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Fourier and wavelet transformation of eye movement temporal series

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***Abstract* - Saccadic eye movements, recorded from healthy human subject with an infrared camera eye tracking system, were analyzed in order to be compared with typically quasi-periodic, chaotic and random signals, theoretically generated from differential equation. To do this, we applied the Fourier transform and also the wavelet transform based on Haar function as suggested by the quasi-rectangular shape of the recorded saccadic signal. Both computational applied tests revealed that the investigated temporal data series can't be classified into none of the theoretical cases.**

Keywords: visual-guided saccade, semi-quantitative tests, dynamics type assignment.

I. INTRODUCTION

The saccadic eye movement is known as the rapid oculo motor response involved in rapid shift of the visual fixation (maintaining of the visual gaze on a single location) between two points in space [1].

To execute a visual guided saccade, the information coming from retinal pathways (visual input, Fig.1) goes to the superior colliculus (SC) and visual cortex (VC). Then, the saccades are initiated by activity in neurons of frontal and parietal eye fields (FEF and PEF) of the cerebral cortex.

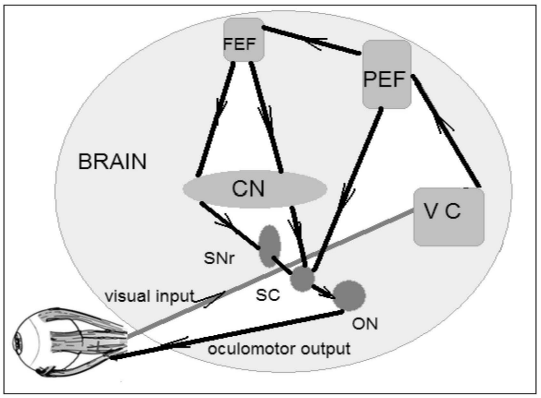

Fig. 1. Brain areas involved in the generation of saccadic eye movements (FEF – frontal eye field; PEF – parietal eye field; SC – superior colliculus; SNr – substantia nigra pars reticulata; ON – oculomotor network; CN – caudate nucleus; VC – visual cortex).

After processing the signal along the neural pathways shown in Fig.1, the oculomotor output results in the saccadic eye movement toward the desired position.

Eye tracking systems enable us to record the eye shift during the saccadic visuo-spatial exploration [2], while adequate software allowed the recorded signals analysis and interpretation. Various computational algorithms i.e. semi-quantitative tests are expected to do the difference between the pathological and physiological situations [3].

II. MATERIAL AND METHODS

Saccadic eye movements were recorded from one healthy human subject in Sensorimotor Research Laboratory, at National Eye Institute, USA, using an infrared iView X Hi-speed eye tracking system sampling at 1 kHz, a dark pupil system that uses infrared (IR) illumination and computer-based image processing. The eye is illuminated by IR light at an angle and the reflected beam is captured by an IR sensitive camera (Fig. 2). The eye reflects this illumination although the pupil will absorb most IR light and appear as a high contrast dark ellipse.

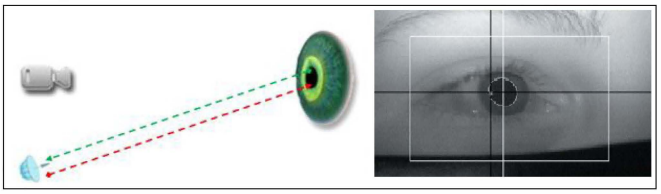

Fig. 2. The basic scheme of eye tracking system.

The eye movements were executed in response to two red visual stimuli projected from lasers onto a translucent screen placed 105 cm in front of the subject eyes. One spot was fixed, acting as the visual fixation point for the subject and the other one, the target, could be moved at the left or at the right of the central fixation point. The visual stimuli were presented in a predictable way, meaning the same angular shift amplitude, the same duration and frequency. For this study we have chosen a sequence of 10000 data points, and

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