

**RECOGNITION OF STRESS VIA AN  
ELECTROCARDIOGRAPHY (ECG) SIGNAL**

**STUDENT NAME  
THIVYAA NIROSHANAA D/O ASOKAN**

**SUPERVISOR NAME  
MADAM NOR KHARUL AINA BINTI MAT DIN**

**POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH**

**RECOGNITION OF STRESS VIA AN  
ELECTROCARDIOGRAHY (ECG) SIGNAL**

**THIVYAA NIROSHANAA D/O ASOKAN**

This Report is Submitted in Partial Fulfillment of The  
Requirements for Bachelor of Electronic Engineering Technology (Medical  
Electronic).


Electrical Engineering Department  
Polytechnic Sultan Salahuddin Abdul Aziz Shah

**MARCH 2016**

**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).

Signature

:  .....

Name of Supervisor

: Nor Kharul Aina Binti Mat Din

Date

: 08 July 2016

**DECLARATION**

I hereby declare that the work in this report is an authentic record of my own work except for quotation and summaries which have been duly acknowledge.

Signature

: .....  .....

Name

: Thivyaa Niroshanaa D/O Asokan

Registration No.

: 08UEU14F3020

Date

: 08 July 2016

## ACKNOWLEDGEMENT

First of all, I would like to express my deepest gratitude to Mrs. Nor Kharul Aina Binti Mat Din (supervisor). She's kindness and generosity in giving help, guidance, information and advice have further motivated. Special thanks to electric & electronic lecturers who are help because of their ceaseless support and help throughout the final project.

Big thanks goes to my parents and family for their endless advice, love and prayers. My thanks and appreciation goes to all these people and others who directly or indirectly involved in this research. Without them, this research work would never have been completed.

## ABSTRACT

This study was conducted to recognize the stress based on Electrocardiography (ECG) waveform. Subjects for this research were 20 of students from Sultan Salahuddin Abdul Aziz Shah Polytechnic. Experimental setup using Electrocardiography (ECG) was used as the main research instrument. This research focused on ST segment in the ECG waveform for recognition of stress. Besides that, the questionnaires were distributed to investigate the factors and effects of stress among students. From the 20 subjects, 10 subjects were stressed due to their value of the ST segment in the range from 0.11 to 0.34mV. From the questionnaire, 70% of the subjects was sense of heart rate increase or heart missing a beat when they are in stress. 65% of subjects also agreed that because of stress they experienced breathing difficulty. From this research, it is concluded that the effect of stress among students include breathing difficulty and sense of heart rate increase or heart missing a beat when they are stressed. It is proved based on the subject's ST depression via ECG waveform. Then, Graphical User Interface (GUI) by Visual Basic has been designed for recognition of stress.

## ABSTRAK

Kajian ini adalah mengenai penentuan *stress* melalui isyarat Elektrokardiografi (EKG). Tujuan kajian ini dilaksanakan untuk menentukan *stress* melalui isyarat ECG. Subjek bagi kajian ini terdiri daripada 20 pelajar dari Politeknik Sultan Salahuddin Abdul Aziz Shah. Dua kaedah telah digunakan dalam kajian ini. Kaedah yang pertama adalah kaedah eksperimen. Elektrokardiografi (EKG) digunakan sebagai peralatan yang penting dalam kajian utama ini. Kajian ini memberi tumpuan kepada segmen ST dalam ECG gelombang bagi menentukan *stress*. Kaedah kedua adalah pengedaran soal selidik untuk mengetahui faktor-faktor dan kesan *stress* di kalangan pelajar. Daripada 20 subjek, 10 subjek mengalami *stress* kerana nilai mereka di segmen ST dalam julat 0.11 hingga 0.34mV. Daripada soal selidik, 70% daripada subjek merasakan serangan jantung secara minima apabila berada dalam *stress*. Manakala 65% daripada subjek juga bersetuju bahawa *stress* mengalami kesukaran semasa pernafasan. Kesimpulannya, berdasarkan kepada soal selidik tentang kesan *stress* di kalangan pelajar, terdapat tindakan ke arah jantung dan kesukar semasa bernafas apabila mereka menghadapi tekanan. Ia dibuktikan berdasarkan nilai ST segmen pada subjek melalui ECG gelombang.

