

EYE MICROSACCADIC MOVEMENTS – NOISE IMPROVED VISION?

During a visual task the human eye is perpetually under movement. Many reasons are proposed to explain the role of such movements: tracking of a moving object, pattern recognition. . . However, even during a fixational task, an involuntary saccadic movement of high frequency and small amplitude remains. Such microsaccades can be viewed as random and considered as noise. However, microsaccades are claimed to be implied in various phenomenon such as:

- *Cancellation of the fading effect* [1, 2]. During a fixational task, when the motion of the eye is compensated so that the eye is perfectly fixed compared to the scene, after a small period the perception of the scene tends to disappear. Thus, microsaccades are evoked to counteract the fading.
- *The information reduction before the information processing of the stimuli* [3]. Natural images are known to exhibit long range correlation. In other words, two pixels at a short distance in an image are highly correlated, implying of strong redundancy of information. In parallel, the human retina is composed of a huge number of photoreceptors. Thus, a large amount of information is perceived by the retina, whereas only a few of it is transmitted to the deeper layers (bottleneck). Some authors show in elementary models of retina that the saccadic movement improved the reduction of information.
- *The hyperacuity phenomenon* [4, 5]. The human eye is able to distinguished details in a image at a finer scale than the resolution allowed by the sampling of the retina by the photoreceptors (vernier experiments, etc.). To explain this hyperacuity effect, some authors evoke that the microsaccades play this role of improvement of the resolution of the retina. such ideas are even applied in engineering to improved the resolution of sensors thanks to mechanical vibrations [6].

Although microsaccades are evoked to play a functional role rather than to be an artifact, such a functional role remains under debate. Its existence itself is debated (it is sometimes claimed to be a laboratory artifact).

The purpose of this study is to further study if microsaccades are beneficial or not in the visual process. This investigation will be perform from experiments and/or numerical models.

- 1. The first aim of the project is to test the relationship between microsaccades and environmental signal to noise ratio. Using simple psychophysic tasks, the candidate will quantify if the amplitude of microsaccades can adapt to the visual information available in different context.**
- 2. In parallel, a simple model of retina and a measure of performance (e.g. input-output Shannon information, etc.) should be studied to quantify if the microsaccades can enhance information processing of not.**

The candidate should have previous experience with either behavioral experimentation or a strong mathematical or computer science background and a strong interest in pluridisciplinary works.

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Nathalie Guyader (GIPSA-Lab, neurocognition aspects in relation with the LPNC) and Pierre-Olivier Amblard (GIPSA-Lab, noise-enhanced processing) will be involve in this study.

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