Operator Functional State Assessment System

VibraStaff

MANUAL

ELSYS Corp.

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CONTENT

1. Introduction

VibraImage technology measures micromovement (micro motion, vibration) of person by standard digital, web or television cameras and image processing. Human head microvibration is linked with the vestibular-emotional reflex (VER) of a person and reflects emotion status and personality traits. VibraStaff system detects human emotions by the control of three dimensional (3D) head-neck movements and fluctuations, accumulated as frame difference in several video frames.

Micro mode measures micromovements, time and spatial fluctuations of object, by calculation of vibration parameters (frequency and amplitude) for each element (pixel) of the researched image. With the help of this method it was possible to define, that VibraImage parameters indicates (measures or quantitatively characterize) emotions or personality traits and psychophysiological status of a person.

The human operator is a crucial component of complex modern systems. The complexity of these systems, the rapid tempo of contemporary civil/military operations and reduced staffing all contribute to the high cognitive demands experienced by civil/military personnel. Unfortunately, these systems do not account for the functional state of the human operator. The rate of information flow, the number of decisions, and actions that must be carried out can become so demanding that the cognitive capacity of the operator can be exceeded. This can result in disastrous consequences. These catastrophic events are brought about by human error when operators are placed in situations requiring cognitive resources beyond those currently available. Other system components are routinely monitored for their state of health. If deficiencies are found, then corrective actions are taken or the mission is aborted. Similar monitoring and corrections are needed for the human component.

1.1. Basic applications

VibraStaff is designed for psychophysiological diagnostics and psychological researches of human operators before the shift. VibraStaff solves the following tasks:

- operator functional state assessment before a shift and stopping access to the shift for persons with the risk of human factor;
- functional and psychophysiological personal diagnostics based on corresponding individual and statistic norms;
- operator functional and psychophysiological states monitoring and statistics processing for operators of complex modern systems, like airport supervisor, traffic controller, nuclear station operator, drivers, etc.

1.2. Specifications

1.2.1. Basic parameters

- Resolution, TVL, more than   400
- Noise level of vibraimage, bit, less than   0,1
- Frame speed, frame/sec, more than   25
- Frequency range, Hz, more than $0,1 \div 10$

1.2.2. Digital (web) camera requirements

- Sensor   CCD or CMOS Sensor
- Resolution, pixel., more than   640 x 480
- USB compatible   USB 3.0; USB 2.0; USB 1.0
- Frame speed, f/s, more than   25
- Microphone   external
- Exposition control   auto and manual
- Color mode   color and B/W switch
- Flicker mode   Flicker 50 Hz and 60 Hz

1.2.3. System requirements for local module computer

- Operation System   Windows 7/8/10 with DirectX 9.0 or later
- Processor   Pentium Core Duo 2 2400 MHz or higher
- RAM   more than 2048 Mb
- HDD   more than 10 Gb
- USB port   1 free USB ports version USB 2.0
- Installed software 1   DirectX 9.0 or later
- Installed software 2   Windows Microsoft.NET Framework 1.1, 2.x, 3.5 or later
- Video capture   WDM-compatible video device

1.3. Package delivery contents

1. VibraStaff software   -   1
2. Activation code   -   1
3. User's manual   -   1
4. Digital USB camera (option)   -   1
5. Personal computer (option)   -   1

2. VibraStaff software installation

To install VibraStaff please follow steps below:

1. Go to Web page http://www.psymaker.com/support/downloads/
2. Load file VibraStaff http://www.psymaker.com/downloads/VibraStaff.exe
3. Run file VibraStaff.exe from archive file
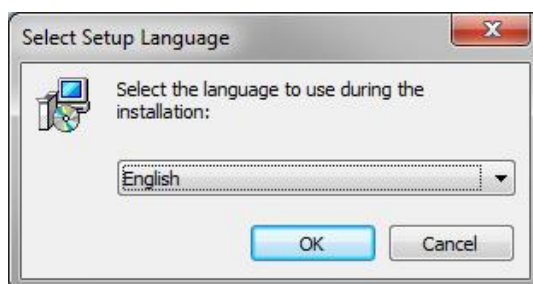4. Select language for installation procedure (fig. 2.1).

Fig. 2.1. Choice of language installation

5. Press button «Next» in the appeared window of the beginning installation.
6. Accept the license agreement and to press button «Next» in the appeared window.
7. In the appeared window specify a way to the catalogue where files of the program will be written down, then to press button «Next».
8. Press button «Next» in the appeared window, allows installation of software files on your computer.
9. In the appeared window select versions of the program which you want to install on the computer (fig. 2.2).

Fig. 2.2. Choice of additional tasks during installation

10. Press button «Install» at the start of installation.

11. Press button «Finish» at the end of installation.
12. VibraStaff program pictogram appears after the end of installation in system menu and on desktop of your computer.
13. To reboot a computer.

2.1. VibraStaff software activation

Attention:

1. Procedure of activation is made once at the first start of the program.
2. Before the program activation it is necessary to buy this modification of the program in the online shop Psymaker http://www.psymaker.com/ru/shop/
3. Activation procedure requests access to the Internet for receiving answer code from server.
4. Activation code has the structure given in the table.

Key type	Software modification
VI8_xxxxxx_STF	VibraStaff software is intended for: • operator functional state assessment before a shift and stopping access to the shift for persons with the risk of human factor; • functional and psychophysiological personal diagnostics based on corresponding individual and statistic norms; • operator functional and psychophysiological states monitoring and statistics processing for operators of complex modern systems, like airport supervisor, traffic controller, nuclear station operator, drivers, etc.

2.1.1. Standard activation

1. To start activation is necessary to get starts the program VibraStaff.
2. At the first start of the program the activation window will be displayed (fig. 2.3).

Fig. 2.3. Activation window

3. In the field «**Request**» it is necessary to enter the activation code received by e-mail or specified by the seller. After input of activation code to press the button «**Get Answer code using HTTP**».

   Attention! Please, be careful and paste code without additional gaps!

4. The activation code will be checked up through the Internet and, in case of successful end of activation procedure, the answer code will be sent (fig. 2.4).

Fig. 2.4. Successful activation

5. Press button «**OK**». VibraStaff will be automatically started. **Attention! The first launch must be carried out with administrator rights!**

Fig. 2.5. The first start of the program
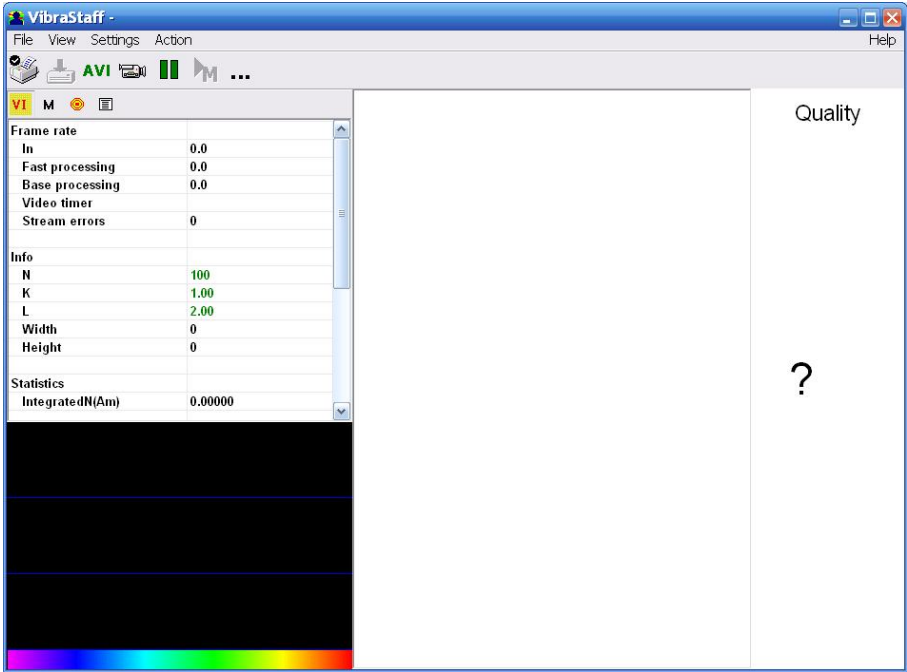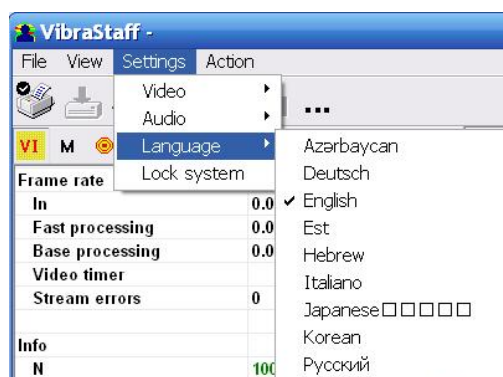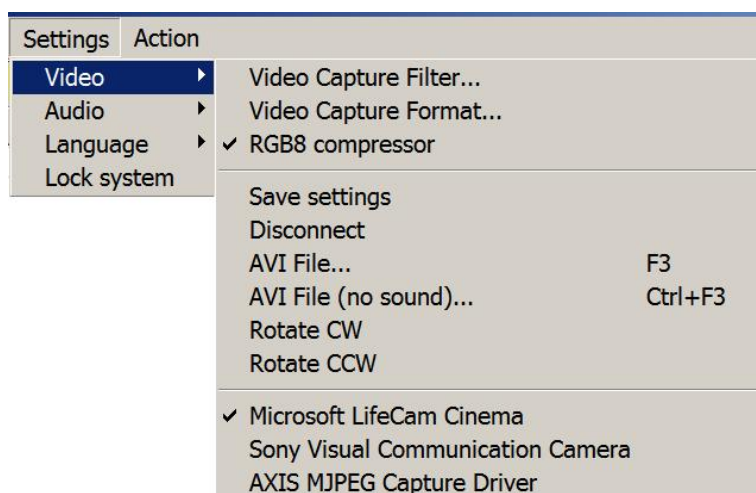
6. To select program language in the menu «**Settings**» => «**Language**» (fig. 2.6).

Fig. 2.6. The choice of the program language

7. After connecting to the computer the camera to select the camera for operation in the menu «**Settings** » => «**Video**» (fig. 2.7 – camera Microsoft LifeCam Cinema).


Fig. 2.7. The camera connecting

8. Start operation with system.

2.1.2. DEMO activation

Note, for each modification you have a possibility of the program start in the DEMO mode only 5 times. Then the Internet code is required to be bought.

1. To start activation it is necessary to get starts the program VibraStaff.
2. At the first start of the program the activation window will be displayed (fig. 2.8).
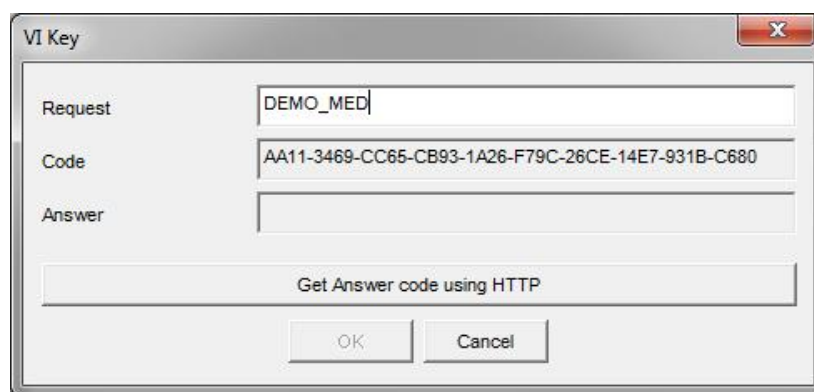
Fig. 2.8. DEMO activation window

3. In the field «**Request**» it is necessary to enter uppercase letters of «**DEMO_MED**» (fig. 2.8). After input of an demo activation code to press the button «**Get Answer code using HTTP**».
4. The activation code will be checked up through the Internet and, in case of successful end of activation procedure, the answer code will be sent and will be appeared in the field «**Answer**» (fig. 2.9).
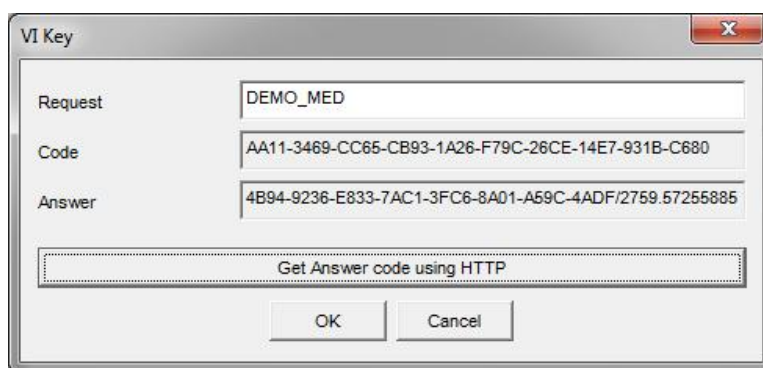
Fig. 2.9. Successful DEMO activation

5. Further items 5-8 as in case «**Standard activation**»

2.2. Reinstallation of VibraStaff

Note, the ability to reinstall VibraStaff software on a new computer is given to user. For this purpose it is necessary to execute the following actions:

1. To connect computer to the Internet.
2. To start VibraStaff program for reinstallation on a new computer.
3. In a program window, having pressed the mouse right button, to cause the menu and to choose item «About Vibraimage…» (fig. 2.10).
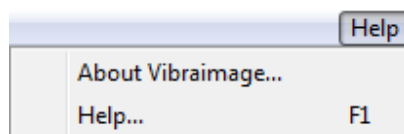
Fig. 2.10. Menu «Help»

4. In the opened window to press the button «**Unregister key**» (fig. 2.11).

Fig. 2.11. Information about the program

5. Close the program.
6. Connect a new computer to Internet.
7. On the new computer to install the chosen program modification and to make registration of an «old» modification activation code through the Internet, according to recommendations of section 2.1.
8. After successful program registration the given activation code will be fixed to the given computer.

