L A Z

ECT TRACKER

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E C T

ECTtracker Pro

User's Manual

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About ECTtracker

ECTtracker (**EyeComTec Tracker**) – is eye-tracking software, which allows identifying the current state of the eyes of the user (open or closed). This software can be used in conjunction with different video-capturing applications for web-cameras or other devices connected to PC (e.g. **ECTcamera**, **Skype**, **Media Player**). **ECTtracker** assigns different states of the user's eyes with selected key codes, which can be transmitted to any other controlling application (**ECTkeyboard**, **ECTmorse** and many others). This program is really flexible and adjustable, as well as portative and can be personalized for any specific user and performance characteristics of the computer. In fact, **ECTtracker** is an alternative way of smart computer vision realization.

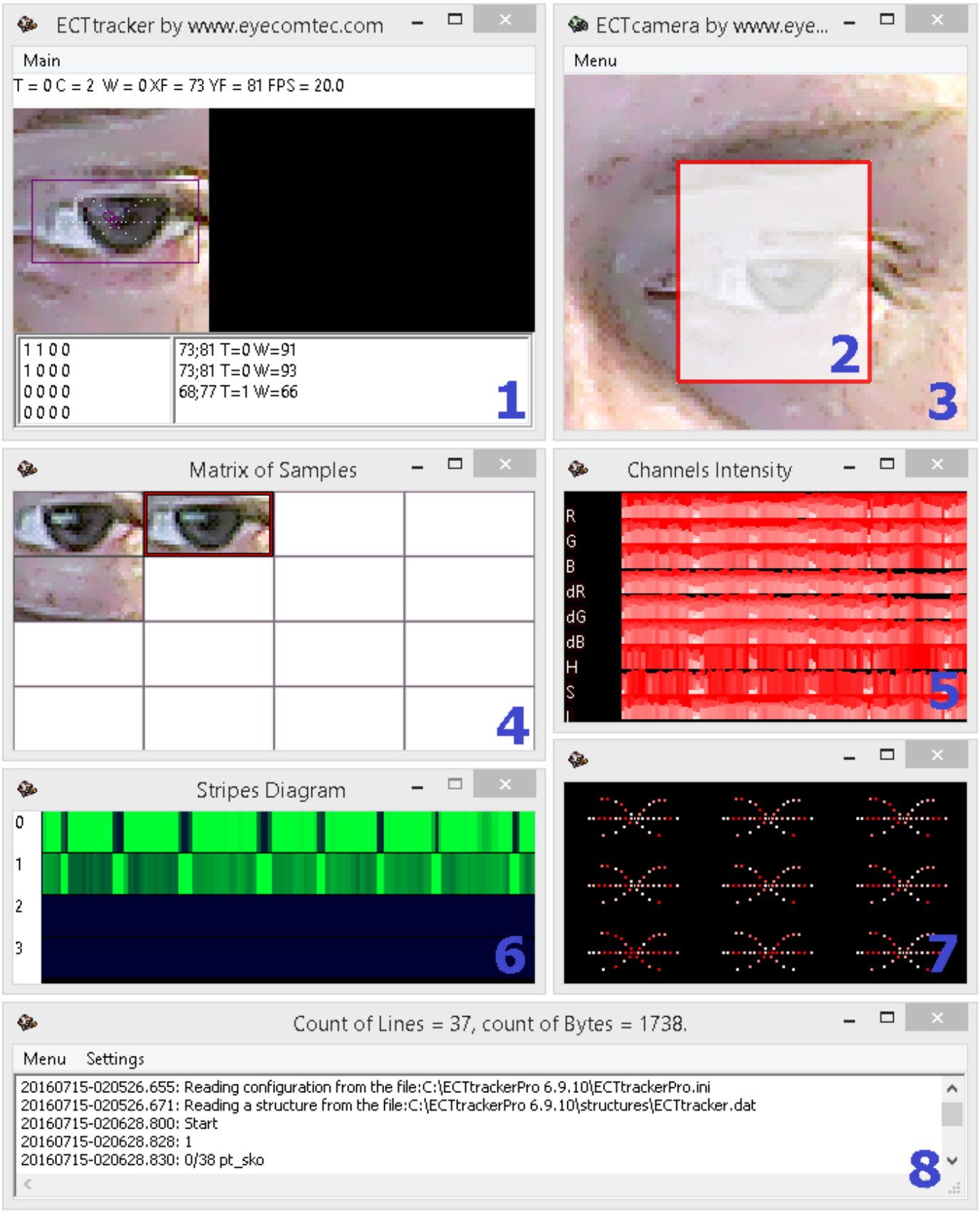
Unlike many other programs with similar functionality, **ECTtracker** analyzes images using the special Matrix of Samples, which is unique for any specific user and environment (camera position, illumination conditions, etc.). The program can be used by both fully paralyzed patients and those who suffer from uncontrollable muscular activity (tremors, tics). **ECTtracker** provides assured tracking of the current state of the eye even for those patients with physical damages of the face - injuries, burns or post-operative states.

The program is really flexible and customizable. The user can set the image recognition structure, the matching level between images and samples, the video processing speed (in frames per second), idle time for cases when there's no image and key codes to be transmitted into third-party controlling applications. The software contains more than 50 different parameters, which can be used to change the appearance and functionality of **ECTtracker**. Some parameters allow the user to lower computing requirements, providing stable work even on computers with low performance levels.

ECTtracker has a really convenient interface and reach functionality for proper and precise setting and debugging procedures. The initial setting procedure is really easy due to the auto-calibration feature. Furthermore, **ECTtracker** supports various localizations, allowing patients to use software in their own native language.

ECTtracker is a highly practical and convenient application due to its ability to adapt to the physical condition of the user, and different environments and computer system resources. A flexible setting process and unlimited amount of user accounts makes it possible to use the application in all conditions.

All main elements of the interface and an example of their positioning are shown on fig. 1.



(Fig. 1. The main interface of the program)

The standard interface of **ECTtracker Pro** without the settings window of the program is shown on the image. The numbered figures show:

1. the main window of **ECTtracker**, which shows the processed part of the image, the recognition structure and statistic fields;
2. the grab-form, or so-called 'target window', which allows the application to capture a part of the image for analysis.
3. the window of **ECTcamera**, which is used to capture the image.
4. the Matrix of Samples – a special table of **ECTtracker** applications, which contains small sample snapshots with eyes of the user in different states (both eyes open or closed, or only one eye open). The program supports samples and recognition structures for one or both eyes. During its operation, the software compares samples and the current image, thus identifying the current state of the eyes.
5. the channel intensity window. In this window channels, which have the highest value changes for different images, are shown as a red and higher diagram.
6. the debug window with graphical stripe indicators. By changing the color of the stripe, software clearly shows which row in the Matrix of Samples corresponds with the acquired image. This window is used during the initial setting of **ECTtracker** and during the determination of tracking quality;
7. PRO the SCO9 window, which shows the intensity level of changes of each point of the recognition structure. This window is intended for more advanced users, who can edit the recognition structure file.
8. PRO the program log, which contains information about all the important actions and events. The log contains the date and time of tracking start and stop, the structure selection and some other data. All the information can be exported as a text file.

More detailed information about elements 4-8 can be found in the **Debugging elements** section of this manual.

Main advantages of ECTtracker

In comparison with software products of other companies with similar functionality, ECTtracker has a range of significant advantages:

- the adaptation of the program to specific needs of the physical condition of each individual user. **ECTtracker** can work with both fully paralyzed patients and patients with various disorders of motor activity.
- the complete trainability. The program allows the user to work in virtually any environment: camera position, lighting, user's position. **ECTtracker** tracks the user's eye state by comparing it with saved samples, providing a high quality of tracking and stable operation.
- The wide range of different algorithms. The program involves not only an RGB color system for image analysis, but an HSL system too, which is more similar to human vision. The user can select the priority level for each of the channels, thus increasing the overall recognition quality. **ECTtracker** can set the priority of the channel automatically after filling the Matrix of Samples.
- the unlimited amount of configurations. The program makes it possible to save configurations into separate files and switch them on the fly when it's necessary. The very light size of such files allows the user to store them on any portable device and share using e-mail.
- the portability and the small size of the program allow the user to run it from any external storage device. **ECTtracker** does not require installation and does not change the registry of the operating system.
- rich customizability and average technical requirements. **ECTtracker** provides stable work even on low-end computers due to its ability of elements disabling.
- flexible setting and support of customized recognition structures. More advanced users can change the recognition structure files and even select the priority level for each of its points.
- localizations. The program supports various languages of interface, which provide a high level of comfort and allow the user to work with the program in their own language.
- the simple and intuitive interface allows the user to familiarize with the program very quickly and change all the settings easily.

The main feature of **ECTtracker** is the adaptation to the physical abilities of the user. The program can be used by both fully paralyzed patients and those who suffer from uncontrollable muscular activity (tremors, tics). In case of a contrast marker usage, **ECTtracker** provides the proper quality even for those patients with physical damages of the face: wounds, burns, singed eyelashes, or postoperative eye conditions. The ability to change the matching level between analyzed image and samples, as well as a wide selection of structures and some other parameters, allow the user to adjust ECTtracker for specific needs and optimal tracking results.

A favorable difference of **ECTtracker** in comparison with similar software is its full trainability, which allows users in any physical state to work with the program. The tracking algorithm of **ECTtracker** works independently to the position of the user, lighting or technical parameters of the computer. Nowadays most of the algorithms are using light and dark parts of the image for analysis, while **ECTtracker** allows the user to create a base of samples for tracking, which are unique for each user and environment (including lighting or camera position). Such a high level of trainability provides a high quality of tracking in almost any case. As a result, the user can work with the virtual keyboard more confidently and faster, creating less stress at the same time. Furthermore, **ECTtracker** allows the user to enter symbols not only by eye blinking, but with any

movement or gesture clearly visible in the frame. This feature can be used by patients with a wide variety of physical activity limitations.

All changes of settings performed by the user can be saved as separate configuration files, making it possible to change such files 'on the fly', allowing different users to work on the same machine. Recognition structures and personal settings are adjusted to specific needs of each user. The program allows the user to create an unlimited amount of settings profiles, while the light size of those files allows the user to send them through email or in any other way.

The portability and the small size of the program allow the user to run it from any external media. **ECTtracker** does not require installation and does not make changes to the registry of the operating system.

Information fields of the main window of the program, the additional debugging windows and the detailed event log are handy features for fine-tuning. At the same time, all debugging elements can be disabled during the normal operation of the program. The ability to reduce the amount of processed frames per second can reduce the load on the processor and other system resources of the computer. This allows the user to adjust **ECTtracker** for comfortable work even on computers with low performance.

The simple and user-friendly interface allows the user to perform the initial setting procedure really fast and to begin working with **ECTtracker**. All the basic functionality of the main menu is duplicated with 'hot keys' for quick management. In addition, **ECTtracker** supports different localizations, allowing users to work with the program in their native language.

The setup of **ECTtracker** will not take too long. In case of changes in the lighting conditions or the position of the patient, the user can create new samples for really fast tracking by using the auto-calibration feature. There’s no need to delete old samples, because the program allows the user to save and load an unlimited amount of settings profiles.

All these features provide extreme flexibility in the configuration and operation of **ECTtracker**.

Getting started

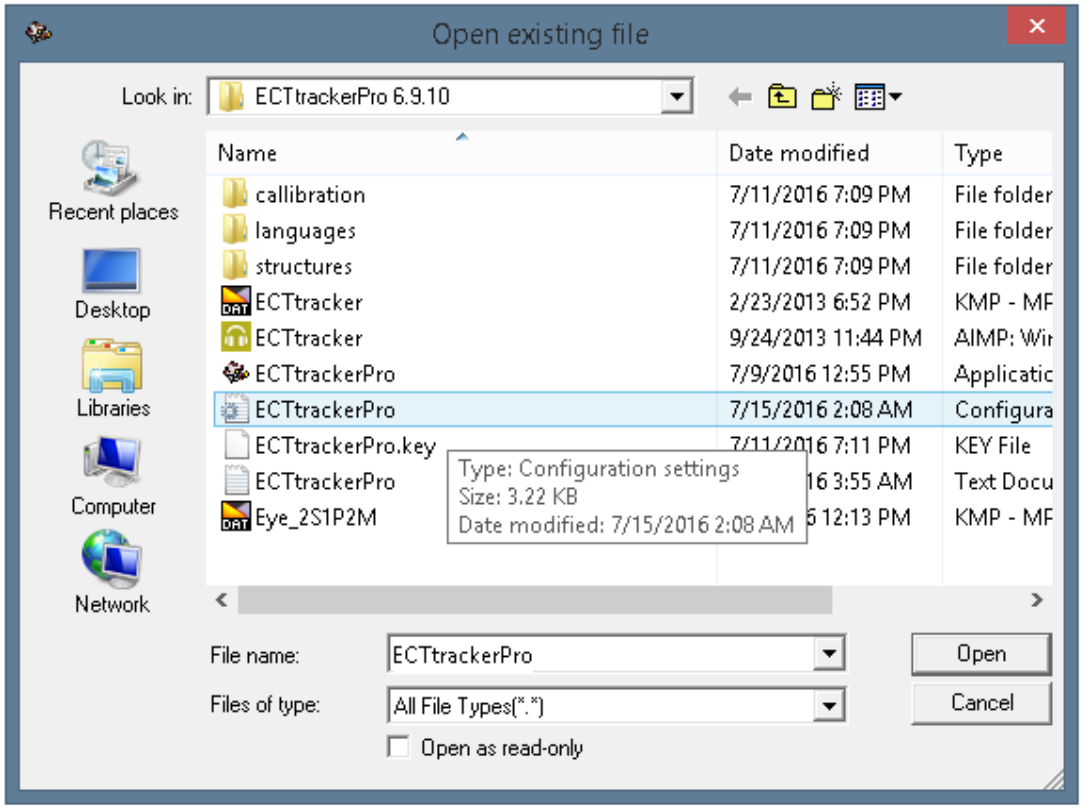
In order to provide the proper image analysis level of the program, it's necessary to calibrate it and fill the Matrix of Samples. It's also necessary to change several parameters depending on the physical characteristics of the patient and performance of the computer. This is especially important during the first start of the application.

The initial setting procedure of **ECTtracker** and further work with the program include the following stages:

1. Start of the program and user settings loading if necessary.
2. Selection of the recognition structure.
3. Image source setting and grab-form positioning (the user's manual will describe setting and use of **ECTtracker** in conjunction with **ECTcamera**).
4. Automatic or manual calibration of **ECTtracker** (filling the Matrix of Samples).
5. Setting of any receiving program, key codes and actions, as well as some additional parameters.

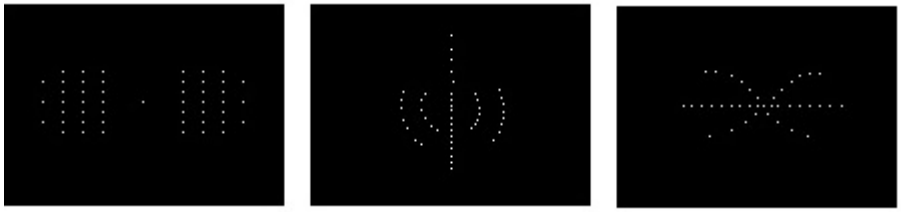
Start of the program and selection of the recognition structure

To start working with the program, the user needs to launch the eye-tracking application by opening the ECTtracker.exe file. In case the user needs to use a previously saved settings profile, then the user has to select the 'Settings' – 'Load Settings' menu item after starting the program, then choose the desired file in the dialog box of the program (see fig. 2). All the changes are applied after selection of the new configuration file



(Fig. 2. Loading configuration file for **ECTtracker**)

After doing so (only if it's necessary, because the type of the recognition structure is already predefined in the selected configuration file) the user has to select the recognition structure – for one eye only or for both eyes. Selection can be done through the '**Samples**' - '**Choose Structure**' menu items. Recognition structures differ in positions of key points, which are used during comparison of saved samples and images in the program window. Different structures are shown on figure 3. It is worth noting that different structures allow identifying the user's selection not only by opening or closing eyes, but also using other actions. Such actions include eyebrow or lip movements or finger removing from the source image with bringing it back in a while; in other words – they include any clearly identifiable states of one object.



