# SIGNAL INTERFERENCE TO ELECTROENCEPHALOGRAM AND ELECTROCARDIOGRAM SIGNAL

NORAINI BTE ABDUL SAMAD

UNIVERSITI TEKNOLOGI MALAYSIA

# SIGNAL INTERFERENCE TO ELECTROENCEPHALOGRAM AND ELECTROCARDIOGRAM SIGNAL

NORAINI BTE ABDUL SAMAD

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Master of Engineering (Electrical)

Faculty of Electrical Engineering
UniversitiTeknologi Malaysia

FEBRUARY 2015

*Specially dedicated to*

*My beloved father and mother,*

*To my family members and friends*

*Thanks for all the encouragement and support*

## ACKNOWLEDGEMENT

Alhamdullillah, Praise to Allah S.W.T, The Most Compassionate and Gracious for His blessing and guidance along this journey in completing my thesis. In this short column, I would like to express my gratitude for the support from people around me in accomplishing this journey.

In particular, I wish to express my sincere appreciation to my main supervisor, Associate Professor Dr RubitaBintiSudirman, for encouragement, guidance, critics and friendship. I am also very thankful to my co-supervisor Dr NasrulHumaimi Bin Mahmood for the guidance, advices and motivation. Without their continued support and interest, this thesis would not have been the same as presented here. Besides, I want to thank to all the techniciansof the Medical Electronic Laboratory and Electronic Industry Laboratory for helping me throughout the semesters.My sincere appreciation also extends to all the respondents who had helped me in the experimental and technical work.

Most importantly, I would like to convey my special deepest thanks to my dearest parents, Abdul Samad Bin Samungin and HasnahBinti Ahmad, who had persistently giving spiritual motivation and inspiration throughout my study. With their concern and support, I managed to motivate myself to finish this study.

Last but not least, I would like to dedicate my great appreciation to all my friends for their useful views and tips for the development of this project and also for them who is involved indirectly. Again, my sincere thanks and appreciation is extended to all of you.

## ABSTRACT

The increment in a number of electric and electronic devices nowadays ignites the curiosity about the effect of Electromagnetic Interference (EMI) coming from those devices especially in medical environment. In general, the probability for EMI incidents to occur is small. However, the effect from the incident could lead to a very fatal and hazardous side effect. This study strictly focuses on the effect of electromagnetic interference from medical devices that are placed close to the electrocardiogram (ECG) and electroencephalogram (EEG) devices during ECG and EEG signal acquisitions. Since both ECG and EEG machine are most crucial equipments to examine critical part of human body, the devices should be handled with extra precaution towards EMI contamination. An analysis was carried out by using the Fast Fourier Transform (FFT) and QRS Wave Peak Detection to study the effect of EMI from several types of medical devices on both ECG and EEG signals. The result of analysis on the signal exposed to the interference from medical devices was compared to the signal obtained in environment without medical devices.The results showed that interference from blood pressure cuff, electroglotograph, ultrasound, microspirometer and electro muscle stimulator disturbed the quality of signal displayed as well as the amplitude and frequency component of the ECG and EEG signals at 0 cm distance. Even though the EMI can be easily filtered out by using highpass and lowpass filter, the noise can be misinterpreted as a symptom of arrhythmia and consequently leads to unnecessary treatment and panic situation on medical staff.

# ABSTRAK

Peningkatan dalam jumlah alatan elektrik dan elektronik pada hari ini membangkitkan rasa ingin tahu tentang kesan gangguan elektromagnetik (EMI) *'*yang dihasilkan oleh alatan tersebut terutamanya dalam persekitaran perubatan. Secara umumnya, kebarangkalian bagi kejadian EMI untuk berlaku adalah kecil. Walaubagaimanapun, kesan daripada kejadian tersebut boleh membawa kepada kesan sampingan yang boleh mendatangkan maut dan sangat berbahaya. Kajian ini memberi tumpuan kepada kesan gangguan elektromagnetik dari alat-alat perubatan yang diletakkan berhampiran dengan alat *'electrocardiogram* (ECG) *'*dan alat *'electroencephalogram* (EEG)*'* semasa mendapatkan isyarat ECG dan EEG. Memandangkan mesin ECG dan EEG adalah peralatan paling penting untuk memeriksa bahagian kritikal dalam badan manusia, peranti tersebut harus dikendalikan dengan lebih berhati-hati terutamanya terhadap gangguan EMI. Satu analisis telah dijalankan dengan menggunakan Jelmaan Fourier Pantas dan Pengesan Puncak Gelombang QRS untuk mengkaji kesan EMI dari beberapa jenis alat perubatan ke atas isyarat ECG dan EEG. Hasil analisis ke atas isyarat yang terdedah kepada gangguan dari peranti perubatan dibandingkan dengan isyarat yang diperolehi dalam persekitaran tanpa peranti perubatan. Hasil kajian menunjukkan bahawa gangguan dari pengukur tekanan darah tinggi, '*electroglotograph*', '*ultrasound*', '*microspirometer*' dan '*electro musle stimulator'* mengganggu kualiti isyarat serta amplitud dan komponen frekuensi bagi isyarat ECG dan EEG. Walaupun EMI mudah disingkirkan dengan menggunakan penapis lulus tinggi dan penapis lulus rendah, kebisingan boleh disalah tafsir sebagai petanda *'arrhythmia'* dan seterusnya membawa kepada rawatan yang tidak perlukan dan situasi panik kepada staf perubatan.