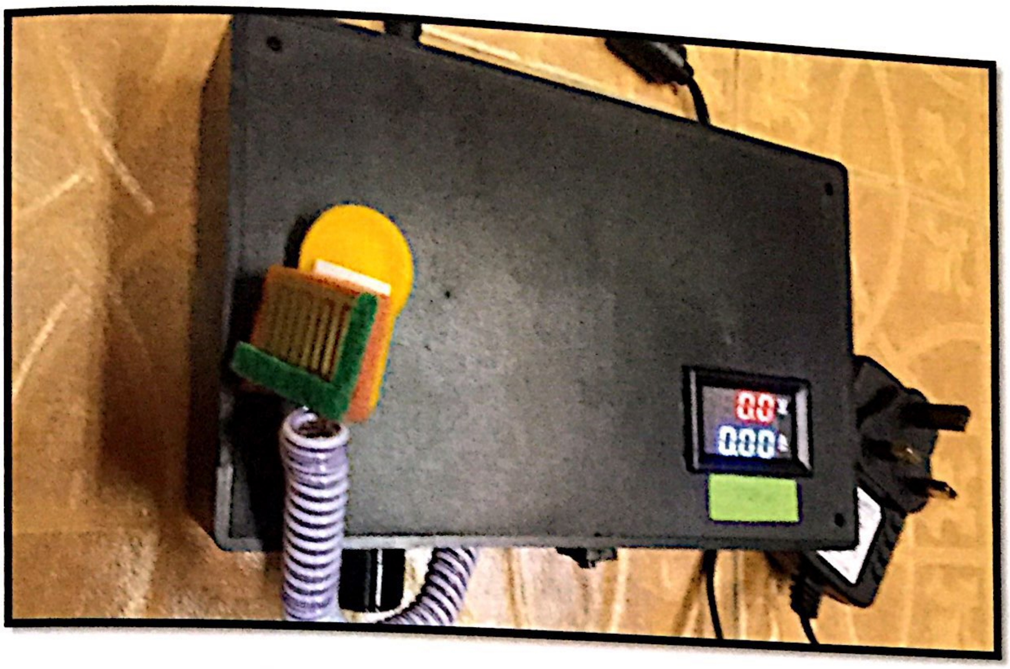


Figure 3.9: The Digital Skin Moisture Sensor

3.9 Project Testing

After the hardware is done, the Digital Skin Moisture Sensor was test on subjects. Project testing was being test to 27 persons of random subject that were from the population of Premier Polytechnic of Sultan Salahuddin Abdul Aziz Shah, Shah Alam student.

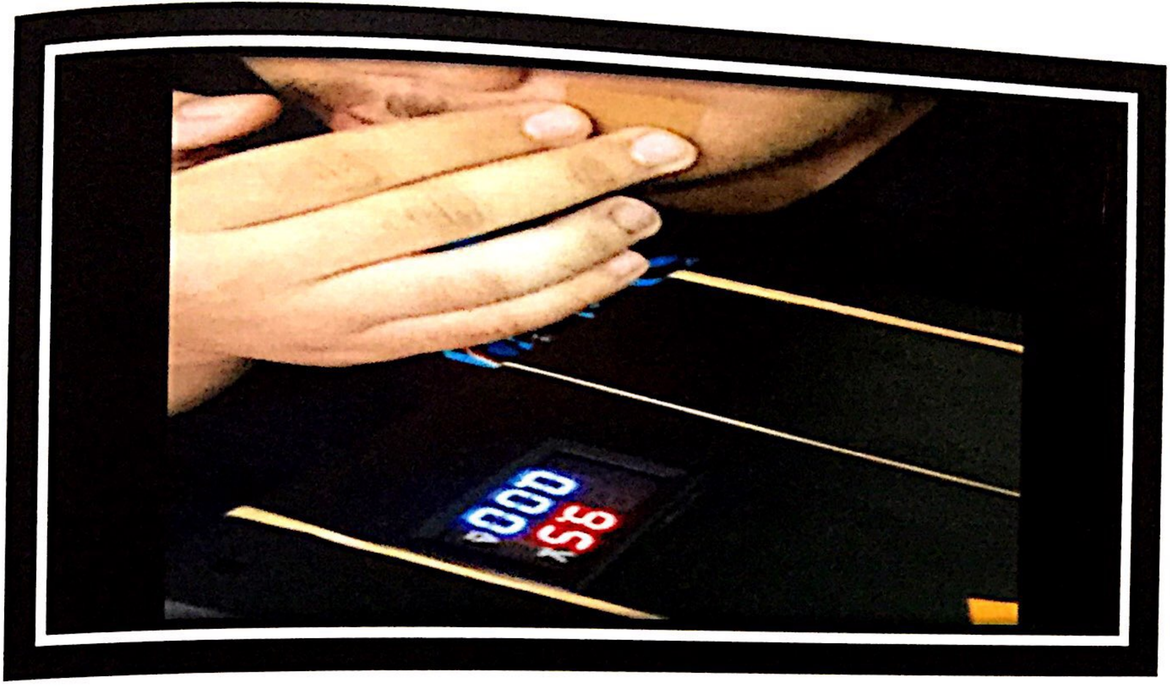


Figure 3.10: Project Testing

Figure 3.10 show the project testing focusing on students of Electrical Department. Purpose of project testing is to ensure the device is functioning and working in good and safe aspect.

CHAPTER 4

RESULT AND ANALYSIS

4.1 Introduction

This chapter constitutes the results from the data gathered. The findings presented here were based on project testing. This chapter only focused to the most data collection. The data were collected at Polytechnic Sultan Salahuddin Abdul Aziz Shah. Data Project testing is done by tested the Digital Skin Moisture Sensor on 27 random subjects. The data evaluation determination collecting data to the 27 student of Degree In Technology Engineering Electronic (Medical) With Honours, in Polytechnic Sultan Salahuddin Abdul Aziz Shah. The result was show as table and that are 6 part region of human body. Then should classified to each of the part region on human body and do the bar chart to recognize the voltage value for each part region.

4.2 Result of Technical Testing

Region	Part	Subjects(voltage)											
		1	2	3	4	5	6	7	8	9	10	11	12
Hand	Right	7.7	4.5	4.5	6.7	7.8	4.5	5.9	6.6	6.6	5.7	7.2	6.7
	Left	7.5	5.0	5.0	6.2	7.6	6.5	5.0	7.8	5.8	7.8	6.7	7.0
Wrist	Right	7.4	5.0	6.0	5.3	5.9	6.7	6.8	5.7	7.0	5.7	7.7	6.7
	Left	8.0	5.2	5.7	5.6	7.0	5.5	7.8	7.8	7.9	6.2	6.9	5.8
Cheek	Right	7.7	7.0	7.0	7.7	7.8	7.3	7.6	7.5	7.3	7.8	7.8	7.7
	Left	7.9	7.8	7.8	7.5	7.7	6.8	7.7	7.9	7.0	7.7	7.4	7.2
Backside of palm	Right Left	5.6 6.7	6.7 7.8	5.5 6.6	5.7 4.5	7.0 6.6	7.7 6.5	5.0 6.2	7.1 6.3	6.7 7.8	6.2 7.2	5.1 7.5	6.5 6.4
Forehead	Centre	4.5	5.6	5.3	6.0	5.4	4.9	6.1	4.8	3.9	6.2	6.7	5.7
Below eyes	Right Left	7.2 7.8	6.7 7.2	6.2 7.8	7.3 6.9	7.8 5.6	7.8 7.9	7.2 6.9	7.8 7.5	7.8 7.6	7.1 7.2	7.3 6.6	6.8 7.8
Average(voltage)		12.9	11.4	11.2	11.6	12.7	11.7	12.0	12.7	12.6	12.5	12.8	12.4

Table 4.1: Data for male

4.2.1 Test on male moisture part

The table 4.1 shows the tested data for skin moisture to determine the voltage reading from capacitance meter are display from LED. From the result, can conclude to justify the level of skin moisture from the 6 part region of the body. It have 12 subject of male.