2.3 Camera's setting

2.3.1 Video camera choice

It is necessary to select in the main menu **«Settings»** => «**Video**» => «.../**name used camera**/...». In figure 2.12 the process of selecting the camera «Microsoft LifeCam Cinema» is shown. If the camera is connected, selected and works, then the left of the name there will be an icon «✔», and the menu will be extended with the **«Video capture filter...»** and **«Video capture format...»**.
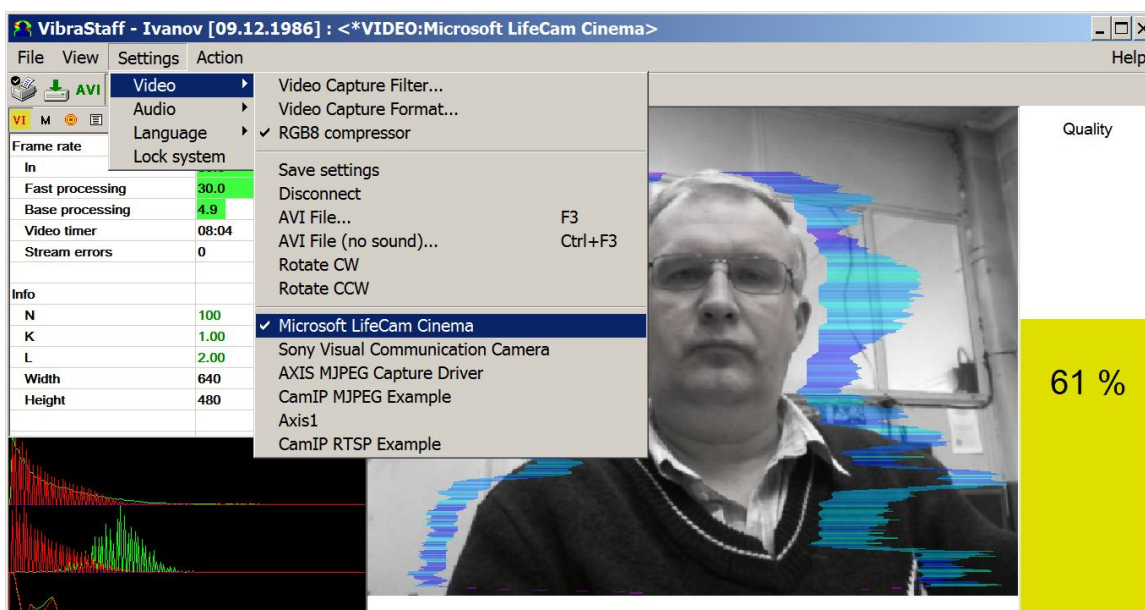

Fig. 2.12 The camera «Microsoft LifeCam Cinema» » is selected

2.3.2 Video capture filter

To open the menu of the camera settings you must be select «**Video capture filter......**» in the submenu «**Video**» (fig. 2.13). Item «**Video capture filter...**» appears in the menu only in case of the correct installation of drivers of the camera and a choice of the working camera.
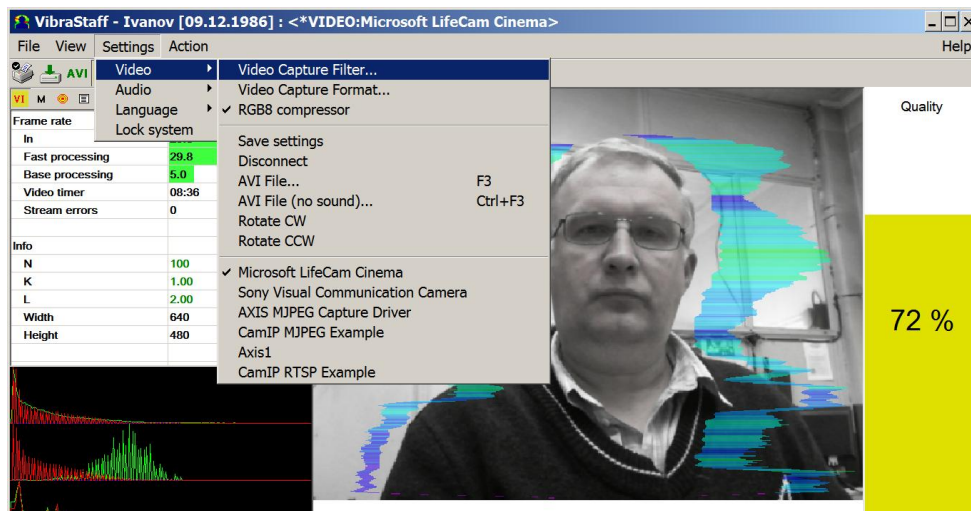
Fig. 2.13. Opening of the camera's settings menu («Video capture filter...»)

After a choice of the «**Video capture filter...**» the window «**Settings**» will open. Settings window differs depends on camera type. The first tab of this window is usually devoted to the image setup (Brightness, Contrast, etc.). In a figure 2.15 the window «**Settings**» for the camera «**Microsoft LifeCam Cinema**», and in a figure 2.14 for the camera «Look 1320 V2» is shown. Camera Microsoft LifeCam Cinema has low noise level and is preferable for vibraimage applications among webcams.

«Brightness», «Contrast» and other parameters should be set up so that image of object has more contrast. Switching on/off flicker-effect from artificial lighting could be necessary for some illumination types.
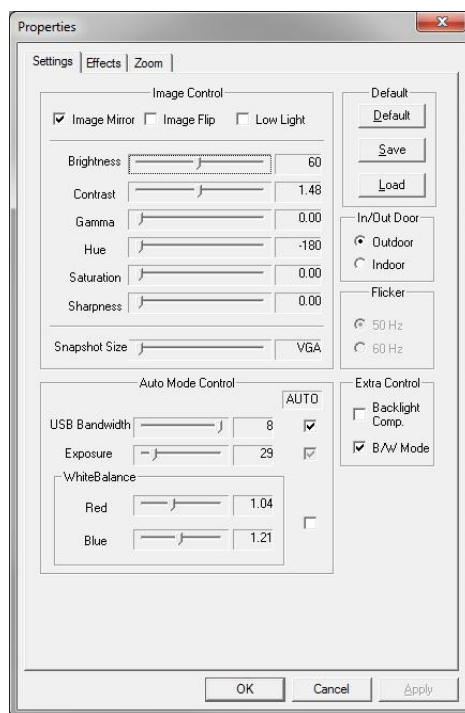
Fig. 2.14 Window «Settings», video setting, camera «Look 1320 V2»
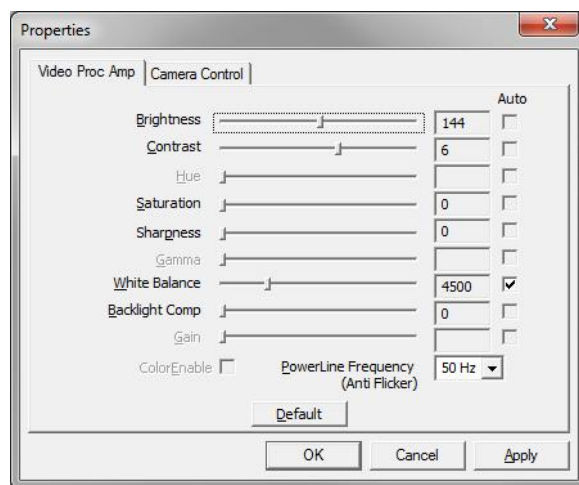
Fig. 2.15. Video setting, camera « Microsoft LifeCam Cinema»

Depending on the experimental conditions and light is necessary to select auto or manual settings «**Focus**», «**Exposure**». If the illumination is constant, then it is recommended to use manual configuration, if you change (for example, the illumination of an object depends on street lighting), it is better to use automatic configuration. The «**Scale**» (Zoom) is recommended to select based on two factors. Firstly you need to have maximum image size of control object and it is preferably to stand maximum zoom level. From the other side high level of electronic zoom in some cameras could go down the frame rate and it is necessary to control this parameter and fixed frame rate more than 25 f/s. So for webcam Microsoft LifeCam Cinema the optimal meaning of zoom for personal control is 4, see Fig. 2.16. For other cameras is possible to adjust other optimal zoom settings.
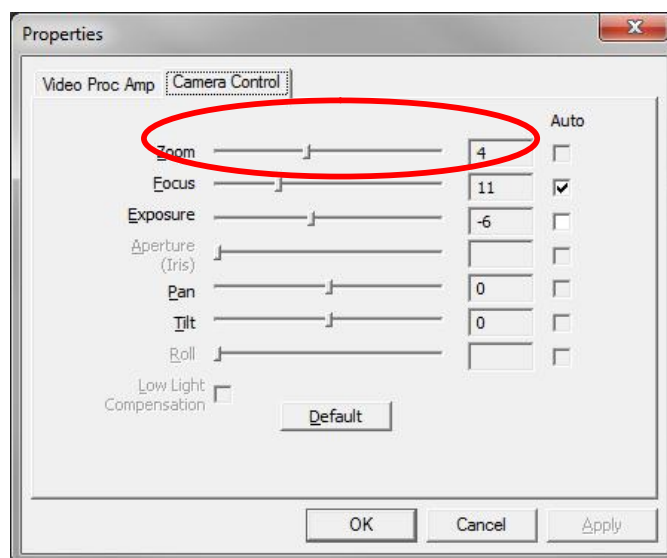
Fig. 2.16. Zoom setting, camera « Microsoft LifeCam Cinema»

2.3.3 Video capture format

To open the menu of the camera settings you must be select «**Video capture filter...**» in the submenu «**Video**» (fig. 2.17). Item «**Video capture format...**» appears in the menu only in case of the correct installation of drivers of the camera and a choice of the working camera. Frame rate is necessary to set 30 and the frame size to set («Output Size») 640 x 480 elements (fig. 2.18).
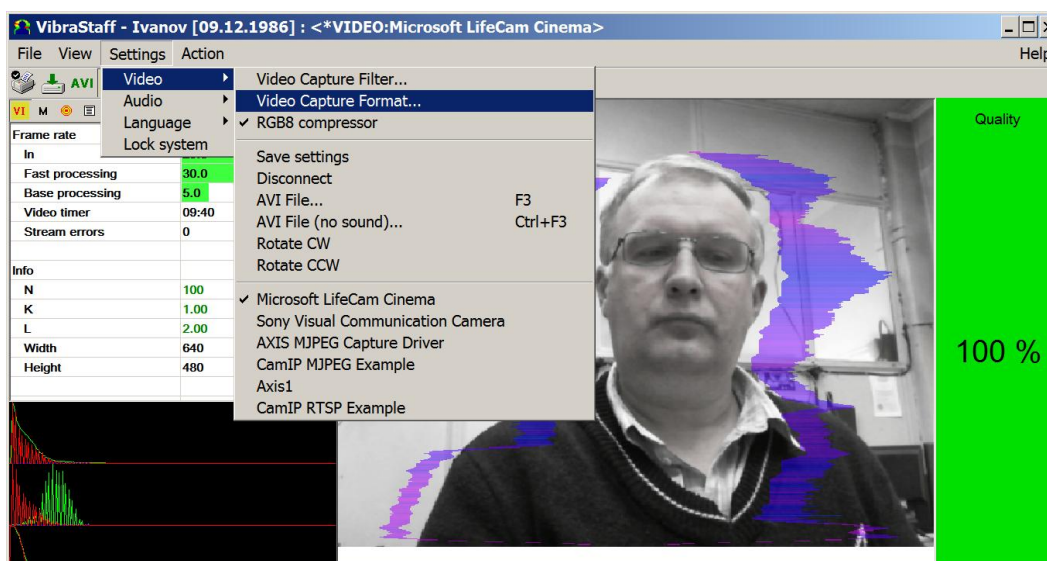
Fig. 2.17. Opening the settings window «Video capture format»
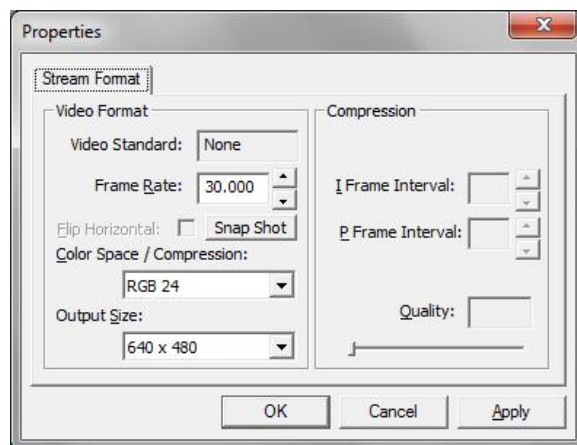
Fig. 2.18. Window «Video capture format»

Note, when changing camera settings in the program VibraStaff frame rate «In» should be in the range of 25 - 30 frames/s. The parameter IntegratedN (Am) must be minimum, but not exceeding 0.1.

2.3.4 Checking the settings on the test table

During the first start of Vibraimage system and periodically it is recommended to test image quality by the test table. It is required to place a test pattern opposite to the camera so that the image of the table occupies the entire space of the frame. To achieve the optimal contrast range of object is need to stand in camera settings auto regulation of illumination in case of unstable illumination (fig. 2.19) and manual regulation of illumination in case of a constant illumination (fig. 2.20).
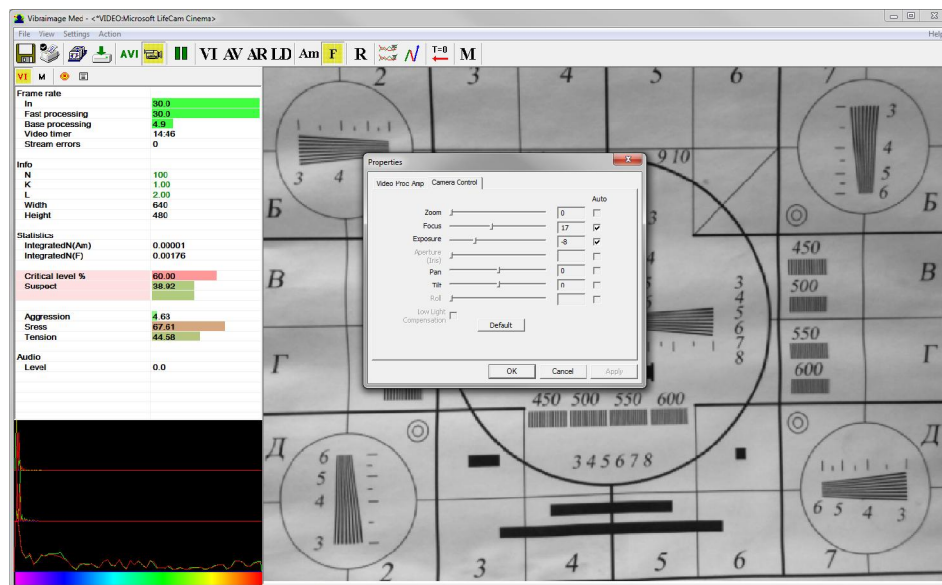
Fig. 2.19. Checking the camera settings on the test table, automatic regulation of the exposure (mode is recommended for unstable object illumination).
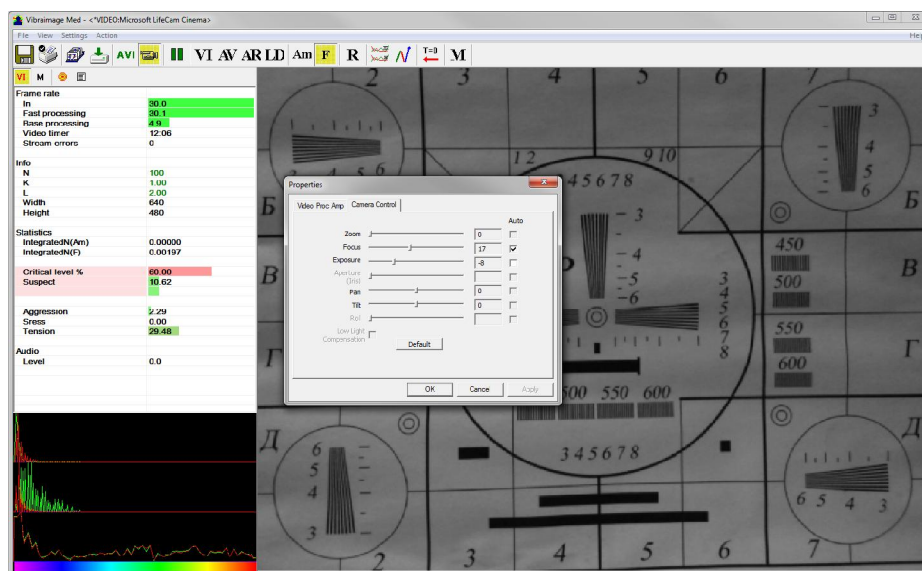
Fig. 2.20. Checking the camera settings on the test table, manual regulation of the exposure (mode is recommended for stable object illumination).