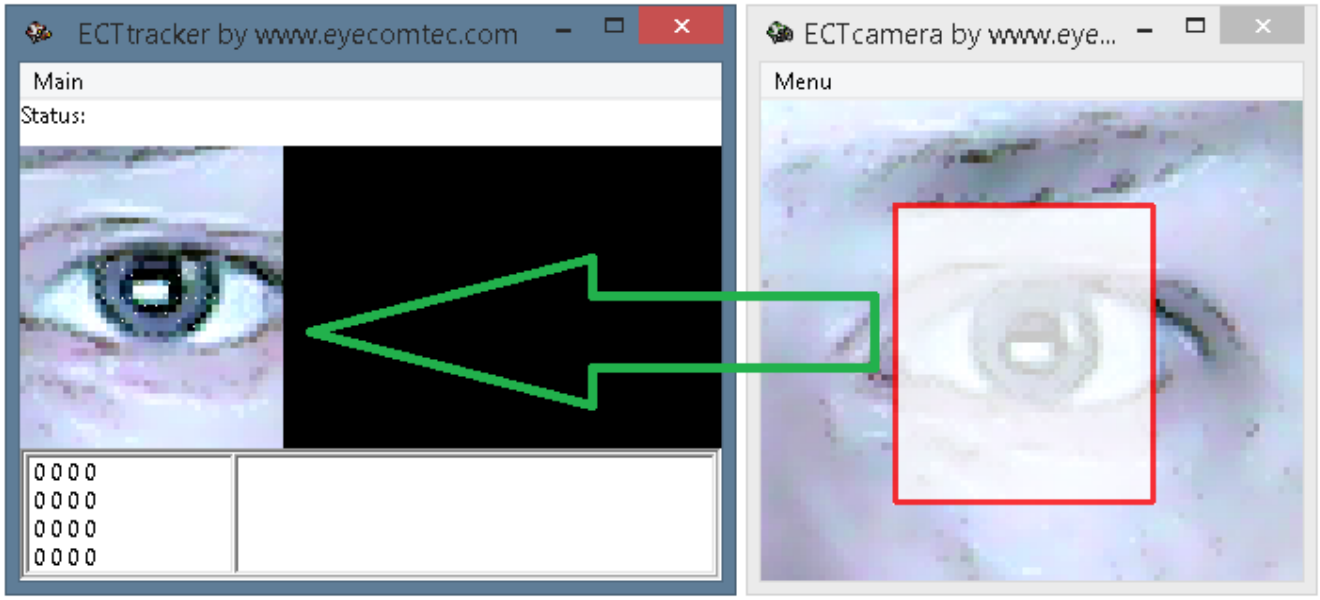
(Fig. 3. Different recognition structures)

The main principle for the structure selection process is to put a maximum amount of key points above any fragment of the image with a maximum amount of visually distinguishable changes. Key points of the structure, which are located above a static area of the frame, increase the total load on the system and negatively affect the quality of tracking.

Selecting the image source and setting up the grab-form

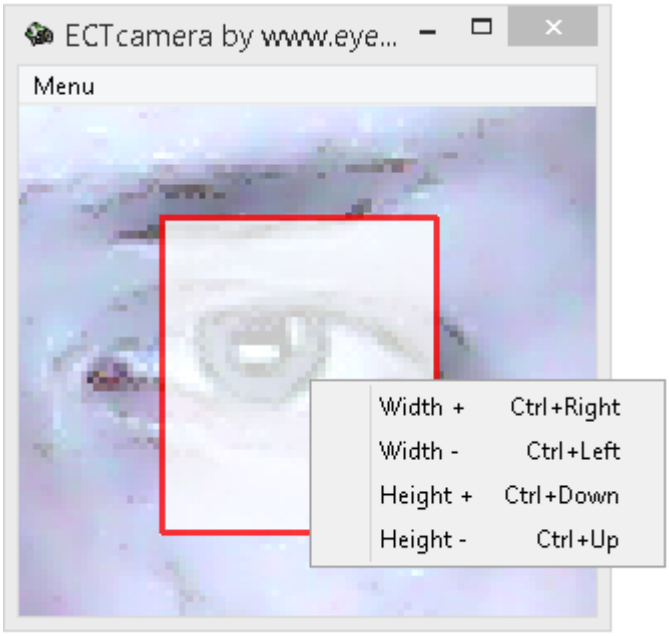
Before tracking, the user has to predefine the image source in **ECTtracker**. If the program is used with a different application that acquires video from a web-camera or any other device, the user has to start that application first. If the program works with already recorded video, it's necessary to open the media player window first. This user's manual describes the joint work of **ECTtracker** and **ECTcamera** software. **ECTcamera** is an application intended for use with the web-camera of a laptop or any removable camera which is connected to a computer.

In order to provide the correct display of the video fragment from an **ECTcamera** window, it's required to place the target window (grab-form) above such window. During the start of **ECTtracker**, the user can see a semi-transparent rectangular area with a red border, which is intended for video capturing and transmitting it into the program. To set up video capturing, it's necessary to move the target window above the video window (see fig. 4). It's worth noting that key points of structure in the video window of ECTtracker have to cover the maximum possible changeable area of the image.



(Fig. 4. Capturing video fragment with the target window)

If one needs to change the size of the grab form immediately, it can be done by right-clicking on it. The user has to select one of the actions in the menu that appears (see fig. 5).



(Fig. 5. The grab form size changing menu)

The user can also left-click on the grab form in order to make it active, and use hot keys to change its size on the fly:

- **Ctrl+Right** – increase the grab form width
- **Ctrl+Left** – decrease the grab form width
- **Ctrl+Down** – increase the grab form height
- **Ctrl+Up** – decrease the grab form height

Each of the mentioned combinations will cause an immediate update of the grab form and the main window of the program.

After selection of the structure and correct positioning of the grab-form above the captured image, it's necessary to create or load the matrix of working samples for program operation and correct image recognition. If the user created such a Matrix of Samples before, it can be loaded:

- by using '**Samples**' – '**Choose Matrix of Samples**' menu items, if The Matrix of Samples was saved as one file.
- by using '**Samples**' – '**Import Matrix of Samples**' menu items, in case all samples were saved as separate files.

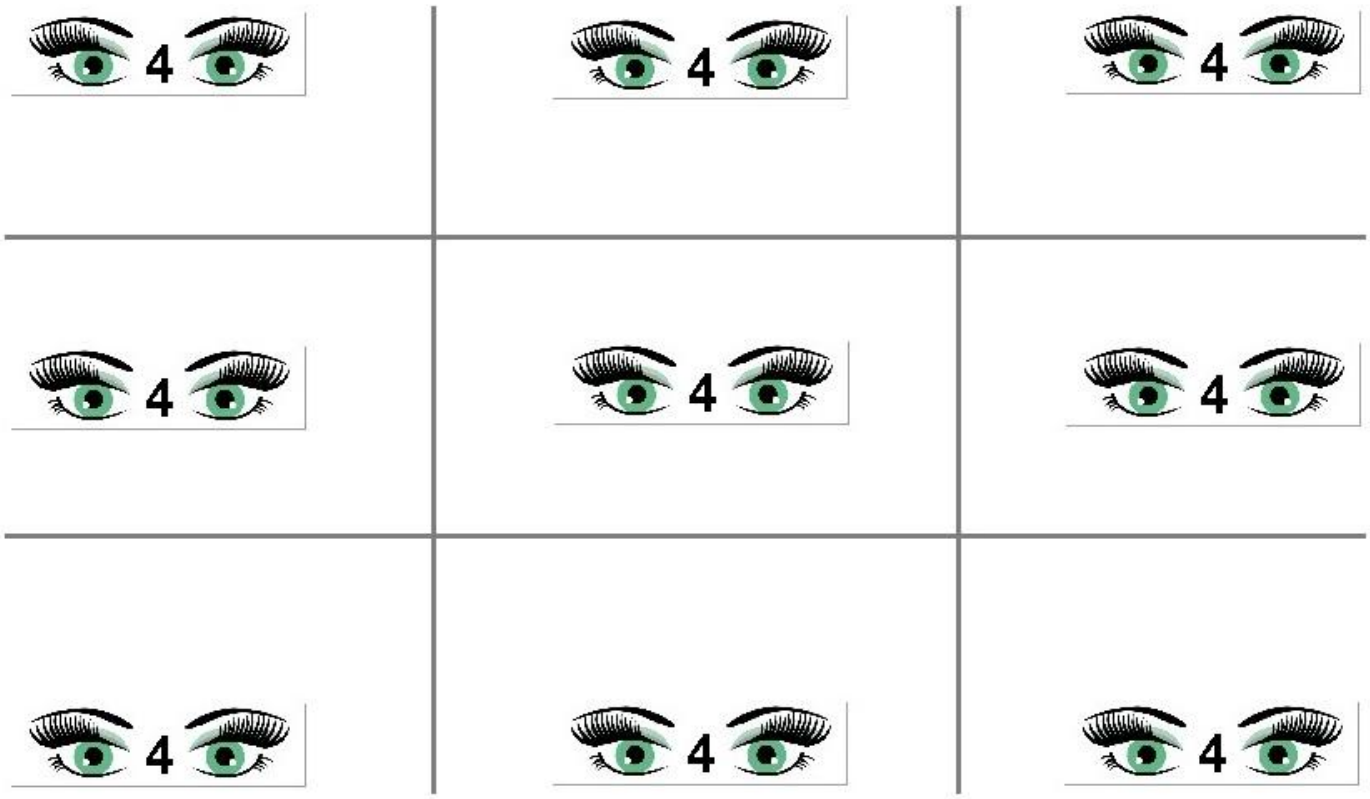
If there was no Matrix of Samples created, the user has to create it in manual mode or by using the automatic calibration feature.

Automatic calibration

Automatic calibration involves a script, which shows auxiliary images with various eye states to the user (both eyes open, only right eye open, only left eye open, both eyes closed). The user has to follow such images and close one or both eyes in accordance with the image on the screen. Different examples of such images are shown on figure 6.

(Fig. 6. Auxiliary images for automatic calibration)

Depending on the selected script, images are going to be shown on different parts of the screen. If one divides the screen into 9 different parts, each part will correspond with one auxiliary image (see fig. 7). The program is going to create a different sample in the Matrix for each position and eye state. This method is necessary to provide proper working of the program regardless of the part of screen the user is looking at.



(Fig. 7. Various positions of auxiliary icons)

Parameter 48 of the **ECTtracker** settings window allows the user to select a file with the auto-calibration script. Functionality of the script can be determined by the name of the file, because it contains a special symbol encoding. A number before the S letter shows the quantity of eye states, which are shown on the auto-calibration icon. A number before the P letter shows the quantity of different positions of the icon on the screen. A number before the M letter shows the quantity of rows in the Matrix of Samples.

1st example*: if the Eye_2S5P2M.dat script is selected, the user will see icons with open and closed eyes. The icon is going to be shown in 5 different screen positions (in the center, in the upper left corner, in the upper right corner, in the lower left corner and in the lower right corner). The calibration process is going to fill 2 rows of the Matrix of Samples.*

2nd example*: if the Eye_4S5P4M.dat script is selected, the user will see icons with four possible states of eyes (both eyes open, right eye open, left eye open, both eyes closed). The icon is going to be shown in 5 different screen positions. The calibration process is going to fill 4 rows of the Matrix of Samples.*

Thus, it's possible to select the type of auto-calibration that fits a specific user. E.g. if the patient can move only one eye, it can be useful to load a script that makes two types of samples - open eye and closed eye (in such case, the user has to locate the grab-form only above the area of the working eye and use the recognition structure for one eye). If the patient can blink with both eyes, then it can be useful to load a script for 4 states of eyes and the recognition structure for both eyes. The Eye_2S1P2M.dat script is used by default in **ECTtracker**.

To start the calibration process, it's necessary to select '**Samples**' – '**Automatic calibration**' menu items or press the **F11** button. The user will see images with a countdown timer changing one by one. There is a sound

at the end of each time period, after which the program saves the sample and goes to the next image. The calibration procedure allows the user to fill the Matrix of Samples in the fully automatic mode.

Some results of the auto-calibration feature may not look good, due to:

- significant image shift after head movement, if the patient retained motor activity;
- indistinct pictures caused by pupil movement, blinking, or head rotation;
- excessive shading of the images in case of poor lighting from the camera side.

In such cases, the user may erase the Matrix of Samples by using the '**Samples**'– '**Reset Matrix of Samples**' menu item, and can then re-calibrate, providing proper conditions for the process.

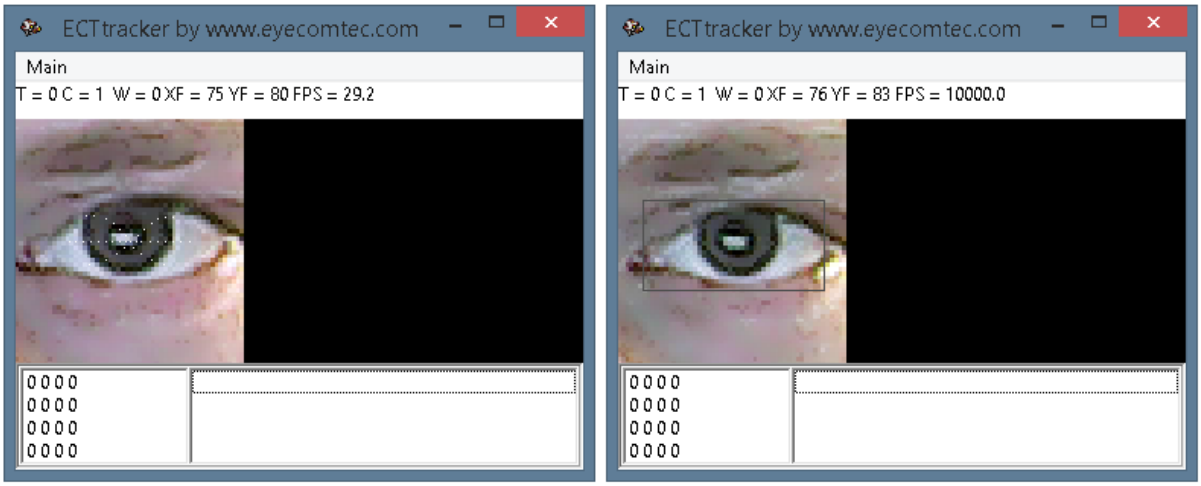
Manual calibration

The user can select samples for the Matrix of Samples in manual mode. By using this feature, the user can replace samples with bad quality received during auto-calibration, without re-calibration or selecting all samples in the manual mode.

