Dependence of Emotional Parameters Values on Inter-Frame Difference Accumulation in Vibraimage System

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Abstract: *Dependence study was conducted of the characteristics of emotional parameters on the frames number (20, 50, 100) for inter-frame difference accumulation by vibraimage technology. Recommendations on the use of optimal settings of vibraimage system depending on the application are proposed. Are given data on adjusting the norms for measured emotional parameters for various settings of inter-frame difference.*

Keywords: *vibraimage, inter-frame difference, emotional parameters, optimal settings, technical profiling.*

In various applications of vibraimage systems (Minkin, 2017; 2019; 2020) default settings are used, however, very often users of vibraimage systems do not understand the relationship between the settings of vibraimage system and measurement parameters of a testee. A certain complexity in the process of understanding the vibraimage systems settings is introduced by their significant amount exceeding a hundred for the base program Vibraimage PRO10 (Vibraimage PRO10, 2020).

Naturally, the task of security systems and technical profiling is to obtain the required information about a person in a minimum time, while most psychological and medical applications of vibraimage technology are practically unlimited in time, but they require high accuracy in detection of psychophysiological state and emotions.

The aim of this paper is to study the influence of the main setting — the number of frames N for accumulation of interframe difference (Sekine et al., 1999) on the basic emotional parameters measured during human head vibraimage capturing.

Materials and Methods

The study of the dependence of basic emotional parameters was carried out on one test subject, a man of 30 years old, a programmer in the specialty. The measurements were carried out during working hours and when the subject performed production tasks from 11.00 to 18.00 in February-March 2020, with the consent of the subject. The study of basic emotional parameters was carried out with three values of N (the number of frames for obtaining the inter-frame difference at a frequency of main processing of 5 k/s) set at 20, 50 and 100.

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The measurement of the basic emotional parameters of the subject was carried out using the technology of vibraimage (Minkin, 2017; 2020) using the Vibraimage PRO10 program (Vibraimage PRO10, 2020). The duration of each measurement of emotional parameters was 600 seconds. Measurements with different settings took place randomly relative to working time to eliminate the time error on the measurement results in different groups. In total, 100 measurements of emotional parameters were done at each setting of interframe difference (IFD).

Microsoft LifeCam Studio webcam was installed in front of the subjects with a resolution of 640x480 elements, a frame rate of 30 Hz, mounted on a monitor. The image of the subject's head was on the webcam photodetector and included to at least 200 horizontal pixels. VibraStat program (VibraStat, 2020) carried out statistical processing of the measurement results.

Results

The results of measuring the average values of the emotional parameters T1–T10 determined by the full measurement range of 600 seconds are shown in table 1.

Table 1

The results of measuring the average values of M (Mavg), SD (Savg), V (Vavg) of the emotional parameters of the test subject for various values of the interframe difference. Measuring range was set 600 seconds

var	Mavg			Savg			Vavg		
	M_20	M_50	M_100	S_20	S_50	S_100	V_20	V_50	V_100
T1	50,369	39,486	33,819	7,824	6,066	5,183	15,619	15,465	15,374
T2	24,705	23,598	22,406	6,750	5,827	4,797	27,529	24,631	21,578
T3	15,684	16,171	15,360	10,226	10,766	10,403	67,737	69,744	71,300
T4	30,907	26,984	24,434	5,212	4,731	4,322	16,785	17,547	17,717
T5	79,637	76,905	72,670	8,788	7,539	6,917	11,089	9,851	9,560
T6	74,642	78,145	81,055	8,170	5,261	3,778	11,126	6,784	4,683
T7	33,476	27,080	24,417	10,937	8,324	5,790	34,023	31,653	24,306
T8	76,638	77,250	76,705	6,604	5,136	4,320	8,694	6,684	5,646
T9	23,822	22,540	23,591	5,291	5,429	5,431	22,291	24,171	23,069
T10	45,199	45,097	45,972	21,174	21,687	21,928	40,038	39,971	40,405

Naturally, the results obtained with a standard measurement time of 60 seconds at the same MCR values would slightly differ from the table, primarily due to an increase in the standard deviation for almost all parameters with minimal MCR, and the error in determining the M value would be higher. That is why we present the results of determining the parameters at a 600 second interval in order to reduce the influence of random variation and errors on the determined trend in measuring emotional characteristics.

Separately, we consider the characteristic of brain activity period (BAP), obtained over the full time range of 600 seconds, determined with three different values of the inter-frame difference of 20.50 and 100 samples in the form of table 2.

Table 2

Characteristics of the period of brain activity, determined by the values of the inter-frame difference of 20, 50 and 100

Brain period (P16)	N=20	N=50	N=100
Max, s	24,2	31,5	39,9
Med, s	24,31	31,99	40,39
M, s	25,49	32,68	40,99
S, s	5,33	5,17	4,86

The mathematical estimates given in table 2 for the period of brain activity show a predicted increase in BAP with an increase in the time of accumulation of IFD.

