BLOOD GLUCOSE DETECTION USING GSR SENSOR

NURUL NADIAH BINTI BORHANNODIN

This report is submitted in partial fulfillment of the requirements for the Bachelor of Electronic Engineering (Industrial Electronics)

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Sesi Pengajian : 1 5 / 1 6

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Signature : .....

Supervisor's Name : DR. WIRA HIDAYAT BIN MOHD SAAD

Date : 15 JUNE 2016

DEDICATION

Special dedicated to beloved parents and siblings who have a lot of support to complete the study. May all appreciate the sacrifice you are rewarded by Allah SWT.

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"In the name of Allah, the most Gracious, most Powerful, and the most Merciful"

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Thank you.

ABSTRACT

The galvanic skin response (GSR) is the skin conductance, which influenced by a variety of factor, though the most important to be moisture. A low-level electric voltage will apply to the skin and the skin's conduction is measured. Skin conductance is considered to be a function of the sweat gland activity and the skin's pore size. The project is developed based on the polygraph test where the small amount of sweat released will make the GSR sensor reactive due to the change in conductance. The purpose of this project is to detect the blood glucose by using the GSR sensor and to establish a correlation between GSR and the blood glucose level. This project was divided into two parts, which are the hardware implementation and software implementation. For the hardware implementation, it is between the GSR sensor and human skin conductance which to detect the glucose level which contains in sweats. While for software implementation, the Arduino program is developed to collect and save the user data. Based on the analysis of data and the linear value, it can conclude that there is a correlation between the skin response and blood glucose level. The correlation between blood glucose and GSR is R^2= 0.7342. This linear equation can be used to predict the value of blood glucose based on the GSR voltage value which had been measured.

ABSTRAK

Tindak balas Galvanik Kulit (GSR) adalah kekonduksian kulit yang dipengaruhi oleh pelbagai faktor, dimana faktor yang paling penting adalah kelembapan. Voltan elektrik tahap rendah akan diaplikasikan kepada kulit dan kekonduksian kulit diukur. Kekonduksian kulit merupakan salah satu daripada fungsi aktiviti kelenjar peluh dan saiz liang-liang kulit. Projek ini dibangunkan berdasarkan hasil ujian poligraf dimana jumlah pengeluaran peluh yang kecil akan mengaktifkan sensor GSR bergantung kepada perubahan dalam kekonduksian. Tujuan projek ini adalah untuk mengesan tahap kepekatan glukosa darah dengan menggunakan sensor GSR dan membuat korelasi diantara GSR dan tahap kepekatan glukosa darah. Projek ini telah dibahagikan kepada dua bahagian, iaitu pelaksanaan perkakasan dan pelaksanaan perisian. Pelaksanaan perkakasan adalah antara sensor GSR dan kekonduksian kulit manusia dimana ianya mengesan tahap glukosa yang terkandung dalam peluh. Manakala bagi pelaksanaan perisian, program Arduino digunakan untuk mengumpul dan menyimpan data pengguna. Berdasarkan analisis data dan nilai linear, kesimpulan dapat dibuat bahawa terdapat hubungan antara tindak balas kulit dan tahap glukosa darah. Terdapat korelasi diantara glukosa darah dan juga GSR secara linear dengan nilai R^2=0.7342. Persamaan linear ini boleh digunakan untuk menjangka nilai kepekatan glukosa dalam darah berdasarkan nilai voltan GSR yang diukur.

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LIST OF ABBREVIATIONS

GND	-	Ground
GSR	-	Galvanic Skin Response
LCD	-	Liquid Crystal Liquid
NIR	-	Near Infrared
PC	-	Personal Computer
RC	-	Resistor-capacitor
SC	-	Stratum Comeum
USB	-	Universal Serial Bus

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CHAPTER I

INTRODUCTION

1.1 Project Introduction

The galvanic skin response (GSR) is the skin conductance, which influenced by a variety of factor, though the most important to be moisture. A low-level electric voltage will apply to the skin and the skin's conduction is measured. Skin conductance is considered to be a function of the sweat gland activity and the skin's pore size. The project will be developed based on the polygraph test which the small amount of sweat released will make the GSR sensor reactive due to the change in conductance. The purpose of this project is to detect the blood glucose by using the GSR sensor and to establish a correlation between GSR and the blood glucose level.