## CONTENTS

CHAPTER	TITLE	PAGE
1	<b>INTRODUCTION</b>	
	1.1 Introduction to Project	1 – 4
	1.2 Problem Statement	4
	1.3 Objective of project	5
	1.4 Scope of study	5
	1.5 Importance of research	5
2	<b>LITERATURE REVIEW</b>	
	2.1 Electrocardiography (ECG)	6 – 8
	2.1.1 Preparation for ECG checking	8 – 9
	2.1.2 Feels of ECG	9
	2.1.3 Risks	9 – 10
	2.2 Stress	10 – 11
	2.2.1 Type of stress	12
	2.2.2 Factors causing stress	12 – 13
	2.2.3 Reaction towards stress	13 – 14
	2.3 Heart	14 – 15
	2.3.1 Factor causing heart disease	16 – 17
	2.4 Relationship with stress, electrocardiogram and heart disease	17 – 22
3	<b>METHODOLOGY</b>	
	3.1 Introduction	23
	3.2 Flowchart	24 – 36
	3.3 Gantt Chart	37



4	<b>RESULTS AND ANALYSIS</b>	
	4.1 Introduction	38
	4.2 Analysis of data from ECG report	39 – 40
	4.2.1 Percentage of Subjects are in stress and not In stress	41
	4.3 Analysis of data from questionnaire	42
	4.3.1 Percentage of Subjects That Felt Too Many Assignments	43
	4.3.2 Percentage of Subject's Sleeping Hours	44
	4.3.3 Percentage of Subjects That Felt Breathing Difficulty	45
	4.3.4 Percentage of Subjects that felt action toward heart	46
5	<b>CONCLUSION &amp; RECOMMENDATION</b>	
	5.1 Conclusion	47 – 49
	5.2 Recommendation	50
	<b>REFERENCES</b>	51 – 53
	<b>APPENDICES</b>	A1 –A2

## LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Results of ECG	10
3.1	Gantt chart	37
4.1	Subject's value of ST segment	39 - 40
4.2	Percentage of Subjects are in stress and not in stress	41
4.3	Percentage of the subjects that felt too many assignments:	43
4.4	Percentage of the subject's sleeping hours	44
4.5	Percentage of the subjects that felt breathing difficulty	45
4.6	Percentage of the subjects that felt actions toward heart	46

## LIST OF FIGURES

FIGURE		PAGE
1.1	Electrical system of heart	2
1.2	Normal & Stress ECG signal	4
2.1	ECG tracing	7
2.2	Chest pain	14
2.3	Anatomy of Heart	15
3.1	Process of research on this dissertation	24
3.2	ECG Holter	25
3.3	Process of experimental setup	26
3.4	Insert SD memory card into the Holter unit	27
3.5	Insert two new AA batteries	27
3.6	Replace the battery compartment lid	28
3.7	Lead patient cable	28
3.8	Mini USB cable	29
3.9	Disposable electrodes, proper size belt and Holter pouch	29
3.10	CardioPoint Application	30
3.11	Selection of pacemaker	31
3.12	Selection of lead system	31
3.13	Drawing of placement of electrodes to the patient	32
3.14	Informative message of disconnection of USB cable	32
3.15	Pouch Holter	33
3.16	Placement of ECG electrode	33

<b>3.17</b>	Open battery compartment lid	34
<b>3.18</b>	Remove the batteries	34
<b>3.19</b>	Insert the SD card into the supplied SD card reader	34
<b>3.20</b>	Click Load Holter	35
<b>3.21</b>	Click Load and Open (1) to review the ECG record	35
<b>3.22</b>	Click Finish (1) to reviewing report	36

**LIST OF APPENDICES**

<b>APPENDICES</b>	<b>PAGE</b>
APPENDIX A	A1
APPENDIX B	A2

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Human heart consists of four main parts which is right ventricle, left ventricle, right atrium and left atrium. It is the main organ of human to supply blood and oxygen to all parts of the body. This amazing muscle produces electrical impulses through a process called cardiac conduction. These impulses cause the heart to contract and at rest, producing what known as heartbeat. The heart is, in the simplest terms, a pump made up of muscle tissue. Like all pumps, the heart requires a source of energy and oxygen in order to function. The heart's pumping action is regulated by an electrical conduction system that coordinates the contraction of the various chambers of the heart.