2.3.5 Video quality auto checking function

VibraStaff program has auto checking function and image quality control during the test. Auto checking function switch on in Information table ⊙ in the section «Face detection» «Quality test» For correct operation of the quality test it is necessary to switch on «Face detection» (Face detection – Yes). If you do not want to look frame around face you should «draw» switch off, see fig. 2.21.
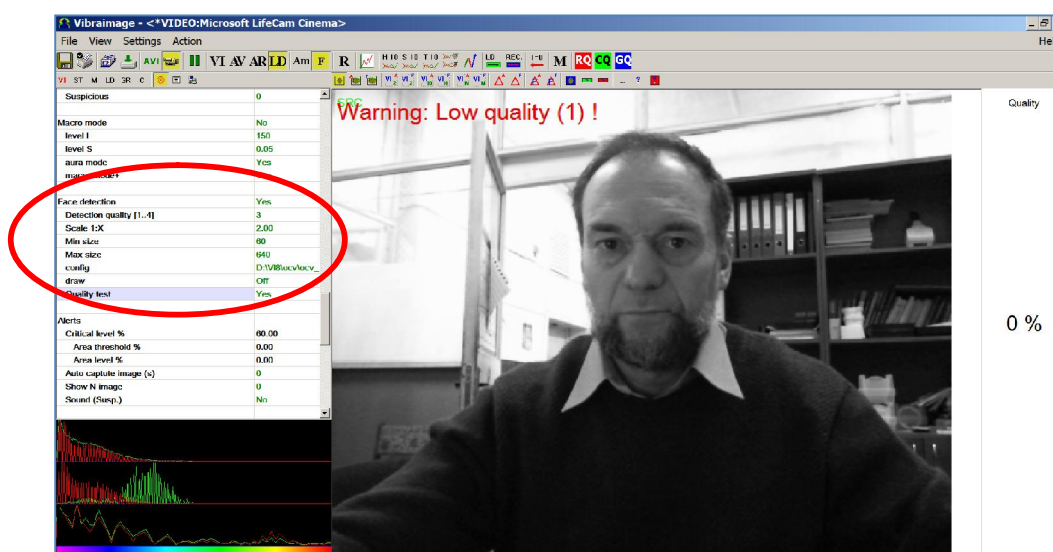
Fig. 2.21. Quality test indication stands Yes in settings and Error 1 shows in the image window. Head image size is lower than requested.

Program gives error indication if the image quality is lower than standard vibraimage requests:

Error 1 – indicates when facial image is lower than necessary. For cancel this error is need to move checked person near to camera or start zoom function on camera.

Error 2 – indicates when camera noise level is higher than necessary. The reason of this error could be low illumination, incorrect camera settings or camera vibration.

Error 3 – indicates when computer input frequency rate is lower than necessary. Requested norm for processed frame frequency is more than 24 f/s. This errors indication was done for deleting unqualified staff influence during results control.

Quality column shows time % during the testing when image quality is equal 100%. When we have quality indication 91 %, that means 91% of testing time image quality hasn't errors and 9% of testing time image quality includes errors with the number 1 or 2 or 3.

Pressing button R reset image quality to the beginning 100 %. In lie detection mode and M mode image quality is very important and testing with image quality lower 80 % could not be acceptable for processing.

3 VibraStaff. User's manual

Welcome to the VibraImage World! Thank you for your purchase of VibraStaff system. This manual is written to help you enjoy Vibraimaging and open new features in well-known objects!

VibraStaff is intended for studying of psycho-physiological and psycho-emotional characteristics of living biological objects and also can be applied to the lifeless objects making periodic vibrational motions. The main application is medical diagnostics.

After start of VibraStaff in the main window there is an image from connected video device.

3.1. Main window

Main window (fig. 3.1) consists of the following parts:

- image area (on right side);
- information column (on left side);
- toolbar (on top).

In an information column (at the left side on the screen) it is displayed, calculated by the program, values of person emotion level parameters.

In heading of the basic window the following information is indicated (fig. 3.1):

- type of video source: Video camera or AVI file;
- model of video source: Video camera model or AVI file name;
- name of program.

Information column   Toolbar   Image area
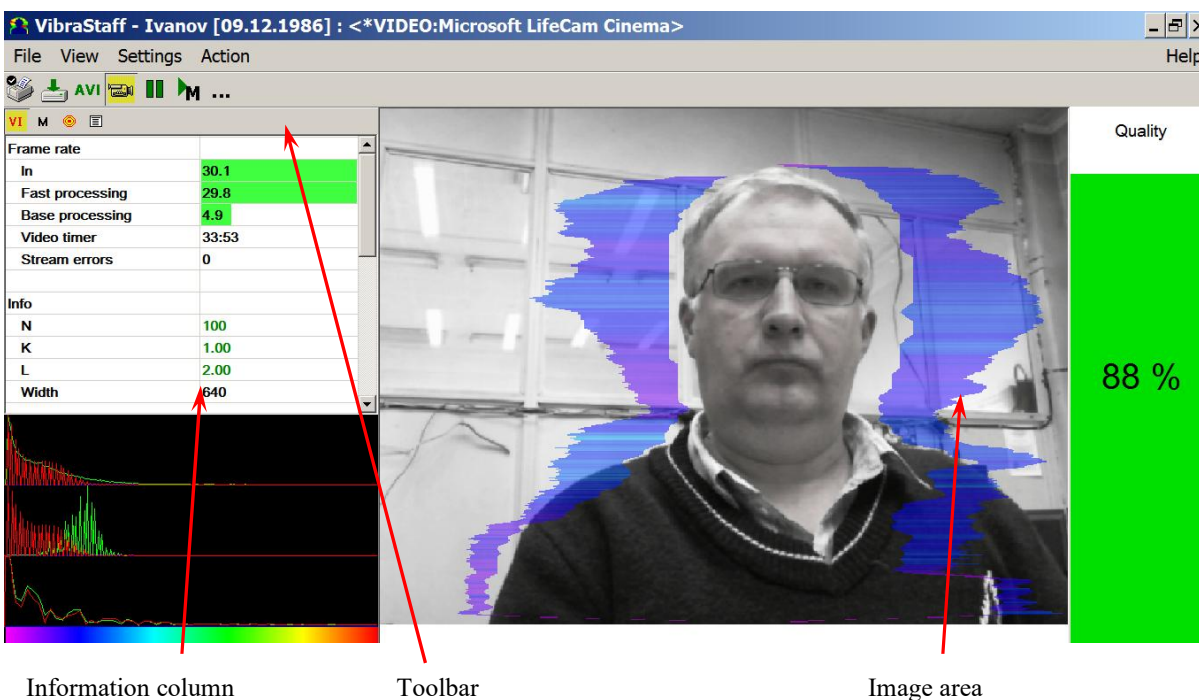
Fig. 3.1. Main window VibraStaff

Note, double click by the left button of a mouse in the image field of makes **RESET** of all saved up information and statistics about frames and start new cycle collection of information.

3.2. Main menu

The main menu contains the following items:

- «**File**»
- «**View**»
- «**Settings**»
- «**Action**»
- «**Help**»

3.2.1 Menu «File»

Menu «**File**» (fig. 3.2) contains following items:
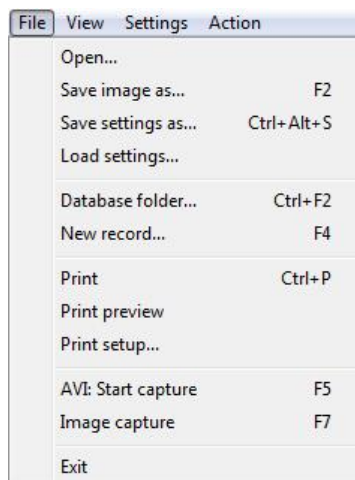
Fig. 3.2. Menu «File»

Item «**Open…**» - for viewing and printing the saved file of XML format with parameters of system for the supervision interval.

Item «**Save image as…**» - saving the current frame of a window in BMP, JPG, PNG or GIF-file.

Item « **Save settings as …** » it is intended for saving of the current system settings to the external file.

Item « **Load settings …** » it is intended for loading before saved the system settings from an external file

Item «**Database folder…**» - changing folder where archive data is kept. If the database folder is not specified, record of AVI or BMP files is blocked.

Note. Until you specify a folder to archive record of AVI and BMP files in the archive will be blocked.

Item «**New record...** » - Create a new record in archive folder. Further saving of AVI and BMP files in archive will be made in the folder connected to a name of entered record.

Item «**Print**» - printing the current frame from image area.

Item «**Print Preview**» - printing preview of current frame from image area.

Item **Print Setup…**» - set printing options.

Item «**AVI: Start Capture» -** start record AVI-file. If the database folder is not specified, record of AVI files is blocked.

Item «**Image capture…» -** saving the current frame of a window in the database folder.

Item «**Exit» -** exit from program.

3.2.2 Menu «View»

Menu **«View»** (fig. 3.3) defines visible in the basic window information and contains the following items:
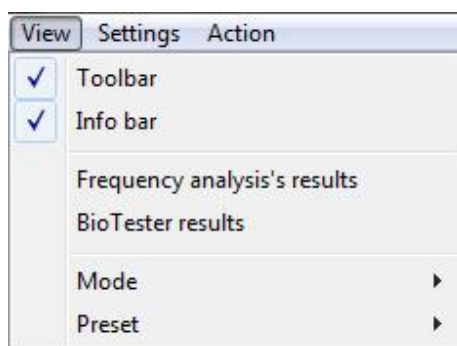
Fig. 3.3. Menu «View»

Item **«Toolbar»** - switch on/off the toolbar.

Item **«Info bar»** - switch on/off the information panel.

Item **«Frequency analysis's results» -** show/hide histogram of frequency analysis of the set values (fig. 3.4).

Item **«BioTester results» -** show/hide window with biotester analysis results (fig. 3.5).
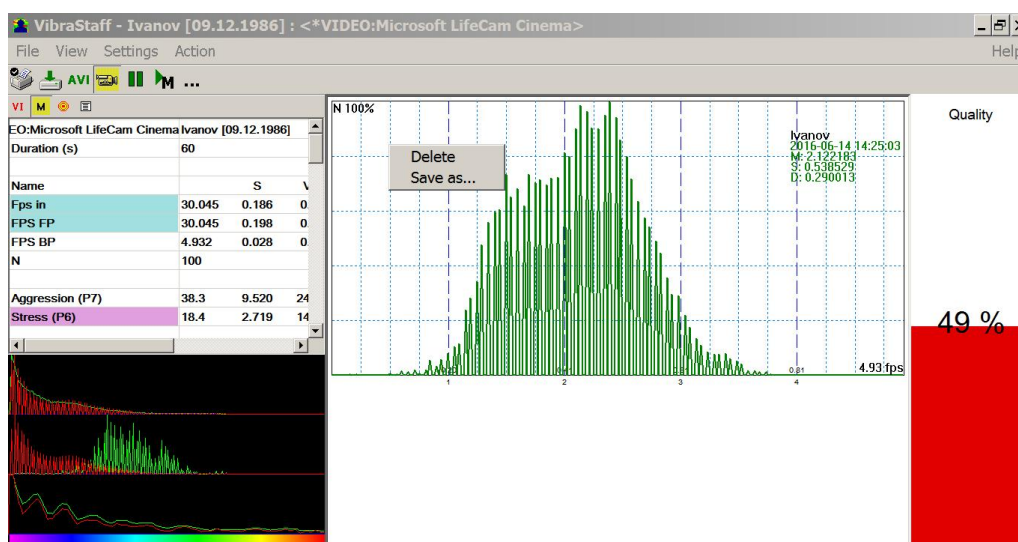
Fig. 3.4. Frequency analysis's results

To save the resulting graphics to an external file you must click the right mouse button on the graph and select item «**Save as...**» (fig. 3.4). For removing the received graph of the frequency analysis is necessary to bring the mouse pointer to the chosen diagram, press the right mouse button and to choose item **«Delete»** (fig. 3.5).
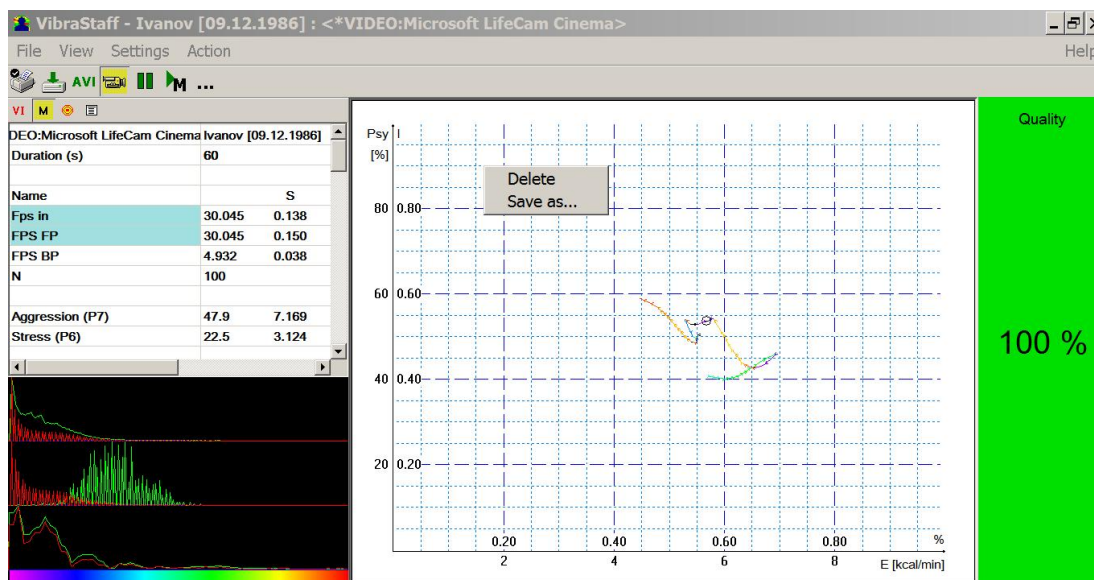
Fig. 3.5. BioTester results

Submenu «**Mode**» defines additional configuration and number of windows with an image displayed in the image area.