The Matrix of Samples for **ECTtracker** can be filled in 2 ways:

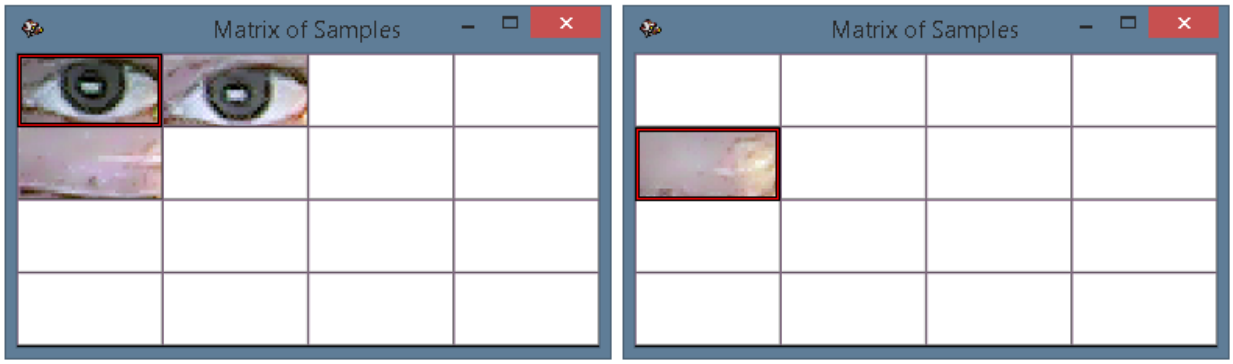
1. Create samples with the open eye of the user (usually 2 samples are enough when the program is set up correctly), then add them into the first row of the Matrix of Samples. Then create a sample with the closed eye of the user (one sample is more than enough) and add it into the second row of the Matrix of Samples. Then it's necessary to specify key codes and action codes (key stroke or release) by filling in parameters 111 and 112 of the settings window. The default value of parameter 111 (assigned to the open eye in the Matrix of Samples) is '32 2', which means 'release space button'. The default value of parameter 112 (assigned to the closed eye in the Matrix of Samples) is '32 1', which means 'press space button'. More information about key codes and other actions can be found in the 'Settings and additional parameters of **ECTtracker'** section of this manual.
2. Create a sample for closed eye and put it into the second row of the Matrix of Samples. Set the key code and the action code by filling in parameter 112 (by default, it has the '32 1' value, which means 'press space button'). Specify the value for parameter 110 (by default, it has the '32 2' value, which means 'release space button'). Parameter 110 defines the key code and the action code in cases where **ECTtracker** is not able to find at least one corresponding sample. Therefore, the program can work using only one sample with the open eye of the user! This feature simplifies the operation of **ECTtracker** and speeds up the initial setup process.

   In order to add samples in the Matrix of Samples, it's required to start the image capturing process in **ECTtracker** by using the '**Start**' menu item or the **F2** key, followed by right-clicking on the image. The image will freeze on the current frame with a rectangular selection area centered on the click location (see fig. 8). Another right-click on the image inside the **ECTtracker** window will update the current frame. A left click will cancel the selection and restore the video capturing process.



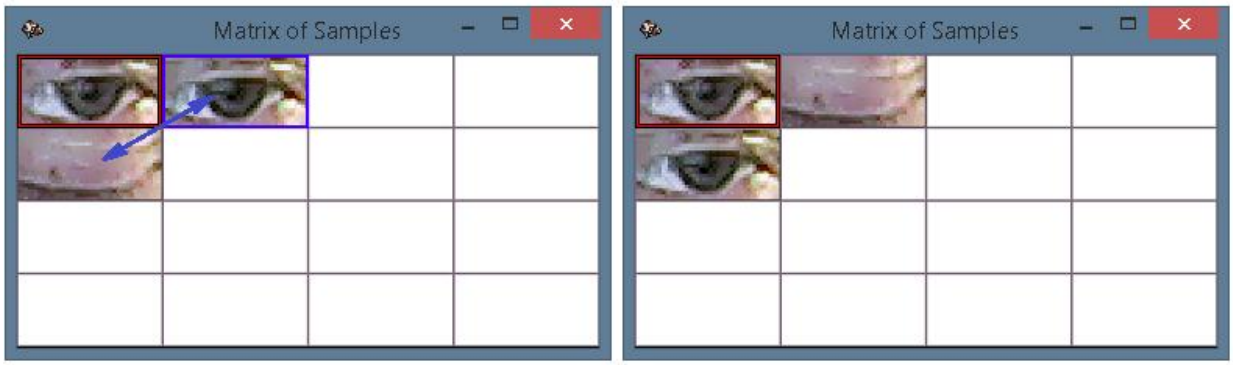
(Fig. 8. Selection of the image for the Matrix of Samples filling)

3. After selecting a proper sample, the user has to save it. In order to do so, the user has to click with any button on a desired cell of the Matrix of Samples. The sample is going to appear in the Matrix. In cases where the cell already contains a sample, it's going to be replaced without any additional confirmation. The appearance of the full Matrix of Samples is show on figure 9.



(Fig. 9. The full Matrix of Samples. The right image - operation of the program with one sample and enabled parameter 110)

In order to provide more comfort during the filling of the Matrix of Samples, the user can switch the places of the samples. In order to do that, the user has to stop the program by pressing the '**Stop'** item of the menu. After that, it's required to use the left or right mouse buttons and click on a sample that needs to be relocated. That sample will be highlighted with a blue border (see fig. 10). After that, the user has to click on the second sample and they will be switched.



(Fig. 10. Switching samples in the Matrix of Samples)

Important information! Proper calibration and correct Matrix of Samples filling are required to improve image tracking quality. The overall accuracy of the current state of the user's eye tracking depends on the initial setting quality. After performing a proper calibration, the patient will be able to work with the matrix of symbols longer, making less mistakes and reducing stress.

Guidelines for the filling of the Matrix of Samples:

- it's necessary to click on the center of the pupil during the sample selection. This moment is really important, because all further tracking stabilization will be based on this point.
- the first row of the Matrix of Samples is created for samples with an open eye; the second is for samples with a closed eye. In any other case, it's necessary to correct the transmitted key codes (parameters 110-112).
- it's recommended to use not more than 2 samples of images with an open eye to provide proper operation of the program. One sample is more than enough for the closed eye of the user (see fig. 9).
- If it's possible, the patient has to look exactly at the camera. The **ECTkeyboard** virtual keyboard window has to be placed as close as possible to the web camera.
- the size of the main window of the **ECTkeyboard** and the distance between the patient and the display have to be selected in such a way that the pupil has as little movement as possible during working with the program. If the patient is located too far from the display, it's possible to change the font size without changing the size of elements in the Matrix.
- it's recommended to use only **ECTcamera** functionality to change the scale level or position of the image.
- the light source has to be placed in such a way that it doesn't create an excessive shadow on the face of the patient. The user can dim any light that comes from things other than the display and place an additional source of light next to the display (e.g. LED-torch).

More detailed recommendations, full descriptions, diagrams and illustrations can be found in the '**Tips and tricks**' chapter.

Completing configuration

To complete the initial setting process of **ECTtracker**, the user also has to indicate the following parameters in the settings window of the program (it can be opened with the '**Settings**' – '**Show Settings**' menu items or by pressing the **F3 hot key**):

a. Parameter 100 has to contain the following value: **ECTkeyboard by www.eyecomtec.com**, which is the name of the main window of the **ECTkeyboard** Symbol Matrix, which ECTtracker is going to use to transmit controlling key codes.
b. Parameter 2 – the matching level of the sample and the analyzed image. It's recommended to decrease this value if the **ECTtracker** program is not able to find adequately corresponding samples during its operation. If the program finds two samples at the same time, then it's recommended to increase the value. The matching level of one row of the matrix has to be higher than the level of another row at any given time period (this can be clearly seen in the Stripes Diagram window). Depending on the camera, the lighting level and other parameters, an optimal value of wlim stays in the range from 18 to 35. The default value is 20.
c. Parameter 5 – the maximum shift of the sample relative to the analyzed image. **ECTtracker** searches for matching images not only in the initial position of the image, but also in the area around it. This

feature is required in order for the program to work correctly in cases of insignificant movements, inclination and rotation of head, when the the user retained only partial motor activity. The default value is 3.

d. Parameter 4 – the frames per second rate of the image in the video window of **ECTtracker**. The higher this value is, the more often the image is updated. As a result, the quality of tracking increases as well as the requirements of the computing resources. The value of this parameter can stay in a range from 1 to 60, while the default value is 20.
e. Parameters 24 and 25 – the width and the height of the target window (grab-form). The default values are 140 and 160 respectively. If the patient makes some insignificant movements, the analyzed image can go out of the grab-form view. It usually happens when the zoom level is significantly increased. It's recommended to increase these parameters in order to keep the maximum possible amount of movements in the limits of the grab-form.
f. Parameters 110-115 – key codes and action codes. These fields define key codes, which are sent to any receiving software when the image in the **ECTtracker** window corresponds with one of the saved samples. They also define performed actions (press key, release key, press and release key).

In order to improve the overall image recognition quality, the user has to define the priority levels of the color channels. Advanced users can select these priority levels manually by changing the value of parameter 15 of the settings windows of the program. The program also supports the automatic priority calculation mode. In order to use it, it's required to select the '**Settings'** – '**Set Channel Formula'** items of the main menu.

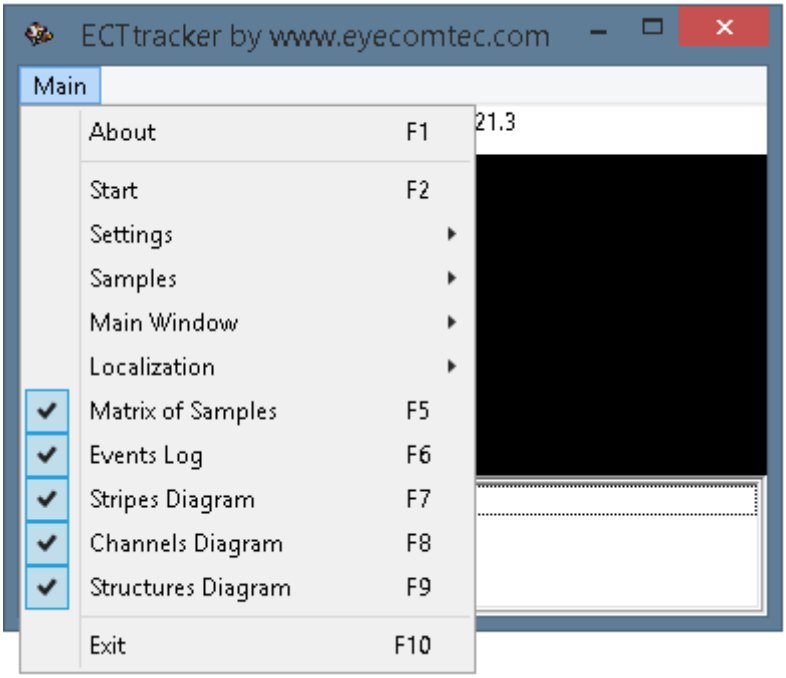
When the user completes the selection of all desired parameters and the recognition structure, specification of the analyzing area of the image using the target window and creation of the Matrix of Samples, **ECTtracker** can be started. To start operation of the program, the user needs to select the '**Start**' item of the main menu or press the **F2** button.

Comparison of the analyzed image and samples from the Matrix is performed for each frame, while coordinates of centers of samples exceeding the predetermined matching level (wlim parameter) are shown in the list of recognized samples in the main program window. Information about the sample with the maximum matching level is shown in the information field of **ECTtracker**.

The program determines the most appropriate sample for the current image. The corresponding sample is highlighted with the red color in the Matrix of Samples. Depending on the row of this sample, the program selects a predefined key code and action, which are then sent to any receiving software. In cases where none of the samples correspond with the current image, the program completes one of the actions predefined in parameter 9 of the settings window. If parameter 9 has the C value (search samples from the center part), **ECTtracker** moves the search point to the center of the analyzed image and resumes the search process in a while. If this parameter has the F value (search samples starting from last coordinates, where match was found), the program is going to search the sample within the limits of the last matching zone. The amount of frames to skip when no corresponding samples are found can be specified in parameter 6 of the settings window of the program.

Main menu and functionality of ECTtracker

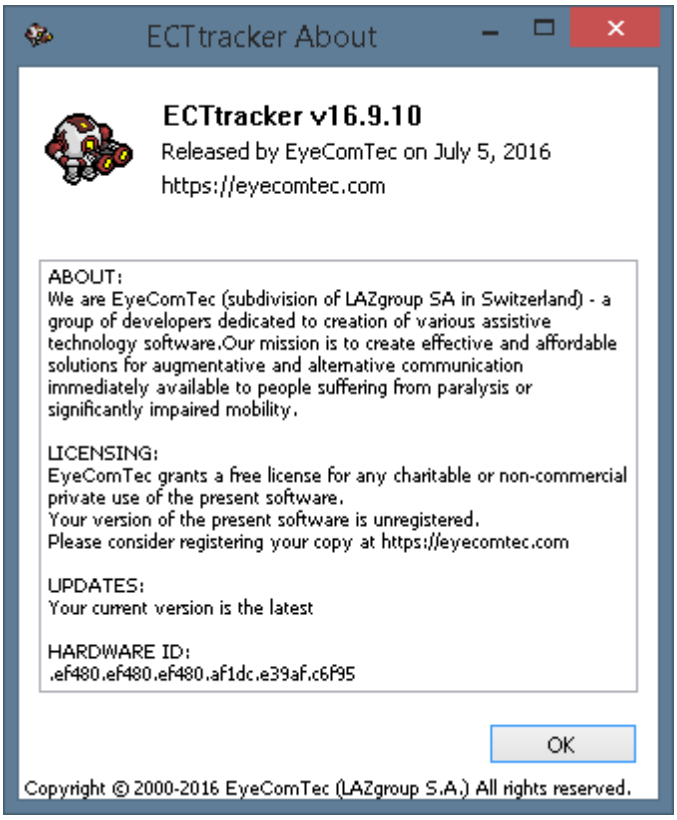
All the items of the ECTtracker main menu are conveniently grouped. The user can start and stop the image tracking process, load and export user settings, load and save samples for tracking (including the auto-calibration feature), show or hide additional items of the main window of the program, select localization, show debugging windows or exit **ECTtracker**. In order to provide more comfort and increase the operation speed, all main items of the menu are assigned with so-called 'hot keys'. The appearance and the interface of the main menu are shown on the figure 11.



(Fig. 11. The main menu of the program)

Let's look closer at the items of the main menu.

'**About',** the **F1** key. This menu item shows the information window of ECTtracker, which contains information about the version of the program, a short description and materials about the developing company, licensing status, available updates and the hardware ID (see fig. 12).



(Fig. 12. The About window of the program)

'**Start**', '**Stop**', the **F2** key. During the first start of the program the user has to select the settings profile and adjust it if necessary, as well as create or load the Matrix of Samples from any file for further recognition. Therefore, the image tracking function is turned off by default. In order to use it, the user has to select the '**Start**' item in the main menu of **ECTtracker**. In cases when the tracking process is running already and the user needs to adjust program settings, select other samples or just pause the tracking, the user can use the '**Stop**' item in the main menu of **ECTtracker**. The user can also adjust parameters while tracking is performed, because it's going to stop automatically in cases where changes are made and followed with the '**Set Current**' menu item selection.

'Matrix of Samples', the **F5** key. This item of the menu can be used to show or hide the Matrix with saved Samples. This window can be hidden during operation in the standard mode in order to save additional space on the desktop. The Matrix of Samples has to be shown during the initial setup process.

PRO**'Events Log'**, the **F6** key. This additional window of the program shows the list of all the main actions performed in **ECTtracker**: e.g. start and stop of the recognition process, import and export of user profiles, various settings changes.

'**Stripes Diagram**', the **F7** key. This additional window of the program shows the level of matching between the image in the program window and the samples in the Matrix in real time.

'Channels Diagram', the **F8** key. This debugging window is used to show the graphical information about the color channels (RGB, delta RGB, HSL). The higher the position of the red channel intensity line, the more susceptible the channel is to changes of the video stream. Such channel changes have to be minimal for the

same eye states, while maximal for the different eye states. This approach allows the user to identify the most important channels for the recognition of the image and matching with samples.

