Image Registration in Digital Images for Variability in VEP

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Abstract

The visually evoked potential (VEP) is the measure of cortically evoked electrical activity that provides information about the integrity of the optic nerve and the primary visual cortex. The analysis of P-100 latency and amplitude measurement variability based on visual pathway conduction in VEP has been shown to have clinical utility. The reliable measurement of VEP techniques to do are less well developed. This work presents a technique for a reliable extraction P-100 latency and amplitude using a wavelet based technique. The challenge of image registration (the process of correctly aligning two or more images accounting for all possible source of distortion) is of general interest in image processing. Several types of VEPs are routinely used in a clinical setting. These primarily differ in a mode of stimulus presentation.. This registration can be carried out for VEP waveforms of the same subject taken at different times, waves taken under different modalities, and wave pattern which have only a partial overlap area. This research focused on investigating potential registration algorithms for transforming partially overlapping VEP waves which have only a partially overlapping waveform of the retina into a single overlapping composite waveform to aid physicians in assessment of retinal health, and on registering vectors from known common points in the images to be registered. All potential transforms between waveforms are generated, with the correct registration producing a tight cluster of data points in the space of transform coefficients. The technique has been applied to different types of retinal waveforms – B/W checker board (pattern reversal),B/W checker board (flash),LED Goggles (pattern reversal) and LED Goggles(flash) stimulations and the technique can be readily used to provide cross – modal.

Keywords:

Electro diagnostic instrument, VEP stimulator, Image Registration, Discrete wavelet transform and VEP signals.

1.Introduction

The VEP is the measure of cortically evoked electrical activity that provides information about the integrity of the optic nerve and the primary visual cortex. The optic nerve joins the retina with the brain. On giving pattern or flash stimulation, not only there is increased metabolism in primary visual area but also in the visual association areas. The VEP studies in patients with well defined cortical lesions provide additional about its generator sources. It is important that the infant or child does fix on the stimulus. In the children below five years, the pattern reversal is first carried out; if the potentials are un recordable then a flash VEP should be undertaken. The pattern reversal useful as these assess the visual acuity whereas the flash VEP determines the presence or absence of light perception.

It is important to check the variability of a number of above mentioned parameters for reliable interpretation of VEP. The P-100 latency increases with the decrease of luminance. The reduction of contrast between black and white squares results in increased latency and decreased amplitude of P-100. Usually black and white checks or gratings are employed in clinical practice. Use of colors such as green-black or red-black increase the frequency of VEP abnormalities. The pattern reversal frequency if

increased from 1Hz to 4Hz , the P-100 latency increases by 4.8 m sec. At a faster rate, the waveforms become less distinct and stimulation above 8-10 Hz results in a steady state VEP. The VEP is not influenced by the direction of pattern shift.

