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# ANALYSIS BY VIDEO METHODS OF NYSTAGMUS IN SIMULATED AND STIMULATED MOVEMENTS

**Mihaela Baritz[1], Daniela Barbu[1]**
[1] Transilvania University, Brasov, ROMANIA, e-mail: mbaritz@unitbv.ro, dbarbu@unitbv.ro

***Abstract:*** *Some theoretical considerations and experimental biomechanical analysis of physiological nystagmus type of eye movements are presented in this paper. In the first part of the paper is presenting the theoretical aspects of the processes developed during the eyeballs movement and also the positioning limits of binocular visual system. The principles and structure of induction and investigation methodology of simulated and / or stimulate the eyeballs movements are presented in the second part of the paper. Also it is showing the developed experimental aspects highlighted during the analysis. In the third part of the paper we present the results of this analysis and there are defined some data correlation strategies by determining the level of binocular movement in tracking the video light stimuli methods. Conclusions of the paper are set from records and analyse. Also are presented future directions of research development, in the final part of the paper.*
***Keywords:*** *nystagmus, eye movements, trajectory, tracking video*

## 1. INTRODUCTION

Rhythmic and oscillating movements of the eyeball define nystagmus. This is a position disorder of oculostatic or oculogyric system and causes a dysfunction in a complex and correlation unit. Generally nystagmus is bilateral. State of high tension in the extrinsic muscles even by extreme positions of the eyeball, either by a deficient part or all into a muscle or group of muscles, leading to oculostatic disturbances by dysfunction of the eye muscles proprioceptive systems (mio-static mechanisms). These mechanisms define eyeballs instabilities manifested through various forms of nystagmus, such as fixing nystagmus or extreme deviation, tired nystagmus, or paretic nystagmus [1]

*Oculogyric system* is a complex assembly that coordinates eyeballs conjugated movement. Oculogyric supra-nuclear centers are linked to three information systems from the vestibular apparatus and from subcortical system. Each of these systems would lead to a deviation of the eyeball in a certain position, bearing in mind that rotations of the eyeball in the antero-posterior axis cannot be due only to the vestibular apparatus. [1]

Excitations coming from the visual and the vestibular systems present certain qualitative and quantitative characters and may give a special dynamics of oculogyric device. It is manifested by a deviation of eyeballs and that their deviation is linked rhythmically through the intervention of a rapid counter-deviation due of a compensatory reflex system. The end result is a biphasic oscillation, rhythmic, with a slow phase deviation which corresponding to a tonic eyeball deviation imposed by visual or vestibular excitation, and a rapid opposite phase corresponding to a counter-deviation reflex compensating. That oscillation is nystagmus itself, distinguishing like an opto-kinetic nystagmus determined by visual excitation and like vestibular nystagmus caused by the vestibular excitation. [1]

Certain organic lesions of the nervous system, important for different levels of the nervous system of oculogyric structures can disturb its dynamic. In the absence of visual or vestibular excitations, these disorders can be manifested through a nystagmus.

*Physiological nystagmus*

*a. Nystagmus by extreme lateral fixation.* When a normal subject is asked to maintain eye fixation in extreme gaze, then occurs most often nystagmus.

*b.Opto-kinetic nystagmus.* When in the front of eyes succeed a number of objects then nystagmus is developing (*railway nystagmus*). Eyes are pursuing an object toward the periphery of the field of view when attention is suddenly drawn to the other object that is appearing so there is a movement back of the eyes. [2]

*c.Vestibular nystagmus.* This form of purely reflex nystagmus is artificially in clinical research of labyrinth state.

There are many causes of occurrence of nystagmus, it may appear at birth or can be installed due to diseases of the eye or brain damage. Some types of nystagmus can be given

- Albinism is given to decrease the pigment in the eye;
- Damage to the labyrinth: they can be caused by inflammation in the inner ear. The subject may experience dizziness, nausea, nystagmus even;
- Brain Injury: conditions in some parts of the brain can result in nystagmus;
- Alcohol and drugs can induce nystagmus;
- Multiple sclerosis: a disorder of the central nervous system. [2]

*Nystagmus of ocular origin*

*1.* Amblyopic nystagmus is a nystagmus lacks of macular fixation reflexes. It behaves like a pendulum nystagmus, more or less regularly, with small breaks at the end phase of the oscillation. It has small amplitude that is only visible to the ophthalmoscope exam.

