VARIANCE ANALYSIS OF A VESTIBULO-OCULOMOTOR SYSTEM STATE IN A SINUSOIDAL STIMULATION ON THE BASIS OF A RECONSTRUCTED COMPONENT METHOD

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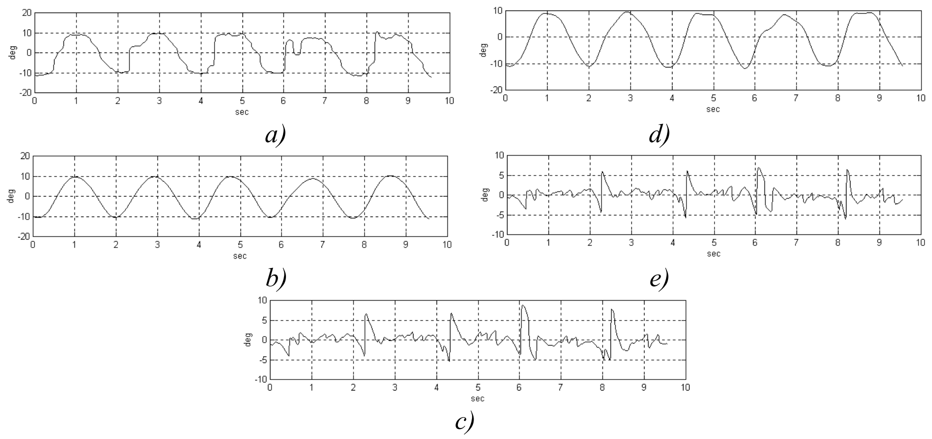
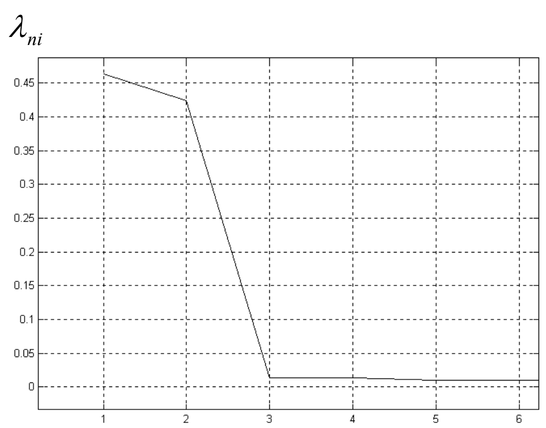
The variance approach based on using principal component analysis for estimating VOS state is proposed. Its essence consists in controlled ENG signal decomposition on a number physiologically easily interpreted reconstructed components by means of a selection of optimal relation among a time window length of the ENG signal analysis, ENG signal length and its basic period. Quantitative estimation of ENG signal structure variability is based on using the proposed new diagnostic parameters obtaining from an eigenvalue spectrum of the initial ENG signals. Result of modeling for the groups of patients with different types of VOS disturbances shows diagnostic significance of proposed parameters for estimating VOS states.



Reconstructed components of ENG signal for central VOS pathology: a) initial ENG signal; b) sum of the three first reconstructed components; c) sum of the rest reconstructed components for the case (b); d) sum of the five first reconstructed components; e) sum of the rest reconstructed components for the case (d)



Eigenvalue spectrum of the initial ENG signal for central VOS pathology

Diagnostic parameter values for distinguishing VOS state.

VOS disturbance	$\overline{\lambda}_{slow}$ (m=3)	$\overline{\lambda}_{slow}$ (m=5)	$\overline{\lambda}_{diff}$	M_{tr}	H_n		
						D	I
central	9.0855	12.3198	0.01163	2.5321	0.1903	0.235	0.8097
peripheral	15.5408	23.3482	0.01533	2.3229	0.1592	0.1894	0.8408
none	115.0736	250.7658	0.06619	2.0502	0.1131	0.1275	0.8869