Submenu «**Preset**» defines the type of the display image: the real image (mode LD), vibraimage (mode VI), the vibra-aura on the real image (mode AR), the vibra-aura on vibraimage (mode AV). Also, you can configure the corresponding buttons on the toolbar.
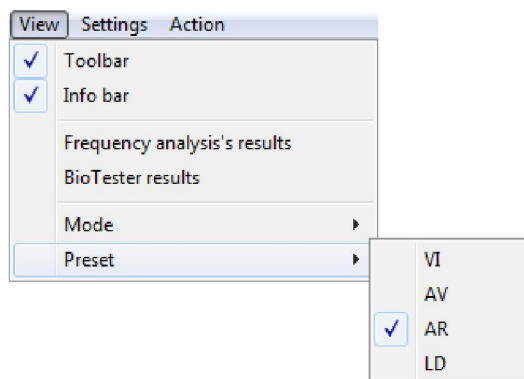
Fig. 3.6. Submenu «Preset»

3.2.2.1. Submenu «Preset»

In the field of the image area (fig. 3.7a – 3.7d), depending on the chosen mode, the user can see the «real» video image, vibraimage, external vibraimage (vibra-aura), or graphs time dependences for control in LD mode, or any other mode.

Note, in the upper left corner of the displayed image the processing mode of the image and the time from start viewing the AVI file indicates.
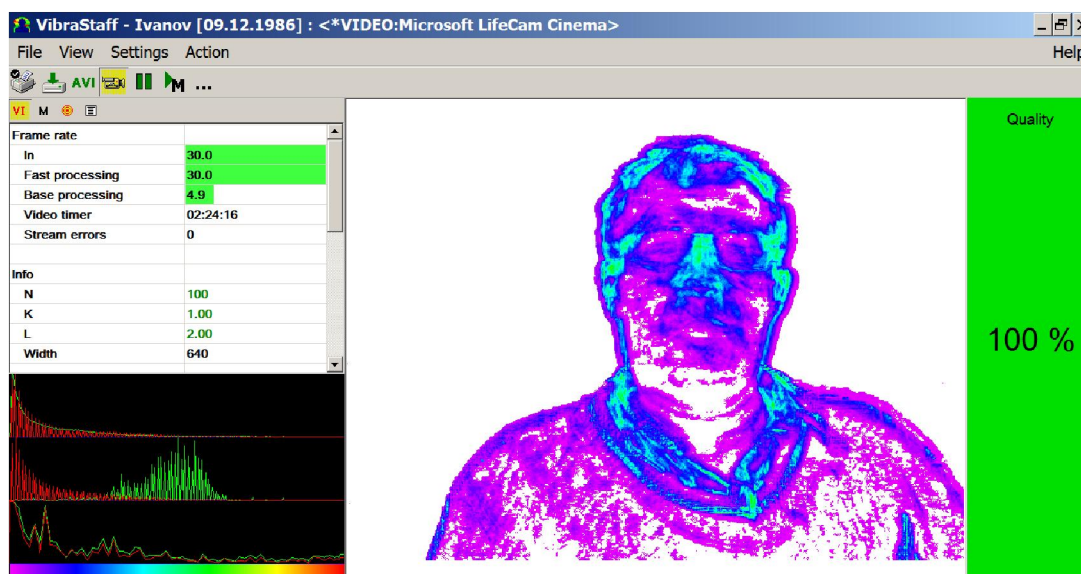
Fig. 3.7a. VI mode on the white background with the analysis of the vibration frequency points (F) and on the accumulation of N = 100 frames
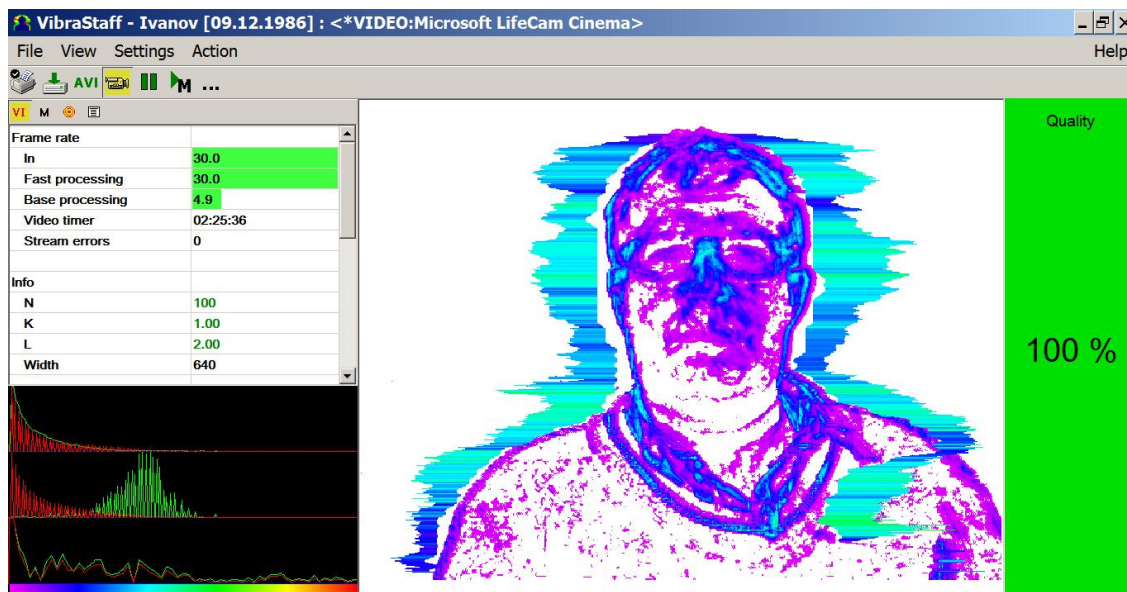
Fig. 3.7b. AV mode
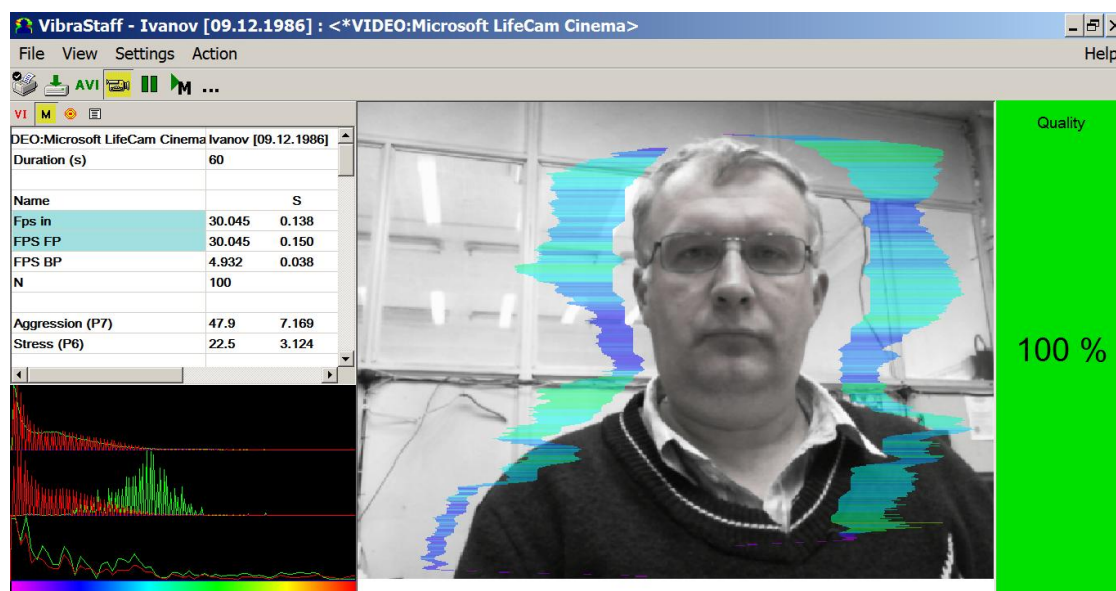
Fig. 3.7c. AR mode
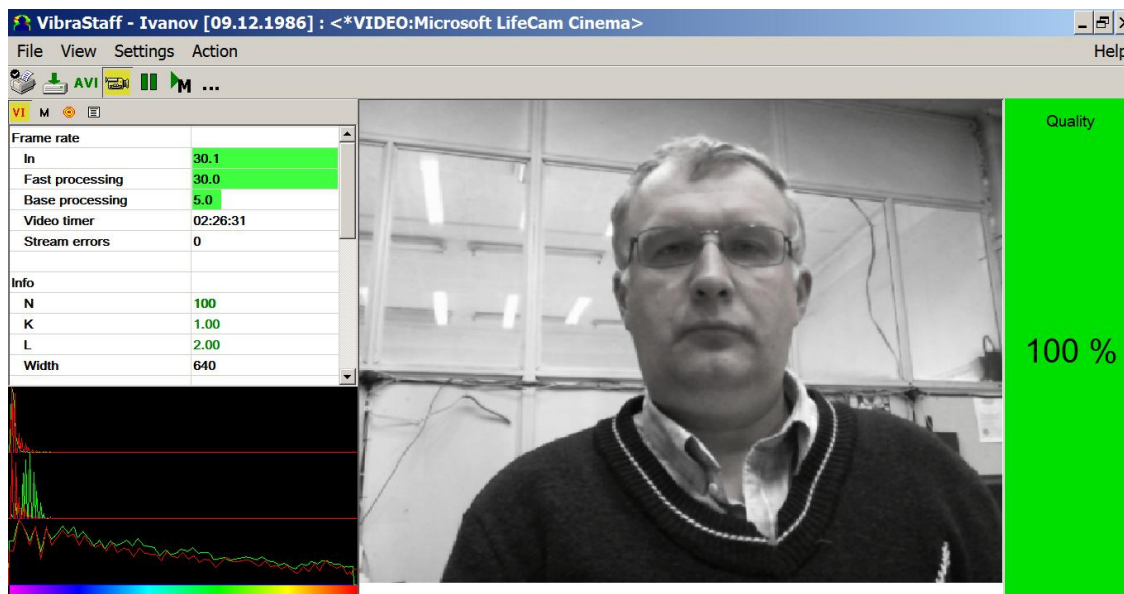
Fig. 3.7d. LD mode

Item **«Presets»** menu (fig. 3.5) designed to choice one basic mode in image area.

- In **«VI»** mode [«VibraImage mode»] displays vibraimage of person. Color for every image pixel depends on its amplitude or frequency of vibrations (fig. 3.7a). In VibraStaff version color for every image pixel depends on its vibrations frequency.

- In **«AV»** mode [«Aura Vibraimage mode»] external vibraimage (aura) allocated around the internal vibraimage or simple vibraimage. Aura line size depends on medium line vibration amplitude. Aura line color depends on maximum line vibration frequency inside vibraimage contour (fig. 3.7b).

- In **«AR»** mode [«Aura on the Real image»] the aura of the person is shown around his real image (fig. 3.7c).

- In **«LD»** mode [«Lie Detector mode»] image area shows real object image (fig. 3.7d).

3.2.2.2. Submenu «Mode»

Item **«Mode»** (fig. 3.8) selects additional settings of information in image area:
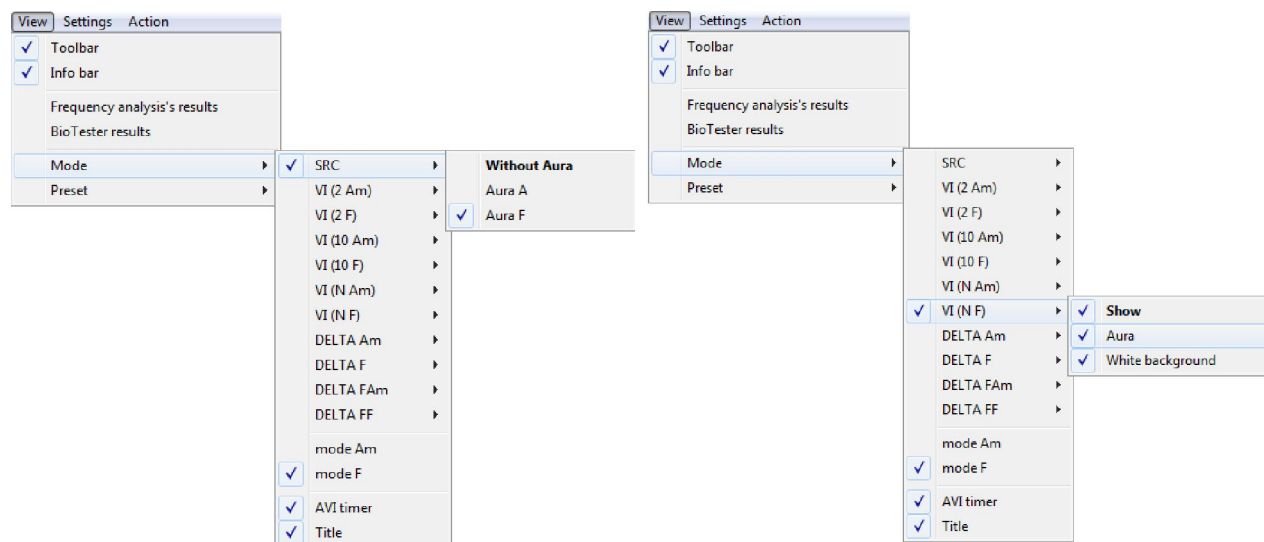
Fig. 3.8. Menu «View». Submenu «Mode»

Note, at a displayed of the image in VI and AV modes it is possible to change color of a background of the image, having chosen main menu item «**White background**».

Note, at the same time in the program can be switched only one display mode.

- In **«SRC»** mode shows source video from camera without processing (fig. 3.7d). It is additional possibility to display the aura on the real image of person constructed on the analysis of pixels vibration amplitude, or pixels vibration frequencies. The length of the beam vibra-aura in this case will be determined by the average value of the points parameter in a row, and the color of the beam vibra-aura – by the maximum value.