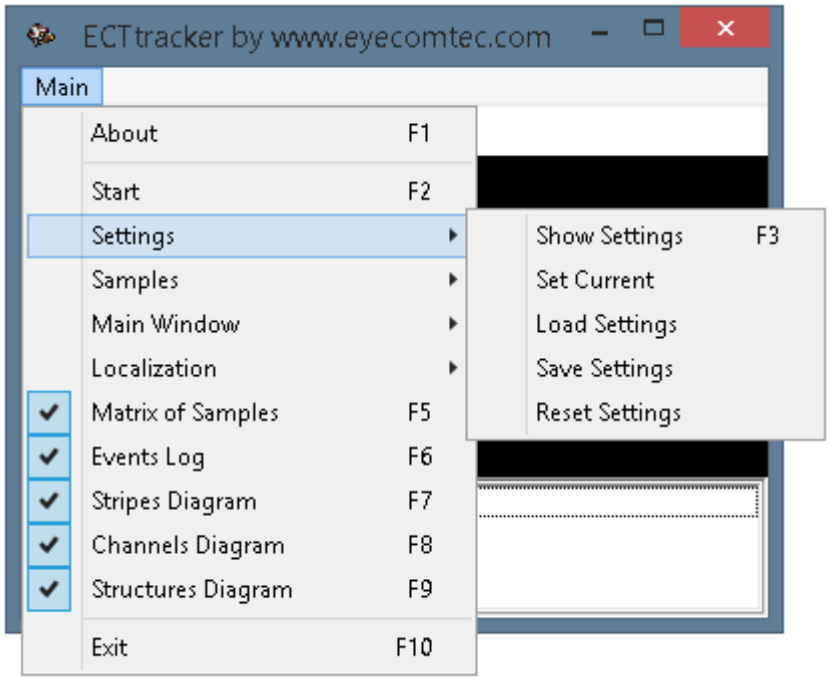
PRO'**Structures Diagram**', the F9 key. Allows the user to hide or show the SCO9 window, which is used to show the intensity of color channels for each point of the recognition structure. This debugging window is created for more advanced users who are able to edit the recognition structure file.

More information about the additional debugging window can be found in the 'Debugging elements' section of this manual.

'Exit', the **F10** key. This menu item terminates the recognition process if it's enabled, and consequently closes all open windows of **ECTtracker** and terminates the application. All settings changes (window sizes and positions, elements visibility parameters and all other program settings) are automatically saved and will be applied during the next launch of **ECTtracker**.

'Settings' submenu

By using the '**Settings**' submenu (see fig. 13), the user can show the window with the advanced settings of **ECTtracker**, import or export user profiles with program settings, apply settings after adjustments, as well as restore default values of all program settings.

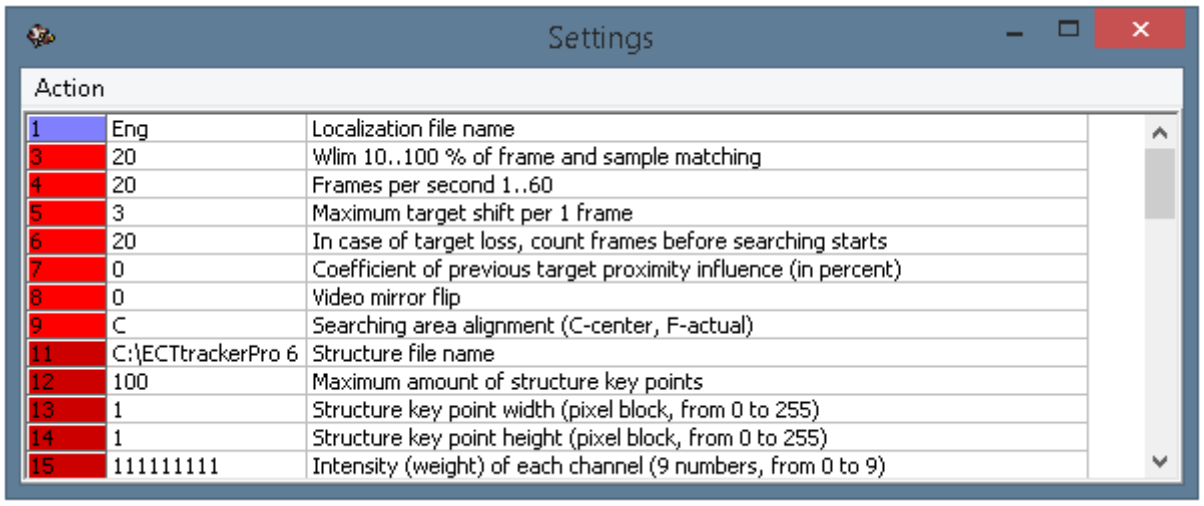


(Fig. 13. The 'Settings' submenu)

'**Show Settings**', the **F3** key. By using this menu item or the hot key, the user can hide or show the settings window of the program (see fig.14), which contains all the adjustable parameters of the program. The settings window of **ECTtracker** is visible by default.

The user can change the matching level of the sample and the analyzed image, the recognition structure type, target window size and position, idle time after loss of the image, the receiving program name, which receives all the data from **ECTtracker**, as well as key codes and actions, additional window parameters, autorun

settings and many other parameters, making more than 50 changeable parameters. The user can find more information about program settings in the 'Settings and additional parameters of **ECTtracker**' chapter of this manual.



(Fig. 14. Settings window of the program)

'**Set Current**'. This menu item allows the user to apply any parameters adjusted by the user through the settings window. All the changes performed by the user are applied only after selection of this menu item. This feature is really convenient for the settings profile creation process when there's no need to apply changes immediately, as well as for fast settings adjustment in **ECTtracker**. The '**Set Current**' item can be found on the main menu of the program, as well as in the additional menu of the settings window.

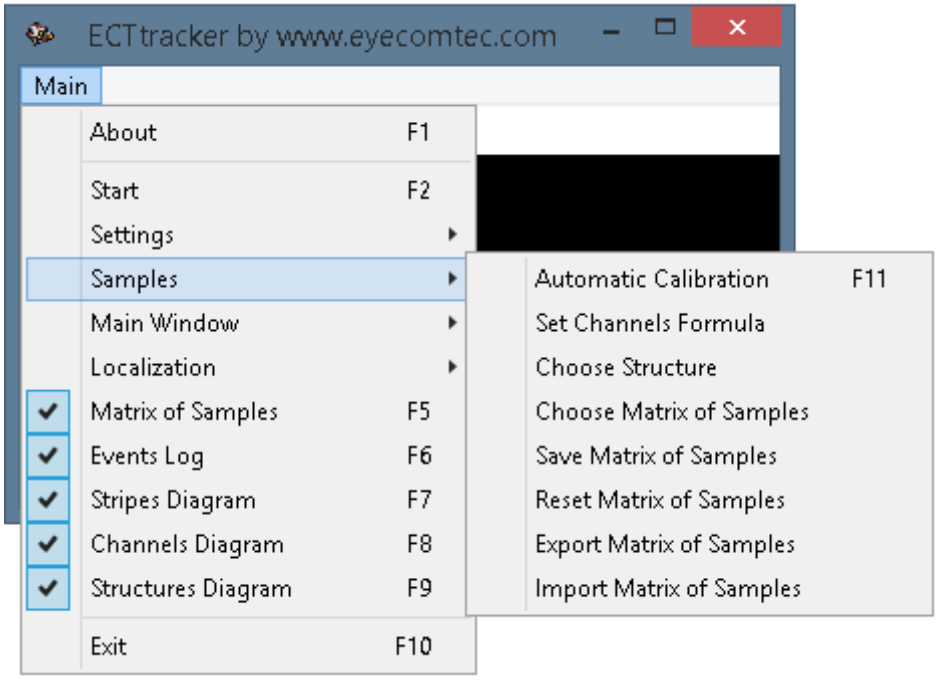
'Load Settings'. By using this menu item, the user can load any previously saved settings profile. This feature allows the user to use an unlimited amount of settings profiles and to switch them 'on the fly', including even those parameters that can take some time when adjusted in manual mode (e.g. maximum shift of user's eyes, capturing and processing speed, etc.). This feature also provides comfort work with portable versions of the program. The wide variety of settings can affect processor load and consume other system resources, therefore it's recommended to use different profiles on computers with different configurations and parameters.

'**Save Settings**'. This menu item allows the user to save all the parameters of **ECTtracker** in a separate configuration file. When the user selects this menu item, a new window of operation system appears, allowing the user to select the location and the name for the new file. The file is going to be saved in a specified folder, having a specified name. Configuration files have a really small size, which makes it really easy to keep and sort them, as well as copy to any portable devices or send through e-mail and so on.

'Reset Settings'. The user can go back to the factory settings of **ECTtracker** in automatic mode. It's recommended to perform this action only in cases when the user set parameters that require high amounts of computing resources and the current computer is not able to provide them, resulting in unstable functioning of **ECTtracker,** as well as in some other cases.

'Samples' submenu

By using the '**Samples**' submenu (see fig.15), the user can start auto-calibration and select a desired recognition structure. This menu also allows the user to work with the Matrix of Samples, i.e. save samples as files divided into folders or as one file; load previously saved samples; erase all the information from the Matrix; and calculate the color channels' priority level in automatic mode in order to increase the recognition quality.



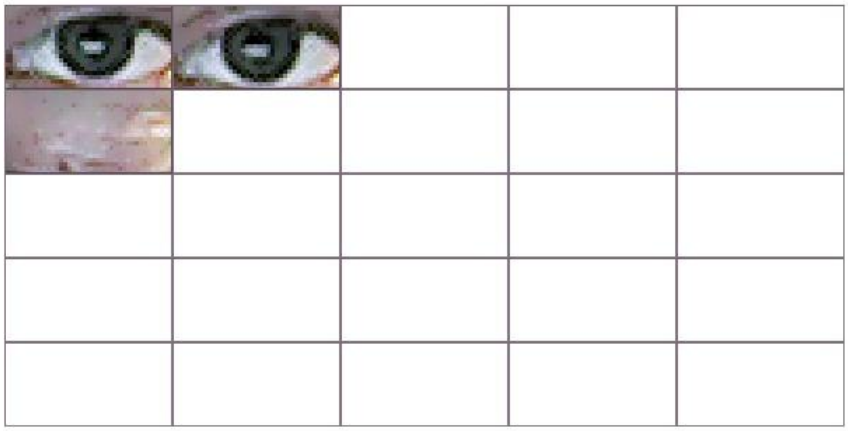
(Fig. 15. 'Samples' submenu)

'Automatic Calibration', the **F11** key. By using this item of the menu, the user can start the automatic calibration in order to create materials for the Matrix of Samples.

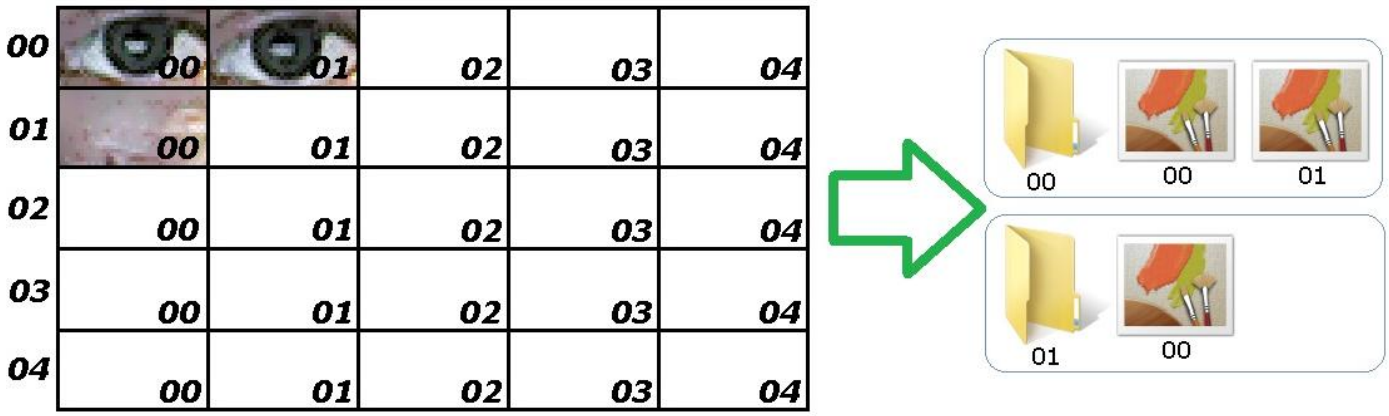
'Set Channel Formula'. It allows the user to select the priority level for each color channel in automatic mode. This feature provides an optimal level of recognition in the current conditions (the resolution of the camera, the lightning intensity, positions of the light sources, the distance between the camera and the face of the user and so on). This calculation can be performed only after proper filling of the Matrix of Samples, and the final value is going to be saved as the value of parameter 15 in the settings window of **ECTtracker**.

'**Choose Structure**'. When the user selects this item, a new widow of the operation system appears, allowing the user to select one of the available recognition structures. The structure is selected based on the current motor activity of the patient: ability to blink with one or both eyes, move lips, move thumb, and so forth. By selecting different recognition structures, the user can empirically determine the best structure for each particular case.

Other items of the 'Samples' submenu are intended to work with the Matrix of Samples. The current version of **ECTtracker** makes it possible to save the Matrix as one united graphical file (see fig.16) or save each sample in a separate file, dividing them into folders (see fig.17). In both cases, all the images are saved in the .bmp format in order to provide maximum clarity.



(Fig. 16. Matrix of Samples as one file)



(Fig. 17. Samples divided into folders)

'**Choose Matrix of Samples**'. This item allows the user to import the Matrix of Samples from one graphic file.

'**Save Matrix of Samples**'. This item saves the Matrix of Samples into one graphic file.

'**Reset Matrix of Samples**'. This item deletes samples in the Matrix of Samples that were created during manual or automatic calibration. The Matrix of Samples is cleared automatically during the automatic calibration.

PRO '**Export Matrix of Samples**'. This item saves samples into separate files, dividing them into folders.

PRO '**Import Matrix of Samples**'. This item imports samples from different folders.

Saving the Matrix as one file can be really useful when it's necessary to work with profiles of several users. These files can be stored in external portable devices, sent through e-mail and printed when necessary. Furthermore, if the user opens a file without running **ECTtracker**, the file can give total information about all saved samples.

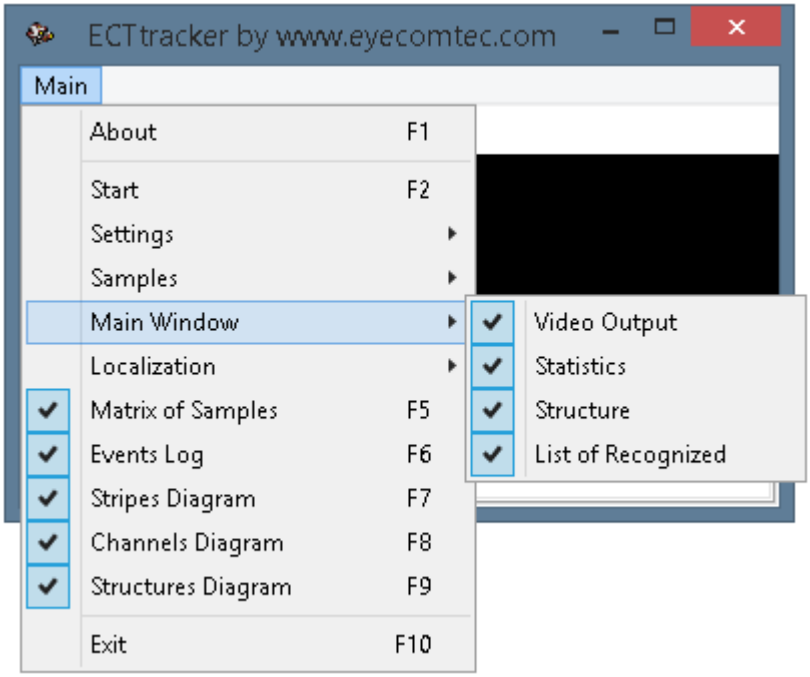
The storage of samples in separate files has some advantages and makes it possible to change the Matrix of Samples without running **ECTtracker** or by using any third-party graphic editor. In order to change the position of any sample in the Matrix, the user can just change its name or move it to another folder. Thus, the user can switch two samples without any need to create them once again. The user can also copy or delete any samples

using the file manager of the operating system. All changes will appear in **ECTtracker** after reloading the samples.