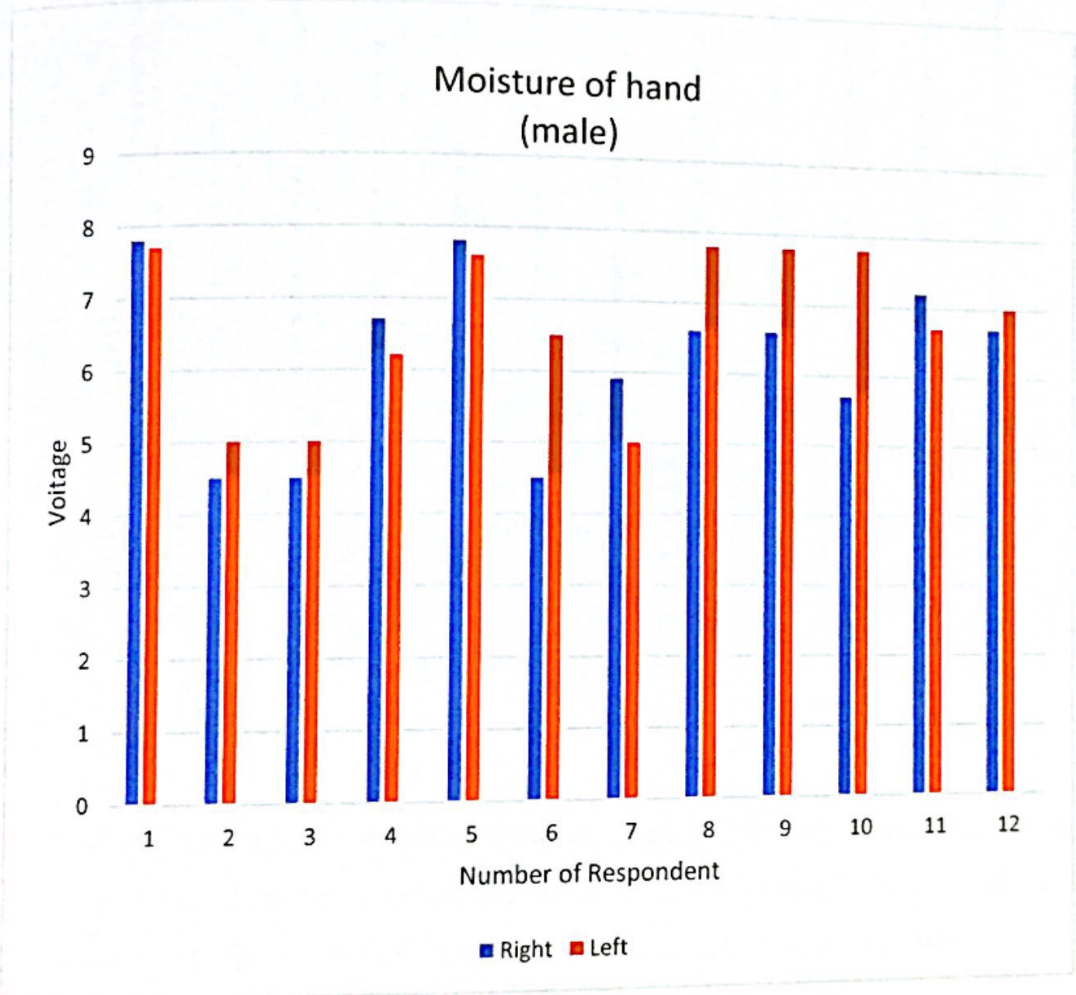


Figure 4.1: Graph of Moisture (hand)

From the figure 4.1, that shows the graph of moisture at hand. The observation of moisture contained in the hands of relatively high because the surface of the palms are less susceptible to surrounding conditions. This causes frequent perspiration and quite humid. There are different between moisture between left and right hand.

Figure 4.2: Graph of Moisture (wrist)

From the figure 4.2, that show the graph of moisture at wrist. From that, the number of respirations is divided as exposed to relatively high ambient temperature. There have different moisture between right and left wrist.

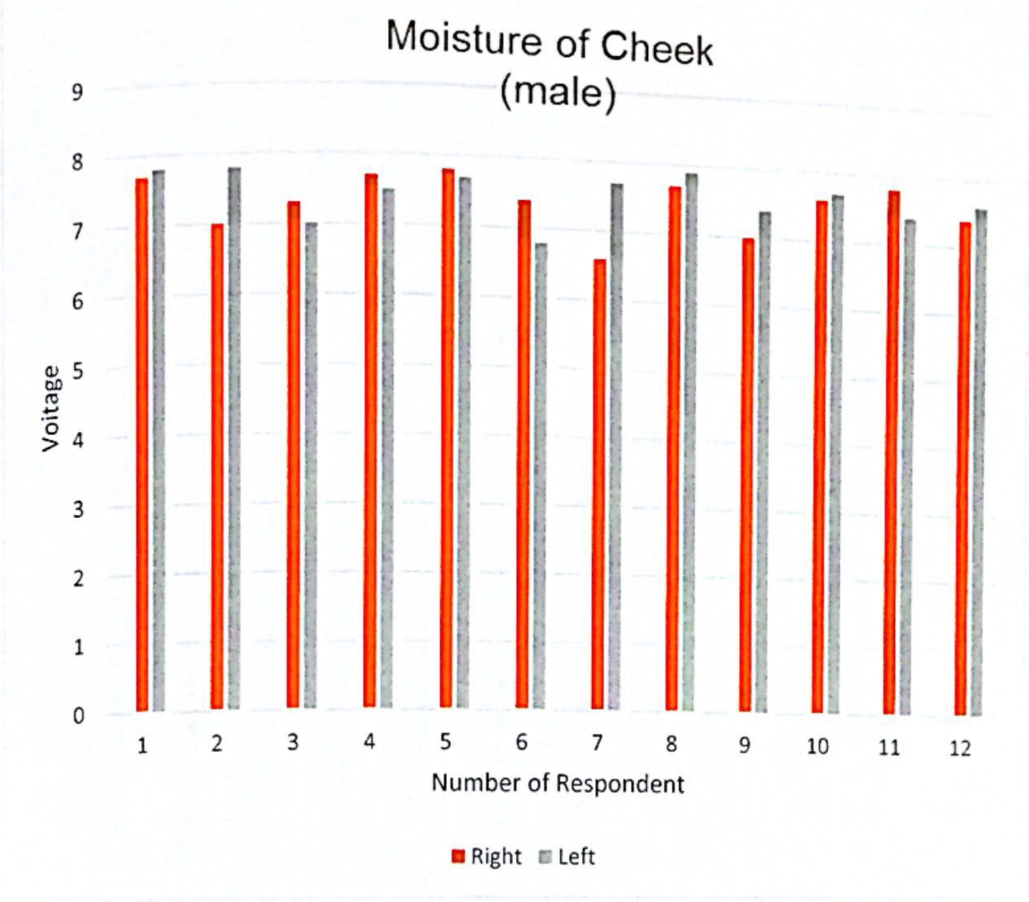


Figure 4.3: Moisture (cheek)

From the figure 4.3, the moisture level at cheek, between the cheek is shown alongside the humidity level is high because the area is exposed to ambient temperature and having a relatively high perspiration. There have different between left and right part of cheek.