- In **«VI (2 Am)»** and **«VI (2 F)»** modes display vibraimage, processed during 2 frames and constructed on the basis of amplitude **Am** and frequency **F** analysis of vibration. It is additional possibility to change color of background image and to add vibra-aura to vibraimage (fig. 3.7b).

- In **«VI (10 Am)»** and **«VI (10 F)»** modes display vibraimage, processed during 10 frames and constructed on the basis of amplitude **Am** and frequency **F** vibration analysis. It is the additional possibility to change color of a background image and to add aura to vibraimage.

- In **«VI (N Am)»** and **«VI (N F)»** modes display vibraimage, processed during N frames and constructed on the basis of amplitude **Am** and frequency **F** vibration analysis. It is the additional possibility to change color of a background image and to add vibra-aura to vibraimage. The number of frames, corresponding to parameter N, is set in information panel in mode «**VI**».

- In **«Delta Am »** and **«Delta F»** modes display frame difference on the basis of amplitude Am and frequency F vibration analysis in base processing mode.

  Note, in this mode the vibra-aura will be based on the vibraimage which has been accumulated for N frames!

- In **«View mode Delta FA »** and **« View mode Delta FA »** modes display frame difference on the basis of amplitude Am and frequency F vibration analysis in fast processing mode.

- In **«mode Am»** visualization and calculation of object parameters processed by pixel vibration amplitude.

- In **«mode F»** visualization and calculation of object parameters processed by pixel vibration frequency.

- Items **«AVI timer»** and **«Title»** displays (in the left top corner in each of visible windows with images) the name of a processing mode which is used for the given window, and time from the beginning of viewing AVI file.

3.2.3. Menu «Settings»

Menu **«Settings»** (fig. 3.9) allows choosing language, locking system, choosing camera settings and contains the following items:
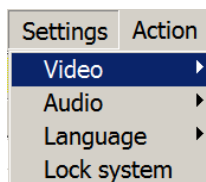
Fig. 3.9. Menu «Settings»

3.2.3.1 Submenu «Video»

Submenu **«Video»** contains options of video modes. Its can differ depending on connected devices. For example this menu contains the following items (fig.3.10). You can choose as video source one from many installing in PC video-devices or load external video file.
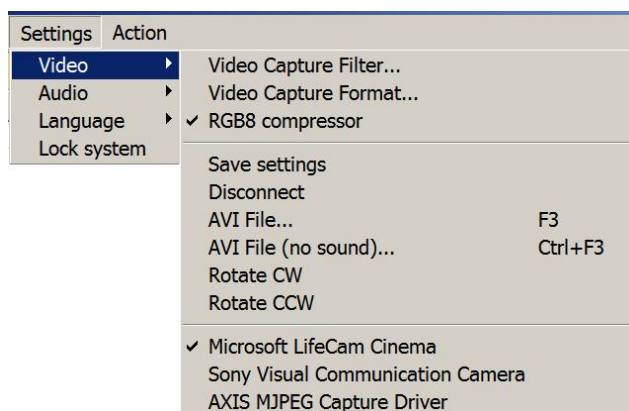
Fig. 3.10. Submenu «Video»

Subitem **«Video Capture Filter…»** - by pressing the window of video device setting (contrast, exposition, brightness) opens. Each device has the especial window of settings.

Subitem **«Video Capture Format…»** - change video capture format.

Subitem **« RGB8 compressor »** are intended for management of a videofile record format. If this item is chosen, that, for economy of a space on a hard disk, the videofile saved in a black-and-white format.

Subitem **«Save settings»** allows to save current camera settings in the Windows registry in order to load them at next startup programs with this camera

Subitem **«Disconnect»** allows to disconnect all videocamera or videofile

Subitems «**AVI File…**» and «**AVI File (no sound)…**» [AVI File (no sound)…] are intended for selecting for the analysis of an external video file

Subitems **«Rotate CW»** and **«Rotate CCW»** allow allow to make turn of an input video image on 90 and 270 degrees before its processing in the VibraStaff.

The bottom menu allows you to choose a used device video capture from multiple installed on this computer.

3.2.4. Menu «Action»

Menu «**Settings**» (fig. 3.11) contains the following items:
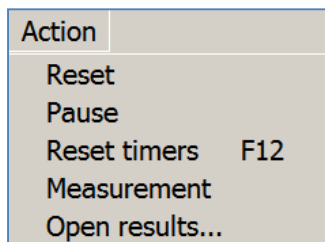
Fig. 3.11. Menu «Action»

Item **«Reset» -** reset all saved up information and statistics about frames and start new cycle collection of information.

Item **«Pause» -** stop last accepted frame of data in image area of windows.

Item **«Reset timer»** **-** reset to «0» video file timer. The conclusion video begins all over again.

At a choice of item **«Measurement»** (or corresponding toolbar button) the system makes accumulation, averaging and a display of parameters for the specified time period. The results display is made in the information panel in a mode «M». In the same place in seconds value of the averaging period **«Duration»** is set.

3.3 Toolbar

Toolbar of VibraStaff shown on the fig. 3.12.

Fig. 3.12. Toolbar of VibraStaff.

Tools panel of VibraStaff program includes functions corresponding to buttons on the Tools panel from left to right:

– printing current image;

– AVI file - start record;

– loading AVI file;

– connection of operating video source, for example, webcams;

– pause;

– switching on/off mode of accumulation and averaging of parameters for the certain period;

– open archive folder with results files.

3.4. Information column

Indication of information column (fig. 3.13) depends on using mode:

Fig. 3.13. Modes of the information column

- In the mode [VI] information about adjustments of system and results of data vibraimage processing is displayed;

- In the mode [M] the average values of vibraimage parameters which have been calculated and are average for the certain period are displayed;

- In the mode [◎] settings of basic parameters for vibraimage processing are configured;

- In the mode [▤] input and selection of the demographic information and a folder for archive storage is configured.

Note, values of parameters in fields which are allocated by a green font, can be changed by the user (fig. 3.15, parameters N, K, L - it is possible to change in Information table). For this purpose it is necessary to bring the mouse pointer to the chosen field and twice to click the left button of a mouse.

In the bottom part of information panel displays three windows with results of the frequency analysis (fig. 3.14). In the first window the frequency analysis vibraimage on the whole frame (by red color - amplitude, green color - frequency of vibration pixels) is displayed. In the second window the frequency and amplitude histograms for external vibraimage (aura), and in the third - spectrums of the frequency analysis with application of FFT of two parameters (A1X and F1X) are displayed.
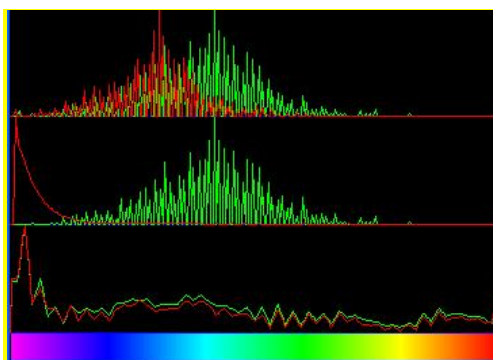
Fig. 3.14. Histograms windows

3.4.1. Information column. VI mode

In the mode «**VI**» information panel (fig. 3.15) displays following information:

Fig. 3.15. Information column in the VI mode

Frame rate:

- «**In**» – Number of the frames per second, received from the video source;
- «**Fast processing**» – Maximum number of the processed frames per second used for calculation. Selected by user;
- «**Base processing**» – Number of the processed frames per second used in base algorithm. Selected by user;
- «**Video Timer**» – For camera mode-displays time of supervision. For recorded video - time of current video-file record. For viewing a video-file - time from the file beginning);

- «**Stream errors**» – The counter of mistakes which increases if time between the next accepted frame unstably. This mistake can arise, if productivity of a computer suffices or poor-quality video is loaded;

Info:

- **N** – Number of the frames for accumulation. Selected by user;
- **K**. – Gain Factor. Selected by user;
- **L** – Palette Threshold. Defines a threshold in the displayed image, value of brightness less threshold is considered «black». Selected by user;

Width and **Height** – Displays the current video camera or avi file resolution;

Statistics:
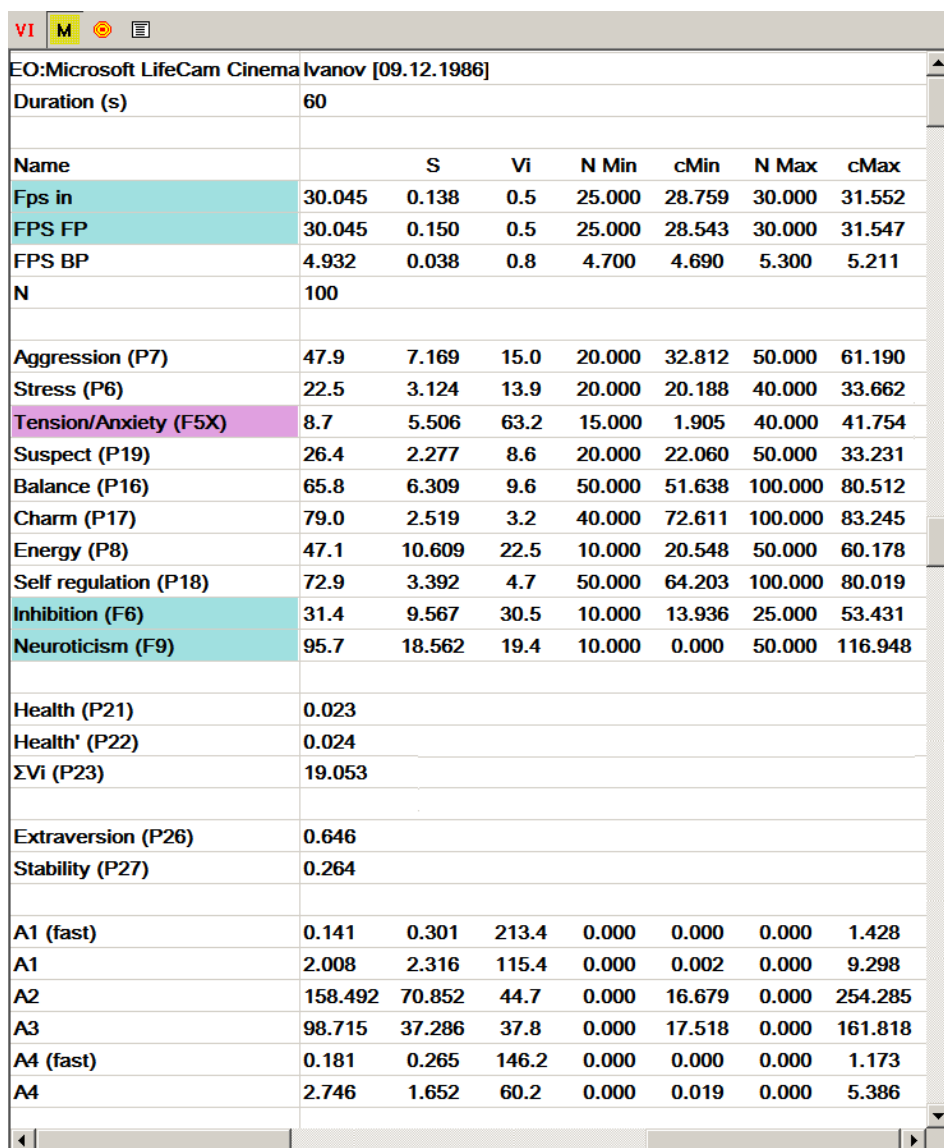
- **IntegratedN(Am)** – Average frame amplitude vibraimage intensity processed for the N frames;
- **IntegratedN(F)** – Average frame frequency vibraimage intensity processed for the N frames;

- «**Critical level %**» – Threshold of a psychoemotional status of the person exposed in % in case of which exceeding on the remote terminal the warning message will be issued;
- «**Suspect**» – Calculated level of suspect for object in frame;

- «**Aggression**» – Calculated level of anger for object in frame;
- «**Stress**» – Calculated level of stress for object in frame;
- «**Tension**» – Calculated level of tension for object in frame;

Audio:

- «**Level**» – current level of audio signal.

3.4.2. Information column. M mode

In a mode «**M**» an information column (fig. 3.16) allows to control average for the period parameters value of psycho-emotional person conditions and their deviation from the established norm. The basic applicability of the given mode is use of vibraimage system for medical diagnostics and psychological researches.

Name		S	Vi	N Min	cMin	N Max	cMax
Fps in	30.045	0.138	0.5	25.000	28.759	30.000	31.552
FPS FP	30.045	0.150	0.5	25.000	28.543	30.000	31.547
FPS BP	4.932	0.038	0.8	4.700	4.690	5.300	5.211
N	100						
Aggression (P7)	47.9	7.169	15.0	20.000	32.812	50.000	61.190
Stress (P6)	22.5	3.124	13.9	20.000	20.188	40.000	33.662
Tension/Anxiety (F5X)	8.7	5.506	63.2	15.000	1.905	40.000	41.754
Suspect (P19)	26.4	2.277	8.6	20.000	22.060	50.000	33.231
Balance (P16)	65.8	6.309	9.6	50.000	51.638	100.000	80.512
Charm (P17)	79.0	2.519	3.2	40.000	72.611	100.000	83.245
Energy (P8)	47.1	10.609	22.5	10.000	20.548	50.000	60.178
Self regulation (P18)	72.9	3.392	4.7	50.000	64.203	100.000	80.019
Inhibition (F6)	31.4	9.567	30.5	10.000	13.936	25.000	53.431
Neuroticism (F9)	95.7	18.562	19.4	10.000	0.000	50.000	116.948
Health (P21)	0.023						
Health' (P22)	0.024						
ΣVi (P23)	19.053						
Extraversion (P26)	0.646						
Stability (P27)	0.264						
A1 (fast)	0.141	0.301	213.4	0.000	0.000	0.000	1.428
A1	2.008	2.316	115.4	0.000	0.002	0.000	9.298
A2	158.492	70.852	44.7	0.000	16.679	0.000	254.285
A3	98.715	37.286	37.8	0.000	17.518	0.000	161.818
A4 (fast)	0.181	0.265	146.2	0.000	0.000	0.000	1.173
A4	2.746	1.652	60.2	0.000	0.019	0.000	5.386

EO:Microsoft LifeCam Cinema Ivanov [09.12.1986]
Duration (s): 60

Fig. 3.16. Information column in the M mode

Value of the averaging period is set in seconds in a field **«Duration»**. Start of the beginning of information accumulation is made by a choice of item [«Measurement»] the menu [«Action»] or

pressing of the toolbar button ![M]. After start of a accumulation and averaging mode in the top of an information column there is a running line [«Progress»], displaying a course of data accumulation process.

Information column in the «**M**» mode shown following information:

- Speed of input frame from the camera [«FPS_in»], speed of frame processing for a base processing mode [«FPS_BP»] and speed of frame processing for a fast processing mode [«FPS_FP»];

- Current values of based processed VibraImage parameters A1-A4, F1-F9, S1-S7, P1-P4.