2.Methods of Visual Evoked Potential

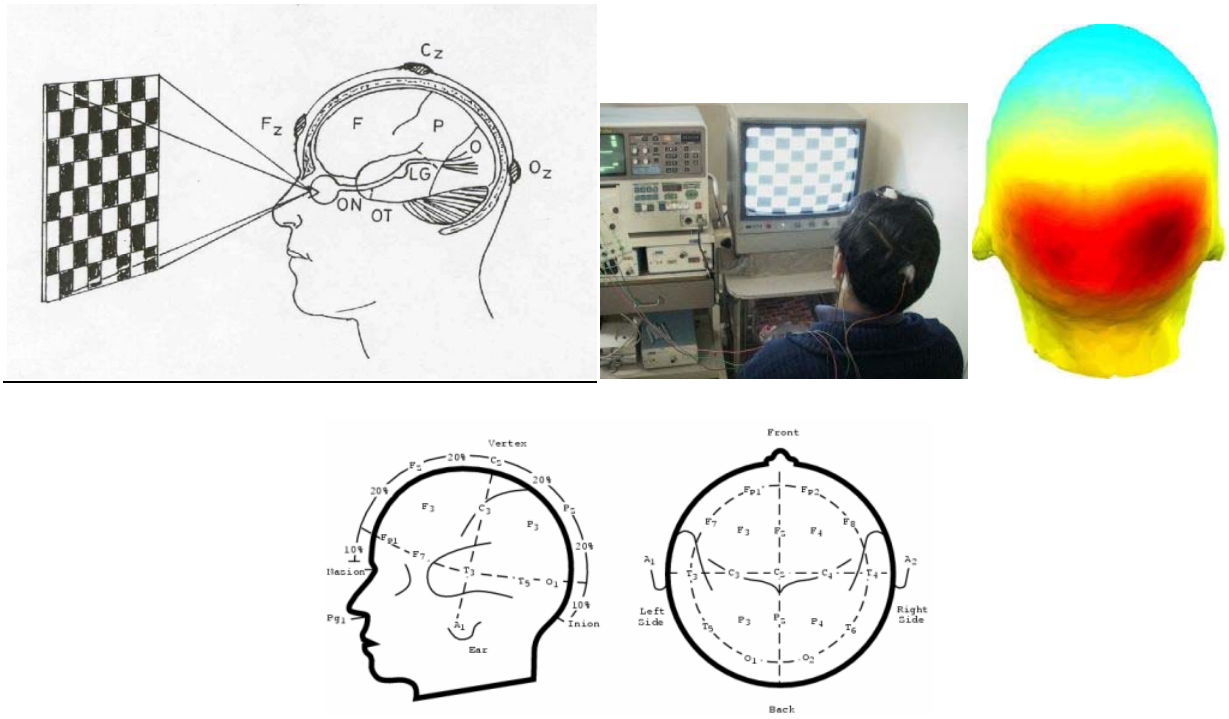


Fig 1.Basic VEP different parts

For the best results of VEP testing, patient should be explained about the test to ensure full cooperation and should avoid hair spray or oil after the last hair wash. The usual glasses if any should be put on during the test. The results of ophthalmological examination such as visual acuity, papillary diameter and field changes should be review before starting the test. The VEP recording were performed in a dark and sound attenuated room in a laboratory. Subject was asked to sit comfortably in front of the checker board pattern at an eye screen distance of 100 cm. The preferred stimulus for clinical investigation of the visual pathways is a reversal of a black and white checker board pattern, as it tends to evoke larger and clear responses than other patterns. For VEP, standard disc EEG electrodes are used. The recording electrode is places at Oz using conducting jelly or electrode paste as per 10-20 international system of EEG electrode placement. The reference is placed at FPz or 12 cm above the nasion. The ground electrode is placed at the vertex at Cz. The electrode impedance should be kept below 5 kilo ohms.

The square checks alternate from black/white to white/black at a specified rate without change in the overall luminance of the screen. This is accomplished by displaying 8*8 checker board pattern on the computer screen using visual basic software. These stimuli elicit VEP responses in the visual cortex. From the VEP recordings, measured values of P-100 component because of waveform consistency and reliability among the normal subjects. Normal amplitude component are much less useful interpretive tools than latencies because of variation in results obtained from normal subject.

3.Introduction to Image Registration

Image registration is the process of transforming the different sets of data into one coordinate system. Registration is necessary in order to be able to compare or

integrate the data obtained from different measurements. Medical imaging registration for data of the same patient taken at different points in time often additionally involves elastic registration to cope with elastic deformations of the body parts imaged. The original image is often referred to as the reference image and the image to be mapped onto reference image is referred to as the target image. Image similarity based are broadly used in medical imaging. A basic image similarity based method consist of a transformation modal, which is applied to reference image coordinates to locate their corresponding coordinates in the target image space, an image similarity metric, which quantifies the degree of correspondence between features in both image spaces achieved by a given transformation and an optimization algorithm which tries to maximize image similarity by changing the transformation parameters.

The choice of an image similarity measure depends on the nature of the images to be registered. Common examples of image similarity measures include cross-correlation, Mutual information, Mean square difference and ratio image uniformity. Mutual information and its variant ,normalized registration of multimodality images. Cross-correlation ,mean square difference and ratio image uniformity are commonly used for registration of images of same modality.

4.Discrete wavelet transform (DWT)

If the function being expanded is discrete (ie, a sequence of coefficents.If the function being expanded is discrete ie,a sequence of numbers) the resulting coefficents are called the discrete wavelet transform (DWT).