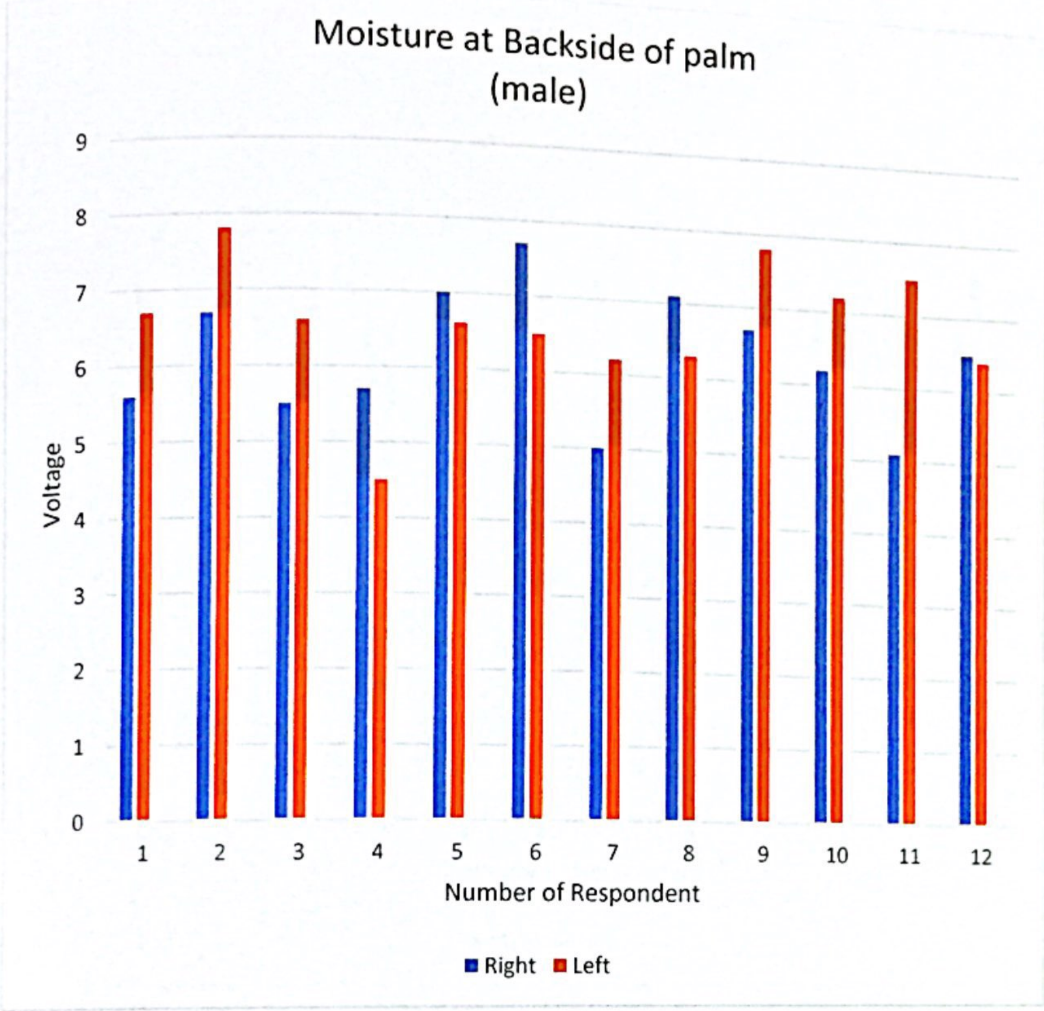


Figure 4.4: Graph of Moisture (Backside of palm)

From the observation of figure 4.4, the humidity level is not as high as the thinner skin. Each objects need to be rubbed with alcohol swap to get the humidity reading.