### Electrical System of the Heart

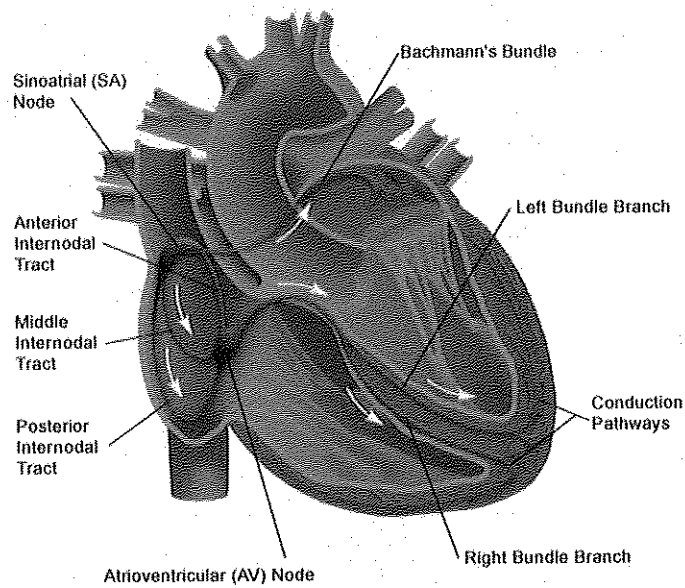


Figure 1.1: Electrical system of heart

Heart disease is the leading cause of death in the United States and can be attributed to the lifestyle factors that increase the risk of atherosclerosis or narrowing of arteries. Smoking, along with poorly controlled hypertension, and diabetes, causes inflammation and irritation of the inner lining of the coronary arteries. Over time, cholesterol in the bloodstream can collect in the inflamed areas and begin the formation of a plaque!

Tests to diagnose heart disease can include Electrocardiogram (ECG), Holter monitoring, Echocardiogram, Cardiac catheterization, Cardiac computerized tomography (CT) scan and Cardiac magnetic resonance imaging (MRI).

This study focused on ECG Holter because ECG Holter monitor is a portable device for continuously monitoring various electrical activity of the cardiovascular system for at least 24 hours. Electrical activity of heart can be recorded with surface electrodes on chest or limbs.

Function of ECG are check the heart's electrical activity, find the cause of unexplained chest pain or pressure. This could be caused by a heart attack, inflammation of the sac surrounding the heart (pericarditis), or angina, find the cause of symptoms of heart disease. Symptoms include shortness of breath, dizziness, fainting, and heartbeats that are rapid and irregular (palpitations), check the health of the heart when other diseases or conditions are present. These include high blood pressure, high cholesterol, cigarette smoking, diabetes, and a family history of early heart disease. ECG also used to identify the Autonomic Nervous Activity (ANS) of emotion and stress identification[1].

Stress is simply the body's non-specific response to any demand made on it. Stress is not by definition synonymous with nervous tension or anxiety. Stress provides the means to express talents and energies and pursue happiness; it can also cause exhaustion and illness, either physical or psychological; heart attacks and accidents[2]. Stress is one of the serious factors for causing many diseases, mental illness and disorders. There are several research investigations are gradually coming up to resolve the limitations on measuring, analyzing and identifying the human stress levels[3].

In electrocardiography the ST segment connects the QRS complex and the T wave and has a duration of 0.080 to 0.120 sec (80 to 120 ms). The ST segment in an ECG is an indicator of heart muscle blood flow. A normal ST segment, signifies adequate blood flow. A depressed ST segment, signifies inadequate blood flow. When there is blockage in a heart artery, the resting blood flow is sufficient for the resting heart, so the ST segment is normal. During stress, there is demand for more blood flow. Because of the narrowing, the supply of blood cannot meet the heart muscle demands, and the ST segment gets depressed[4]. ST segment depression  $\geq 0.1$  mV[5].



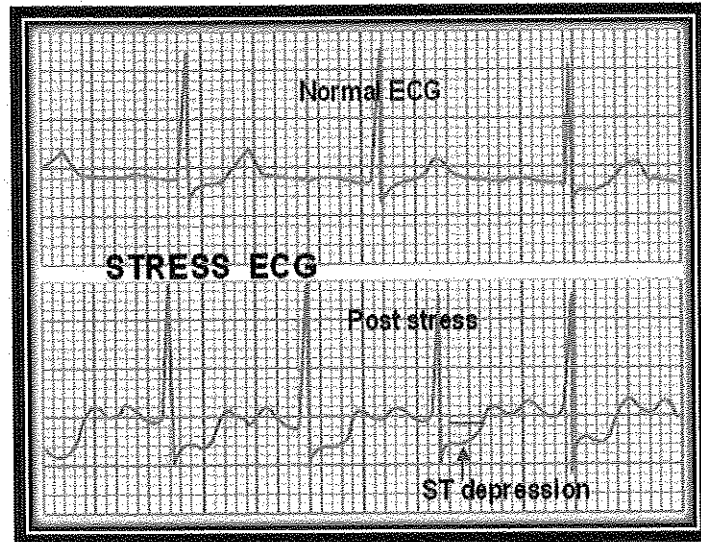


Figure 1.2: Normal & Stress ECG signal

Hence, in this research, will recognize the stress via an ECG signal.