If f(n) =f(Xo +ΔNx) for some Xo,ΔX and n=0,1,2,3…..M−1,the wavelet series expansion coefficents for f(x) defined by

$Cjo(k) =<f(x),Øjo,k(x)>=\int f(x)Øjo,k(x)dx$ and---------(1)

$Dj(k)=<f(x),\psi j,k(x)>=\int f(x)\psi j,k(x)dx$-------(2)

Become the forward DWT coefficents for sequence f(n):

$wØ(jo,k)=1/\sqrt{m}\sum f(n)Øjo;k(n)$---------(3)

$wØ(j,k)=1/\sqrt{m}\sum f(n)\ \psi j,k(n)$ for j≥jo-------(4)

The $\psi(0),k(n)$ and $\psi j,k(n)$ in the equations are sampled versions of basic functions $Øjo,k(x)$ and $\psi j,k(x)$.

If $\psi\ jo,k(n)=Øjo,k(\ xs+\Delta xs)$for some xs,equally spaced samples over the support of the basic functions. In accordance with equations

$f(x) =\sum jo(x)\psi jo,k(x)\sum\ \sum dj(x)\psi j,k(x)$--------(5)

Normally,we let jo=0 and select M to be a power of 2.So that summations in equations (3) through (5) are performed over n=0,1,2,….,M-1,j=0,1,2…….j-1 and k=0,1,2,……..2 -1. The W Ø(jo,k) and Wψ(j,k) in equations (3) to (5) correspond to the Cjo( ) and dj( ) of the wavelet series expansion.Note that the integration in the series expansion have been replaced by summations and a $1/\sqrt{m}$ normalizing factor,reminiscent of the DFT.

Using the equations (3) through (5),consider the discrete functions of four points in VEP study,ie,f(0),f(1),f(2) and f(3).Where f(0) is the checker board pattern reversal,f(1) is the checker board flash, f(2) is the LED Gogges pattern reversal and f(3) is LED Goggles flash stimulation. These four points to be considered as f(0)=1,f(1)=4,f(2)=-3 and f(3)=0.Because m=4,j=2 and with jo=0 and summations are performed over x=0,1,2,3,j=0,1 and k=0 for j=0 or k=0,1 for j=1.

We will use the Hear scaling and wave let functions and assume that the four samples of f(x) are distributed over the support of the basic function,which is in width,Subtituting the four samples into equations (3),we find that

$W\psi(0,0)=1/2\ \sum f(n)\ \psi o,o(n)$

=1/2[107.5 m sec +113.1 m sec -113.1 m sec+116.9 m sec]

=1/2[224.8 m sec]

= 112.4 m sec

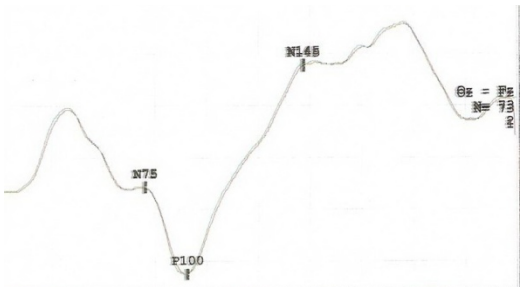
Because $\psi o,0(n)=1$ for n=0,1,2,3 note that we have employed uniformely spaced samples of the Hear transmission matrix. Therefore the P-100 latency of four point stimulations of DWT are uniformely spaced samples of the scaling and wave let functions are used in the computation of the inverse.

The four point DWT in the VEP P-100 latency measurement of a two scale decomposition of f(x),ie,j={0,1}.To underlying assumption was that starting scale Jo was zero but other starting scales are possible.

5.Experimental procedure

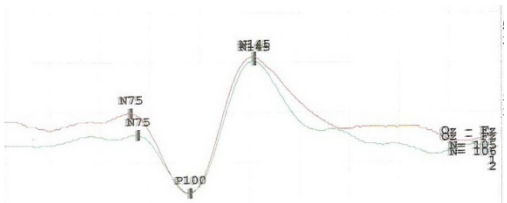
The VEP recording were performed in a dark and sound attenuated room in a laboratory. Subject was asked to sit comfortably in front of the checker board pattern at an eye screen distance of 100 cm. The preferred stimulus for clinical investigation of the visual pathways is a reversal of a black and white checker board pattern, as it tends to evoke larger and clear responses than other patterns. The

stimulus pattern was a black and white checkerboard displayed on a computer screen. The checks alternate from black/white and white/black at a rate approximately of twice per second. The subject was instructed to gaze at a colored dot on the center of the checkerboard pattern. Every time the pattern alternates, the patient visual system generates an electrical response and was recorded using electrodes. Signal acquisition and stimulus presentation was synchronized using software program. The starting point of VEP waveform is stimulus onset. The VEP waveform recording is done over a period of 250 m sec. More than 100 epochs were averaged to ensure a clear VEP waveform. For judging the reproducibility, the waveform is recorded twice and superimposed. A typical averaged various types of stimulations like



