ABNORMAL HEART BEAT DETECTOR

LOH SOON WEI

This report is submitted in partial fulfillment of the requirement for the award of Bachelor of Electronic Engineering (Industrial Electronics) with Honours

Faculty of Electronic and Computer Engineering
University Teknikal Malaysia Melaka

May 2008

© Universiti Teknikal Malaysia Melaka

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : ABNORMAL HEART BEAT DETECTOR

Sesi Pengajian : 2007/2008

Saya LOH SOON WEI mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (v) :

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	**TIDAK TERHAD**	

Disedia Oleh:

(TANDATANGAN PENULIS)
Alamat Tetap: 29 Jalan Kesumba,
Pekan Baru,
34200 Parit Buntar,
Perak

Tarikh: 9 May 2008

(COP DAN TANDATANGAN PENYELIA)
YUSMARNITA BT YUSOP
Pensyarah
Fakulti Kej Elektronik dan Kej Komputer (FKEKK),
Universiti Teknikal Malaysia Melaka (UTeM),
Karung Berkunci 1200,
Ayer Keroh, 75450 Melaka

Tarikh: 9/5/08

© Universiti Teknikal Malaysia Melaka

"I hereby declare that this report is the result of my own work except for quotes as cited in the references"

Signature :.....

Author :LOH SOON WEI.....

Date :9 MAY 2008.....

© Universiti Teknikal Malaysia Melaka

"I hereby declare that this I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Electronic Engineering(Industrial electronics) With Honours"

Signature :.....

Supervisor's Name : YUSMARNITA YUSOP

Date :4 MAY 2008

© Universiti Teknikal Malaysia Melaka

Dedicated to my loved family especially my father and mother, lecturer and also to all my friend

© Universiti Teknikal Malaysia Melaka

ACKNOWLEDGEMENTS

First and foremost, I would like to praise God for his blessing. He gave me physical and mental strength to carry on my final year project up to completion

I would like to express gratitude and thanks to my supervisor, Mrs . Yusmarnita Yusop for her support and unfailing patience throughout the duration of the project. Her encouragement and guidance are truly appreciated. Otherwise, this project would have not been possible.I have learned a lot under her guidance, be it practically or theoretically.

In addition to that , I would also like to thank my friend Mr. Khoo Boo Hock who was helping me to understand the microcontroller . He is needed a nice person as no matter how busy he would offer some time to give some invaluable advice on certain issues.

Other than that I am also grateful to all my friends who have help and guide me in searching for important noted and books.

Finally, I would like to thanks my parents for their moral support as I can count on them whenever I am down and upset.

© Universiti Teknikal Malaysia Melaka

ABSTRACT

This report describes the application of the biomedical theory and communication theory in the medical field. This project was proposed to help and assist those with heart problem especially for those elderly people. Heart attack may happen during the absence of their children from home which may result in death. Therefore, an Abnormal Heart Beat Detector may help to avoid such accidents as the device can detect mild attack. When the attack happens, it will automatically send an alarm signal to their children or neighbours via wireless communication. The scope of study for this project is narrowed down to the people with the abnormal heart beat (arrhythmia). Abnormal heartbeats occur when the heart has an irregular heart rhythm, beats too fast (Tachycardia), or beats too slow (Bradycardia).There are three important parts in this project. The first part is the sensor's circuit where an infrared light sensor is use and not harmful to human body. It must have the ability to sense mild heart attack. The second part of the project is the circuit design. This circuit is design using the PSpice and Multisim software for simulation. The main concerned on this circuit is that the device must be small enough in order to make it easy to be taken anywhere. The third part is the transmitter and the receiver circuit. These two circuits must be able to send and receive the alarm signal by using the proper modulation or method.