ESTIMATION OF EYE MOVEMENT ASYMMETRY ON PHASE PORTRAITS OF ELECTRONYSTAGMOGRAMS IN SINUSOIDAL STIMULATION

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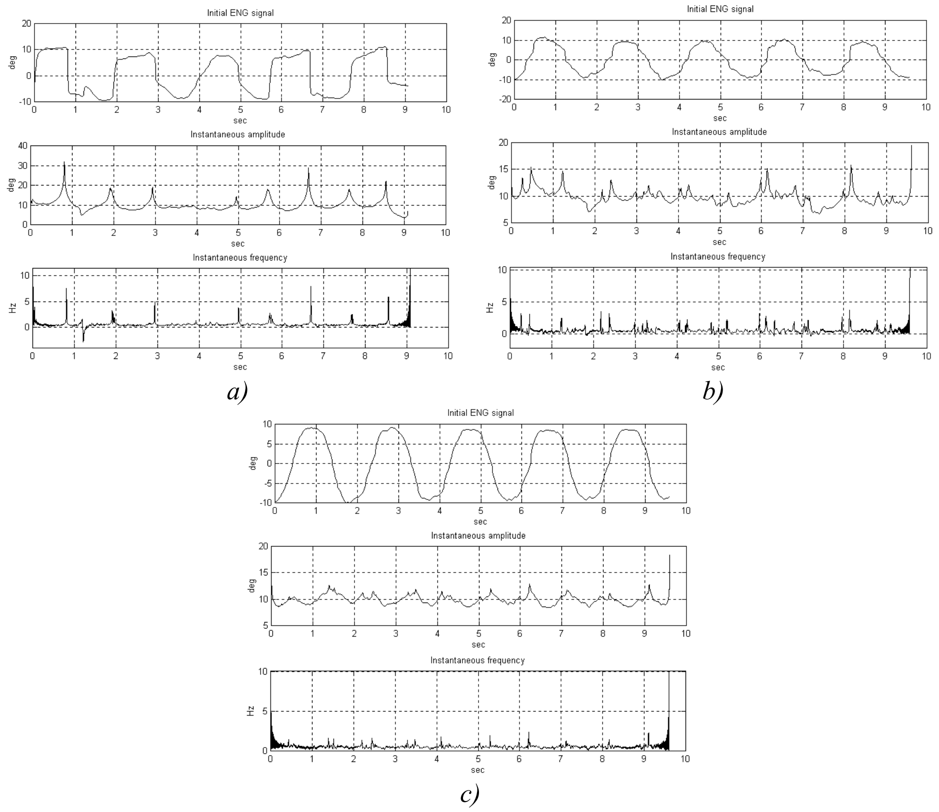
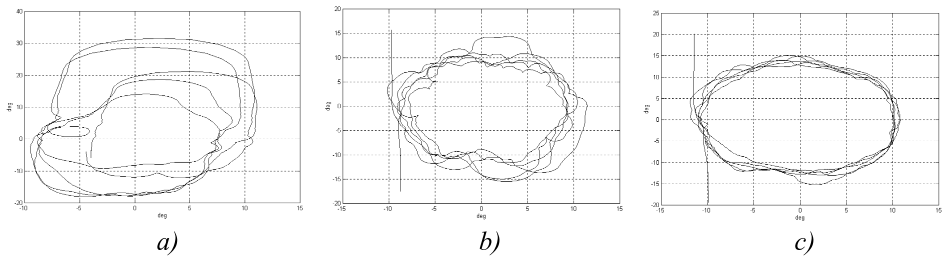
The phase portrait method based on using a Hilbert operator are an effective tool for visual and quantitative estimating asymmetry degree of the electronystagmograms (ENG) signal structure. The proposed set of asymmetry factors on the basis of instantaneous amplitude and frequency, phase velocity and curvature are effective tool for determining side and level of VOS disturbances and distinguishing pathologic asymmetry from physiologic one.