Amblyopic nystagmus is unilateral; this is due to a lack of vision and macular diseases such as albinism occurs, achromatopsy, corneal opacities, cataracts, myopia, optic atrophy. These conditions caused a sharp decline in visual acuity which disturbs muscle function and binocular vision.

Nystagmus is caused by a defect in the development of fusion and fixation. Blind from birth do not have nystagmus, they have irregular, high amplitude of eye movements and they are unconscious (search movements); these individuals do not realize that ignores movements and trembling eyes. This type of nystagmus occurs after birth, after several months or 2-3 years we can realize that amblyopia is installed.

A characteristic of the amplitude and frequency eye movements is the presence of a blockage to look right or left side. In this position visual acuity can be better compared to other directions of gaze [2]

*2. Latent nystagmus* occurs when one eye is covered; is a nystagmus in saccade which "beats" of in the open eye. Nystagmus may occur if a high power convex lens is put in front of an eye.

*3.Nystagmus for dark „spasmus nutans".* A few weeks after birth may occur a pendulum nystagmus emphasized. This type of nystagmus is seen especially in spring time to the children who stayed at home in winter time, locked in a dark room, with defect fixation, but this type of nystagmus is transient and disappears quickly. *Spasmus nutans* it is determined by three elements: nystagmus, head tilt, torticollis. [2]

*4. Congenital nystagmus.* Family and hereditary congenital nystagmus is affecting both males and females. This is a horizontal and tilting nystagmus. [2]

Mechanism of nystagmus is based on the action of two muscle systems, namely:

- Extrinsic ocular muscle tonic contraction to maintain that position and
- Cooperation between the various synergistic or antagonistic muscles to perform movements of the of the two eyeballs.

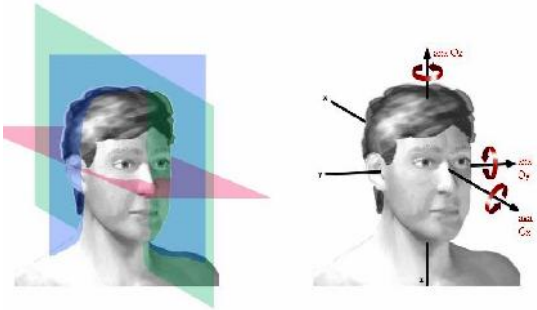

**Figure 1:** Reference Systems (plans and axes) of visual assembly

Disturbances occurring in the functioning oculostatic (visual function operating in low-light environment, insufficient information, excessive muscle tension, excessive stimulation of muscle groups through extreme positions in middle distance like reading or work computer) causes of instability, of irregular rhythmic oscillations as nystagmus or ocular deviation, tired or paretic nystagmus etc. In addition to these cases there may be some huge other situations (functional, physiological, neurological or pathological) and that can cause some form of nystagmus. [3]

These causes can include: visual stimuli (radiation stroboscopic, flashing poly-chromatic computer monitor radiation, etc.) that can cause a form of opto-kinetic nystagmus or special stimuli (thermal, electrolytic, motor - balance the rotation) that may cause the manifestation of vestibular nystagmus. Another main cause like muscle fatigue causes nystagmus is ocular-motor situation which is avoided in particular examinations in extreme positions of gaze and duration (concentration while reading or computer work).