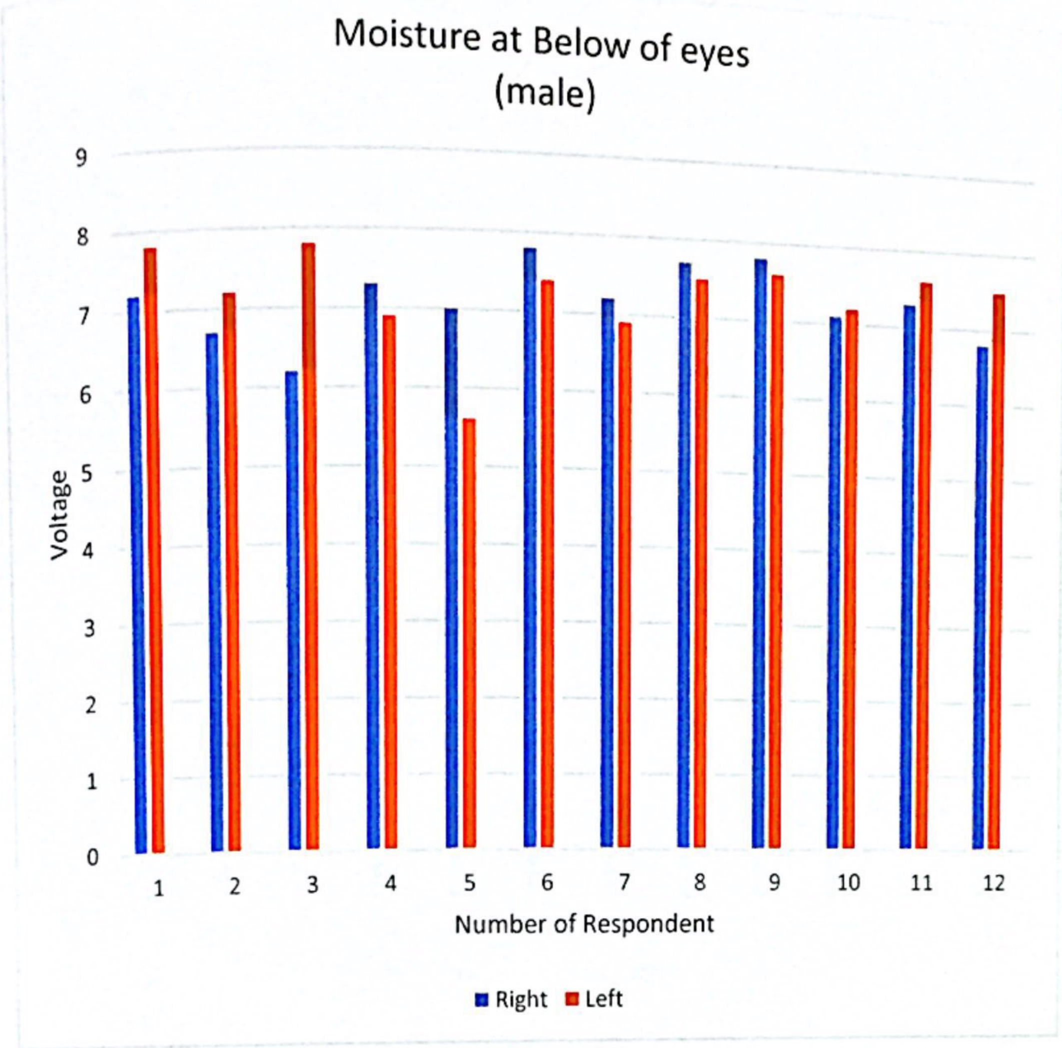


Figure 4.5: Graph of Moisture (Below of eyes)

Based on figure 4.5, that shows the graph moisture on the below of eyes. From that, the moisture respondent are very higher on this part region. This part are freely from air and can produce many humid.

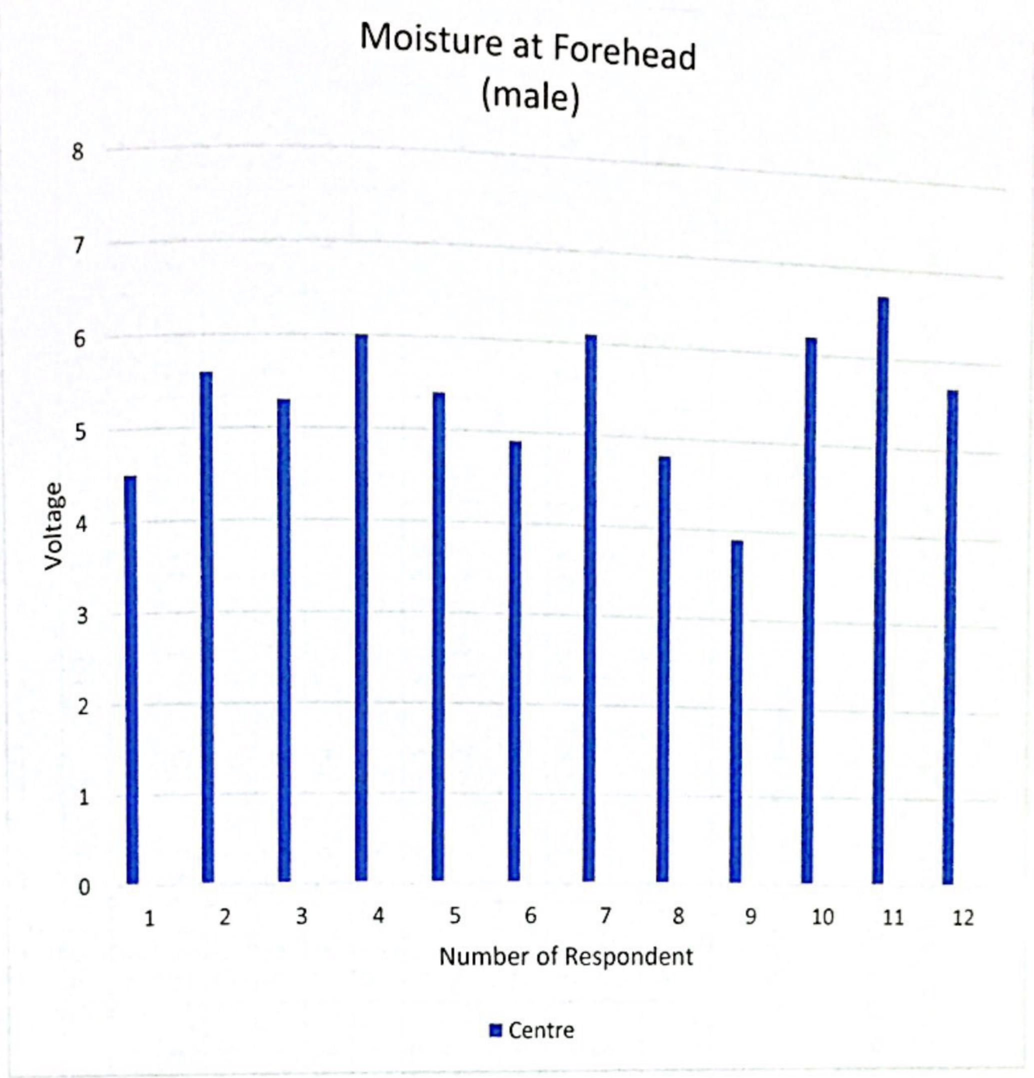


Figure 4.6: Graph of Moisture (Forehead)

From the figure 4.6, that shows the graph of moisture on the forehead. Have some object get the reading below 5V and that state for dry condition.

4.2.2 Test on female moisture part

Region	Part	Subjects(voltage)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hand	Right	4.0	1.8	1.4	5.3	5.6	7.6	3.1	6.5	6.9	4.5	5.6	5.7	3.4	5.7	6.6
	Left	2.0	2.0	2.5	6.4	5.0	2.4	4.6	4.6	2.5	6.1	4.9	7.8	7.7	4.5	5.4
Wrist	Right	3.4	3.7	5.3	7.9	2.2	7.6	7.8	5.4	6.9	3.2	2.4	4.6	5.4	7.0	6.6
	Left	3.8	7.8	5.2	7.8	2.1	7.8	3.4	3.5	4.1	7.0	7.8	7.8	7.0	4.5	6.9
Cheek	Right	7.7	7.2	7.5	7.3	7.6	7.1	7.5	7.4	7.4	7.5	7.0	7.6	7.5	7.0	7.4
	Left	7.5	7.4	7.1	7.2	7.2	7.0	7.3	7.4	7.3	7.2	7.5	7.5	7.0	7.4	6.7
Backside of palm	Right Left	3.4 6.6	4.4 7.8	5.4 7.8	4.5 4.9	5.1 7.8	7.7 2.4	5.7 5.2	3.5 5.7	5.1 4.7	6.9 4.1	7.8 4.5	7.8 5.6	4.3 5.1	4.1 5.6	5.6 6.0
Forehead	Centre	5.8	5.5	3.4	7.7	5.3	9.8	4.0	5.6	5.0	7.8	5.6	7.7	6.2	4.5	7.1
Below eyes	Right Left	2.3 7.8	3.9 7.0	7.8 6.7	5.8 7.8	3.7 7.3	3.5 7.8	3.5 6.9	4.3 7.2	5.8 6.3	3.7 5.9	4.5 7.8	7.8 4.3	7.7 7.1	6.7 7.2	6.4 6.8
Average(voltage)		9.1	9.8	10.0	12.1	9.8	11.8	9.8	10.2	10.3	10.7	10.9	11.1	11.4	10.7	11.9

Table 4.2 Data for female

The table 4.2 shows the collecting data for skin moisture to determine the voltage reading from capacitance meter are display from LED. From the result, can conclude to justify the level of skin moisture from the 6 part region of the body. It have 15 subject of female.