The group of parameters **A1-A4** registers amplitude of vibrations:

A1 –	Frame difference between two consecutive frames
A2 –	Frame difference accumulated in 10 consecutive frames
A3 –	Frame difference accumulated in N consecutive frames
A4 –	Value of parameter A1 filtered on 10 frames

The group of parameters **F1-F9** registers frequency of vibrations (amount of changing points):

F1 –	Calculated value of changed signal pixels amount in 2 consecutive frames
F2 –	Averaged value of changed signal pixels amount in 10 consecutive frames
F3 –	Average value of elements quantity which have changed for the period of N frames
F4 –	Changed pixels maximum frequency during N processed frames
F5 –	Ratio of «high» frequency density to «low» frequency for parameter F1. Characterized tension parameter.
F6 –	F5 – current tension level (%)
F7 –	Average value of the F1 parameter period (in seconds), determined during readout F6N. Value of parameter F6N is set in section [Filters] an information column in a mode of system parameters setup and defines quantity of the frame processed in Fast Processing mode
F8 –	F6 – Inhibition parameter
F9 –	Root-mean-square deviation for F6 parameter

The group of parameters S1-S7 registers symmetry of vibrations between left and right parts of person body:

S1 –	Ratio (symmetry) of amplitude left to the right changed pixels inside the object in 2 consecutive frames
S2 –	Difference between the left and right average amplitude of object vibration in 10 frames

S3 –   Difference between the left and right average amplitude of object vibration in N frames

S4 –   Ratio of the changed pixels quantity in the left part of object to the changed pixels in the right part in 2 consecutive frames

S5 –   Ratio of the changed pixels quantity in the left object part to the changed pixels quantity in the right object part calculated in 10 frames

S6 –   Ratio of the changed pixels quantity in the left object part to the changed pixels quantity in the right object part calculated in N frames

S7 –   Difference between the maximal frequency of vibrations of the left and right object parts in N frames

The group of parameters P1-P4 registers features of mathematical Processing of vibrations:

P1 –   Dispersion of vibration density for frequency distribution at 10 processing frames

P2 –   Dispersion of vibration density for frequency distribution at N processing frames

P3 –   Center density distribution displacement of frequency at 10 processing frames

P4 –   Center density distribution displacement of frequency at N processing frames

- Current values of fast processing VibraStaff parameters A1 fast, A4 fast, F1 fast, F5 fast;

- Basic parameters describing psycho-emotional condition of the person: Aggression, Stress, Tension/Anxiety, Suspect, Balance, Charm, Energy, Self-regulation, Inhibition, Neuroticism.

- For each parameter the following numerical values are displayed:

V –   The value of the parameter average for the set period

S –   root-mean-square deviation of parameter

cMin –   The minimal value of parameter for the period

cMax –   The maximal value of parameter for the period

NMin –   The minimal value of parameter for a normal condition of the person

NMax –   The maximal value of parameter for a normal condition of the person

Note, values of cMin, cMax parameter, are displayed only when measurement mode «M» has been began and the information for the specified period of time is saved up.

Note, after ending of the information accumulation some lines of an information column can be allocated by color:

- ▮ - parameters, which values less than the set limits are allocated.
- ▮ - parameters, which values more than the set limits are allocated.

Note, for correct diagnostics psycho-emotion conditions of the person speed of data input from the camera should be within the limits of 25-30 frame/second.

3.4.3. Information table

Information table (fig. 3.17) allows adjusting vibraimage parameters and displays the following information:

Frame Rate Settings

Fast processing	Frequency (fps) for processing «fast» parameters of vibraimage, noted by a word «fast»
Base processing	Frequency (fps) for processing «base» parameters of vibraimage, noted by a word «base»
FPS proc. period	Frequency of the frames (fps) during calculation period
Downrate	Reduce input frame rate. At value 3, will be processed every third frame.

Main settings

N(2)	Minimum number of accumulated frames. By default, 2
N(10)	Average number of accumulated frames. By default, 10
N	Maximum number of accumulated frames. By default, 100
K	Gain factor.
L	Threshold of a palette. Defines a threshold of displayed image, value of less brightness considers as «black»
Parallelization	Parallel number of processing in multi core systems. Default 0- for Core 2 Duo
Apply global filter	If this parameter is included, all the remaining calculated parameters change on processed by filters.

VI M ⊙ ▤

Frame rate	
Fast processing	0.0
Base processing	5.0
FPS proc. period	2.00
Downrate	0
Main	
N(2)	2
N(10)	10
N	100
K	1.00
L	2.00
Parallelization	0
Apply global filter	No
Filters	
Single points	Yes
Extended	8
Extended (fast)	8
Stretch	No
Max speed contour	No
Am scale	16.00
Space	4.00
color image	Yes
crop X	0
crop Y	0
crop X pos	0
crop Y pos	0
F6 HF	0
F6 LF	10
F6 N	100
FPS filter	No
Auto downrate	No
Fixed contour	No
State levels	
Ag	80.00
St	80.00
Tn	80.00
disable std. sound	No
AVG filter	
Aggression	10
Stress	10
Tension	10
Suspicious	0
Face detection	Yes
Detection quality [1..4]	3
Scale 1:X	2.00
Min size	60
Max size	640
config	C:\ELSYS\Vi
draw	Off
Quality test	Yes
Micro default	Set

Fig. 3.17.Information table

Filters

Single points	Removes single points, surrounded by black
Extended	It is intended for reduction of noise of a video camera. Delete video noise in bit. By default, 8. This filter is important, when the object is motionless, and values changed because of camera noise.
Extended (fast)	Delete video noise for fast processing.
Stretch	Scale normalization filter to a range 0-255 after its «trimming» by filter Extended
Max speed contour	At the included mode, calculation fast parameters are made only inside of aura contour, at switched off - on the whole frame.
Am scale	Multiplication factor used for vibraimage visualization in a «amplitude» mode
Space	Reduce vibraimage on borders of motionless contrast objects.
Color image	No – Black and white real image in image area. Yes – color image in image area.
Crop X, Crop Y	If real image size more than 640x480 pixels, than will be use only 640x480 pixels from center part of image.
Crop X pos, Crop Y pos	When cropping images define the coordinates (position of the upper-left corner) of the clipping region
F6 HF	Sets in % frequency of a cut for the filter of high frequencies at processing F1_fast parameter.
F6 LF	Sets in % frequency of a cut for the filter of low frequencies at processing F1_fast parameter.
F6 N	Number of averaging frame at calculation of F6 parameter
FPS filter	It is used for exact synchronization with a binding to the concrete frame at work with AVI files. Frequency of the input frame from the camera divided on set Base processing frequency and for processing will undertake each N frame.
Auto downrate	Automatic calculation of **Downrate** parameter is made in view of frequency of the input frames, Base processing frequency and computing capacity of a computer.
Fixed contour	In this mode vibra-aura around the human contour will be built around a fixed path, and not to repeat the contours of the body.
Suspicious thresholds Ag, St, Tn	Suspicious level in the Aggression parameters (Ag), «Stress» (St), «Tension» (Tn) is set. When exceeding level of danger the system gives out a sound signal and fixes a frame.

AVG filter

Aggression	Number of frames for aggression level averaging
Stress	Number of frames for stress level averaging
Tension	Number of frames for tension level averaging
Suspicious	Number of frames for suspect level averaging

Face detection

Face detection	Yes – face detection mode is used. No – without face detection
Detection quality	Quality of face capture. 1 – capture one large person face in the frame (loading of the processor is minimal), 4 – search of all (even small) persons face in the frame (loading of the processor is maximal).
Min size, Max size	Sets in pixels the size of rectangle for search of persons
Config	In VibraStaff software for person search use basic algorithm ocv_face.xml only.
Draw	No – not draw rectangle around face, Yes – draw rectangle around more danger single person, All – draw rectangle for all person in frame. For non-danger person rectangle draw green color, but if person suspect level more than «Critical level», than rectangle draw red color.
Quality test	Auto checking function quality of vibraimage. No – auto checking function switched off. Yes – auto checking function switched on. There is a scale of the quality of the video on the right side of the program window. Error message appear in the upper left corner of the image area.
Micro defaults	Switch on Micro mode. Use for single men mode.

3.4.4. Information column. DB (data base) mode.

In the «**DB**» mode information column (fig. 3.18) adjusts parameters of recorded video information and shows the following information:

Fig. 3.18. Information column in the DB mode

- «**DB folder**» – way to the database folder for written video files and files of statistics;

- «**Selected record**» – data on current object of research.

- «**New record**»: «**Name**», «**Birth date**», «**Comments**» – The demographic information on object of research (fig. 3.19). To delete new record it is necessary to delete the data folder on a disk and having selected the «**DB folder**» item again to select the folder for saving.

Fig. 3.19.Create «New record»

4 VibraStaff. Measurement and control of operator functional state and critical psychophysiological parameters

VibraStaff main program objective is measuring psychophysiological parameters of person and testing person functional state. It is known that the functional and psychophysiological state of a person are constantly changing under the influence of external and internal factors.

VibraStaff system allows to measure and examine the functional and physiological parameters of a person as an objective, as there is measurement of physical quantities, in no way connected with the person or biometrics, because it directly measured physical parameters of the head movement which are functionally linked to functional state by vestibule-emotional reflex.

4.1. M mode

The average values of personal psychophysiological parameters, their deviation and variability are measured in the «M» mode. The main goals of this mode are application of vibraimage system for accuracy security checking, medical diagnostics and psychological testing and researches. M mode is based on measurement and calculation of psychophysiological parameters T1–T10 and checking its math variability during testing period. For vibraimage visual control in this chapter are given the pictures characterizing changes of said psychophysiological parameters T1–T10.

The mathematical expectation M, standard deviation (SD) S and variability V (S are calculating for the following human psychophysiological parameters:

 T1 – Aggression (P7)
The parameter is determined by the frequency histogram and represents the maximum allocation of the frequency and SD vibration frequency of the human face. The higher value of the maximum distribution and higher SD value gives the greater value of the parameter T1.
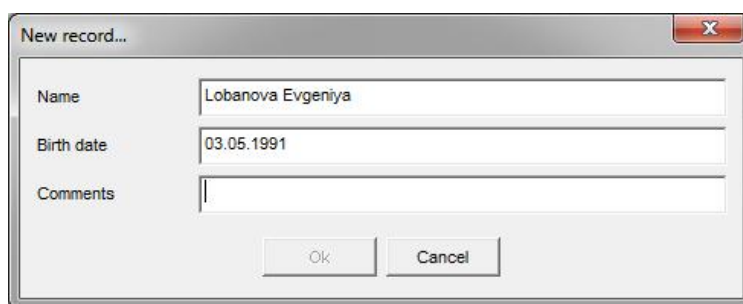
Aggressive state is not every time coordinates with tension, and tension state is not always coordinates with aggression. But often these two emotions accompany each other. Aggressive state obligatory characterized by high frequency vibrations and red colors in aura. Aura size is more than normal and gaps could absent, but color and form non uniformity must present (fig 4.1b). Stress level could be low, less than 0,3. Anger level more than 0,7 and tension level more than 0,4.

Frequency histogram distribution has maximum in right part of the range and distribution has amount dispersion. High speed signals spectrum envelope looks like uniform distribution.

a)   b)
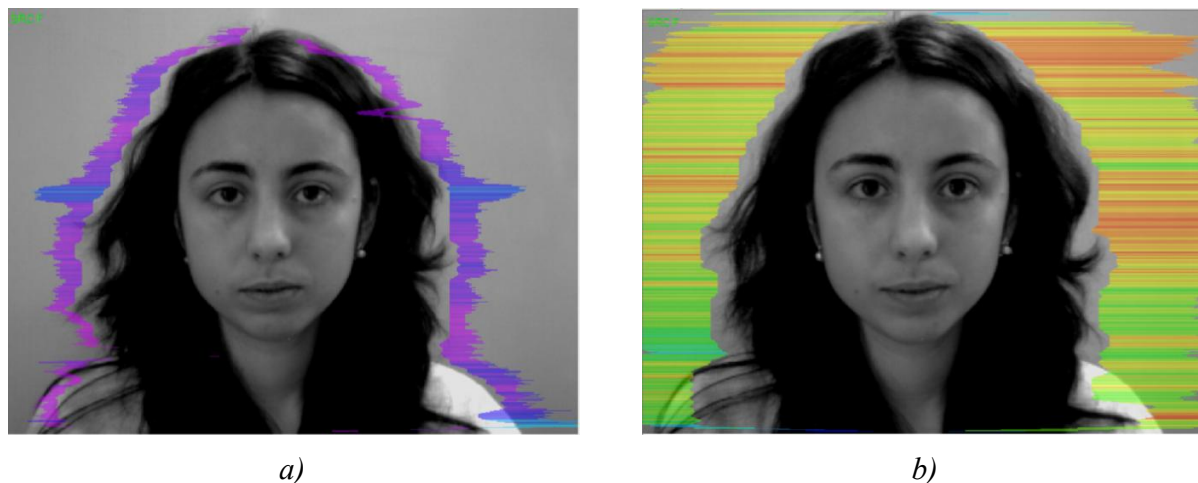
Fig. 4.1 Aggression a) T1 = 18 %, b) T1 = 60 %

T2 – Stress (P6)

Parameter is determined by degree of the external vibraimage (vibra-aura) asymmetry, means asymmetry of micromovements from the left and right parts of the persons head. The great difference in amplitude and frequency movements for the left and right parts of the face (head) characterizes the increased T2 parameter level.

Stress state characterized by amount gaps in aura form and greatly aura colors non uniformity. Aura includes every scale colors and sharp color transfer, like red color could transfer to blue (fig 4.2b). Stress level more than 0,7. Aggression or activity level is low, not more than 0,5 and tension level is high and usually more than 0,4.