Important characteristics of nystagmus are:

- *Direction* - horizontally, vertically and sometimes rotary;

-*The amplitude size* - the amplitude nystagmus angle of up to $5^0$ is a fine form (shown only in ophthalmoscopic examination); The average nystagmus is characterized by oscillations of amplitudes of up to $15^0$; and nystagmus occurs in broad form from more than $15^0$;
- *During oscillation* - pendulum nystagmus has a constant frequency and biphasic nystagmus is characterized by uneven periods, consisting of slow and fast phases;
- *Intensity* - is a feature that classifies forms of nystagmus in three grades: grade I only occurs when the eyeball is oriented towards rapid phase: Grade II appears in the primary position; Grade III occurs in the direction of the slow phase;
- *Associating binocular* - nystagmus occurs normally in both eyes and rarely dissociated sense or monocular amplitude.[2]

## 2. EXPERIMENTAL SETUP

If the case of an analysis of the eye movements, constantly it is important to study symmetrical position, orthophoric position of the two eyeballs of potential latent deficiencies namely heterophories. For this, ocular fusion phenomenon is temporarily suppresses and its possible compensating components. Eye movement analysis system comprises a video camera focused on the visual axis of the eye to be analyzed, a system for positioning and retaining the subject's head and a software for this kind of analyse.

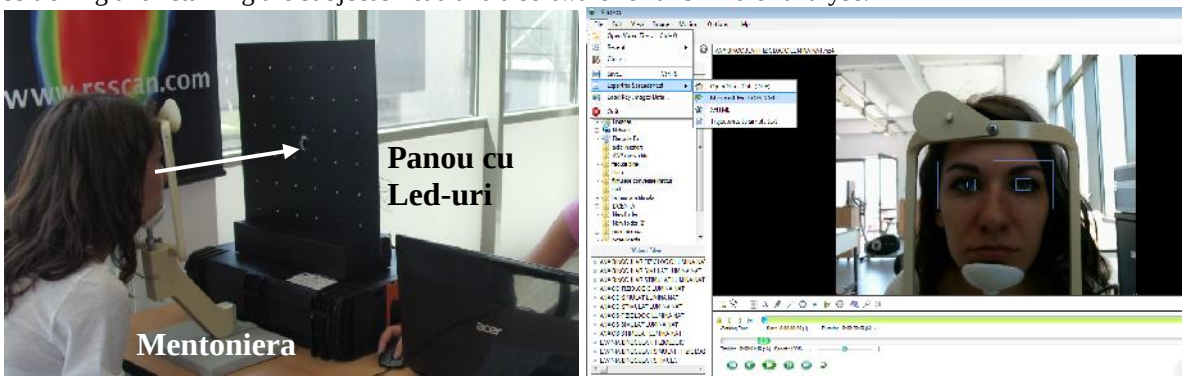


**Figure 2**. Recording system and main window of analyze software

Selected subjects from the sample were instructed on testing procedures and also to make primary investigations to determine the normal activity level. Human subjects (number 10) that are part of the sample are 22.6 years average, without ocular abnormalities or refraction and are in a good metabolic state. Each experiment was recorded for minimum 3 times for each subject. [4,5]
For each of the subjects were analyzed *simulated and stimulated nystagmus movements* with the device help from Figure 2. Likewise environmental conditions were uniform for all entries. This is necessary to analysis of eye movements to be not influenced by any external factor (stray light radiation, vibration, noise, temperature, atmospheric pressure) and focus only simulated or stimulated movements of nistagmus. For example was chosen human subject no.1 who shows no optical correction (normal visual system-emmetropic), is in a normal metabolic state and to which the procedures were performed by recording eye movements provided in three variants: *physiological motion* tracking sequence of flash LEDs on the panel; *simulated horizontal nystagmus moving* (left-right) and *stimulated nystagmus moving* by panel lights from experimental setup (Figure 2 -left). The trajectory that subjects have to follow is determined by a set of LEDs on the experimental device, shown in the Figure no. 3. Monocular recordings of these three variants are shown in Figure 4 for human subject no.1.