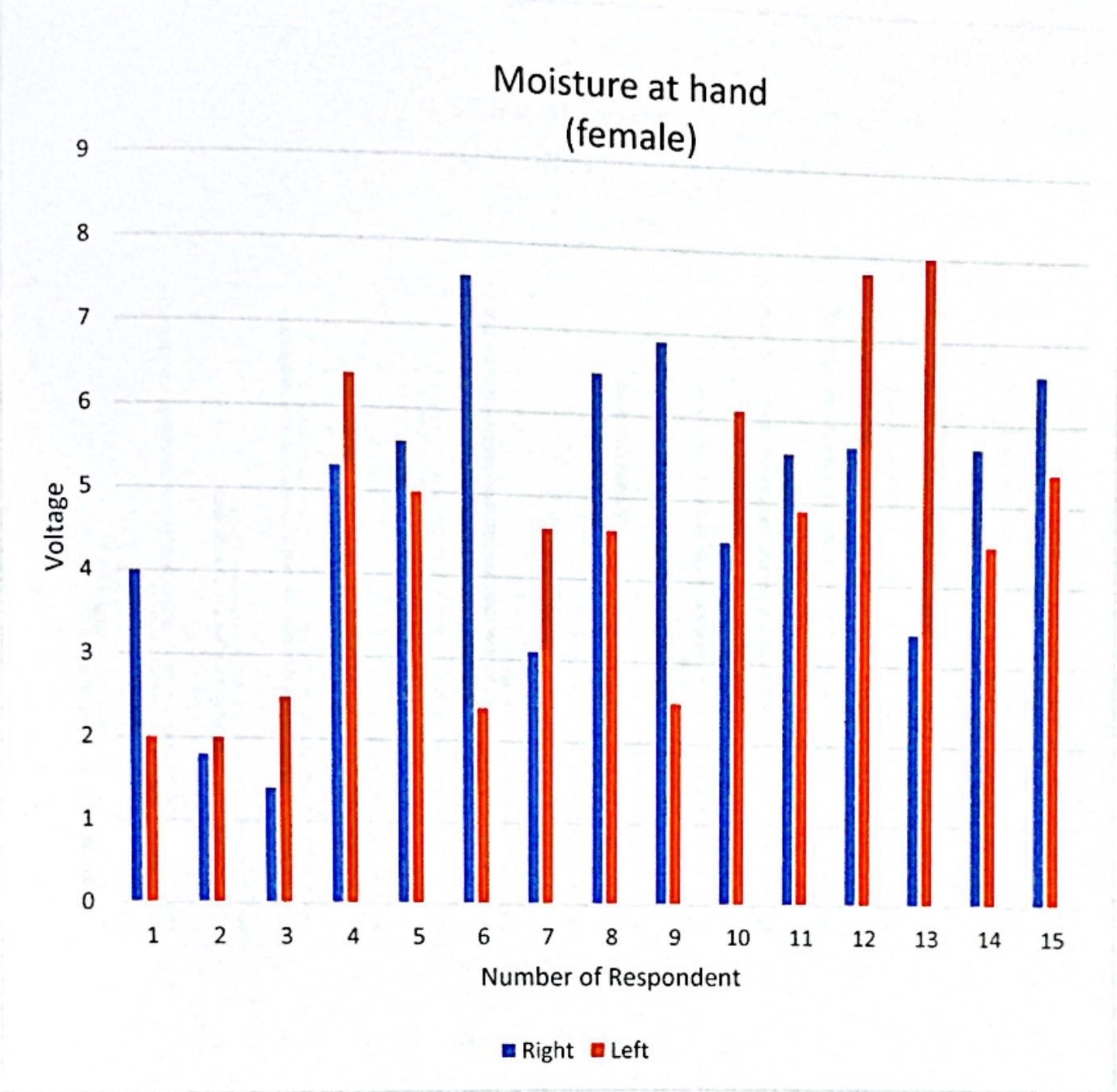


Figure 4.7: Graph of Moisture (hand)

Based on the figure 4.7, that shows the graph of moisture for female on their hand. Have 3 subject get dry reading which is below then 5V.

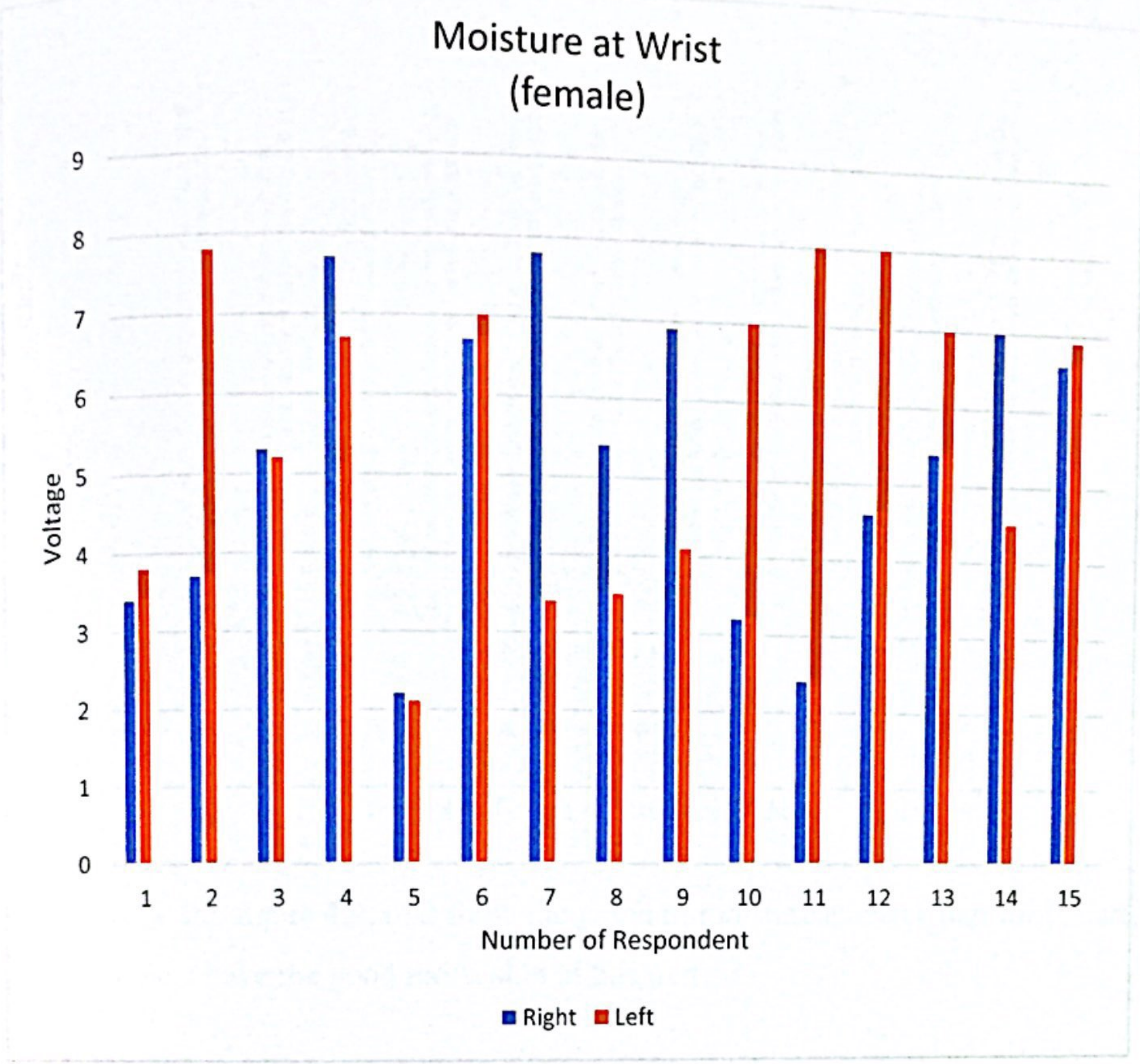


Figure 4.8: Graph of Moisture (Wrist)

Based on the figure 4.9, that show the moisture of wrist for female. From the observation, the wet skin because the subject usually use watch on the wrist.