Discussion

The number of samples of interframe difference is one of the most important settings of vibraimage technology, since the accumulation of IFD allows to convert video stream into the physiology of activity or the characteristic of reflex micromotion of the head (Minkin&Nikolaenko, 2008). Moreover, from the point of view of hardware costs, it is logical to minimize the number of IFD samples, since an increase in IFD samples leads to an approximately proportional increase in processor resources for the content and processing of the increased information in the processor RAM.

Those, 100 MKR samples require 5 times more processor power than 20 MKR. However, presumably, an increase in the MRC counts should lead to an increase in the accuracy of determination of the PPS parameters by reducing random and systematic errors. If we assume that the PPS of the test subject remains stable during the measurement, then the average standard deviation (Savg) of the results during the measurement is a characteristic of the error. For clarity, we consider table 1 of the change in the IFD settings (20, 50, 100) in the form of histograms of the parameters Mavg, Savg and Vavg presented in figures 1, 2, 3 for each value of the IFD.

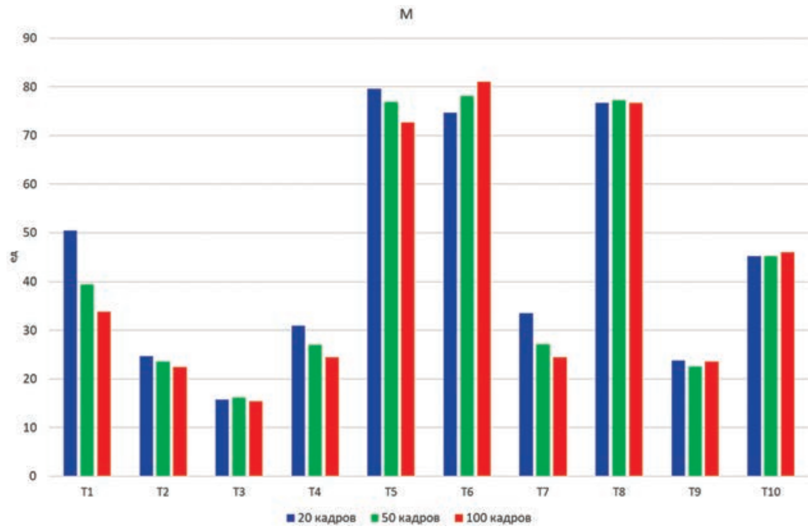

Fig. 1. Histogram of Mavg distribution for emotional parameters at different IFD

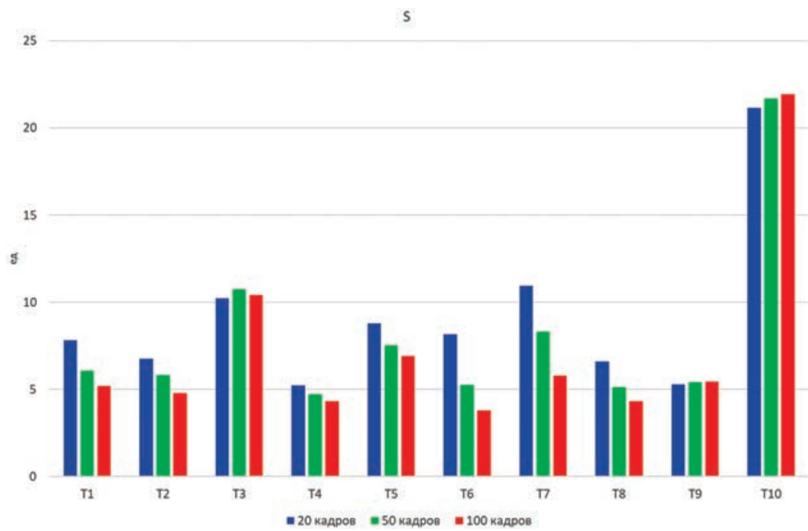

Fig. 2. Histogram of Savg distribution for emotional parameters at different IFD

It follows from figure 2 that most (7 out of 10) of emotional parameters (T1, T2, T4, T5, T6, T7) really have a lower standard deviation with an increase in MCR, for two parameters T3 and T9 a small increase in standard deviation is observed at N=50, and only parameter T10 has a maximum standard deviation at N=100. Most likely, such an anomaly for the T10 parameter is related to the fact that the calculation of the T10 parameter (Neuroticism) is directly related to the standard deviation, and an increase in the time for determining the standard deviation leads to an increase in this parameter due to the PPS regulation mechanism (Minkin&Myasnikova&Nikolaenko, 2019).