Storage of the Matrix of Samples in separate files and folders can be useful in some other cases, e.g. for remote control needs. In this case, the user can create a new Matrix of Samples using the auto-calibration feature, allowing the assistant to edit it remotely by moving files between folders. This makes it really easy to adjust Matrixes for personal needs.

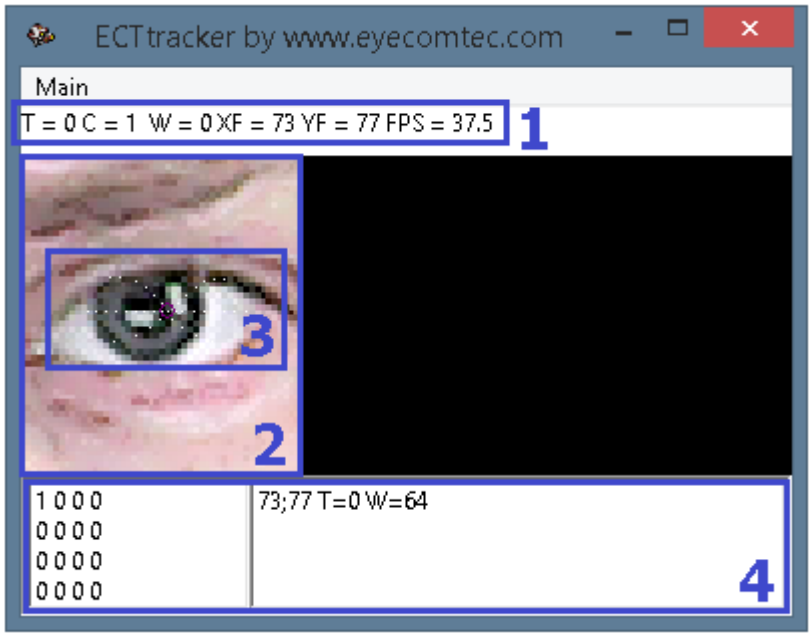
'Main Window' submenu

The '**Main Window**' submenu (see fig.18) allows the user to enable or disable various elements of the main window of **ECTtracker**, i.e. the video area, the structure of the image, statistic information, or coordinates for sample matching. Enabled elements of the program are marked with a tick.



(Fig. 18. The 'Main Window' submenu)

This feature allows the user to properly set up the program initially or adjust some parameters. Furthermore, disabling some elements during normal work of **ECTtracker** allows the user to lower the required level of computing resources. It also allows the user to create some free space on the desktop and use it for some other application windows, e.g. the virtual keyboard window. All debugging element are enabled by default during the very first launch of the program. Positions of such elements are shown on figure 19.



(Fig. 19. Positions of the debugging elements in the main window of the program. 1 – statistics, 2 – video output, 3 – recognition structure, 4 – list of recognized samples)

'**Video Output**'. This menu item allows the user to show or hide the image from any other software in the main window of **ECTtracker**. When the video window is disabled, the user won't be able to see the structure. This feature is useful for computers with low-end technical characteristics, allowing the user to consume computing resources in the optimal way. Despite the fact that the video and the structure are not displayed in the window, tracking is still working and statistic data in the main window of **ECTtracker** and the '**Stripes Diagram**' window is updated; all key codes are also sent to selected receiving software.

'**Statistics**'. The main window of the program contains various useful statistic information, including row and column number of the sample from the Matrix of Samples corresponding with the current image, the matching level, coordinates of the best sample, speed of visualization and processing of video. By disabling statistics through the corresponding item of the menu, the user will obtain an insignificant reduction of the required program resources and save some screen space when using **ECTtracker** on computers with low-resolution displays.

'**Structure**'. Structure visibility in the window with the acquired image allows the user to check if the correct area of the image is recognized by the program in real time, the quality of **ECTtracker** eye area 'control', and the focus on the selected area. When the program is set in the proper way and properly follows the user's eye image, the user can hide the structure from the image, lowering required computing resources.

PRO'**List of Recognized**'. This menu item allows the user to show or hide the additional part of the main window that contains the numeric table of samples, coordinates and maximum matching level between samples and the image acquired from the video window. By disabling this list, the user will have the same result as with items in previous chapters, i.e. decreased level of required computing resources.

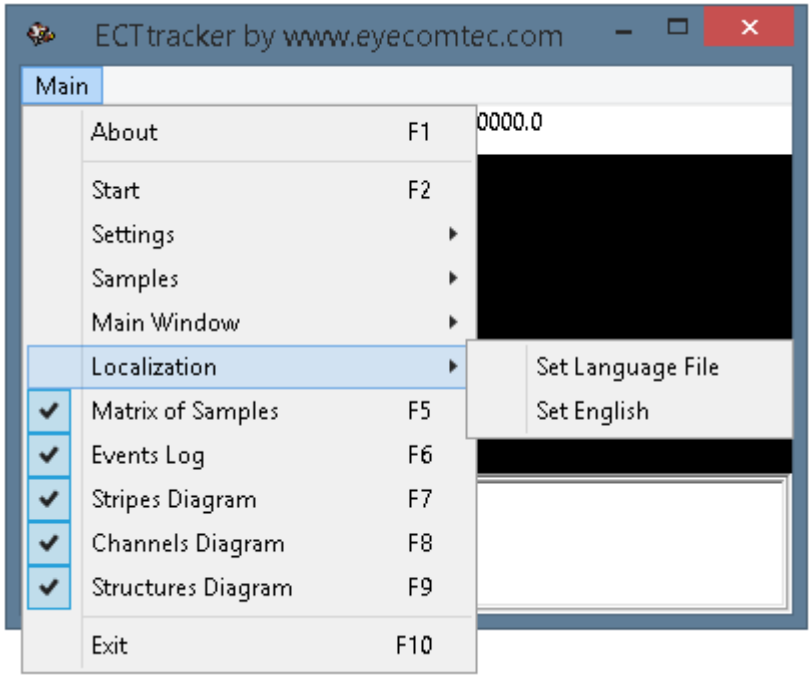
In case there's no area with the list in the main window of the program after the '**List of Recognized**' item activation, the user has to change the value of parameter 34 of the settings window of the program. This parameter defines the height of the list in pixels.

'Localization' submenu

ECTtracker gives all users the possibility of using their own language by using separate localization files. Currently the main menu and the settings description of the program are available in Chinese (Simplified), German, Spanish, French and Russian. The default language is English.

Localization through separate files is really convenient, because it doesn't require a full program update after each release of a new language. Language files are really light and located in the language subfolder.

There's a separate '**Localization**' submenu in **ECTtracker** for language selection (see fig.20).



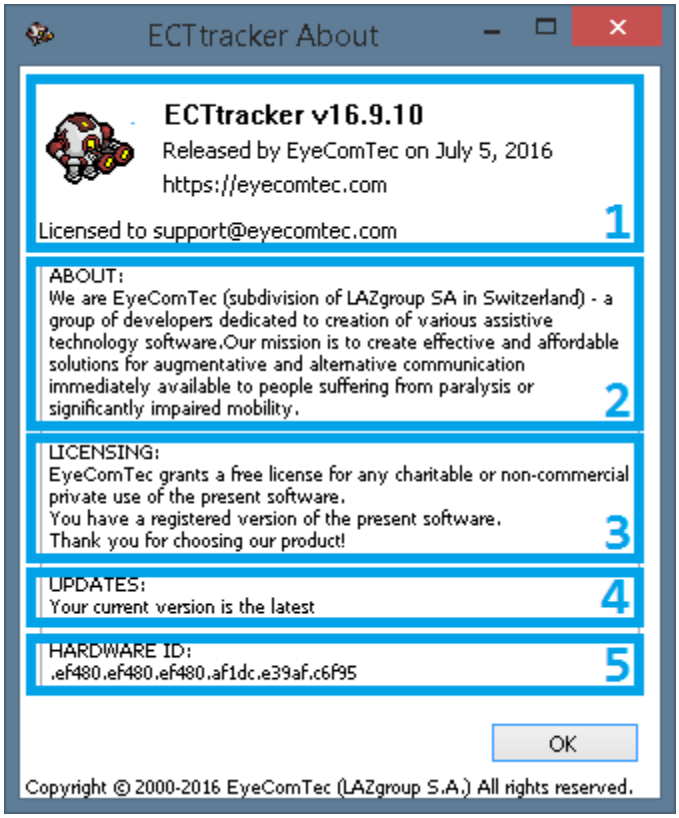
(Fig. 20. The 'Localization' submenu)

'**Set Language File**'. This item of the menu allows the user to select the localization version of the program. The user will see a standard file explorer window, where it's required to select any desired file from available languages.

'**Set English**'. By selecting this menu item of **ECTtracker,** the user will change the language to English without any additional confirmation windows or manual selection. This feature provides extra convenience for the user.

'About' window

When launching a non-activated copy of EyeComTec programs (ECTcamera, ECTtracker, ECTkeyboard, ECTmouse, ECTlistener and ECTmorse), the user will see the **About** window, which contains additional blocks of information (see fig. 21).

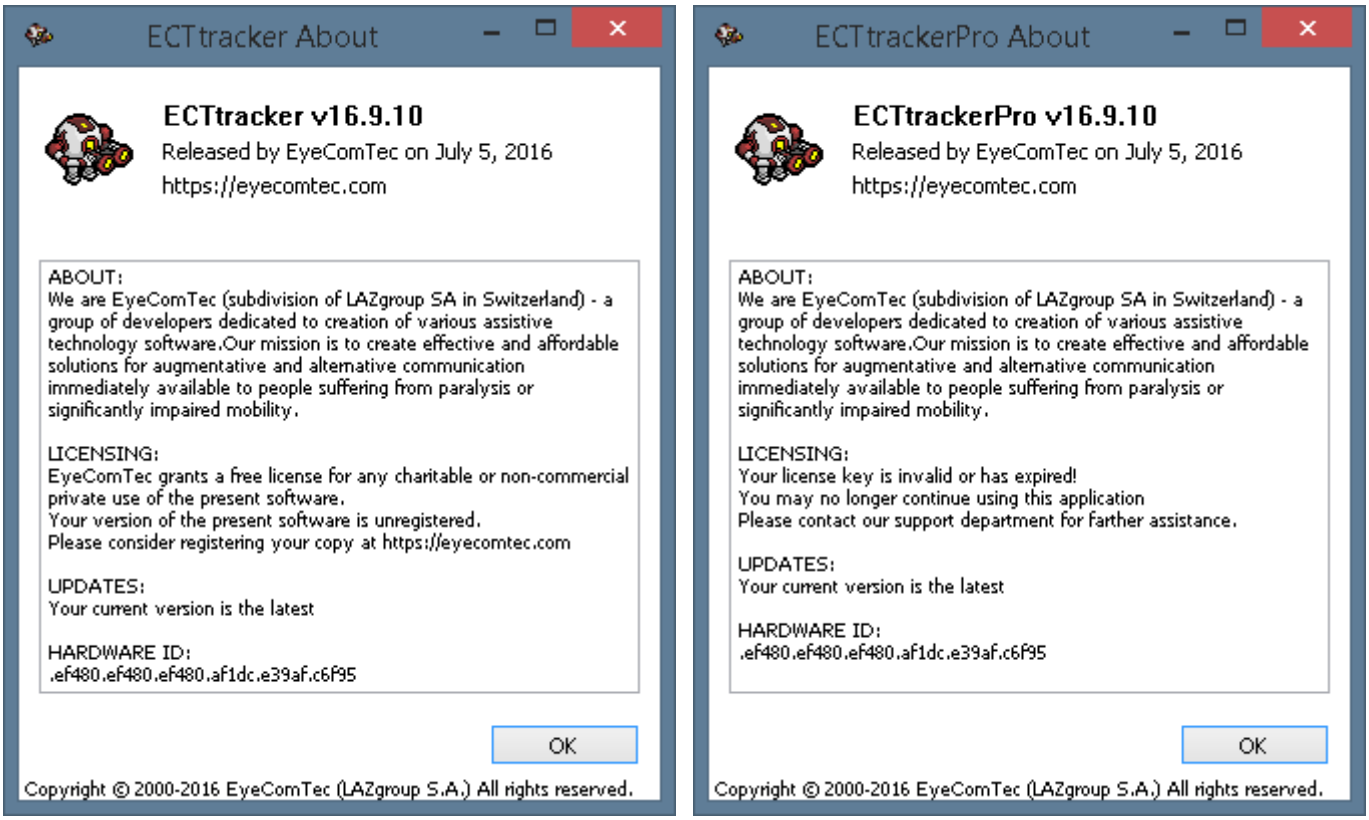


(Fig. 21. An updated About window of the **ECTtracker** program)

On the image above, various information blocks are marked with numbers:

1. The number and the date of the release, the company's website address. For activated versions, this block also includes an e-mail address of the user registered to this copy of the program.
2. The **About** section, which contains the information about the EyeComTec Company.
3. The **Licensing** section, which indicates the license type of the current copy of the program (paid commercial or free non-commercial license);
4. The **Updates** section, which shows if there's an updated version of the program on the developer's website);
5. The **Hardware ID** section, which indicates the hardware code of the computer used to launch the program.

The appearance of the **About** window is different for paid commercial programs (Pro version) and free versions for non-commercial use (see fig. 22).