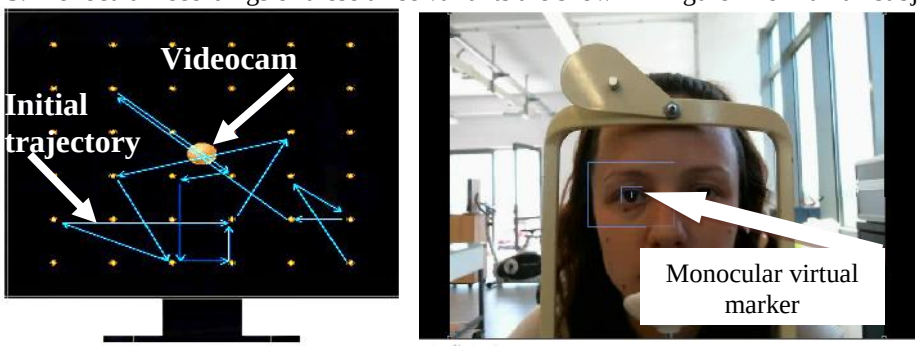


**Figure 3:** Initial trajectory for nystagmus eye movements analyse (left) and image recorded and processing by central videocam and Kinovea software (right)

It can be seen as a physiological movement, starts from the position of equilibrium, central (origin of the coordinate axes) and falls below the horizontal axis which performs micro-movements for adjustment binocular balance. In the same aspect, simulated moving is also performed in the horizontal direction and can cause the same like physiological movement limits (moving conscious and sustained).[6]

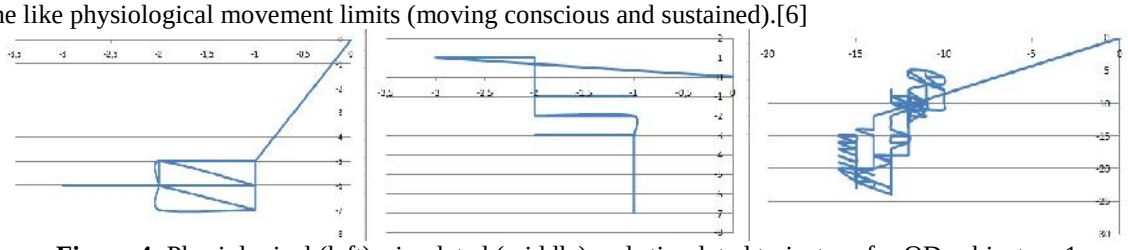

**Figure 4:** Physiological (left), simulated (middle) and stimulated trajectory for OD subject no.1

In relation to these two situations eyeball movement stimulation procedure by successive ignition of the lights on the panel highlights a far greater degree of micro-movements (an increase of 7.5 times compared to the physiological movement trajectory length). [6,7]
This growth lead to changes, in external muscle system tonicity of eyeball and thus to increase eye fatigue, during the same registration period. The procedure was repeated three times for each type of recording monocular (OD and OS) but binocular respectively for the entire sample of subjects (10) given each time to keep the same level of ambient light in order not to influence the movement and positioning of ocular system.

## 3. CONCLUSIONS

Applying the same procedure to the entire subjects sample the following results were synthetic obtained:
- For all subjects in the sample that shows no refraction or ocular pathologies previously detected movements manifest normal physiological monocular.
- Simulated movements are reduced in length by 21% monocular motion path toward physiological movement; stimulated movement represents an average increase of 4 times the length of the movement trajectory physiological.
- Analysis of binocular movement for all subjects in the sample is found a 90% similarity in shape, length and position trajectory toward left and right eye. The only difference (20% of the sample) was found in subjects who were dominant eye - left eye to the rest of the sample that showed his right eye as the dominant eye.
An important application of this study is to analyze the degree of fatigue developed in the ocular system for subjects using on long time period the electronic display systems or stimulation intense illumination, chromatic and intermittent.
This level of eye fatigue can alter alertness, concentration and ability to work and can lead to uncomfortable, progressive and irreversible manifestations at the visual system level.
If the working activity is intense, sustained over a long period, the use of inappropriate illumination or the subject has an uncomfortable position and the initial discomfort may extend in some cases can degenerate in ocular pathologies and can be found a method of mathematical modeling of them. [8,9]

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