Frequency distribution histogram has several modes and high speed vibraimage signals spectrum presents superposition of exponential and uniform distributions.

a)   b)
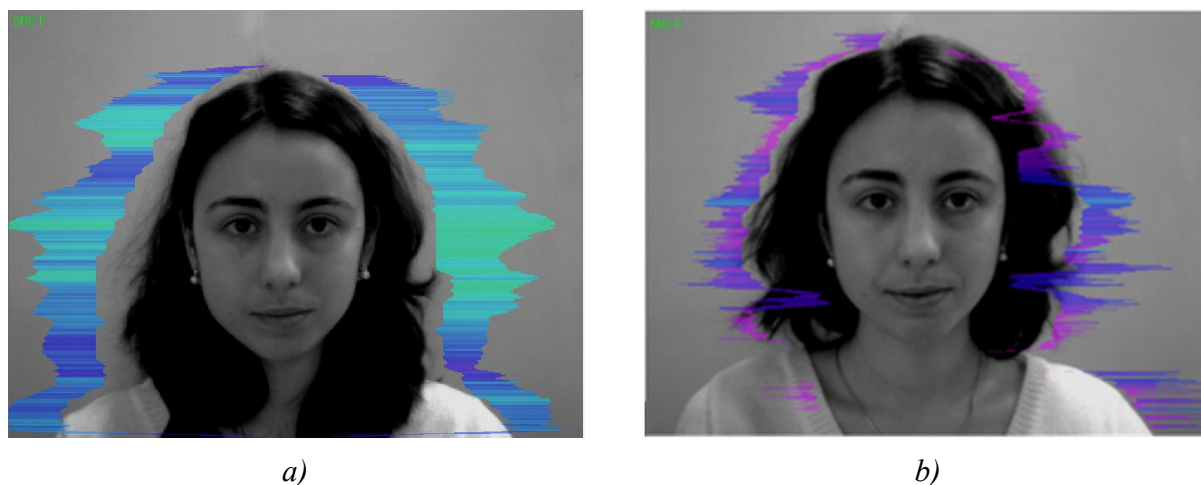
Fig. 4.2 Stress a) T2 = 17 %, b) T2 = 45 %

T3 – Tension/Anxiety (F5X)

Parameter is determined by the relation of high-frequency part of a range of vibrations to the general power in a range of micromovements frequency for human head. High value of high-frequency vibrations density characterizes high value of the T3 parameter.

a)   *b)*
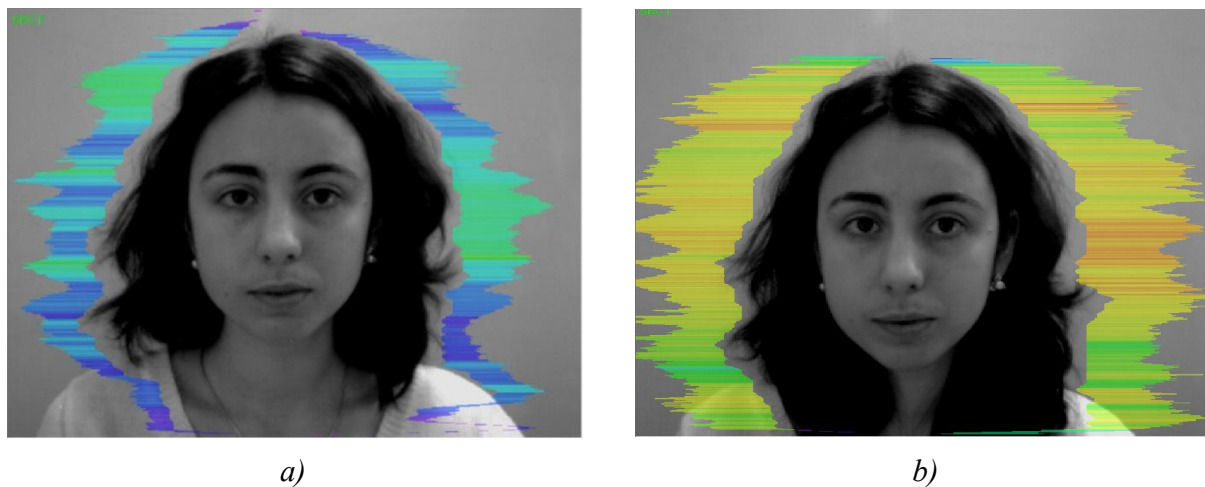
Fig. 4.3 Tension a) T3 = 28 %, b) T3 = 48 %

T4 – Suspect (P19)

The parameter is determined as the sum average of the first three conditionally negative emotions (T1, T2, T3) and characterizes the general level of conditionally negative emotions in a person status.

a)   *b)*
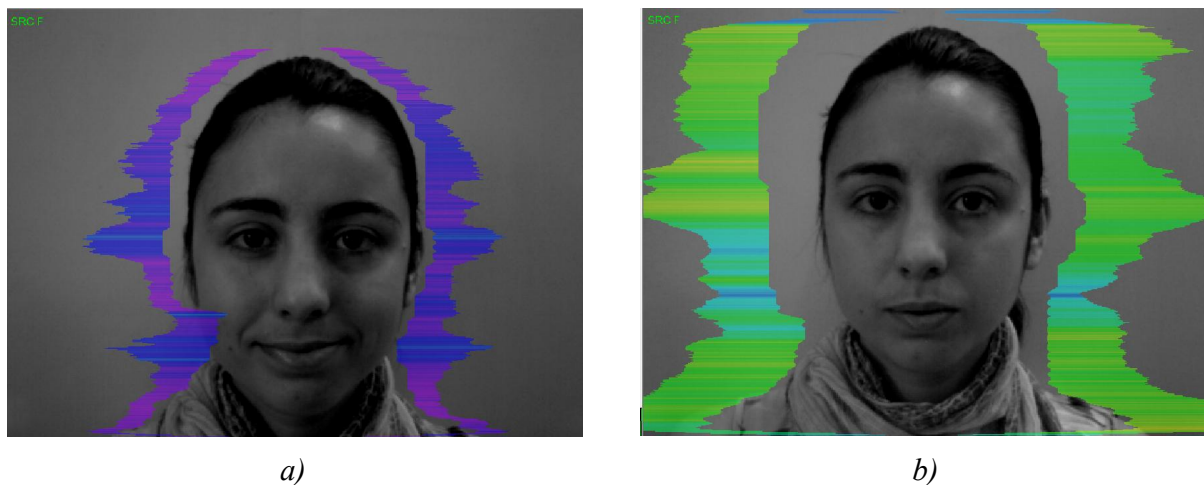
Fig. 4.4 Suspect a) T4 = 20 %, b) T4 = 65 %

T5 – Balance (P16)

The parameter is determined by the frequency histogram and characterizes the level of similarity of the current frequency histogram to the Gaussian distribution law. The high level of frequency histogram similarity to the normal law is characterized by a high level of balance, and significant deviation from the Gaussian distribution is characterized by a low level of the parameter T5.

a)   *b)*
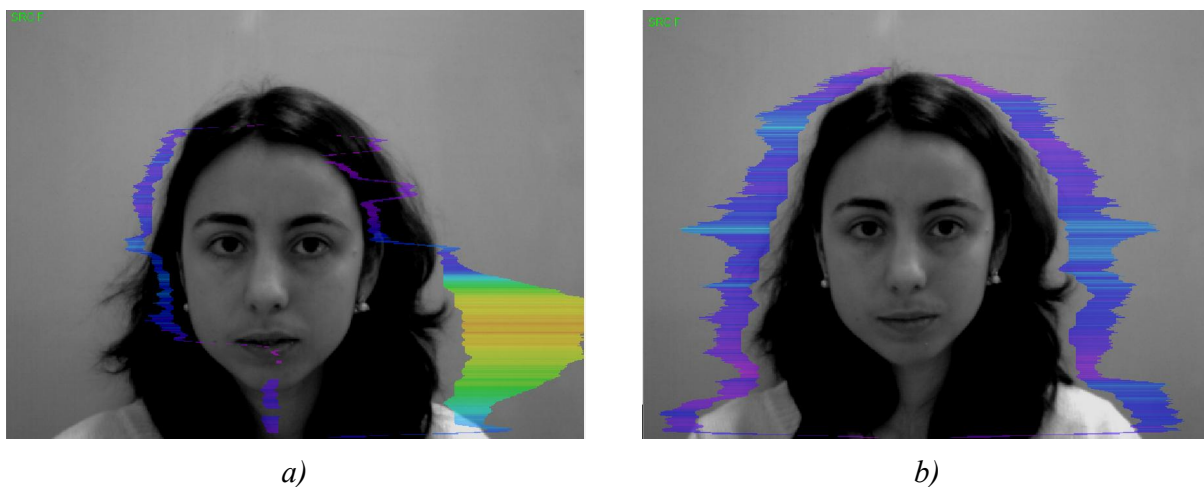
Fig. 4.5 Balance a) T5 = 10 %, b) T5 = 80 %

T6 – Charm (P17)

The parameter is determined by the symmetry (left-right) of the head and face micromovements, the maximum symmetry of movements (including frequency and amplitude) represents a high level of charm T6.

a)   b)
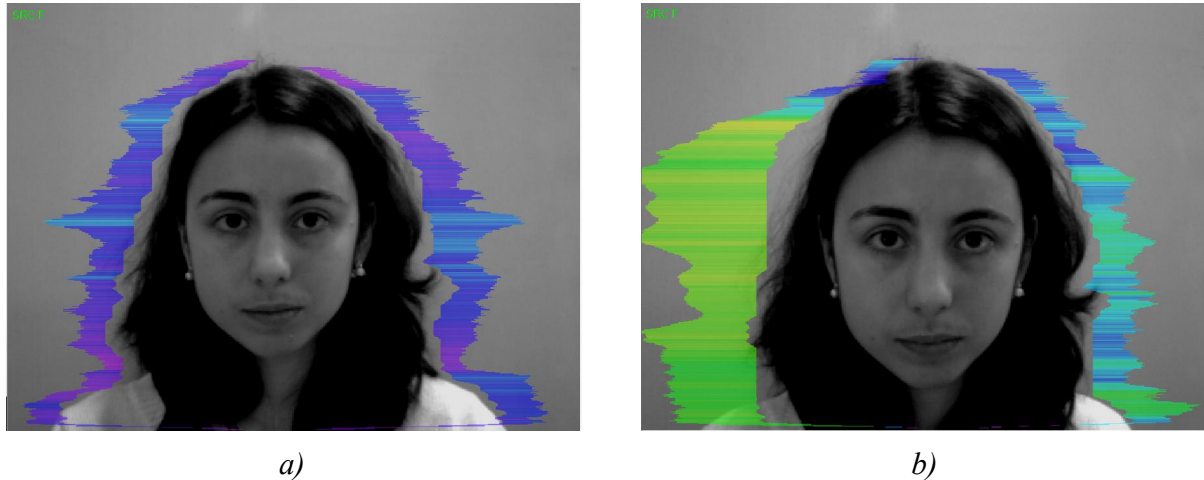
Fig. 4.6 Charm a) T6 = 85 %, b) T6 = 40 %

T7 – Energy (P8)

The parameter is determined by the frequency histogram and characterizes the difference of the maximum density of the vibration frequency and vibration frequency SD for the face and human head. The higher value of the maximum density and lower SD or variation of vibration gives the higher value of energy T7.

a)   b)
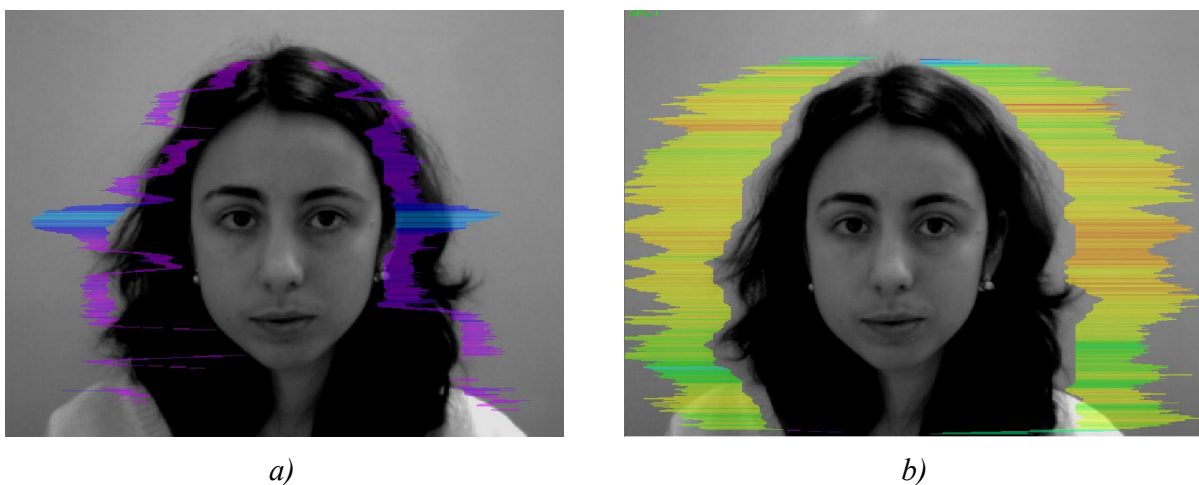
Fig. 4.7 Energy a) T7 = 3 %, b) T7 = 70 %

T8 – Selfregulation (P18)

The parameter is determined as the sum average for conditionally positive emotions (T5, T6) and characterizes the general level of conditionally positive person emotions at the measurement time.

a)   b)
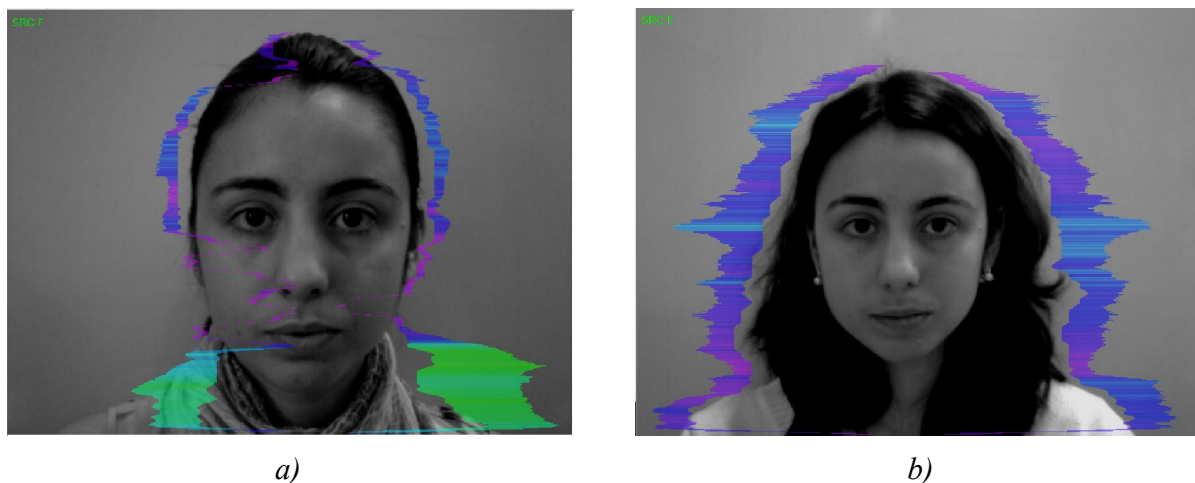
Fig. 4.8 Selfregulation a) T8 = 30 %, b) T8 = 80 %

T9 – Inhibition (F6)

It has a real physical dimension (time in seconds) and characterizes the minimum time of the person reaction for the shown event (the stimulus). The value of the parameter T1 = 0,1 means that the reaction time is 0,1 s. The greater the reaction time corresponds to a higher level of inhibition.