1.2 Problem Statement

Over the year 2014, about 2.6 millions of people diagnosed with diabetes in Malaysia. Many of these people are forced to draw blood every day in order to determine their blood glucose level. This information is vital in order to maintain insulin levels via injection. This entire process is painful and some people scared to undergoes the blood glucose test for the first time. This project is a way to overcome the issue by finding the correlation between the blood sugar level and the phenomenon known as the Galvanic Skin Response (GSR), which measures the conductivity of one's skin.

1.3 Objective of Project

The aim of this project is to design the blood glucose detector using GSR Sensor. In order to achieve that, the objectives have been set for the research. The objectives are:

1. To investigate the dielectric properties of the skin and parameter that relevance to blood glucose detection.
2. To build a device that can detect blood glucose level by obtaining physiological signal (sweat).
3. To interface the GSR sensor with Arduino program.

1.4 Scope of Project

The scope of this project is to design and develop the detection of blood glucose level by using GSR. This system is develop using Arduino board and will be tested by using the GSR sensor. The GSR data will compare with the blood glucose level which tested using the normal glucometer (strip).

1.5 Chapter Review

In Chapter 1, the general overview of this project is described. This chapter consists of short introduction about the project, a problem statement, the objectives, the scope of project and the review all chapter of the thesis.

In Chapter 2, the review on the previous study or work which related to the project had been described. The Galvanic Skin Response (GSR) sensor technology has been discussed in this chapter.

The methodology to achieve the project objectives have been stated in Chapter 3. In this part, it explains about the method used to develop a system. The software will help to stimulate the circuit and display the data of the project. The software and hardware are combined together to develop a GSR sensor device which can detect the blood glucose level.

In Chapter 4, the result obtained is shown and a basic demonstration of how to use the blood glucose detection using GSR sensor is described. The analysis will be discussed in this part. The comparison between the GSR and Glucometer measurement had been taken by conducting the experiment.

Last but not least, in Chapter 5, it presents the conclusion of this project. The advantages and disadvantages of the project are then discussed. The recommendation for the improvement of this project also made.

CHAPTER II

LITERATURE REVIEW

In this chapter, it described the finding of a literature review of the project. Overall, it covers related research for non-invasive blood glucose detection method using GSR sensor. This chapter starts with the basic concept of skin conductance and blood glucose level in sweat condition. Basic understanding about the humidity and skin resistance is essential to control on how to the GSR measured data from the human skin. Next, the basic operation of GSR sensor will be discussed. The component used in the project also had been discussed in here. Lastly, a few past related studies about the non-invasive method to detect glucose level are presented at the end of this chapter.

2.1 Human Skin

Skin is the largest organ of the body, which making up 16% of body weight, with a surface area of 1.8 m^2. There are three structural layers in the skin which are epidermis, dermis, and subcutis while hair, nails, sebaceous, sweat and apocrine gland act as derivatives of skin [1]. The cross section of skin layer can be seen as on Figure 2.1. The epidermis is the outer layer where served as the physical and chemical barrier between the interior body and external environment. The dermis is the deeper layer which provides the structural support of the skin. And the third layer is subcutis which is a loose connective tissue layer and function as a depot of fat.