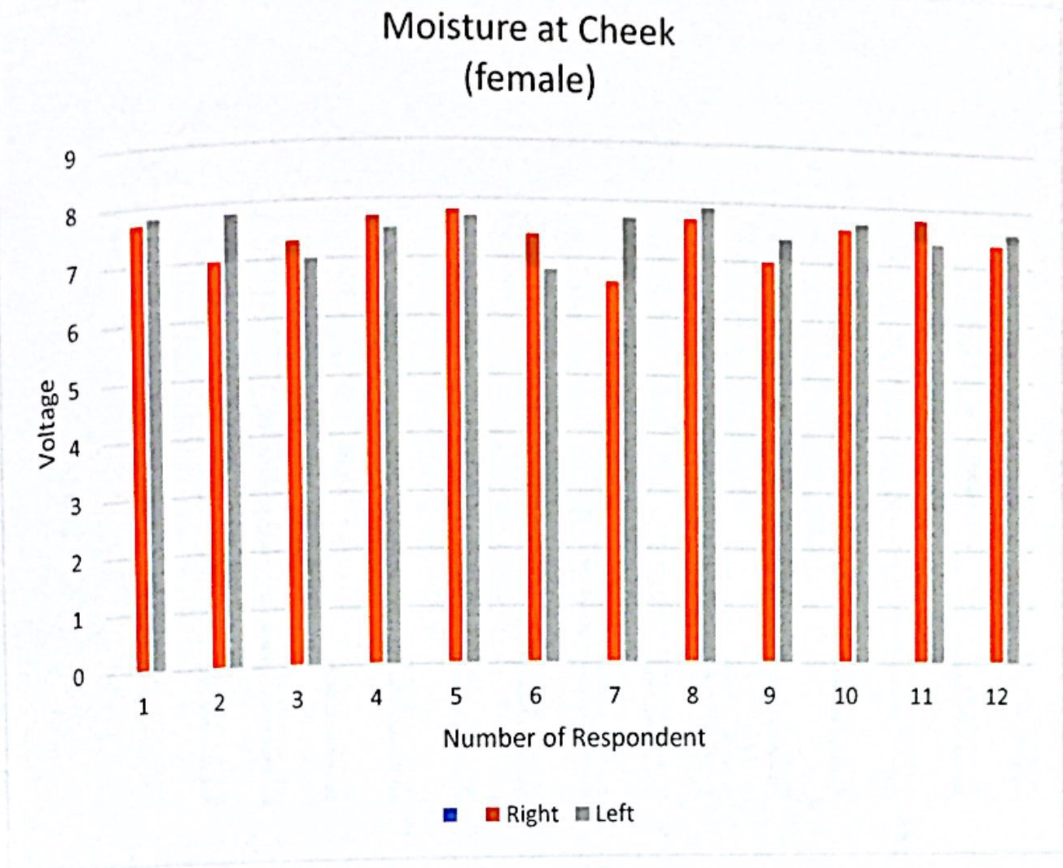


Figure 4.9: Graph of Moisture (Cheek)

Based on the figure 4.9, that show the graph of moisture at cheek part for female. All the subject have the good moist skin at this part.

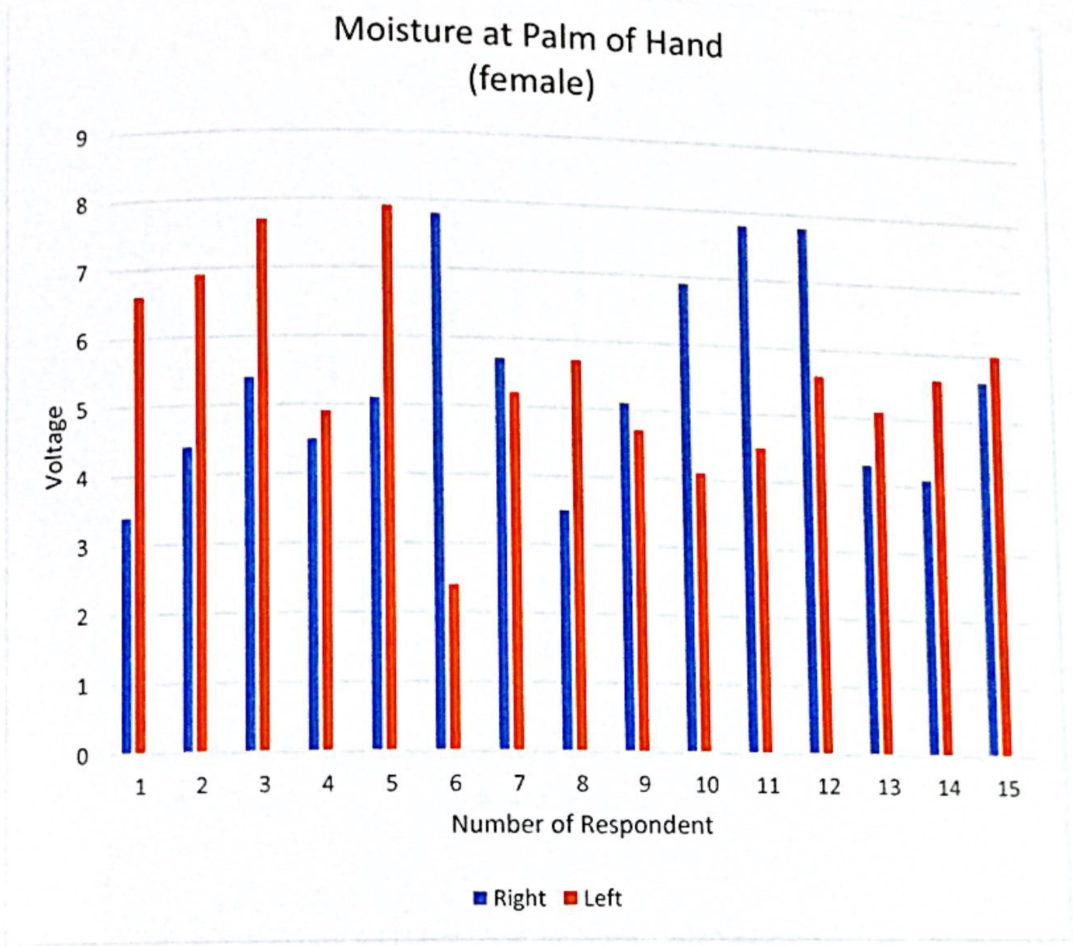


Figure 4.10: Graph of Moisture (Palm of hand)

Based on the figure 4.10, that shows the graph of moisture at region palm of hand for female. The respondent from this part there are differences between them that are put on moisturizer cream on it.