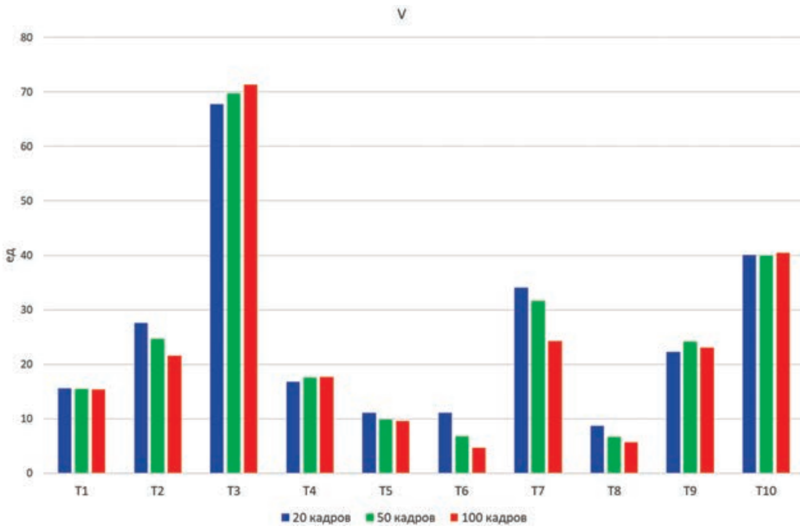

Fig. 3. Histogram of Vavg distribution for emotional parameters at different IFD

The most stable characteristic of emotional parameters is variability and its changes are the most inconspicuous of all the given histograms.

The most obvious changes in the dependence of emotional parameters on MCR are observed in the standard deviations of parameters T6 and T7; therefore, for those applications where the stability of these parameters is important, large values of MKR should be recommended.

Separately, it is necessary to consider the total spectrograms of the changes in the SFC obtained by processing the FFT at various values of the MCR, shown in figures 4, 5, 6.

Fig. 4. Spectrogram of PMA with FFT signal of PPS at N = 20

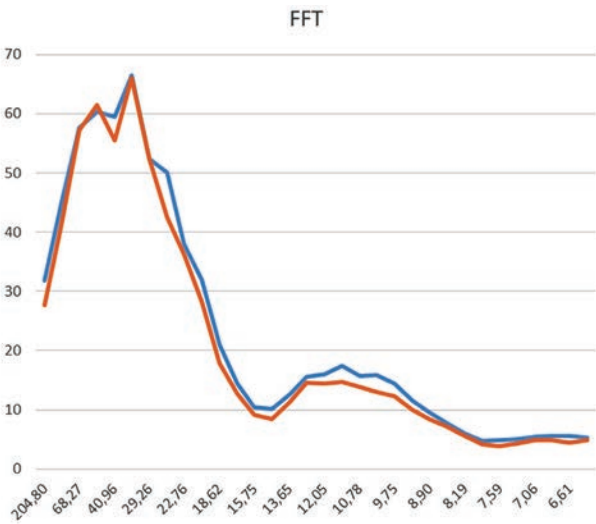

Fig. 5. Spectrogram of PMA with FFT signal of PPS at N = 50

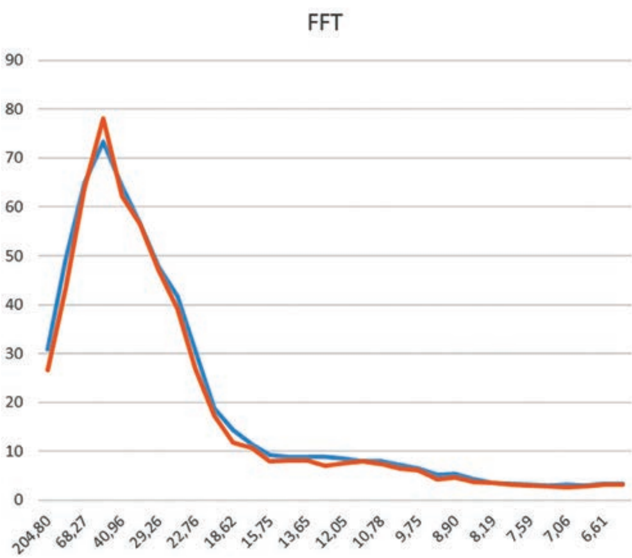

Fig. 6. Spectrogram of PMA with FFT signal of PPS at N = 100

The spectrograms shown in figures 4, 5, 6 give a graphical interpretation of the mathematical data given in table 2. We draw attention to the presence of two explicit maxima in the spectrogram figure 5, most likely, the right (corresponding to a shorter period) maximum has a natural origin, and the left maximum is associated with an increase in the accumulation of IFD.

Conclusion

In vibraimage technology, the processing parameters of testee PPS are the function of not only a testee PPS, but also of the vibraimage system settings. The dependence of the measured value on the characteristics of the measuring system is inherent in any measurement (Novitsky, 1975), this should not be surprising, and on the contrary, this phenomenon must be used to configure the optimal mode for each specific application of vibraimage technology.

The number of frames of accumulation of IFD is the main adjustment that allows users to rebuild the system of vibration images from maximum speed to high accuracy. At the same time, one should not forget that the SFC standards obtained in one mode must be corrected, switching to another settings mode. This article allows evaluating the adjustment of PPS norms for settings 20, 50 and 100 frames accumulation of IFD.

A separate issue is the study of the absolute values of the PMA using vibraimage technology. If comparative studies of PMA with various PPS can be carried out objectively, then it is likely that measurements with PMR settings in the range of 20–50 are necessary for measuring PMA in absolute values. It should be clarified that this work was aimed at studying PPS in a free state of a person, and the study of the dependence of PMA on MCR with the presentation of periodic external stimuli requires additional research.

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