© Universiti Teknikal Malaysia Melaka

ABSTRAK

Laporan ini menggambarkan aplikasi teori bioperubatan dan teori komunikasi dalam bidang perubatan. Projek ini telah dicadangkan untuk menyelesaikan masalah yang kerap berlaku terutamanya kepada orang tua yang mempunyai masalah jantung. Apabila serangan jantung berlaku dengan ketiadaan kanak-kanak di rumah mereka, ia mungkin akan mengakibatkan kematian. Oleh itu, Abnormal Heart Beat Detector yang dapat mengesan serangan sederhanasupaya mengelak daripada berlakunya kematian. Apabila serangan berlaku ia akan menghantar isyarat kecemasan secara automatik kepada anak–anak atau jiran-jiran mereka melalui komunikasi wayarles. Skop kajian untuk projek ini tertumpu kepada orang tua yang mempunyai denyutan jantung luar biasa (aritmia). Denyutan jantung luar biasa berlaku apabila hati mempunyai satu rentak jantung yang luar biasa, denyut terlalu cepat (Takikardia), atau denyut terlalu lambat (Bradikardia). Terdapat tiga bahagian penting dalam projek ini. Bahagian pertama adalah litar sensor cahaya inframerah dimana ianya tidak berbahaya untuk badan manusia. Ia mesti ada keupayaan untuk mengesan sederhana serangan jantung yang sederhana. Bahagian projek kedua adalah rekabentuk litar. Litar ini direka bentuk menggunakan perisian PSpice dan Multisim untuk simulasi. Paling utama dalam litar ini adalah alat mesti kecil supaya mudah diambil ke mana saja. Bahagian ketiga adalah litar pemancar dan penerima. Dua buah litar ini mesti berupaya untuk menghantar dan menerima isyarat kecemasan dengan menggunakan modulasi atau kaedah yang sesuai.

© Universiti Teknikal Malaysia Melaka

TABLE OF CONTENTS

CHAPTER	CONTENTS	PAGE
	TITLE OF PROJECT	**i**
	BORANG PENGSAHAN STATUS LAPORAN	**ii**
	DECLARATION	**iii**
	SUPERVISOR DECLARATION	**iv**
	DEDICATION	**v**
	ACKNOWLEDGEMENTS	**vi**
	ABSTRAK	**vii**
	ABSTRACT	**viii**
	TABLE OF CONTENT	**ix**
	LIST OF TABLE	**xiii**
	LIST OF FIGURE	**xiv**
	LIST OF ABBREVIATION	**xvii**
	LIST OF APPENDIX	**xviii**
I	**INTRODUCTION**	
	1.1 Introduction	1
	1.1.1 Introduction	1
	1.1.2 Scope of Study	3
	1.1.3 Device To Reduce Heart Deaths	3
	1.2 Problem Statement	4
	1.3 Objective and Scope of study	4
	1.4 Project Synopsis	5

© Universiti Teknikal Malaysia Melaka

II LITERATURE REVIEW

2.1	Introduction	7
2.2	Infrared	7
2.3	Heartbeat Detection Sensor	9
	2.3.1 Infra Red Sensor	9
2.4	Principle of Heart Beat Detection using Infra-Red	10
2.5	Maximum Heart Rate	12
	2.5.1 Calculation of Maximum Heart Rate	13
2.6	PIC16F877A Microcontroller	16

III METHODOLOGY/PROJECT WORK

3.1	Introduction	18
3.2	Conceptual of Heart Failure Detector	18
3.3	Planning	19
3.4	Research	26
3.5	Circuit Design	26
	3.5.1 Photodiode Interface Circuit Operation	27
	3.5.1.1 The Importance Of A Capacitor,C1,Operation	28
	3.5.1.2 Noninverting Amp Operation	32
	3.4.1.3 Op-amp U2A Operation	34
3.6	Heartbeat Counter	36
	3.6.1 4-bit Binary Counter	36
	3.6.2 Magnitude Comparator	38
	3.6.3 Timer	39
	3.6.3.1 Astable Multivibrator	39
	3.6.3.2 Delay –On Timer	40
3.7	The Heartbeat Counter Operation	42
3.8	Wireless Transmitter & Receiver	46
3.9	The PIC16F877A Microcontroller Operation	49