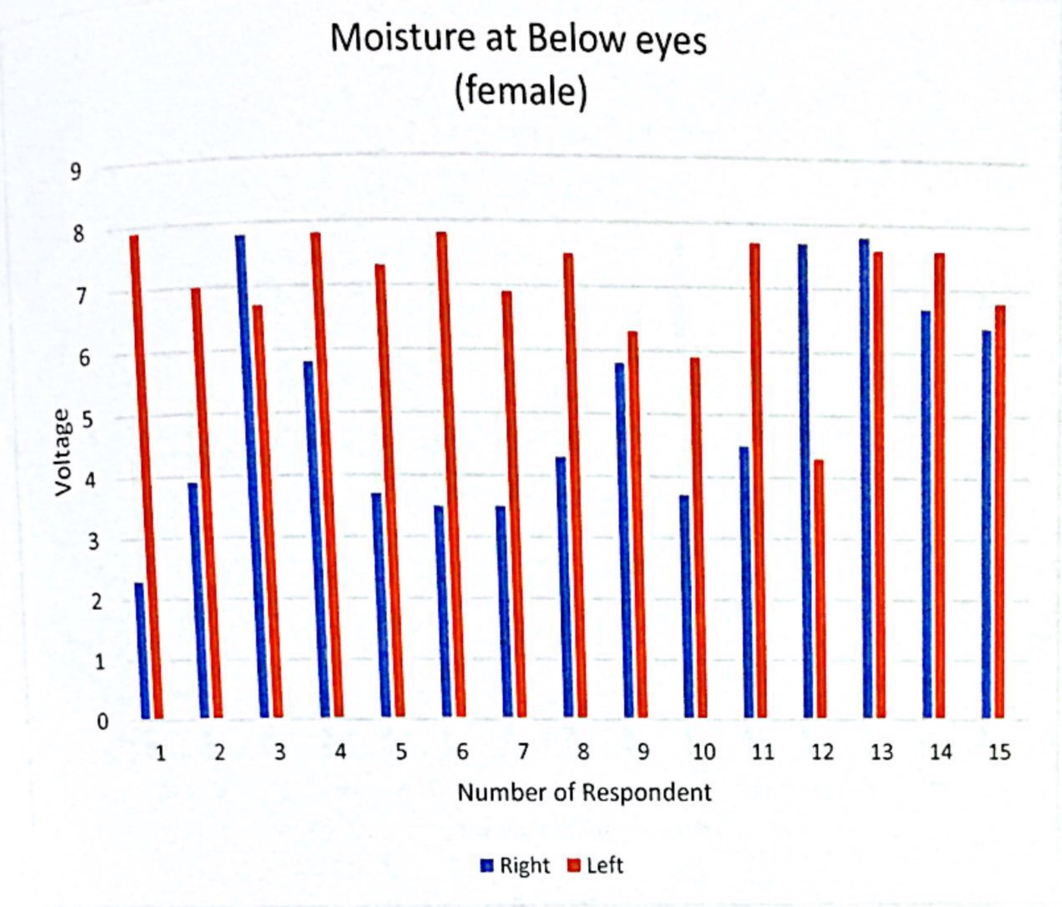


Figure 4.11: Graph of Moisture (below of eyes)

Based on the figure 4.11, that shows the graph of moisture on the below of eyes of female. It is difference against male, based on figure 4.5, for male the moisture reading between left and right not much different.

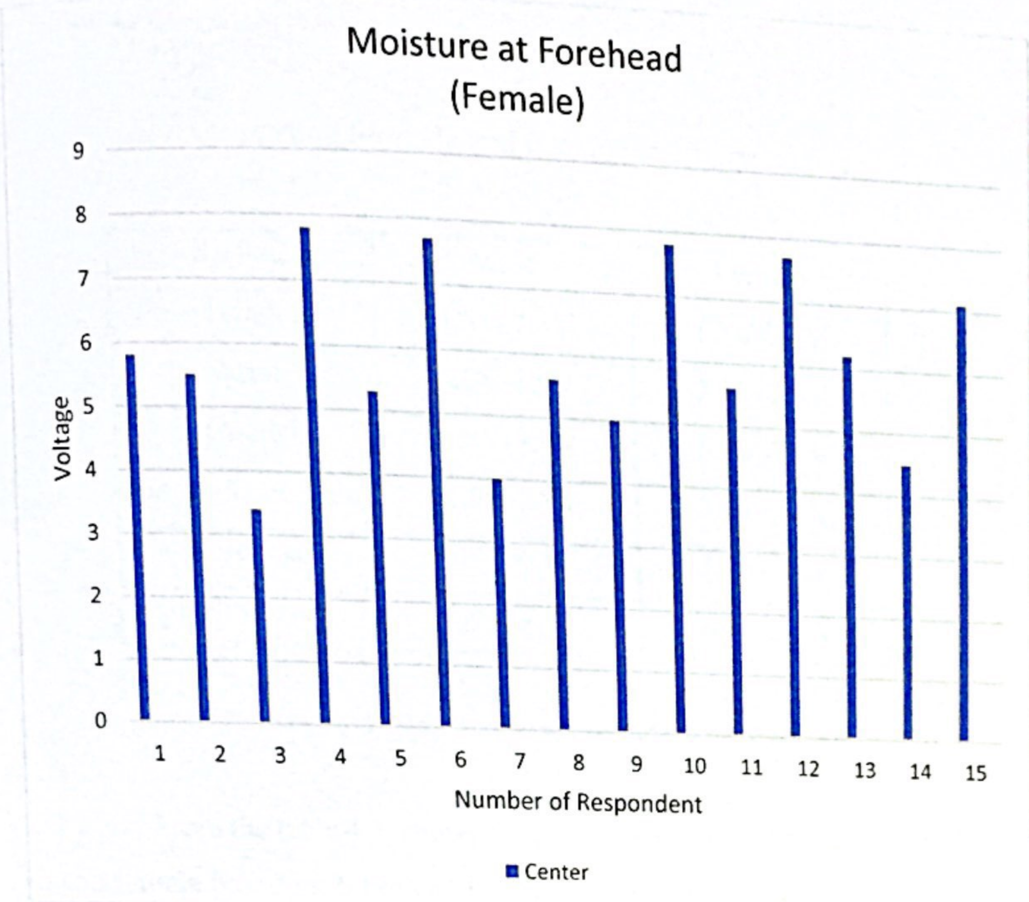


Figure 4.12: Graph of Moisture (Forehead)

Based on figure 4.12, that shows the graph of moisture on the forehead for female. Have 2 subject get reading below than 5V. The observations of those who have lower reading than 5V, they suffer from dry skin and less healthy so can cause pimple in this area.