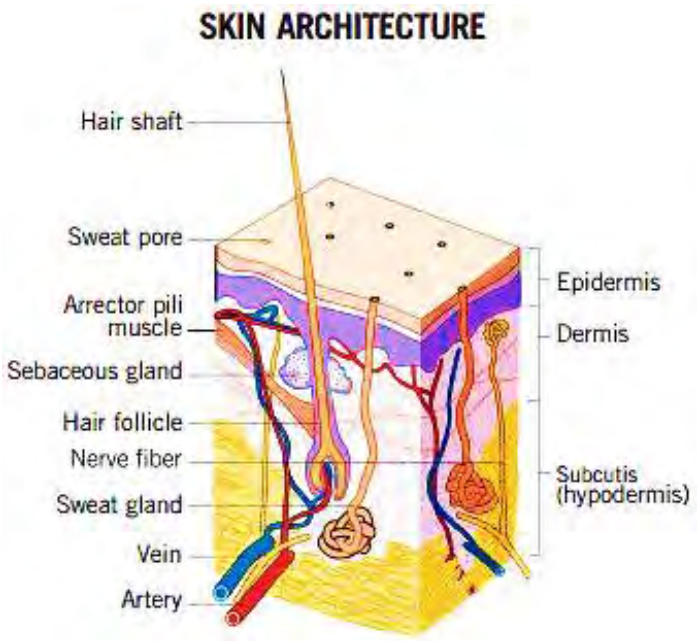

Figure 2.1: Cross section of human skin [2]

2.1.1 Skin Dielectric Properties

Basically, human skin has three different layers which are epidermis, dermis, and subcutaneous tissue. The outer layer of the skin which is epidermis has different thickness. The thinnest layer is on the eyelids at 0.05mm and the thickest is on the palms and soles at 1.5mm [3]. There are different layers of the epidermis, however, the outermost layer, stratum corneum (SC) contributes a great deal to the dielectric properties for the skin. In order to provide a stable and reliable interface between the sensor and skin, it required the measurement of dielectric properties of the skin. The dielectric response of the skin had been attributed to the changes in dielectric polarization and it will give a variation in glucose concentration. [4]

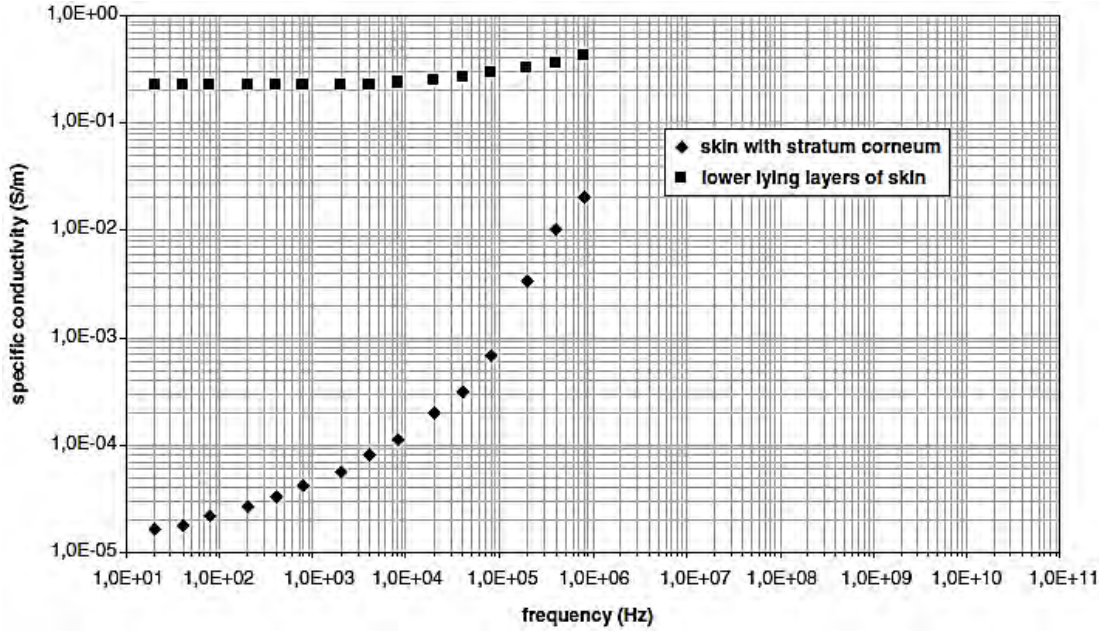

Figure 2.2: Specific conductivity of intact skin with dominating stratum corneum (diamonds) and lower-lying layers of the skin alone (boxes) [3]