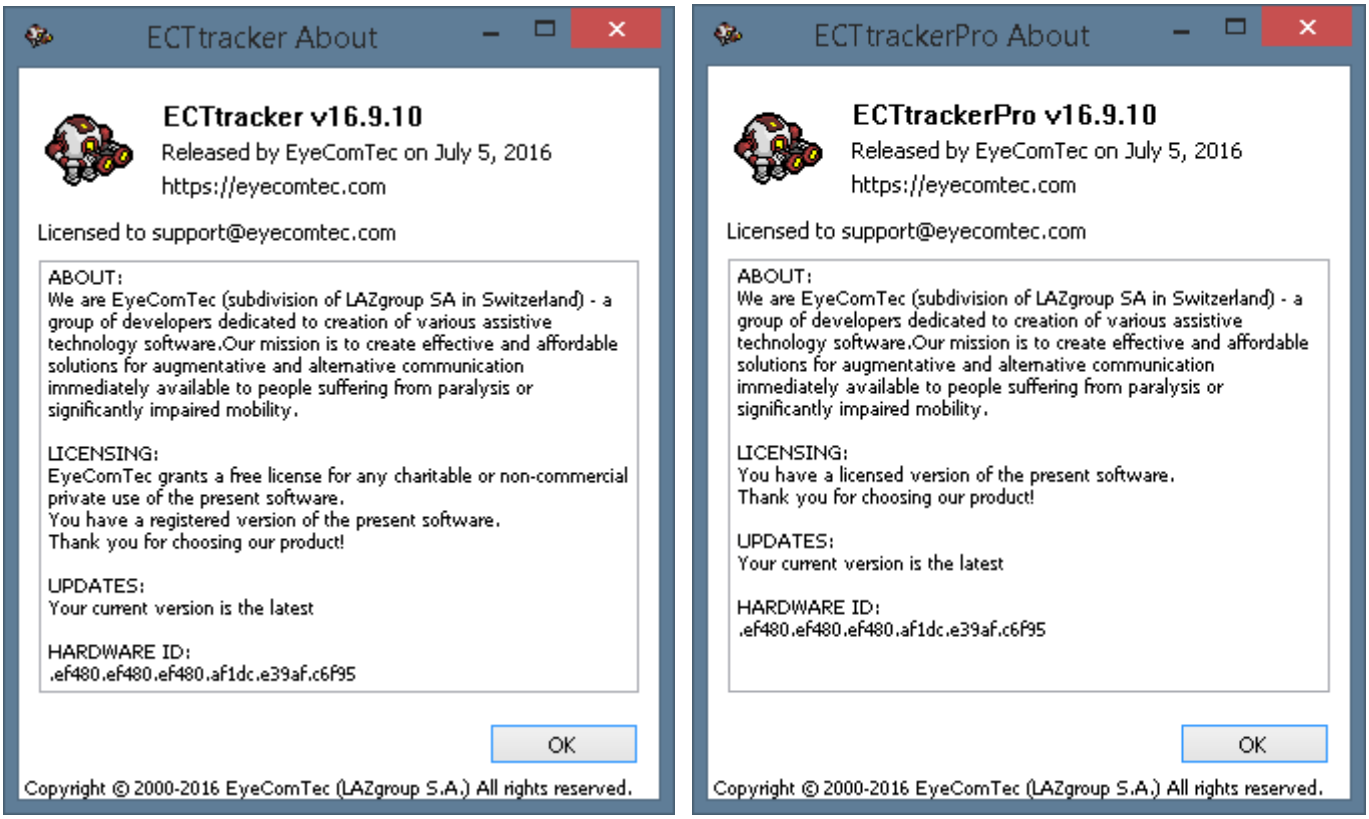
(Fig. 22. The About window for non-activated versions of the program. Left: free license for non-commercial use; Right: paid commercial license)

The user will see the main window of the program after pressing the **OK** button and closing the **About** window in a program with the free type of the license. The non-activated version of the program with a commercial license will not be launched until the user purchases (or prolongs if the license expired) a license and creates a new key file in the program's folder.

All the programs with free licenses are intended for people with a real physical need for assistive technologies from the EyeComTec Company. The registration process is not compulsory in such cases, but the company kindly recommends that our customers do register in order to gain the full benefits e.g. updates and customer support. Free versions of our software products can also be used by non-commercial and charitable organizations. These organizations must register for a licence.

Registration on the company's website and the following activation of the program are compulsory for Pro versions of software.

After completing the activation, the **About** window will not be shown during every launch of the program. The user can open it by using the **About** menu item, or by pressing the **F1** hot key (see fig. 23). There is sometimes a short delay when opening the **About** window, as every time it is opened, the program will check for updates on the EyeComTec website.



(Fig. 23. The About window for activated versions of the program. Left: free license for non-commercial use; Right: paid commercial license)

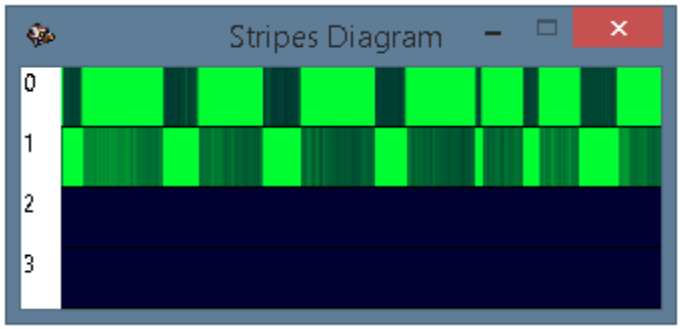
Debugging elements

Debugging elements of **ECTtracker** are additional windows, which can be shown by the user in order to adjust the program and hidden in order to save desktop space during proper program operation. Each of these windows shows some statistical information, which can be used in order to perform a more precise and correct program setting procedure of **ECTtracker**, which results in an improved level of image recognition. As a result, the user will have less stress and work with the program more continuously. The amount of false positives during recognition will also decrease.

The current version of **ECTtracker** supports three types of debugging windows, i.e. Stripes Diagram, Channel Intensity and SCO9, as well as the convenient event log. Let's look closer at these elements.

Stripes Diagram

An additional window of the program that shows the level of coincidence of the images in the window and samples from the Matrix of Samples in real-time (see fig. 24).



(Fig. 24. The 'Stripes Diagram' window)

The number of stripes always corresponds with the number of rows in the Matrix of Samples. When the tracking process is started in **ECTtracker,** lines are painted from the left to the right. The color changes from the dark blue when there's no coincidence to green in cases of a significant coincidence. The Stripes Diagram window is intended to provide a fast evaluation of the tracking accuracy and allows the user to select the proper value of wlim parameter, as well as to select an appropriate structure and correct other settings in accordance with the needs of each specific user and computer's performance.

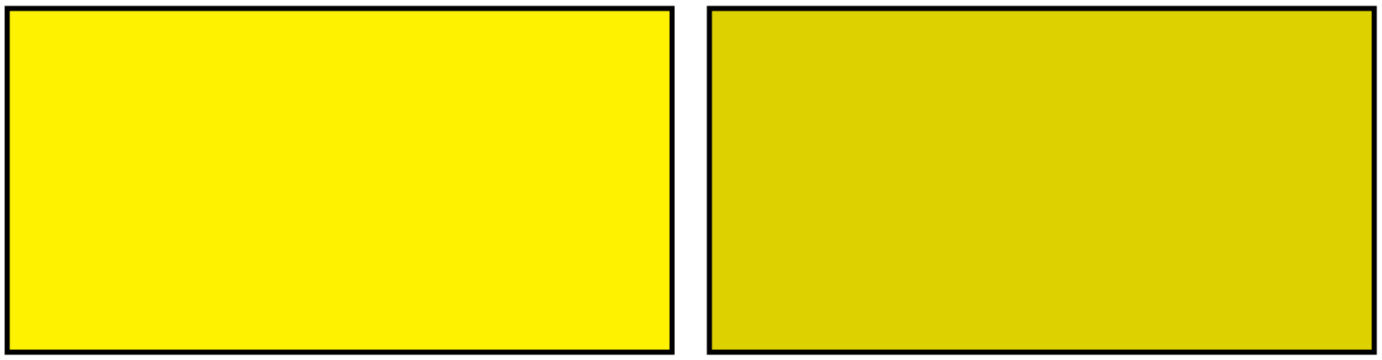
The main condition of the proper recognition is as follows – one of the stripes in the program has to be higher than another at any given time period. On the image above, one can clearly see when the user's eye was open (green color of stripe 0) and when it was closed (green color of stripe 1). This image shows the proper recognition level setting.

Channels Intensity

Current versions of **ECTtracker** include a significantly improved color processing logic and methods of comparing the analyzed image with previously saved samples. In previous versions, the samples and the image were compared only in RGB color scheme, where each color is defined as a massive of three numbers (intensity levels for red, green and blue colors).

But the human eye uses different principles. For example, the bright yellow color and the dark yellow color will have pretty different RGB values. Thus, the program now involves the HSL color model, which is a massive of three number defining shade, saturation and lighting levels. Values of the colors that are not considered extremely different to the human eye will have little difference in the HLS color model.

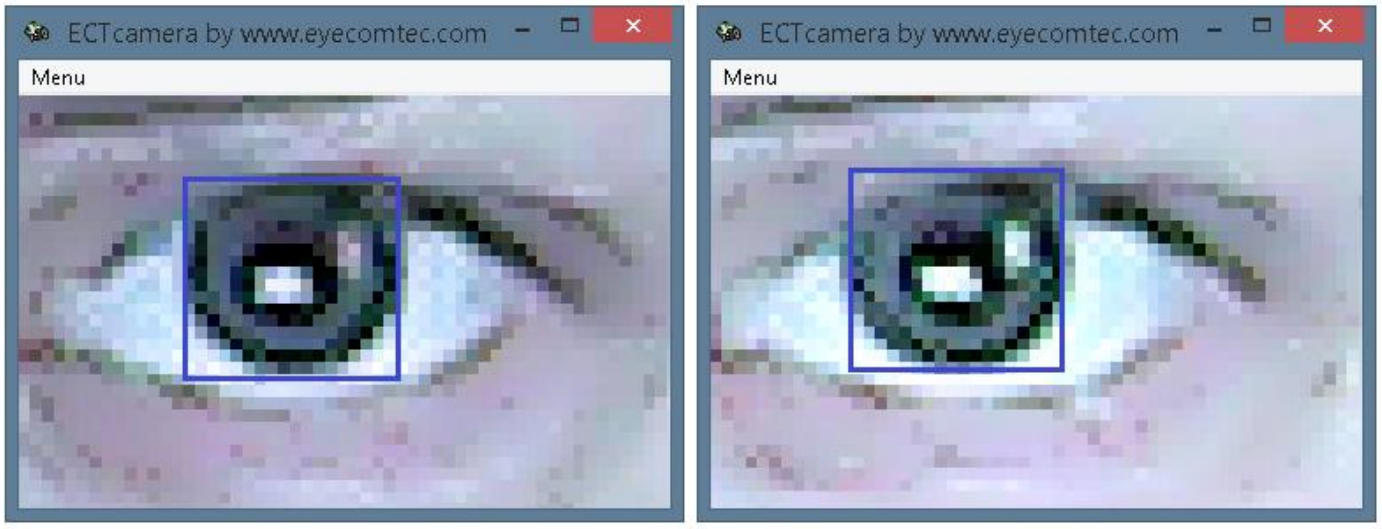
Let's look at RGB and HSL values for two previously mentioned colors, i.e. bright yellow and dark yellow (see fig. 25).



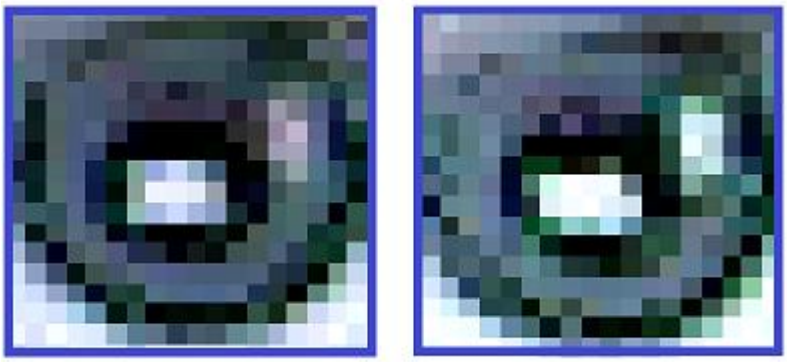
(Fig. 25. Difference between the RGB and the HSL values. Left color: RGB – 255 242 0, HSL – 38 240 120. Right color: RGB – 221 210 0, HSL – 38 240 104)

In the RGB massive, red and green values are changing, while in the HLS massive, only the lighting value is changing. HLS massive values can be compared more easily, thus providing more precise results during the tracking process in **ECTtracker**.

Furthermore, if one takes two consistent frames from a video stream and zooms in, it will be obvious that the color of some pixels may change drastically between such frames (see fig. 26 and 27). As a result, RGB values of such pixels are significantly changing too.



(Fig. 26a. Difference between colors of zoomed images)



(Fig. 26b. Difference between colors of zoomed images)

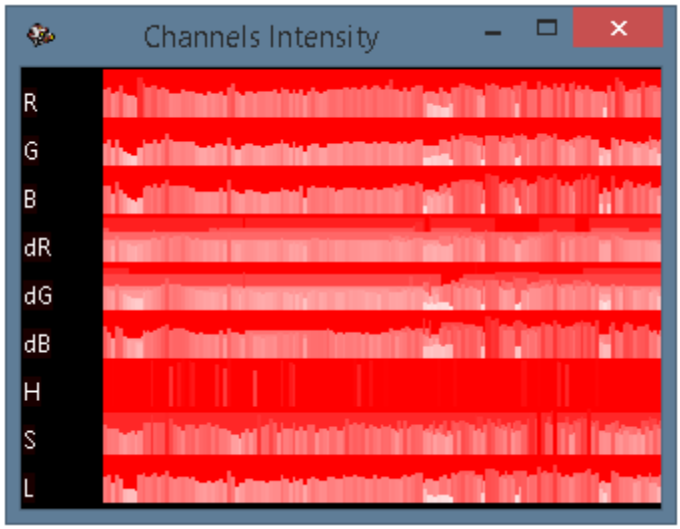
In order to compare an image with the samples, **ECTtracker** performs an analysis of the rectangular zone of each structure point, defining average values for the following parameters:

- RGB (different values for each channel)
- Delta RGB (difference between the maximum and minimum values for each channel)
- HSL (separate values for each channel).

Thus, each frame of the video stream is compared with samples using 9 various values for each point of the structure (i.e. a rectangular area with the center in the structure point).

Various environmental conditions (the intensity of the lighting, the position of the light source, the distance between the face of the user and the camera, the efficiency level of the selected recognition structure, the camera resolution, various image shifts caused by the user's head movement, etc.) can result in significant value differences for each of the channels, even for one state of the eye.

In order to check the intensity level of channels, the user of **ECTtracker** can open the Channels Intensity window (see fig. 27).



(Fig. 27. Channels Intensity window)

This window contains real-time intensity diagrams for each of the channels:

- R – red color
- G – green color
- B – blue color
- dR – red color (the difference between the maximum and minimum values)
- dG – green color (the difference between the maximum and minimum values)
- dB – blue color (the difference between the maximum and minimum values)
- H – hue
- S – saturation
- L – lighting

The general algorithm of the proper setting procedure is as follows:

1. The user has to add several samples for the open eye into the Matrix of Samples in order to check changes in the intensity level of the channels. Channels with the highest intensity levels for one state must have the lowest priority level during calculations.
2. The user has to erase all samples from the Matrix and add new samples for the closed eye. The user needs to check the intensity level of the channels. As in the previous step, the channels with the highest intensity levels must have the lowest priority level.
3. After doing that, the user has to erase the Matrix of Samples and add one sample with the open eye, and one sample with the closed eye. The channels with the maximum intensity levels for each of the states must have the highest priority level.

Important information! In order to perform a proper setting procedure, the user has to select the most intensive channels for different eye states, and the less intensive for one state. The value of such channels for the image recognition process is incredibly high. Important channels must have priority levels in the range from 5 to 8, while less important channels should be in the range from 1 to 3. The maximum range of the intensity level for each channel is from 0 (the channel value is not involved in the calculation process) to 9 (the maximum priority level).

ECTtracker allows the user to set the level of priority independently for each of the channels. In order to do that, the user has to change parameter 15's value in the settings window of the program. Priority levels for all channels are indicated one by one without spaces. For example, if the user selects HSL channels as the most important ones, the value of the parameter may look like 111111888, 222222667 or something like that.

When **ECTtracker** is used for non-medical purposes, (e.g. to sort various image libraries or analyze current states of various analog sensors, etc.), RGB channels must have priority. It's more convenient to use HLS color profile recognition when it's required to analyze various liquid clouding or gas chamber conditions. It's also recommended to use the HLS color profile for medical purposes (at home or at a medical center) when **ECTtracker** is used for patients with limited motor activity. In general, the level of importance of each channel depends on the current environmental conditions, thus a level can be different for each particular situation.