4.3 Summary

Average reading for male and female for difference 6 region

Region	Male	Female
Hand	4.5V-7.8V	1.5V-7.8V
Wrist	5.0V-8.0V	2.1V-7.9V
Cheek	6.8V-7.9V	6.7V-7.7V
Backside of palm	4.5V-7.8V	3.4V-7.8V
Forehead	3.9V-6.0V	3.4V-7.8V
Below eyes	6.6V-7.9V	2.3V-7.8V

Table 4.3: Average reading of moisture skin

From the table 4.3, showed the average reading of moisture skin for male and female based on 6 region. The range of dry 1-2 voltage are more dry skin. Then 3-5 voltage that are in normal range. For the moist skin range in 6-8 voltage.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This chapter discusses the conclusion of the study, the result and analysis of the project. Suggestion for improvement project in the future were also discussed to produce a project that is suitable for users.

5.1 Conclusion

As a conclusion, the digital skin moisture sensor are help person to identify the value of moisture on their skin. The reading for moist are more than 5V and for dry less than 5V. It is easier because this device can read for moist or dry skin situation can be held for those who want to want to maintain healthy skin. This device is convenience for user to perform check the skin moisture at home. Besides that, a proof of concept for the device is achieved through the completion of a fully functioning moisture sensor.

The second objective is to design the circuit of sensor of skin moisture because this device is more effective than the other product. Besides that, the special sensors are used for this tool is the digital inter capacitor.

A usability test was done, 27 normal subjects was used to measure and tested the circuit of skin moisture. During this test, the device was tested on the willingly of the 27 subjects, Once the testing was done, the data will be analysis by using Microsoft Excel. And the result finding that, the developed device is comfortable to be used.

5.2 Recommendation

From this device, it can threshold for suitable multi range of skin type such as dry, normal and moist. After that, this device can be used safely also suitable for all ages. Thus, new solution to the moisture problem by offering continuous monitoring of skin condition.

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VERIFICATION CERTIFICATE

Issued Date : 11 May 2017

Verification Date : 11 May 2017

Issued To : **Nor Azman Bin Abdul Mohamed**
Bachelor of Electronic Engineering
(Medical Electronic),
Department of Electrical Engineering,
Politeknik Sultan Salahuddin Abdul Aziz Shah

Requested Verification Due Date : N/A

Instrument : Skin Moisture Sensor

Model No. : N/A

Manufacturer : N/A

Serial No. : N/A

Condition Received : Good physical condition.

Condition Returned : Planned Preventive Maintenance (PPM) has been performed in accordance to the checklist and the equipment is functioning to the intended purpose.

Reference (s) : IEC 60601 standard requirements.

Result (s) : As per attachment:-
i) Planned Preventive Maintenance Checklist (BMCL/PPM/CHECKLIST.30)

Verified by:

Ramli Bin Jiman
Technical Head

SKIN MOISTURE SENSOR

(Estimated Time: 60 minutes)

EQUIPMENT INFORMATION

Job No:	N/A	Customer:	Nor Azman B. Abdul Mohamed
Manufacturer:	N/A	Model:	N/A
Serial No:	N/A	Location:	N/A
Frequency:	6 monthly ☐ 12 monthly ☐		

TEST INFORMATION

Test equipment needed: Electrical Safety Analyzer

		Measured Value	Pass	Fail	Not Applicable
PHYSICAL CONDITION					
Device is clean and decontaminated			√		
No physical damage to case, display, mounts, cart or components			√		
Switches and controls operable and correctly aligned			√		
Display intensity adequate for daytime use			√		
Control numbers, labelling and warnings present and legible			√		
Inlets and hoses					√
Power cord, accesory cables, charger			√		
Filters and vents clean					√
ELECTRICAL SAFETY					
Ground wire resistance	< 0.3 Ω				√
Chassis Leakage	< 100 µA NC	0.4 µA	√		
	< 500 µA SFC	0.4 µA	√		
Patient Leakage Current	< 100 µA B and BF	1.1 µA	√		
	< 10 µA CF				√
Patient lead leakage current - isolation test	< 1000 µA BF	102.3 µA	√		
(mains on patient applied part)	< 10 µA CF				√
Insulation test (optional) 500 V	< 2 MΩ				√
PREVENTIVE MAINTENANCE					
Replace battery every 24 months					√
Verify proper time and date, correct if necessary					√
Complete model-specific preventive maintenance					√
PERFORMANCE TESTING					
Verify unit operates on battery			√		
Verify sensor function			√		
Complete model-specific performance testing					√

REMARK

1. Attachment: NA_20170511_120113_P for Electrical Safety report (page 1 to 2).

2. PPM has been performed in accordance to the checklist and the equipment is functioning to the intended purpose.

COMPLETED BY: [signature]

DATE: 11-May-17
NEXT PPM DATE: N/A

LIYANA BINTI MAHMUD
CALIBRATION ENGINEER
Centre for Medical Electronic Technology
Politeknik Sultan Salahuddin Abdul Aziz Shah

CMET PSA

File: NA_20170511_120113_P.txt
Date: 2017 May 11
Time: 12:01:13
vPad-ES: VPS14120165

Equipment Information...

Control Number:	NA
Description:	Skin Moisture Sensor
Manufacturer:	N/A
Model:	N/A
Serial Number:	N/A
Location:	N/A
Facility:	CMET

Technician ID: Liyana
Tech Time (hrs): 1

Overall Result: PASS

Signature: LIYANA BINTI MAHMUD
CALIBRATION ENGINEER
Centre for Medical Electronic Technology
Politeknik Sultan Salahuddin Abdul Aziz Shah
Date: 11 May 2017.

Detailed Test Data...

AutoSequence Filename: vpad_as_39.asq
Title of AutoSequence: IEC60601 Class 2
AutoSequence Run Time: 3 minutes

Elec. Safety Standard: IEC60601
Chassis Leakage Limits: Maximum 100 µA NC; 500 µA SFC
Lead Leakage Limit (BF): Maximum 100 µA NC; 500 µA SFC; 5000 µA MAP

Line Voltage L1-L2: 228.5 V
Line Voltage L1-GND: 228.4 V
Line Voltage L2-GND: 1.2 V
EUT power switch "ON"...

Chassis Leakage (POL-R;NEU-O;GND-N):	0.4 µA	PASS
Lead-GND LA/AP1 (POL-R;NEU-O;GND-N):	1.0 µA	PASS
Chassis Leakage (POL-R;NEU-N;GND-O):	0.0 µA	PASS
Lead-GND LA/AP1 (POL-R;NEU-N;GND-O):	0.7 µA	PASS
Chassis Leakage (POL-R;NEU-N;GND-N):	0.0 µA	PASS
Lead-GND LA/AP1 (POL-R;NEU-N;GND-N):	0.6 µA	PASS
Iso Test LA/AP1 (POL-R;NEU-N;GND-N):	2.0 µA	PASS
Chassis Leakage (POL-N;NEU-O;GND-N):	0.4 µA	PASS
Lead-GND LA/AP1 (POL-N;NEU-O;GND-N):	1.2 µA	PASS
Chassis Leakage (POL-N;NEU-N;GND-O):	0.4 µA	PASS
Lead-GND LA/AP1 (POL-N;NEU-N;GND-O):	101.7 µA	PASS