© Universiti Teknikal Malaysia Melaka

IV	**RESULT AND DISCUSSION**		
4.1	Phototransistor Interface circuit Analysis		54
	4.1.1	Phototransistor output analysis	54
	4.1.2	Capacitor C1 output analysis	56
	4.1.3	The op - amp U1A output analysis	57
	4.1.4	The op – amp U2A output analysis	60
4.2	Summary of the result		62
4.3	The Heartbeat Counter Output		62
4.4	The Testing Result of the Counter Circuit		65
V	**CONCLUSION**		
5.1	Conclusion		68
	REFERENCES		
			70

© Universiti Teknikal Malaysia Melaka

LIST OF TABLE

NO	TABLE	PAGE
2-1	Resting Heart Rate	15
3-1	The counting time for heartbeat in 60 and 6 second.	40
3-2	The calculation for Astable Multivibrator and Delay-On Timer	43

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURE

NO	FIGURE	PAGE
1-1	The Heart Beat	1
1-2	The Normal & Abnormal Heartbeat	2
1-3	Block Diagram of Gadget with Heart Attack Detection	5
2-1	Chart of the Electromagnetic Spectrum	7
2-2	Arrangement of photoresistor and lamp(infrared) in a finger probe for pulse pick up: (a) Transmission method (b) Reflectance method .	9
2-3	Graphical Representation of Beer-Lambert Law	11
2-4	(a) Transmission of light through the finger when the attenuation of light is caused by arterial blood (A), venous blood (V) and tissues (T). (b) and (c) show typical pulsatile signals detected in the intensity of detected light when light is shone through a finger.	12
2-5	PIC16F877A	16
2-6	Pin Diagram of PIC16F877A	16

© Universiti Teknikal Malaysia Melaka

NO	FIGURE	PAGE
3-23	Schematic Diagram	53
4-1	The comparison between the simulation result and practical result of the phototransistor output	55
4-2	Q1(Collector) voltage (Assume is the Heartbeat)	56
4-3	U1A output	58
4-4	U2A output	60
4-5	(a): The magnitude comparator will not triggered when the heartbeat is normal	63
	(b): The heartbeat less than 6 beats in 6 second will trigger the magnitude comparator	64
	(c): The heartbeat more than 10 in 6 second will trigger the magnitude comparator	64
4-6	Circuit on Protoboard	65
4-7	The counter PCB layout	66
4-8	The Top and Bottom view of the Counter Circuit	66

© Universiti Teknikal Malaysia Melaka

NO	FIGURE	PAGE
3-1	Project block diagram	19
3-2	Project flow diagram	25
3-3	Infra-red Sensor Interface Circuit	27
3-4	Schematic diagram of op-amp HA17358	29
3-5	The effect of propagation delay to the square wave and pulse input	20
3-6	Waveform caused by a speed up capacitor	31
3-7	Noninverting amplifier	32
3-8	Op-amp Comparator	34
3-9	The structure of the 4-bit binary counter (Taken from 74LS393, Fairchild Semiconductor Datasheet)	36
3-10	The ABCD output of the 4-bit Binary Counter	37
3-11	The connection diagram and function table of the magnitude comparator (Taken from DM74LS85, Fairchild Semiconductor Datasheet).	38
3-12	Astable Timer and the square wave generated by the timer	40
3-13	Delay-On Timer	41
3-14	The complete counter circuit	42
3-15	The Astable Multivibrator Timer output and Delay-On Timer Output	42
3-16	(a): FM-RTFQ 868 Transmitter	46
	(b): FM-RRFQ 868 Receiver	46
3-17	(a): The connection of the transmitter part	47
3-17	(b): The connection of the receiver part	48
3-18	TELEALERT Block Diagram	47
3-19	The conceptual of the receiver part	50
3-20	Shows the flow chart of PIC working sequence	52

© Universiti Teknikal Malaysia Melaka

LIST OF ABBREVIATION

ACD	-	Analog to Digital Converter
BPM	-	Beats per minutes
ECG	-	Electrocardiographs
EPS	-	Electrophysiology Study
IR	-	Infrared
DC	-	Direct Current
PCB	-	Printed Circuit Board
MHR	-	Maximum Heart Rate
DTMF	-	Dual Tone Multiple Frequencies