## 1.2 Problem statement

Today's increased use of electronic stress detector device. Some of the device detect stress via finger temperature [6],[7],[8], skin conductance[9], spittle and etc. Depending on how feel, stress scale will fluctuate between 0 to 3 (low stress), 4 to 7(moderate stress) and 8 to 10 (high stress). However, there are lack of awareness among society because using the stress scale.

Hence, in this research, Electrocardiography(ECG) used to identify stress based on ECG signal. The ECG records the electrical activity of the heart. The change in electrical potential over time that is reflected in the ECG signal measurement.

### 1.3 Objective

The main objective is to recognize the stress based on ECG waveform.

To achieve this objective, the sub objective is:

- I. To identify the characteristics of ECG signal
- II. To determine the stress based on ECG waveform
- III. To validate the stress by GUI system

### 1.4 Scope of the study

The study was conducted to clarify the stress level via ECG signals. Subjects are selected among polytechnic students which consist of 20 students. The study was conducted by experimental method and instrumental method. Questionnaire used as instrumental method whereas ECG Holter used as experimental method to conduct this research.

### 1.5 Importance of research

At present, to detect stress are detected by electronic stress detector such as galvanic skin response stress sensor, portable stress sensor and etc. The ECG records the electrical activity of the heart. The change in electrical potential over time that is reflected in the ECG signal measurement can be used to diagnose stress-related disorders. The importance of this research is to make the younger generation realize importance of heart and to take care of the heart. Besides that, due to lack of awareness among the society, this research is done to alert the society.

## REFERENCES

- [1] V. Malhotra and M. K. Patil, "Mental Stress Assessment of ECG Signal using Statistical Analysis of Bio-Orthogonal Wavelet Coefficients," vol. 2, no. 12, pp. 430–434, 2013.
- [2] R. Stress, "Stress & The College Student," pp. 1–10.
- [3] P. Karthikeyan, M. Murugappan, and S. Yaacob, "ECG Signals Based Mental Stress Assessment Using Wavelet Transform," pp. 258–262, 2011.
- [4] O. Article, "The electrocardiographic differential diagnosis of ST segment depression," no. March 2001, pp. 129–136, 2002.
- [5] E. Diderholm, B. Andre, G. Frostfeldt, M. Genberg, T. Jernberg, B. Lagerqvist, B. Lindahl, and L. Wallentin, "ST depression in ECG at entry indicates severe coronary lesions and large benefits of an early invasive treatment strategy in unstable coronary artery disease The FRISC II ECG substudy," pp. 41–49, 2002.
- [6] M. U. Ahmed, S. Begum, P. Funk, N. Xiong, and B. Von Scheele, "Artificial Intelligence in Medicine A multi-module case-based biofeedback system for stress treatment," *Artif. Intell. Med.*, vol. 51, no. 2, pp. 107–115, 2011.
- [7] V. Sch and V. Sch, "A CASE-BASED DECISION SUPPORT SYSTEM FOR INDIVIDUAL STRESS DIAGNOSIS USING FUZZY SIMILARITY MATCHING," vol. 25, no. 3, 2009.
- [8] M. U. Ahmed, S. Begum, P. Funk, N. Xiong, and B. Von Schéele, "Case-based Reasoning for Diagnosis of Stress using Enhanced Cosine and Fuzzy Similarity," vol. 1, no. 1, pp. 3–19, 2008.
- [9] M. V. Villarejo, B. G. Zapirain, and A. M. Zorrilla, "A Stress Sensor Based on Galvanic Skin Response (GSR) Controlled by ZigBee," pp. 6075–6101, 2012.
- [10] I. Journal and O. F. Medical, "ECG pattern recognition and classification using non-linear transformations and neural networks : a review . *Int J Med Inform.*" no. October 2015, 1998.
- [11] L. Medina, "Identification of Stress States from ECG Signals using Unsupervised Learning Methods," no. April, pp. 1–13, 2009.
- [12] S. Z. Bong, M. Murugappan, and S. Yaacob, "Analysis of Electrocardiogram ( ECG ) Signals for Human Emotional Stress Classification Analysis of

