POLITECNICO
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE

EXECUTIVE SUMMARY OF THE THESIS

Technical Aspects regarding EEG

LAUREA MAGISTRALE IN BCS MIND'S MIRROR

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Academic year:

1. Introduction

. An electroencephalogram(EEG) measures electrical activity in brain using electrodes attached to scalp.
. Brain cells communicate via electrical impulses and are active all the time, this activity shows up as wavy lines on EEG recording.

2. Terminology

. International 10-20 system is the system by which EEG electrodes are applied onto head and displayed on EEG recording system.
. The locations where electrodes should be placed were chosen by 4 basis locations. They are nasion(at bridge of nose),inion(at back of head), pre-auricular points(near ears).
. Each electrode is represented by letters and numbers.
. Number indicates the side of head. Odd number signifies that it is located on the left side and even number signifies that it is located on the right side.
. Lower numbers indicate that they are closer to midline and larger numbers indicate that they are far from midline.
. Midline is represented by z. z indicates zero.
. Letters specify the region at which they are present. F signifies frontal, C signifies central and P signifies parietal.

3. How EEG is recorded

. EEG is recorded using differential amplifier. It takes up 2 inputs and displays the difference between two electrical inputs as output.
. Hence common parts of 2 waveforms are nullified and difference remains. This is called Common Mode Rejection Ratio. Hence any tracing in EEG is rather relative.

4. Polarity Rules in EEG

. If the deflection of channel Input1-Input2 is upward it means that Input1 is negative with respect to Input2 or Input2 is positive with respect to Input1.
. If the deflection of channel Input1-Input2 is downward it means that Input1 is positive with respect to Input2 or Input2 is negative with respect to Input1.
. These 2 ideas are used in Phase Reversal. Phase reversal helps us in identifying regions of maximum negativity.
. Isoelectric indicates that both the regions are of similar polarity.

5. How EEG is Displayed and Bipolar Montages

. It is displayed as Montages, the most common one being Bipolar Montage.

. In Bipolar Montage we compare one region with its adjacent region. If we consider anterior-posterior Bipolar Montage and start at Fp2 and start moving posteriorly. Fp2-F8 gives a channel(aka derivation) and moving posteriorly we get several set of channels(chain). We put a number of chains together to form a montage.

. In general left hemisphere electrodes are shown on top of right hemisphere electrodes.

. Transverse Bipolar Montage: It is arranged as if we are looking at the top of the head and the patient is facing upwards.

5.1. Common Reference Montage

. Here we connect every electrode on head to a common reference. Most common one being Cz. Cz reference montage is arranged in the same way as anterior-posterior bipolar montage.

. Some other common reference montages apart from this are Ipsilateral Mastoid Reference Montage and Contralateral Mastoid Reference Montage.

5.2. Common Average Reference Montage

. Here we compare signal at a region of head to average of signals at rest of head. But as Fp1 and Fp2 are very succeptible to eye movement effect and as O1 and O2 are very succeptible to head movement effect, they are generally excluded from average.

. This is used in Reference Contamination that is as it uses average it declares that some regions are electropositive even though they are not in reality. One way to get out of it is Laplacian Montage.

5.3. Laplacian Montage

. Here we don't compare with average rather we compare with its nearest neighbours. For example we compare Cz with its 4 nearest neighbours i.e Cz-Cz' where Cz'=(Fz+Pz+C4+C3)/4.

. We need to take special care for endpoints. Some may be having 3 nearest neighbours.

. Laplacian Montages has some limitation with very broadly distributed electrical discharges.one example is K complex during sleep.Here it is better if we have choose a distant reference point. Hence Ipsilateral Mastoid Montage serves better here.

.Never read EEG with one montage.

6. Common EEG Patterns

6.1. Eye movements on EEG

. Think as eye as a dipole with polarity with retina being negatively charged and cornea being positively charged. When patient blinks the eye,eyeball moves upward(Bell's Phenomenon)

. As a result Fp1 and Fp2 become more positively charged, F3,F4 less positively charged and C3,C4 are neutral and due to this we can see montages. We can even determine movement of eye using montages.

7. Technical issues in EEG

. Waveforms are divided into several frequency bands(alpha,beta,gamma,delta and theta).We are mainly interested with alpha and beta.

. Alpha Waveforms(8-13Hz) . Theta Waveforms(4-7Hz) . Delta Waveforms(<4Hz) . Beta Waveforms(>13Hz)

7.1. Filters

. Low-frequency filter basically passes high frequencies and hence it is called high pass filter.

. High-frequency filter basically passes low frequencies and hence it is called low pass filter.

. Basically in case of filters we can imagine as if the set is divided into 3 regions: No signal, Diminished Signal and Full Signal.