© Universiti Teknikal Malaysia Melaka

LIST OF APPENDIX

NO	FIGURE	PAGE
A1	Code Source of PIC 16 F 877A	73
B1	Data Sheet: 74 LS393	82
B2	Data Sheet: FM Transmitter & Receiver Hybrid Module	89
B3	Data Sheet: GL 480	96

© Universiti Teknikal Malaysia Melaka

CHAPTER I

INTRODUCTION

1.1 Introduction

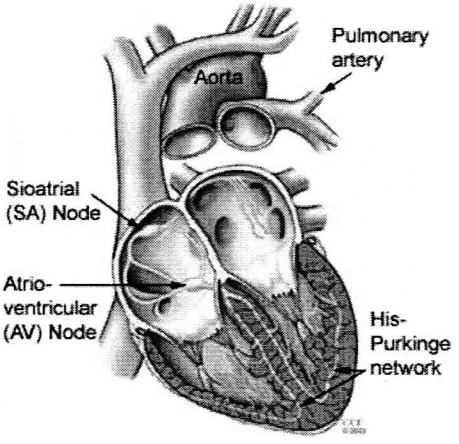

Figure 1-1 : The Heart beat

© Universiti Teknikal Malaysia Melaka

The heart is an amazing organ. It beats in a steady even rhythm, about 60 to 100 times each minute (that's about 100,000 times each day!).

Heartbeats vary depending on various factors such as age, physical state, and stimuli. A child has a smaller heart and therefore their heart needs to beat faster in order to pump the proper amount of blood. The heartbeat rate for infants is 120 per minute, for a child is about 90 times per minute, and for a person over age 18 is about 70 times per minute. A physically fit person has a lower heart rate as compared to an inactive person. Stimuli resulting in stress, fear or excitement will result in a rapid heartbeat. Nerves connected to the heart regulate the speed with which the cardiac muscle contracts. Interestingly, in an average lifetime, the heart continuously beats more than 2.5 billion times.

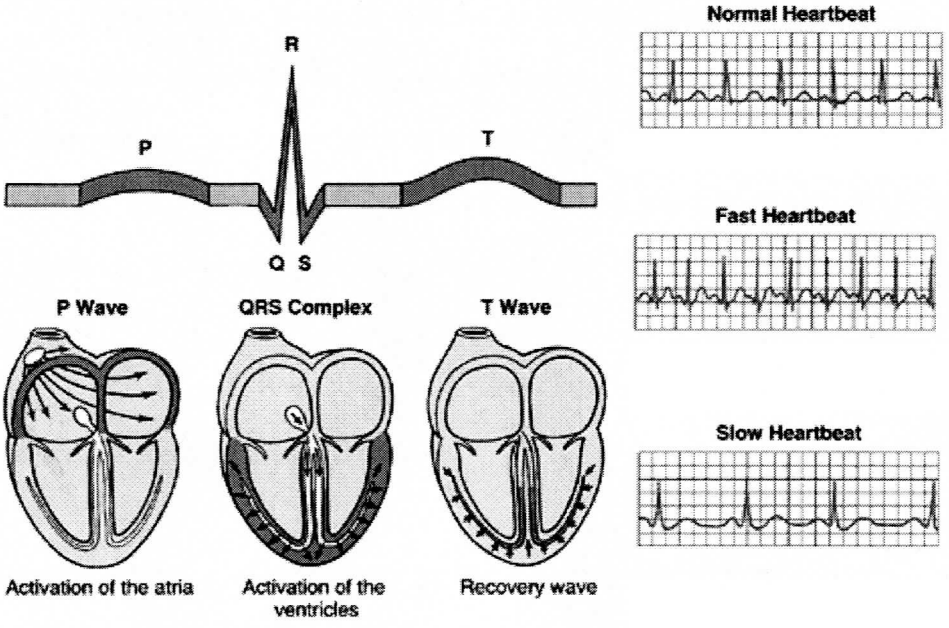

Figure 1-2 : The Normal & Abnormal Heartbeat

© Universiti Teknikal Malaysia Melaka

1. 1. 1 Scope Of Study

The scope of the study will be narrowed down to the people with the abnormal heart beat (arrhythmia). Abnormal heartbeats occur when the heart has an irregular heart rhythm, beats too fast (tachycardia), or beats too slow (bradycardia).

