AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics Engineering and Electrical Communications

Design and Implementation of Electroencephalogram System

A Thesis submitted in partial fulfillment of the requirements of the degree of

Master of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

by

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering (Electronics and Communications), Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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ABSTRACT

The EEG is important in the medical field. The EEG used to record the brain activities that are used in diagnoses strokes. Recently, the advancement in technology of the brain signals enabled the control of equipment that could help the disabled in their daily life such as wheelchair and robots. Now, mindwave and emotive epock are used in EEG Systems. The EEG recording systems play a major role in the Brain Computer Interface machines where the brainwave signals are given as controls. There is development in transmission of these signals into different platforms based on the portability of applications. This thesis presents a virtual electronic system for measuring the EEG signals. The system consists of electrodes, instrumentation amplifier, filters and a DAQ card with LabVIEW application on a personal computer. The system is developed for displaying, measuring, analyzing and recording the EEG signals. The system is practically implemented with success where the experimental results are verified with simulation results. Hence, the EEG system is developed in order to be portable. The portability is in the first step is based utilizing a data acquisition card DAQ and laptop. Our own system is a low cost system, since the LabVIEW plotter application is developed the EEG system. So, our main target is to design and implement a light weight EEG system with three electrodes. These electrodes are used to sense the signals on human brain which are produced by neurons. The main problems with the brain electrical signals are that they are very small. So, they have to be amplified with special amplifiers. Such amplifiers are called instrumentation amplifiers. These amplifiers are characterized by high gain and common mode rejection ratio in addition to high input impedance. With these specifications, human brain signals can be amplified to get the EEG signal. The filter circuits are also required to clean the contamination and artifacts in EEG signal. The EEG system is developed based on our design with DAQ card and computer. The system is a simple and low cost for acquiring the EEG signals.

Keywords:

Electroencephalogram (EEG), Data Acquisition (DAQ), Laboratory Virtual Instruments Engineering Workbench (LabVIEW).

Thesis Summary

This thesis introduces a methodology for enhancing acquisition of the EEG signals. The thesis is divided into four chapters organized as follows:

Chapter One: This chapter explains the importance of electroencephalogram and the development of medical instrumentation systems. Also, the evolution of smart systems is expressed in the medical instrumentation field. This chapter presents electronic system for measuring brain signals. The system consists of electrodes, amplifiers and filters with EEG plotter application is developed on a computer for displaying and measuring the EEG signals. A circuit was developed to amplify the low amplitude brainwave signals and a band pass filter to eliminate the unwanted frequencies. A DAQ card was used to convert the analog signals to digital signals and transmit them into the computer by using USB interface.

Chapter Two: provides an overview of the previous researches in the EEG systems.

Chapter Three: this chapter explains the design of the EEG circuit and Data Acquisition. Hence, a circuit is designed to amplify the EEG signals and to remove the noise. The EEG circuit consists of electrodes, amplifiers and filters, DAQ card for A/D conversion .A LabVIEW graphical user interface design which are interfaced to develop the prototype electroencephalogram system.

Chapter Four: this chapter introduces implementation of EEG circuit on a PCB to reduce some noise in the EEG system and allow for smaller product. Only four resistors, two capacitors, two integrated circuits and three electrodes are used in our EEG circuit implementation. Also, a LabVIEW software is presented implementation where a LabVIEW application is developed for acquiring, controlling, measuring, analyzing, processing and saving the EEG signals on the computer.

Finally, the thesis ends by extracting conclusions and stating future work that might be done based on this work.

Keywords:

Electroencephalogram (EEG), Data Acquisition (DAQ), Laboratory Virtual Instruments Engineering Workbench (LabVIEW).

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A long way has passed until this moment; a way that was full of many ups and downs. And finally, it is the time to thank all those who have contributed to this final outcome.

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List of Abbreviations

EEG	-	Electroencephalogram
FFT	-	Fast Fourier Transform
DAQ	-	Data Acquisition
PC	-	Personal Computer
USB	-	Universal Serial Bus
GUI	-	Graphical User Interface
CMRR	-	Common Mode Rejection Ratio
ADC	-	Analog Digital Converter
LabVIEW	-	Laboratory Virtual Instruments Engineering Workbench

Chapter 1

Electroencephalogram

1.1 Introduction

The Electroencephalogram is important in the medical field. The EEG used to record the brain activities that are used in diagnoses strokes. Recently, the advancement in technology of the brain signals enabled the control of equipment that could help the disabled in their daily life such as wheelchair and robots. Now, mindwave and emotive epock are used in EEG Systems. The EEG recording systems play a major role in the Brain Computer Interface machines where the brainwave signals are given as controls. The electroencephalogram is a recording of the voltage potential across the human scalp. These potentials are recorded from different regions of the scalp. Each region has its own importance according to the neuron activity at different locations of the brain [1-3].

The brain signals are very small (10μV to 100μV) [1]. These signals are collected by using the EEG electrodes that attached to the human scalp [3]. Some noise come from the surrounding environment and the body and the external electrical sources is added. Hence, it is necessary processing the noise. The signals which collected from the electrodes are preprocessed for amplification and noise removal using the analog circuit and then transferred to the computer using DAQ card.

This thesis aims to develop the portable instrument to acquire the EEG signals and use to the systems which monitor patient. A prototype EEG system is developed that collects the EEG signal from the human brain and transmits into a computer for analysis of some parameters.

This thesis aimed for the development of a prototype EEG system which includes analog EEG circuit for preprocessing and digital circuit for transmission into a computer. The analog EEG circuit is designed to perform the amplification of the raw EEG signal obtained using electrodes and noise removal. The DAQ Card is used to convert the analog EEG signals to digital signals and transmit the sampled data into a