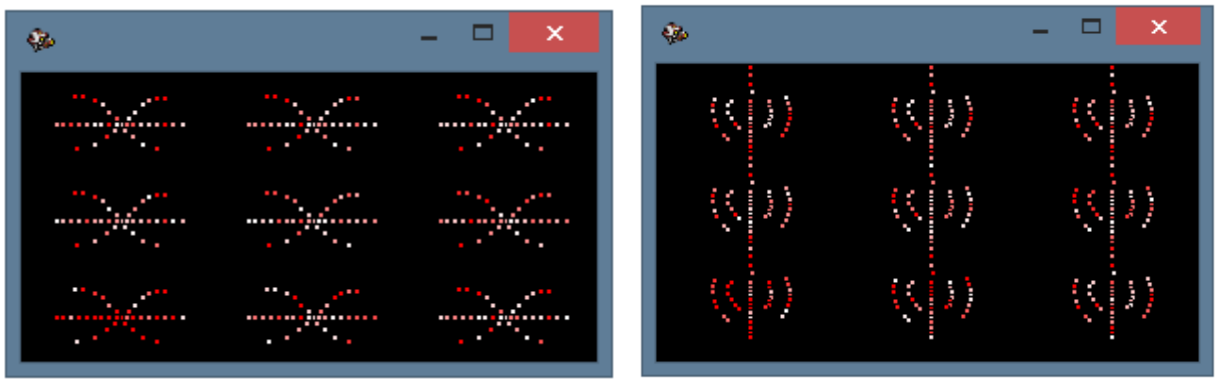
Even though the Channels Intensity debugging window is pretty easy to use, the priority selection process can become a challenge for the user without required experience. That's why **ECTtracker** supports the automatic priority calculation feature. After filling the Matrix of Samples in manual or automatic modes, the user has to select the '**Settings** – **Set Channel Formula**' menu items. The program will compare intensity changes for each

channel in similar states. After that, the program will compare intensity changes for different states. Channels with the minimum intensity changes for one state and the maximum changes for different states will get the highest priority. Channels with the maximum level of intensity changes for one state will have the lowest priority. The final value will be automatically added to parameter 15 of the settings window of the program.

Due to the automatic formula calculation feature, even the most inexperienced user can select the required setting to provide an optimal recognition level.

PRO SCO9 (Structure diagram)

The quality of recognition level can also be improved using the window that contains the structure diagram. This window contains structures for each of the channels, as well as the intensity changes for each of the structure points (see fig. 28).



(Fig. 28. The SCO9 window for various recognition structures: The first row – structures for RGB scheme, the second – structures for delta RGB, the third – structure for HSL scheme)

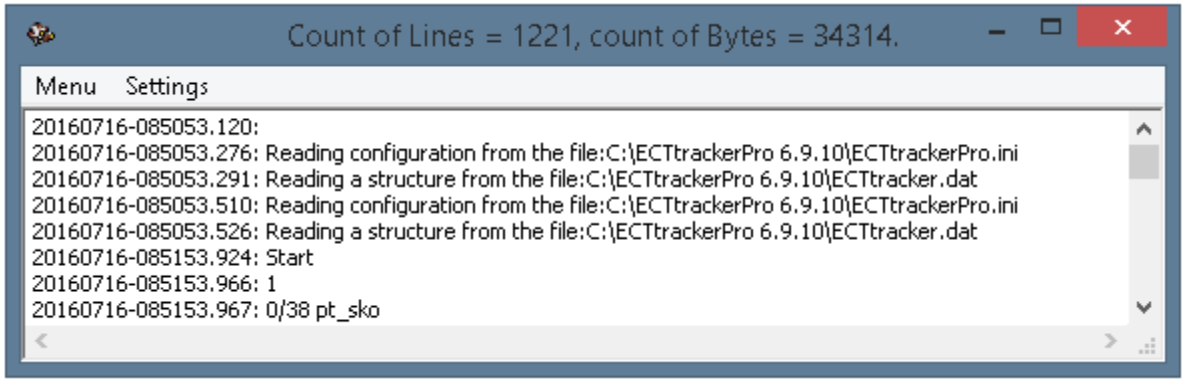
The brightness level of the recognition structure points indicates the variability of each color channel for such points. Even though all structures are universal, some points can be out of the area of the image with the most significant changes. This may lead to reduced recognition quality. For example, when the user selects the recognition structure for one eye, some points may be located in the nose bridge area. Color values for both states for such points (for open and closed eyes) will not have a significant difference.

Thus, the SCO9 window allows the user to identify recognition structure points, which can be located in areas of the image with the most insignificant changes. In this situation it's necessary to perform an additional setting procedure, i.e. relocate the target window of **ECTtracker** more precisely, and increase the scale of the image in **ECTcamera** if it's needed.

In the majority of cases, the SCO9 window is intended only for advanced users who can edit the recognition structure files, i.e. change the amount and position of points and the priority level of each point. However, this debugging window can also be useful even for average users, helping them to set the program up.

PRO Events Log

This additional window of the program shows the list of all important events that took place in **ECTtracker**: tracking start and stop, profile loading or saving, settings changing. Appearance of the events log is shown on figure 29.



(Fig. 29. The events log of the program)

The header of the event log indicates the amount of rows in the current log and the total size of the log in bytes. This information can be shown or hidden through the separate '**Settings**' – '**Statistics**' menu items. The event log menu also provides some other functions:

- '**Clear**' – delete all records about program work from the log
- '**Save**' – save log as text file
- '**Close**' – close the log window.

Settings and additional parameters of ECTtracker

All the adjustable parameters of **ECTtracker** are available through the settings window of the program. The user can open it by using the **F3 hot key** or **Settings – Show Settings** menu items.

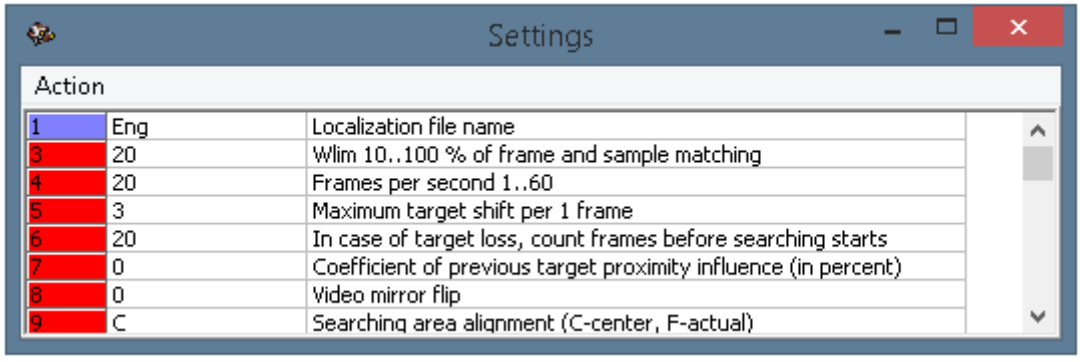
All settings are grouped by categories:

- 1-9 – basic program settings. This group includes localization settings, the matching level between samples and the analyzed image, the frame per second rate of the captured video, the maximum image shift for 1 frame, time of recognition restoring after losing the matching, video mirror flipping, etc.
- 11-15 – recognition settings. This group includes: the recognition structure file name, the maximum amount of the recognition structure points, the width and the height of the area of each point, the color channels priority formula, the color of the structure in the main window of the program, as well as the scale in the SCO9 window
- 20-27 – Matrix of Samples settings. The size of samples and the amount of samples in each row or column. This group also includes all target window settings that affect its size and position.
- 31-34 – debugging elements settings for the main window of **ECTtracker**. Visibility of the elements and the size of the area with information about recognized samples.
- 45-50 – settings for paths, time intervals and automatic start of the recognition process.
- 60-67 – visibility setting of the additional windows of the program.
- 100-115 – settings for keys and actions for the receiving software.

All the settings are grouped in several columns. From left to the right: a number, a parameter value and its short description.

Let's look closer at the settings of the program.

Localization and image analysis settings



(Fig. 30. The settings window, parameters 1-9)

1 – **Localization file name**. The name of the file that contains the description of interface elements and program settings in a required language. In this field, the user has to specify the full path for the localization file and its name.

3 – **Wlim 10..100% of frame and sample matching**. Wlim – is the limit of the matching degree of a sample and the analyzed image. The value of this parameter can stay in the range from 10 to 100. It's recommended to use values from 18 to 25 (depending on the lighting, mobility of the user, camera settings and other parameters). The default level of Wlim is 20. The higher the value selected by the user, the more accurate the matching level of the sample and the recognized image fragment under the structure will be. Wlim can be increased only in the case of proper lighting and high resolution of the camera. This value can also be increased in cases where the program finds several corresponding samples for one image. This situation can be easily seen on debugging lines, when two or more lines are simultaneously filled with the green color. Vice versa, when the level of recognition is low and there are no adequately corresponding samples, the user has to decrease the Wlim value. The proper value for this parameter has to be selected in such a way that only one green debugging line appears in the stripes diagram at any given time.

4 – **Frames per second 1..60**. Speed of the video processing and capturing for tracking purposes. **ECTtracker** receives the image from a source located under the target window (it can be the **ECTcamera** application or any other software that captures video from any camera, media player, Skype or other source). A fragment of the image is shown in the main window of **ECTtracker** and compared with previously loaded or created samples using key points of the structure, followed by information updates in the main and debugging windows. Basing on the received information, **ECTtracker** determines key codes to be sent to receiving software. After finishing this stage, the program switches to the next image and this cycle is repeated. Despite the resource-intensive process, the program can handle up to several dozens of frames per second. The default value of this parameter is 20 frames per second. This parameter value can stay in the range from 1 to 60 frames per second. It's recommended to decrease this parameter below 6 frames per second for computers with low technical characteristics. It's worth noting that this parameter directly affects the speed of the video capturing process. E.g. if the video feed of the user has a rate of 20 frames per second, there's no need to set a higher value for this parameter. This will not increase the quality level, but will increase the overall load on the computer resources during work with **ECTtracker**.

5 – **Maximum target shift per 1 frame**. The maximum shift of the user's eye for one frame. If the user has not totally lost mobility or the user is suffering from uncontrolled muscle activity (teak, tremor), it can result in an unstable image from the camera. Inclinations of the head and various movements can result in a change in the face position, thus the program needs to correct the location of the structure in such a way that it can follow the user's eyes. Thus, the central coordinates of corresponding samples will also change. The faster and more notable the movements of the user, the higher the shift value for 1 frame to be selected. To avoid loss of the target, it's recommended to increase the maximum shift value even for close-up shots. The value of this parameter has to be selected from the range of 0 to 100 pixels. The default value of the maximum shift is 3 pixels. This value can also be increased in cases when the program can't keep focus on the user's eye, as well as decreased for working on low-end computers. This software was initially created for totally paralyzed patients; that's why it's strictly recommended to minimize the amount of any possible movements in the analyzed area. In order to avoid head movements, the user can use a chair with a high backrest or an armchair with a headrest. This approach allows the user to obtain almost complete immobility during the operation of **ECTtracker**.

6 – **In case of target loss, count frames before searching**. The idle time for the program when target is lost. In cases where the analyzed image does not correspond with any sample from the Matrix of Samples, **ECTtracker** has to skip a predefined amount of frames. After that, the program will move the search point to the center of the image (if parameter 9 has the C value) or to the place of the last successful matching

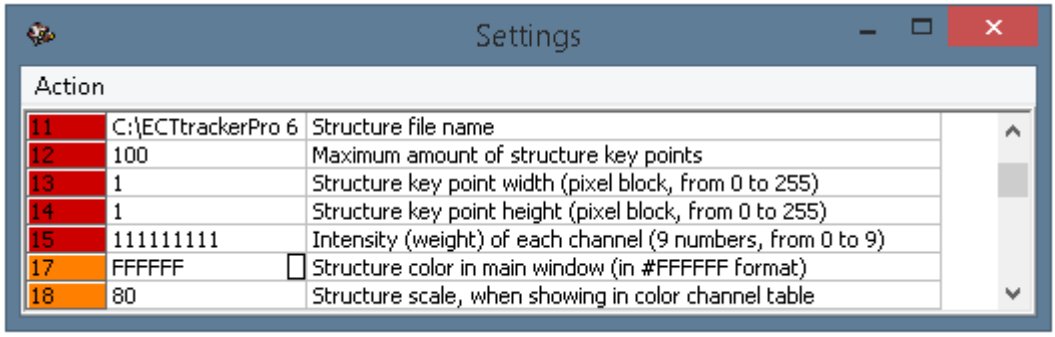
(if parameter 9 has the F value). The structure is hidden during the idle time, allowing the user to see that the target is lost. The default value of this parameter is 20 and it's usually equal to the analyzed video frame rate. In other words, when **ECTtracker** loses focus, it will resume searching for corresponding samples in 1 second. The user can select any desired value in the range from 1 to 1000 frames.

7 – **Coefficient of previous target proximity influence (in percent)**. During the comparison of the current image and samples, the program may take the distance to matched samples into account and choose the closest of them. The value of this parameter can be selected from the range of 1 to 100, thus changing the coefficient of the previous target proximity from 1% to 100%. The default value is 0, i.e. **ECTtracker** selects corresponding samples irrespective of their position.

8 – **Video mirror flip**. The value of this parameter can be equal to 1 or 0. When the 0 value is selected, the **ECTtracker** main window shows the video in the same way as in the application under the target window. When the value of this parameter is equal to 1, the video in **ECTtracker** window is flipped horizontally. The default value of this parameter is 0.

9 – **Searching area alignment (C – center, F - actual)**. Alignment of the search area to the center or according to the last successful coordinates. When the C value is selected and the sample is lost, **ECTtracker** starts searching from the center of the analyzed image. This mode implies total immobility of the patient (in case of paralysis, as well as in case of any uncontrolled head movements with return to its original position). When a sample goes out of the tracking area, **ECTtracker** returns the searching area to the center of the image. This feature allows the user to avoid such situations when software switches to another similar object or searches an object in the area of loss, while it's already in the center of the image. When the F value is selected for parameter 9, software is searching the sample in the area of its loss and not getting back to the center of the image. This mode was invented to use the head (or any other marker) as the mouse cursor. In such cases the user has to select a bigger tracking area and create samples for an eye or a marker. After doing so, the user is able to control the cursor with their head movements. Parameters 51-54 are responsible for this mode. In cases where a sample goes beyond the limit of the analyzed area, **ECTtracker** will try to find it at the same area, without moving to the center of the image. This feature allows the program to perform a fast search of the lost object that left the area and returned in a while. The F value was created to compensate possible tremors and various repetitive movements of the patient. This working mode is more complex. Thus, it's recommended to use the C mode whenever possible.

Recognition settings



(Fig. 31. The settings window, parameters 11-18)

11 – **Structure file name**. The program can work with one of several recognition structures to analyze images and compare their fragments with the predefined samples. This field shows the structure file name. If this field is empty, the program will use the integrated recognition structure.

12 – **Maximum amount of structure key points**. The maximum possible amount of recognition structure points of **ECTtracker**. Higher amounts can improve the tracking quality level, while lower can decrease the overall load on the processor. The default value of this parameter - 100.

13 – **Structure key point width (pixel block, from 0 to 255)**. The recognition structure in the latest versions of **ECTtracker** can include not only separate points, but separate rectangular areas with centers in such points. This parameter defines the analyzed pixel block width. The matching level with samples will be identified using average values. Thus, there's no need to increase the amount of structure points to make the analyzed area bigger. The default value of this parameter is 1.