- ***Tachycardia*** - It is an abnormal rapidity of heart action that usually is defined as a heart rate more than 100 beats per minute (bpm) in adults. The heart may not pump enough blood for the body's needs[1]. This may result in feeling light headed, tired or faint.

- ***Bradycardia*** - It can be defined as a sinus rhythm with a resting heart rate of 60 beats/minute or less. However, few patients actually become symptomatic until their heart rate drops to less than 50 beats/minutes[1]. A person with a tachycardia may feel that their heart is racing. If the heart beats too fast it can also fail to pump enough blood.

1.1.2 Device To Reduce Heart Deaths

The immediacy of the detector's notification of a possible heart problem is the key to this concept. It would mean patients can go to hospital or call an ambulance without delay to get vital clot-busting drugs. These drugs dissolve the potentially life-threatening clot that causes the heart attack and unblock the artery. Currently over 40 per cent of patients admit to waiting more than an hour before seeking medical help for their chest pain. Many patients wait even longer. As a result around 30 per cent of heart attack patients die before reaching hospital. The longer patients

© Universiti Teknikal Malaysia Melaka

wait before seeking medical attention, the more damage can be done - often with fatal consequences.

There are few devices which are used to detect heart problem. Those devices are:-

- Electrocardiographs (ECG)
- Pulse Oximeter
- Stethoscope
- Wristwatch
- Pacemaker
- Electrophysiology study (EPS)
- Ambulatory monitors

1.2 Problem Statement

Heart attack can happen to any people especially to old people. Sometimes these groups of people were left alone in their house while their children go to work. If the heart attack happens during the absence of their children, the consequences might be death. This is because no device that can alert their children, neighbours or hospital when the attack happens.

1.3 Objective

The objective of this project is to design a gadget that can detect the normal heart beat and mild heart beat. The gadget unit on the wrist captures abnormal heart beat signal from the patient. The microcontroller on the gadget runs a heart attack algorithm. Warning is given out to the person about his heart condition. The emergency calling system calls for medical help at the moment of heart attack. This

© Universiti Teknikal Malaysia Melaka

project aims to shorten the time between the moment of heart attack and the arrival of medical personal, neighbors or family members. The warning before the emergency call will give the patient a chance to avoid heart attack.

