Development of Single Channel EEG using LabVIEW

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Abstract - This paper concentrates on Electroencephalography (EEG) signal processing with emphasis on seizure by reviewing EEG recording for detection and classification of interesting electro-graphical pattern for EEG analysis. Epilepsy is common brain disorder characterized by normal neuronal firing in the brain which can lead to seizure. The activities of these neurons can be monitored using scalp electrodes. Sharp waves and spikes recorded during the periods between seizures of the great importance for diagnostic purpose since it can correlate the types of seizure.

Keywords—EEG, Epilepsy, Seizure, Amplifier DAQ card LabVIEW.

I. INTRODUCTION

In this era rapidly developing technology for medical imaging, one test that might seem downright old fashioned is an electroencephalogram (EEG) or brain wave test. But by its very nature, the EEG test will continue to occupy a valuable role in medical diagnosis that brain imaging tests (such as CT and MRI) will never fill [1]. Normal EEG signals are captured by electrodes which are placed on the scalp using 10-20 system. The EEG signal is often very low amplitude in the range of micro volt. The EEG contains very useful diagnostic information on various neurological disorders. It is noninvasive technique for measuring electrical activity of the brain. In today’s Neurology research and clinical services, EEG recording is commonly used as a diagnosing tool. Currently the detection of electrographic pattern, such as epileptic seizures is done manually reviewing the EEG recordings. The EEG is basically divided in four different types of waveforms (with respect to their frequencies) Delta (0.to5-3)Hz, Theta (4to-7)Hz, Alpha(8to-13)Hz and Beta(14to-30)Hz. These four waveforms are basic waveforms of EEG. Abnormality of these waveforms shows the various pathologically changes in epileptic, coma, benzodiazepines, and sleep disorder etc. For that purpose the instrument which shows the different brain waveforms so it helps clinician for better diagnosis. In the analysis of EEG data different methods such as artificial Neural Network(ANN) and Wavelet transform could be used in analyzing physical situation where the signal contains discontinuities and sharp spikes.

II. INSTRUMENTATION

Instrumentation is divided into five parts namely electrodes, preamplifier, filters, DAQ card and interfacing with LabVIEW.

Figure 1 Block diagram of Single channel EEG

Electrodes

The silver-silver chloride electrodes, 10 mm diameter with a small hole at center to inject conductive gel to ensure good contact and lowering of contact impedance at electrode-skin interface.
Preamplifier

EEG signals are very small in amplitude so low noise instrumentation amplifier is used. This amplifier is amplifying microvolt signal to volt. Common mode signal (50Hz) is rejected in instrumentation amplifier having high CMRR. In order to provide optimum signal quality and adequate voltage level for further signal processing, the amplifier has to provide a selectable gain of 1000, 2000, 5000 and 10000.

Filters

Analog (hardware) filters integrated in the amplification unit. A band pass filter is used for passing particular frequency. The frequency range for EEG signal is typically ranges from 0.5Hz to 100Hz. The band pass filter consists of two different types of filters like low pass and high pass filters. The frequency cut off for band pass filter is also defined. For EEG low frequency cut off is 0.5Hz and high frequency cut off is 100Hz[2].

DAQ card

Here used NI DAQ-6009 card to amplify the signals which can be easily processed and transferred to PC. DAQ-6009 device measures the voltage change and import the data to LabVIEW for analysis.

Interfacing with LabVIEW

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a development environment based on graphical programming. It uses terminology, icons and ideas familiar to technician, scientists, and engineers and relies on graphical symbols rather than textual language to describe programming actions. It is graphical programming that uses icons instead of lines of text to create applications. In contrast to text based programming language, where instructions determine program execution, LabVIEW dataflow programming, where data determine execution. Complex Filter using LabVIEW graphical programming were designed having four frequencies ranges from 0.5 to 3 Hz, 4 to 7 Hz, 8 to 13 Hz and 13 to 30 Hz. for separating out EEG wave forms into Delta, Theta, Alpha and Beta waveforms. Visual output is a waveform of graph as well as chart graph.

III METHODS:

10-20 electrode placement system standardizes physical placement and designation of electrodes on the scalp the head divided in to proprtional distance from prominent skull landmark (nasion, preauricular points and inions). To provide adequate coverage of all regions of the brain. Label 10-20 designate proportional distance in present between ears and nose where points of electrodes are chosen. Electrode placement are labeled according adusant brain area: F(frontal), C(central), T(temporal), P(posterior), O(Occipital). Odd numbers at the left side of the head and even numbers right side(Fig 2)[3].

![Fig 2 10-20 Electrode system [3]](image)

(Selected electrode placement in black box)

EEG electrode junction box has a provision to select the following pairs of electrode Fp1-C3 F8-T6 and C4-O2 for EEG recording which can be modified upon the users requirement.

IV. RESULTS AND DISCUSSION:

Fig 3 and Fig 4 shows the recording made at C4-O2 electrode taken for 2 second and 5 second. EEG waveforms split in to four different frequency channel as shown Alpha, Beta, Theta and Delta.

![Fig 3 shows 2 sec recording using C4-O2 pair of electrode](image)
Fig 4 shows 5 sec recording using C4-O2 pair of electrode. Seizures are classified into three major groups namely

1. Partial (focal, local) seizures (seizures begin locally)
2. Generalized seizures (bilaterally symmetrical)
3. Unclassified epileptic seizures

V. CONCLUSION:

Techniques used in feature extraction and classification of EEG waveform in time and frequency domain have been briefly reviewed in this paper. Result shows clear differentiation of the frequency distribution of the EEG waveform.

REFERENCES