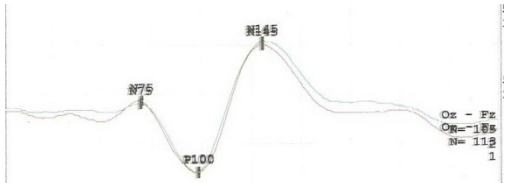
Tr	Montage	N75 (mS)	P100 (mS)	N145 (mS)	(mS)	(mS)	P100 – N75 (μV)
1	Oz - Fz	83.1	107.5	175.0			1.64
2	Oz - Fz	83.1	107.5	175.0			1.66

Fig 2. B/W Checker board (Pattern Reversal)



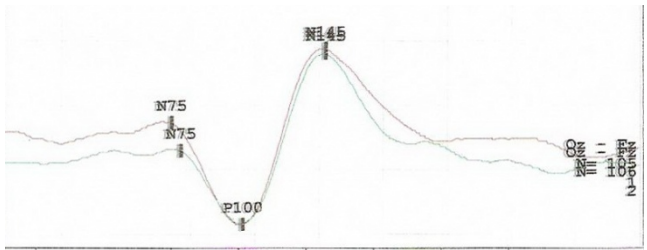
Tr	Montage	N75 (mS)	P100 (mS)	N145 (mS)	(mS)	(mS)	P100 – N75 (μV)
1	Oz - Fz	77.5	113.1	151.9			7.99
2	Oz - Fz	81.9	113.1	151.9			5.78

Fig 3. B/W Checker board-(flash)



Tr	Montage	N75 (mS)	P100 (mS)	N145 (mS)	(mS)	(mS)	P100 – N75 (μV)
1	Oz - Fz	82.5	116.9	155.6			7.22
2	Oz - Fz	81.9	116.9	155.6			6.86

Fig 4. LED Goggles(Pattern Reversal)



Tr	Montage	N75 (mS)	P100 (mS)	N145 (mS)	(mS)	(mS)	P100 – N75 (μV)
1	Oz - Fz	80.0	113.1	151.9			7.93
2	Oz - Fz	84.4	113.1	151.9			5.71

Fig 5. LED Goggles(Flash)

different types of retinal images – B/W checker board (pattern reversal),B/W checker board (flash),LED Goggles (pattern reversal) and LED Goggles(flash) stimulations are recorded with same subject with variability P-100 latencies are amplitudes are noted in the following superimposed waveforms and results. The VEP signal has been labeled to indicate the N75,P100 and N145 marks, the corresponding latencies for the subject being

83.1 ms,107.5 ms and 175 ms for B/W pattern reversal checker board,77.5 ms,113.1 ms,151.9ms for B/W flash checkerboard stimulation,82.5 ms,116.9 ms and 155.6 ms for LED Goggles pattern reversal and 80.0 ms,113.1 ms and 151.9 ms noted for LED Goggles flash stimulation.

Table :1 Developed accuracy P-100 latency measurement

Montage	**Tr**	**N75 ms)**	**P100(ms)**	**N145(ms)**
Oz-Fz	**1**		**112.4**	
Oz-Fz	**2**		**112.4**	

Finally, all the potential transforms between images are generated, with the correct registration producing accurate P-100 latency measurement of 112.4 m sec with different types of retinal waves as shown in the above table (V).

6. Results and conclusion

The developed accurate P-100 latency measurement evaluated using different types of stimulations under the process of image registration correctly aligning of the same subject taken at different stimulations and different modalities. The tables I,II,III and IV were variability of P-100 latency and table V showed accurate P-100 latency using discrete wavelet transform. However, there is a small difference in the P-100 latency measurement because of the subjective behavioral factors, like the quality of the cooperation in fixation and accommodation. Diagnosis of optic nerve diseases for the recorded VEP signals is performed (P-100) on the basis of established for that neuro diagnostic laboratory.

7. References

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