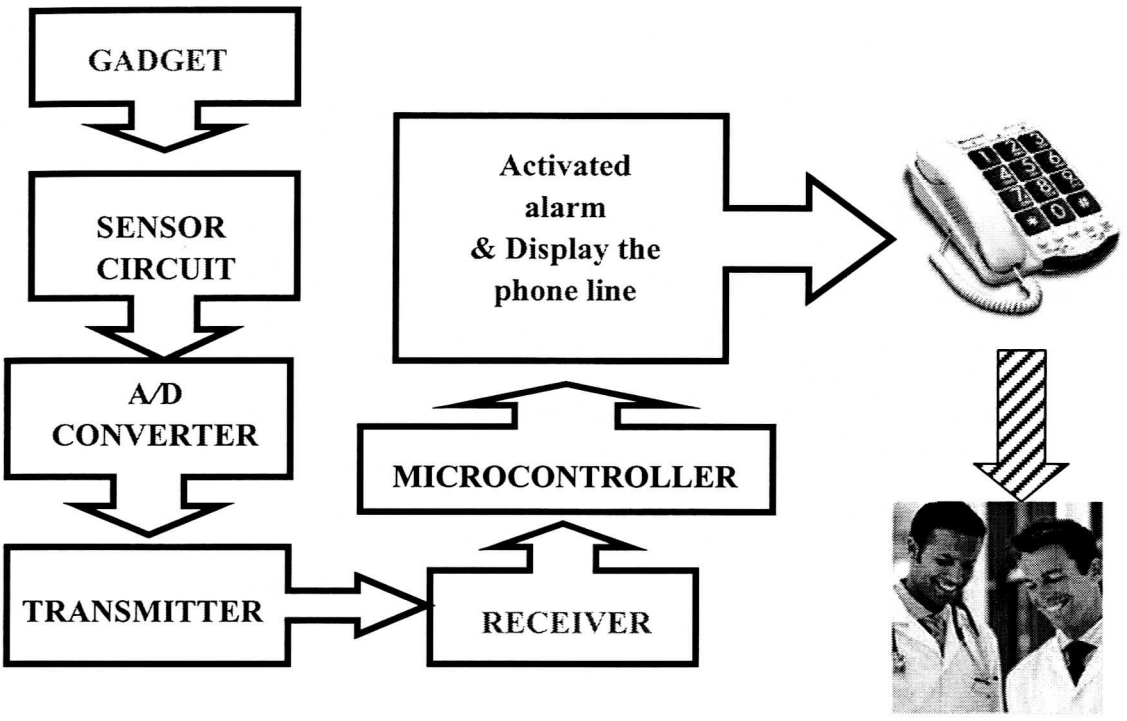

Figure 1-3 : Block Diagram of Gadget with Heart Attack Detection

1.4. Project Synopsis

i. **Sensor Circuit-** The Infra Red light that is shone through the finger will be received by the phototransistor. The resistance of the photoresistor is determined by the light reaching it. With each contraction of the heart, blood is forced to the extremities and the amount of blood in the finger increases. The sensor circuit will amplified the pulse signal so that it can be send to the trigger circuit. The function of the trigger circuit is to set a warning level when a mild heart attack happens, for example when the heart beat is abnormal (<60bpm or > 100 bpm) the circuit will start to trigger.

© Universiti Teknikal Malaysia Melaka

ii. **Transmitter And Receiver**- provide a cost effective high performance Radio data link and operates at 868Mhz The transmitter in able to send a signal at a distance up to 75 meters in building and 250 metres open ground. This distance will be suitable for the patient to walk around in the building without loosing the transmitting signal.

iii. **Microcontroller** - To connect to the output of the wireless transmitter for the purpose of triggering. Then it will be programmed to activate the alarm/display, phone line and dial the emergency number via the normal DTMF telephone that is connected to the *TELEKOM* phone line.

© Universiti Teknikal Malaysia Melaka

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This Chapter is a literature review on theoretical concepts applied in this project. The chapter concludes with brief explanation of how are the Infrared sensor work, and the maximum heartbeat rate formula, what are sensor, and microcontroller . Then ,why choose the specific sensor and microcontroller.

2.2 Infrared

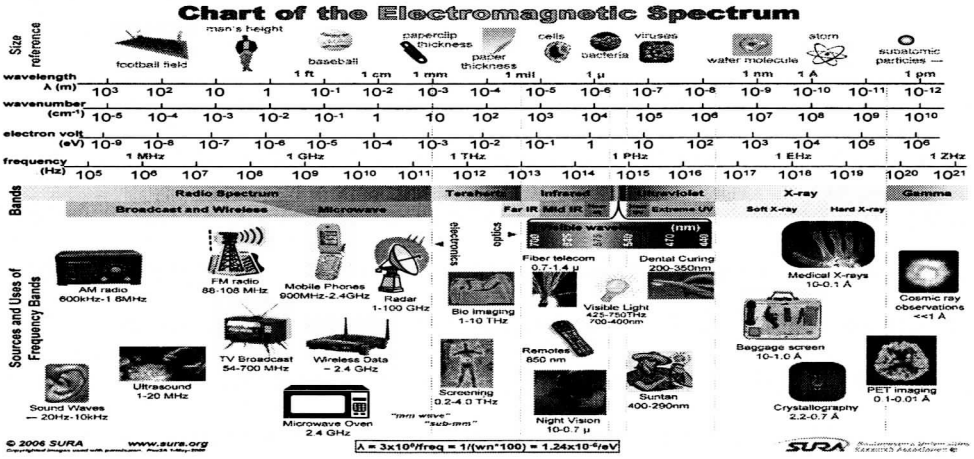

Figure 2-1 : Chart of the Electromagnetic Spectrum

© Universiti Teknikal Malaysia Melaka