- Electrocardiogram ( ECG ) Signals for Human Emotional Stress Classification,” no. SEPTEMBER 2013, 2015.
- [13] K. Vimala, “Stress causing Arrhythmia Detection from ECG Signal using HMM,” pp. 6079–6085, 2014.
- [14] A. Bonjyotsna and S. Roy, “Correlation of Drowsiness with Electrocardiogram : A Review,” pp. 9538–9544, 2014.
- [15] F. G. Hage, J. Heo, and A. E. Iskandrian, “Adenosine-induced ST segment depression with normal perfusion,” vol. 16, no. 2, pp. 121–126, 2009.
- [16] B. S. Zheng, M. Murugappan, and S. Yaacob, “FCM Clustering of Emotional Stress using ECG Features,” *Int. Conf. Commun. Signal Process.*, pp. 305–309, 2013.
- [17] P. Karthikeyan, M. Murugappan, and S. Yaacob, “Descriptive Analysis of Skin Temperature Variability of Sympathetic Nervous System Activity in Stress,” *J. Phys. Ther. Sci.*, vol. 24, no. 12, pp. 1341–1344, 2012.
- [18] M. U. Ahmed and S. Begum, “Heart Rate and Inter-beat Interval Computation to Diagnose Stress Using ECG Sensor Signal.”
- [19] J. K. Cohn, P. F. Cohn, C. Pain, and H. Disease, ““ A,” 2016.
- [20] “No Title,” vol. 3, no. 5, pp. 3–6, 2013.
- [21] D. Vilma, “Original paper Diagnostic value of electrocardiogram stress testing in patients with metabolic syndrome,” pp. 9–15, 2015.
- [22] A. V. A. N. D. E. R. Laarse, V. M. Cats, and A. V. G. Brusckhe, “Stress induced T wave normalization : a new marker of myocardial ischaemia,” pp. 491–493.
- [23] I. Journal and E. Trends, “Emotion Detection in Human Beings Using,” vol. 4, no. May, pp. 1337–1342, 2013.
- [24] R. Lampert, “ScienceDirect ECG signatures of psychological stress ☆ , ☆☆,” *J. Electrocardiol.*, pp. 1–6, 2015.
- [25] E. C. E. Deptt and G. N. E. College, “Fuzzy Classifier for Mental Stress Estimation using ECG Statistical Parameters,” vol. 95, no. 15, pp. 18–21, 2014.
- [26] A. Elhendy, R. T. Van Domburg, J. J. Bax, and J. R. T. C. Roelandt, “The Significance of Stress-Induced ST Segment Depression in Patients With Inferior Q Wave Myocardial Infarction,” vol. 33, no. 7, 1999.
- [27] A. Amal and S. N. Devi, “Diagnosis of Cardiac Ischemia by Analysing Stress ECG,” pp. 23–26, 2013.
- [28] J. Kuncov, J. Slavi?kova, J. Kuncova, and O. Topolc?an, “Plasma

- catecholamines and ischemic heart disease," *Clin. Cardiol.*, vol. 30, no. 7, pp. 326–330, 2007.
- [29] B. D. R. Redwood, "Uses and Limitations of Stress Testing the Evaluation of Ischemic Heart Disease," 2015.
- [30] P. Kligfield and M. S. Lauer, "Beyond the ST Segment Beyond the ST Segment : What Are We," pp. 2070–2082, 2015.
- [31] R. Rauramaa, S. Kurl, J. A. Laukkanen, and T. H. Ma, "Coronary heart disease Asymptomatic ST-segment depression during exercise testing and the risk of sudden cardiac death in middle-aged men: a population-based follow-up study," pp. 558–565, 2009.
- [32] H. N. Senior and H. Officer, "The effects of exercise induced tachycardia on the maternal electrocardiogram," vol. 100, no. January, pp. 41–45, 1993.
- [33] P. Taggart, P. Sutton, C. Redfern, V. N. Batchvarov, K. Hnatkova, M. Malik, U. James, and A. Joseph, "The Effect of Mental Stress on the Non-Dipolar Components of the T Wave: Modulation by Hypnosis," *Psychosom. Med.*, vol. 67, no. 3, pp. 376–383, 2005.
- [34] Y. Ziya, S. Ozdemir, A. Temiz, and F. Celik, "Complementary Therapies in Clinical Practice The effect of relaxing music on heart rate and heart rate variability during ECG GATED-myocardial perfusion scintigraphy," *Complement. Ther. Clin. Pract.*, vol. 21, no. 2, pp. 137–140, 2015.
- [35] S. Goel, "ECG Feature Extraction for Stress Recognition in Automobile Drivers," vol. 12, no. 2, pp. 156–160, 2016.
- [36] S. Begum, *A PERSONALISED CASE-BASED STRESS DIAGNOSIS CASE-BASED STRESS DIAGNOSIS SYSTEM USING PHYSIOLOGICAL SENSOR SIGNALS*, no. 103. 2011.
- [37] P. P. Singh, A. K. Wadhvani, and S. Wadhvani, "Stress Estimation of ECG Signal by using DWT," vol. 7, no. 5, pp. 277–282, 2015.