Initial ENG signal with a) left-, b) right-handed disturbance and c) without one (positive and negative values of ENG signal corresponds to the eye shift to the right and to the left respectively)



Phase portraits for ENG signals with a) left-, b) right-handed disturbance and c) without one

Side of VOS disturbance	K_{σ}^{A}	K_{Q}^{A}	K_{σ}^{ω}	K_{Q}^{ω}
left	-0.2557	-0.2258	-0.2578	-0.0677
right	0.1562	0.1244	0.0759	0.1352
none	0.0024	0.0280	0.0680	0.1295

The table shows some coefficients of asymmetry for ENG signals of VOS with left-, righthanded disturbance and without one

ANALYSIS OF A VESTIBULO-OCULOMOTOR SYSTEM BEHAVIOR ASYMMETRY IN ITS SINUSOIDAL STIMULATION ON THE BASIS OF A PHASE PLANE METHOD

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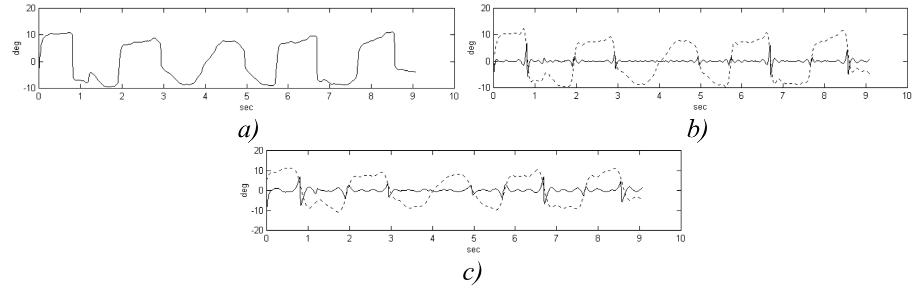
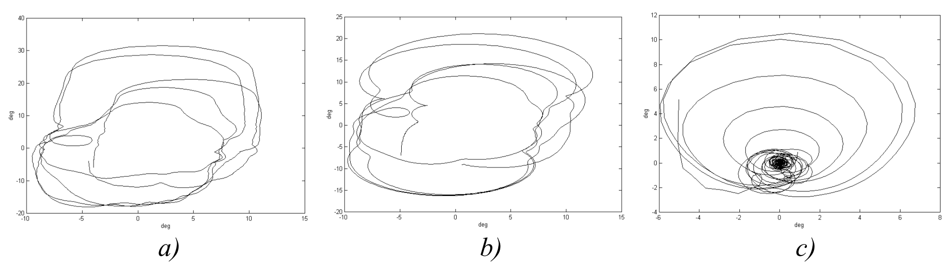
The new approach to analysis of ENG signal asymmetry based on combined using phase plane method and principal component analysis (PCA) is proposed. The phase portrait method based on using a Hilbert operator are an effective tool for visual and quantitative estimating asymmetry degree of the electronystagmograms (ENG) signal structure. The proposed set of asymmetry factors on the basis of instantaneous amplitude and frequency, phase velocity and curvature are effective tool for determining side and level of VOS disturbances. PCA procedure consists in controlled ENG signal decomposition on a number physiologically easily interpreted reconstructed components by means of a selection of optimal relation among a time window length of the ENG signal analysis, ENG signal length and its basic period. The proposed approach allows to represent the phase portrait (PP) analysis of initial ENG signal as a sequential analysis of PPs of reconstructed ENG signal with the different number of the reconstructed components obtained by PCA. The analysis of dependence of asymmetry on the number of the reconstructed components will allow us to evaluate the contribution of each reconstructed component to change of ENG signal asymmetry and to distinguish more reliably pathological asymmetry from physiological one.



ENG signal for lefthanded VOS disturbance: a) initial signal; b,c) reconstructed slow (dotted line) and fast (solid line) signal for m=20 and 10, respectively



Phase portraits for ENG signal of lefthanded VOS disturbance: a) initial signal; b) reconstructed slow signal for m=20 c) reconstructed fast signal for m=20

Amplitude and velocity asymmetry coefficients for lefthanded VOS disturbance.

Number of reconstructed components	Slow components $\sum_{i=1}^{m} x_i^r$		Fast components $\sum_{i=m+1}^{M} x_i^r$	
	K_{σ}^{A}	K_{σ}^{V}	K_{σ}^{A}	K_{σ}^{V}
all	-0.18	-0.38	-	-
m=100	-0.18	-0.3	-0.24	-0.21
m=50	-0.17	-0.18	-0.23	-0.20
m=20	-0.12	-0.11	-0.32	-0.26
m=10	0.06	0.00	-0.27	-0.38
m=5	0.09	0.02	0.06	-0.34