a)   b)
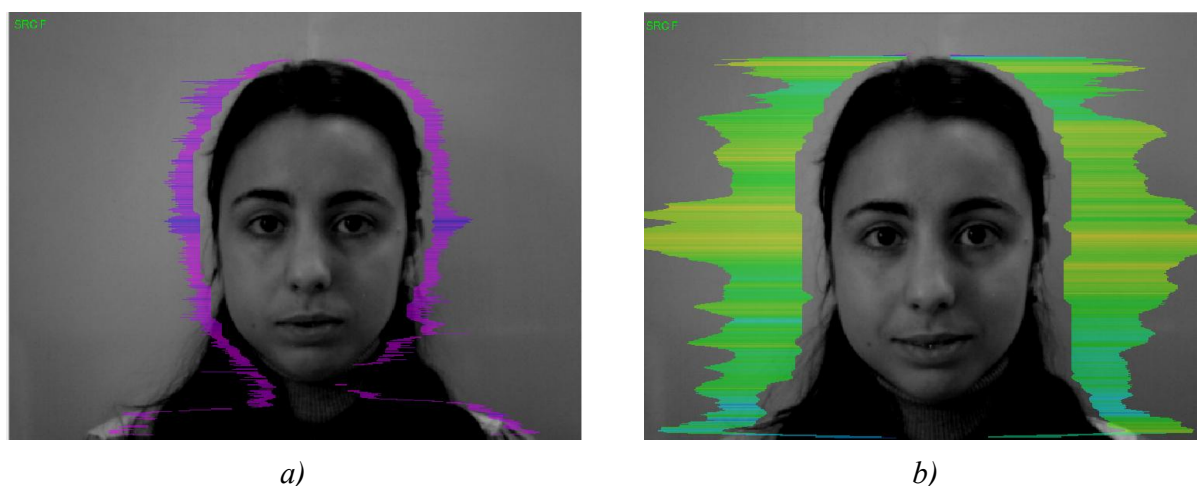
Fig. 4.9 Inhibition a) T9 = 12 %, b) T9 = 25 %

T10 – Neuroticism (F9)

The parameter characterizes the SD measured value of the inhibition level (T9) at the measurement time (default 60 seconds). High level for inhibition SD of psycho-physiological state characterized by instability and indicates high level of neuroticism T10.

a)   *b)*
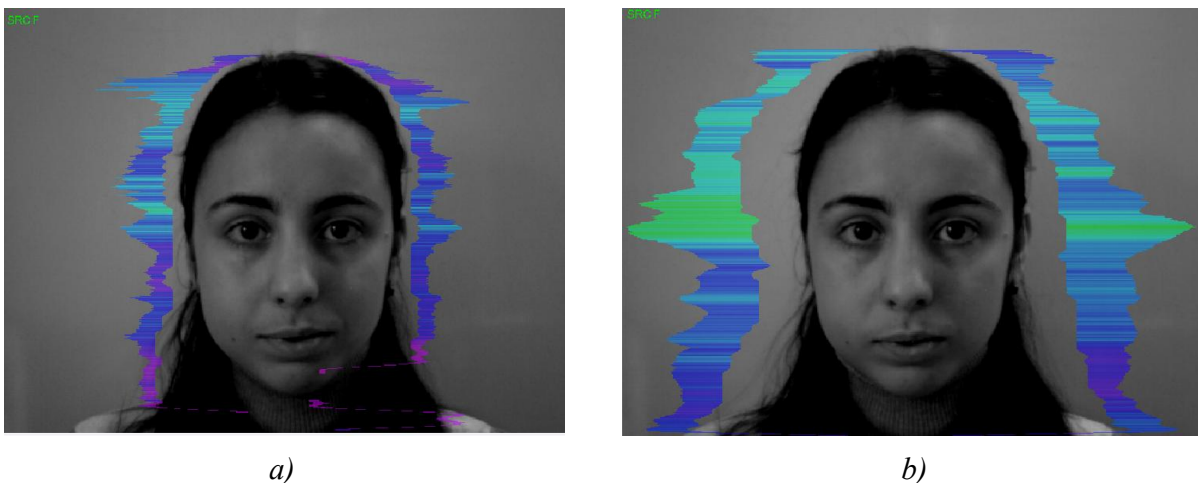
Fig. 4.10 Neuroticism a) T10 = 10 %, b) T10 = 35 %

Mathematical formulas on which basic there is a T1–T10 parameters calculation, are resulted in the description of the Vibraimage statistical analysis software (VibraStat).

Set of the T1–T10 parameters is selected so that with the maximum information content to record all micromovements of a human head. Thus, the name of each T_i parameter can characterize different psychophysiological characteristics depending on use of VibraStaff. For the characteristic of each parameter its name is primary not, it can be read the conditional, and a formula by which this parameter is determined.

Note:

1. All measured by vibraimage system psychophysiological parameters are resulted in a range of 0 – 1 (0 – 100) % with the use of experimentally picked up fixed factors specified in formulas.

2. For everyone measured psychophysiological parameter the mathematical formula is primary, and secondary the conditional name of parameter. The psychophysiological sense of each T1–T10 parameter can change depending on conditions of experiments.

3. Set of measured parameters T1–T10 defines the general psychophysiological (psychosomatically, functional) a condition of the person on the basis of integrated coefficient K.

Note:

This brief vibraimage parameters interpretation correspond default vibraimage system settings and based on main rules for right vibraimage scanning:

- uniform and stable object illumination;

- high quality and low nose camera application;

- frontal plane object before camera;

- maximum facial image size on monitor;

- mechanical stabilization of camera.

4.2 Viewing of psychophysiological testing results

After the end of information processing in a mode «M» user (operator or examiner) can view testing results in one file for person of the «*.xls» format in folder /VibraStaff/_default/. Contents of this file are supplemented with each new inspection of this person. The example of the contents of such file is given in a fig. 4.11.

The most important for the analysis in XLS a file are the following sheets
- **Sheet T.** Contains person test results based on the analysis of risk indexes parameters N1–N5 using the calculation method for the three intervals (Fig. 4.11)
- **Sheet T2.** Containing person testing results based on the analysis of the basic physiological parameters T1 – T10 using the calculation method for the three intervals (Fig. 4.12).
- **Sheet T2a.** Contains person test results based on the analysis of the main physiological parameters T1 – T10 to suit the individual norms limit of this concrete person (Fig . 4.13).
- **Sheet T2b.** Contains person test results based on the analysis of the main physiological parameters T1 – T10 to suit the norms limit rules for the majority of people (Fig . 4.14).
- **Sheet Diag.** Contains graphs of all psycho-physiological and psycho-emotional parameters of the person during the inspection , as well as registers the output parameter values beyond the normal state of human values (Fig . 4.15).

Depends on testing method user can select the base mode for the final solution from T, T2, T2a and T2b sheets.

	A	B	C	D	E	F	G	H
1		According to the pre-shift control the psychophysiological state						
2		is normal.						
3		ALLOWED to work.						
4	name	parameter	lower bound	average value	upper bound	out of bounds		
5	N1	Risk index	-3,458	-0,868	1,722	No		
6	N2	Stress level	13,547	20,702	27,857	No		
7	N3	Stability level	38,428	78,322	118,217	No		
8	N4	PP level	12,493	54,477	96,460	No		
9	N5	Self-control level	48,738	57,011	65,284	No		
10								

Fig. 4.11. Viewing of researches results. Sheet T.

Note, on sheets T, T2, T2a, T2b the following color marks of cells is used:

-          – parameters, which values less than the set norms level for this person

-          – parameters, which values near of norms level for this person and norms level separate excess are possible

-          – parameters, which values stable more than the set norms level for this person.

	A	B	C	D	E	F	G	H
1		According to the pre-shift control the psychophysiological state						
2		beyond the 80% limit of normal.						
3		ALLOWED to work.						
4	name	parameter	lower bound	average value	upper bound	out of bounds		
5	T1	Aggression	24,998	37,636	50,241	No		
6	T2	Stress	19,000	21,653	25,497	No		
7	T3	Tension	9,741	24,516	24,847	Yes		
8	T4	Suspect	18,979	27,852	32,360	No		
9	T5	Balance	67,467	76,673	83,078	No		
10	T6	Charm	73,983	78,172	85,697	No		
11	T7	Energy	17,650	31,976	42,019	No		
12	T8	Self regulation	71,806	77,243	83,236	No		
13	T9	Inhibition	12,398	16,163	28,064	No		
14	T10	Neuroticism	19,967	42,450	85,229	No		
15								

Fig. 4.12. Viewing of researches results. Sheet T2.

name	parameter	lower bound	average value	upper bound	out of bounds
According to the pre-shift control the psychophysiological state				
	beyond the 95% limit of normal.				
	NOT ALLOWED to work.				
T1	Aggression	46,849	46,849	46,849	No
T2	Stress	22,383	22,383	22,383	No
T3	Tension	10,453	10,453	10,453	No
T4	Suspect	26,046	26,046	26,046	No
T5	Balance	71,548	71,548	71,548	No
T6	Charm	80,984	80,984	80,984	No
T7	Energy	37,723	37,723	37,723	No
T8	Self regulation	75,985	75,985	75,985	No
T9	Inhibition	22,840	22,840	22,840	No
T10	Neuroticism	79,180	79,180	79,180	No
	Static levels		2,000		Yes
	Quality		100,000		No

Delete record

T / T2 / **T2a** / T2b / info / X / X2 / GR / M / M2 / DIAG / Set

Fig. 4.13. Viewing of researches results. Sheet T2a.

name	parameter	lower bound	average value	upper bound	out of bounds
According to the pre-shift control the psychophysiological state				
	beyond the 95% limit of normal.				
	NOT ALLOWED to work.				
T1	Aggression	20	46,8	50	No
T2	Stress	15	22,4	40	No
T3	Tension	15	10,5	40	Yes
T4	Suspect	20	26,0	50	No
T5	Balance	50	71,5	100	No
T6	Charm	40	81,0	100	No
T7	Energy	10	37,7	50	No
T8	Self regulation	50	76,0	100	No
T9	Inhibition	10	22,8	25	No
T10	Neuroticism	10	79,2	60	Yes

T / T2 / T2a / **T2b** / info / X / X2 / GR / M / M2 / DIAG / Set

Fig. 4.14. Viewing of researches results. Sheet T2b

Note, on sheet T2a (fig. 4.13) shows results of the analysis psychophysiological parameters of the person with the control of their values over individual norm for the given concrete person. As a result of all control parameters T1 – T10 are marked «green color», i.e. they are in the established limits for a given person. But the final result check the status is a negative **«NOT ALLOWED to work»**. Simultaneously with check of the current parameters of the person on his individual norm in the program the control of the current parameters of the person over average norms (see Sheet T2b, fig. 4.14), and on these norms at the given person have increased levels of «Tension» and «Neuroticism», therefore and final result – «NOT ALLOWED to work».

Thus, to the user the program offers 4 methods of calculation of the current person state (Sheets T, T2, T2a, T2b). On the basis of the experience the user can choose one method of calculation for the work, open in MS Excel file a sheet of calculations of this method and close a file xls with save of changes in a file. Now at the subsequent researches of the person on the screen results of calculations on the chosen method will open by default.
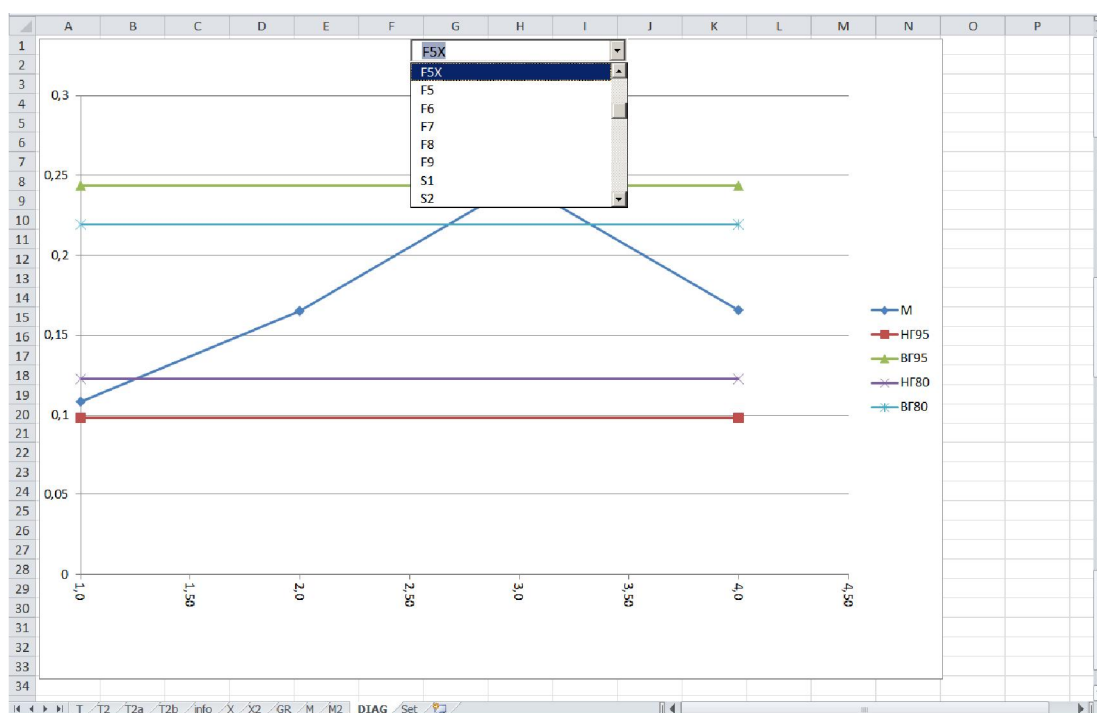
Fig. 4.15. Viewing of researches results. Sheet Diag.

Sheet Diag contain graph of change of all psychophysiological and psychoemotional parameters of the person during inspection (fig. 4.15):
- Parameters A1-A4, F1-F9, S1-S7, P1-P4.
- Parameters P16 (Balance), P17 (Charm). P18 (Self-regulation), P19 (Suspect level), F5X (Tension), F6 (Inhibition), F9 (Neuroticism), P21-P23 (Health level), P26 (Extraversion level), P27 (Stability level), P6 (Stress), P7 (Aggression), P8 (Energy).

- Parameters FN01-FN10 (Formulas of given parameters calculations are programmed by the user independently).
- Parameters «Risk an index», «Level of stressing», «Level of stability», «Level of activation PF», « Level of self-control».

Note, on graph different colors marked horizontal line of 80 % and 95 % confidential borders from norm.

5. Warranty

Maintenance service and service regulations of VibraStaff system is carried out according to this Manual and instructions of used hardware maintenance (a computer, the camera, etc.).

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