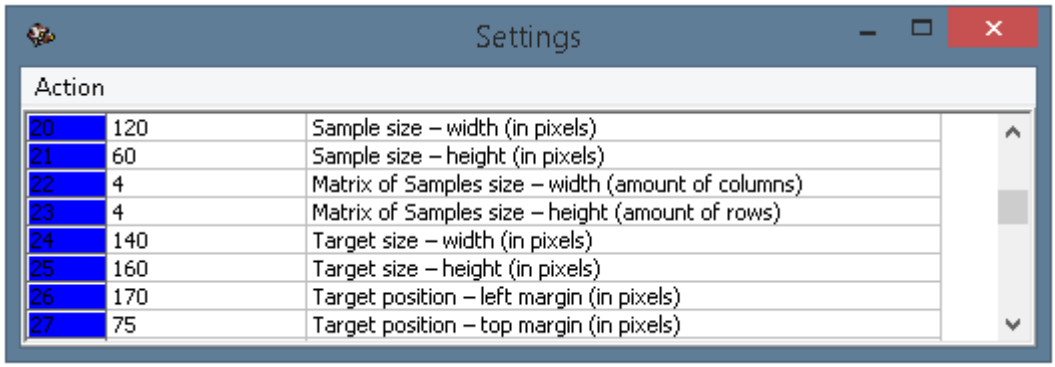
14 – **Structure key point height (pixel block, from 0 to 255**. Similar to the previous parameter, this variable allows the user to define the analyzed pixel block height in the range from 0 to 255 pixels. The default value of this parameter is also 1.

15 – **Intensity (weight) of each channel (9 numbers, from 0 to 9)**. This parameter allows the user to set the priority level for each of the color channels (R, G, B, dR, dG, dB, H. S. L). Thus, the user can increase the priority level of channels with the most significant intensity difference for various states (rows in the Matrix of Samples) and almost no difference for the similar state (samples in one row of the Matrix). A properly selected channel priority formula makes it possible to improve the recognition quality and the overall efficiency of the program operation. The default value of this parameter is 111111111, i.e. all channels have the same level of priority.

17 – **Structure color in main window (in #FFFFFF format)**. Depending on the lighting conditions, eye color and skin color of the user, key points of the structure may look unclear during the creation of the Matrix of Samples. The user can select the most contrast colors by using this parameter, thus making the key points clearly visible on the image. This feature allows the user to perform the initial calibration process more easily. The default value of this parameter is FFFFFF, which is white.

18 – **Structure scale, when showing in color channel table**. This parameter allows the user to define the recognition structure size in the SCO9 window, using a percentage of the original size. The default value of this parameter is 80. The user can decrease this value to reduce the space that is taken by the SCO9 window. The user can also increase the size for continuous operation of the recognition file structure, when it's required to perform a thorough analysis of the information in order to add or remove recognition structure points.

Target window and Matrix of Samples settings



(Fig. 32. The settings window, parameters 20-27)

20 – **Sample size – width (in pixels)**. The height and the width of a sample in the Matrix have to be selected properly in order to contain the biggest part of structure key points and provide proper recognition, but not make it too big, and to stay in the limits of the target window during movements of the user. The width can be selected in the range from 10 pixels up to the current width of the target window. The default value during the first start of the program is 120 pixels.

21 – **Sample size – height (in pixels)**. This parameter of the settings window works similarly to the previous one. The length can be selected in the range from 10 pixels up to the current length of the target window of **ECTtracker**. The default value of the sample height is 60 pixels. Key points of the structure have to be placed on the most frequently changing area.

22 – **Matrix of Samples size – width (amount of columns)**. This parameter determines the vertical amount of samples. The default value of this parameter is 4. That means the user can create no more than 4 samples with the same state (e.g. images with an open eye of the patient).

23 – **Matrix of Samples size – height (amount of rows)**. This parameter determines the horizontal amount of samples. The default value of this parameter is 4. When only two states of the user's eye are analyzed, the user can decrease the height of the Matrix of Samples to 2 in order to save some space. Each row of the Matrix must contain samples with a similar state. The first row - all the images with an open eye, the second row - with a closed eye. This rule was invented to provide proper generation of action codes and key codes, which will be sent to the receiving software.

24 – **Target size – width (in pixels)**. The target window width in pixels. The default value of this parameter is 140. The higher the value selected by the user, the wider the target window and the image analyzing area. The user can increase the size of the target window in cases when the patient retained some kind of motor activity and samples in the Matrix have a bigger size. When the target window is small, the analyzed area may go beyond the borders of the target window, thus **ECTtracker** will lose its focus. The target window size can be decreased on low-end computers with low technical characteristics. More detailed information about the proper selection of the target window size can be found in the 'Changing the target window size in order to improve the quality' section of the 'Hints and tricks' chapter of this manual.

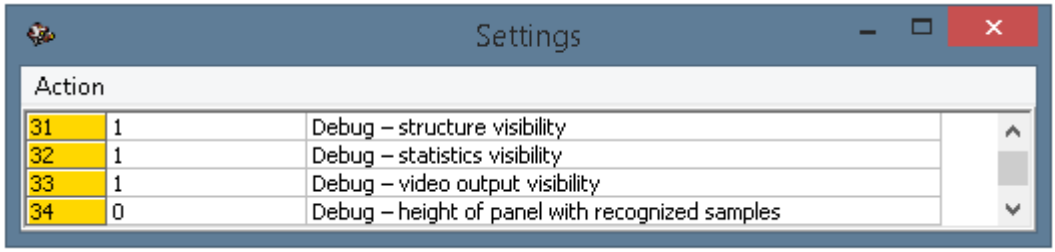
25 – **Target size – height (in pixels)**. The target window vertical size in pixels. Works similarly to the previous parameter and defines the height of the target window, allowing the user to increase the size of the analyzed area. Keeping in mind that the target window has to capture a small area of the analyzed

video to identify the eye state, it's not recommended to use extremely high values. The default value of this parameter is 160.

26 – **Target position – left margin (in pixels)**. This parameter saves information about the horizontal position of the target window. The value determines the distance between the left border of the screen and the left border of the target window in pixels.

27 – **Target position – top margin (in pixels)**. This parameter saves information about the vertical position of the target window. The value determines the distance between the upper border of the screen and the upper border of the target window in pixels.

Main window debugging elements settings



(Fig. 33. The settings window, parameters 31-34)

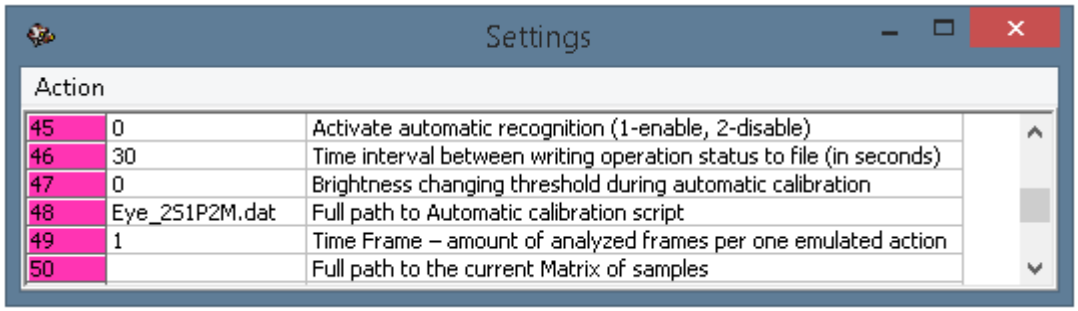
31 – **Debug – structure visibility**. This parameter is responsible for the visibility of the structure above the image in the video window of the program. The structure is visible by default during the first start of the program, allowing the user to control the position of the searching zone in real time and identify cases when the program is losing the image.

32 – **Debug – statistics visibility**. This parameter controls visibility of the statistic panel in the window of **ECTtracker** and makes it visible by default. It displays the coordinates of the most appropriate sample, as well as its position in the Matrix of Samples, matching level and the speed of video processing in frames per second.

33 – **Debug – video output visibility**. This parameter controls the video visibility in the main window of **ECTtracker**. The default value of this parameter is 1 and the current frame is shown in the program. It's recommended to disable this parameter only in cases when **ECTtracker** is working on computers with extremely low technical characteristics, because absence of the video stream can speed up the program in such cases.

PRO 34 – **Debug – height of panel with recognized samples**. The default value of this parameter is 0, i.e. the panel with recognized samples is not visible to the user. It's recommended to set the value of this parameter to 70 when working with a Matrix of Samples that contains 4 different states. The main window of the program will show information about filling the Matrix of Samples (the left area) and matching images (the right area).

Paths, time intervals and automatic recognition settings



(Fig. 34. The settings window, parameters 45-50)

45 – **Activate automatic recognition (1-enable, 0-disable)**. The automatic recognition feature is disabled by default, because the user may need to perform the setting procedure during the first launch, i.e. change parameters, choose a structure, load samples from a previously saved file or perform automatic calibration in cases where the Matrix of Samples is empty. In case all settings have been made already and the Matrix of Samples is loading automatically, the user can enable the automatic recognition feature by changing the value of this parameter to 1. This parameter is very useful for work with totally paralyzed patients. By putting the shortcut of the program into the automatic startup section of the operating system, the user can create a totally automatic launching process for **ECTtracker** and image recognition after starting the computer. Such an approach allows the user to start working without pushing any physical keys or buttons.

PRO 46 – **Time interval between writing operation status to file (in seconds)**. The program creates the events log, which includes various important events, including automatic recognition start and stop, structure selection and many other operations. By using this parameter, the user is able to select the time gap between the 'status' event's saving process. The default value is 10 seconds. The user can set any desired value between 1 and 1000 seconds. This feature gives the user another opportunity to check the current working state of the program. If the program is freezing or showing a dialog box that can't be closed by the user (due to full paralysis), then the program terminates events saving into the log. As a result, the log file stops increasing in size and it can be a signal that the program is not working properly. In conjunction with other programs (e.g. **HandyFileMonitor** – an application that controls file size changes periodically and notifies the user if there's no changes in a while) the user can perform an automatic restart of the program. Fortunately, **ECTtracker** is usually pretty stable and this feature is used in extremely rare cases.

47 – **Brightness changing threshold during automatic calibration**. The brightness change threshold during the automatic calibration. This parameter can be selected in the range from 1 to 200 and defines brightness change during the automatic calibration. The default value of this parameter is 0.

48 – **Full path to automatic calibration script**. In case the automatic calibration script file is located in the same folder as the main file of **ECTtracker**, the user can indicate only the name of it. The default calibration script file of the program is Eye_2S1P2M.dat (two eye states – opened and closed, two rows of the Matrix are filled, the auxiliary icon is shown in only one location - the center of the screen).

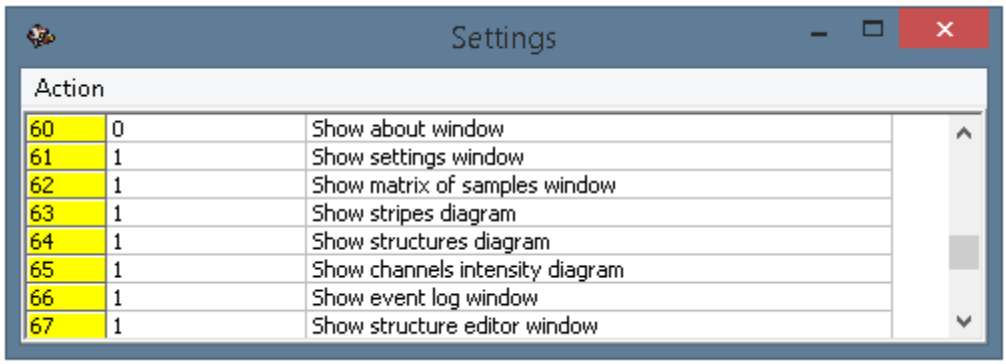
49 – **Time Frame – amount of analyzed frames per one emulated action**. This parameter works as some kind of a filter. It allows the user to block keystroke emulation for all matching images that last less than

the period of time indicated in this parameter. For example, if the patient is suffering from uncontrolled lash twitches, such actions have to be separated and filtered from the controlled eye closing. If the value of this parameter is 20 (the same value as in parameter 4), then all matching samples that last for less than one second will be ignored by the program. Such an approach allows the user to separate conscious actions from uncontrolled ones.

50 – **Full path to the current Matrix of samples**. Allows the ECTtracker to open samples from a predefined folder during the launch of the program. This feature can be handy for cases where **ECTtracker** is already set up for automatic recognition after launching. The default value of this parameter is empty.

Additional program windows visibility settings

Parameters from 60 to 67 may have only one of the following values: 0 or 1. 0 means that an additional window is not shown, while 1 means the window is shown.



(Fig. 35. The settings window, parameters 60-67)

60 – **Show About window**. This parameter controls the visibility of the 'About' window. The default value of this parameter is 0 and the window with information about the program is hidden during the start and operation of **ECTtracker**.

61 – **Show settings window**. This parameter controls the visibility of the settings window. The default value of this parameter is 1 and the settings window is visible to the user. If the user sets the 0 value, the settings window is going to be hidden during each start of the program. Hiding the settings window can be necessary and useful in cases where **ECTtracker** is working on computers with low resolution and lack of free space on the screen, as well as in cases when settings are not changed very often.

62 – **Show Matrix of Samples window**. This parameter controls the visibility of the window with the Matrix of Samples. This window is visible by default, allowing the user to see the current set of samples. Also, the most appropriate sample is highlighted with a red border in the video window during the normal operation of the program. This feature allows the user to identify the best samples faster and change them if necessary, or perform automatic calibration in order to update the Matrix of Samples.

63 – **Show stripes diagram**. This parameter controls the visibility of the debugging stripes diagram and makes it visible by default. At the same time, the debugging window is open and shows the group of samples that is the most consistent with the analyzed image from the video window of **ECTtracker.**

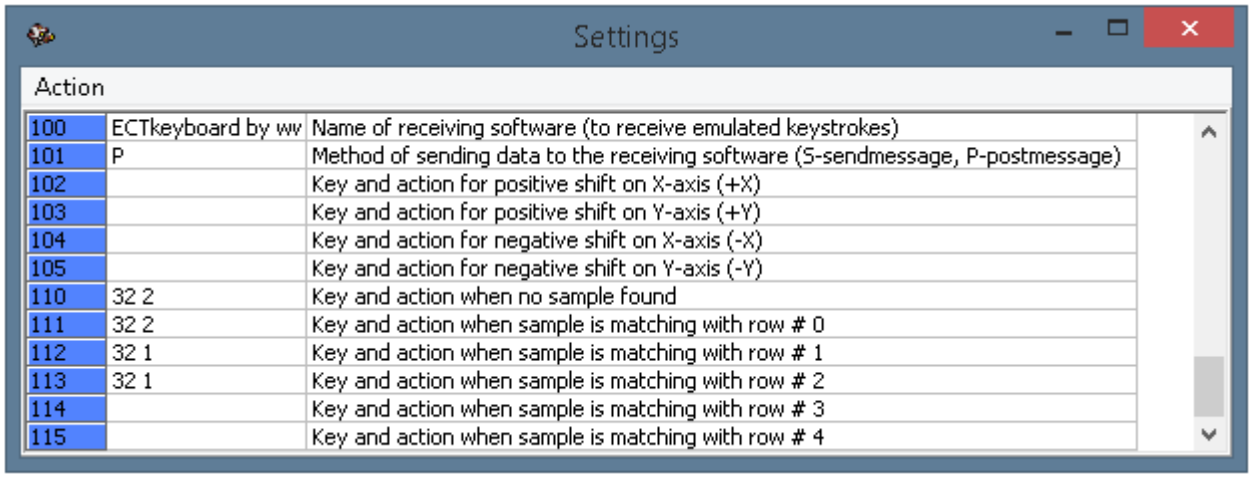
PRO64 – **Show structures diagram**. This parameter is enabled by default and allows the user to show the SCO9 window that contains information about color channels intensity changes for each separate point of the current recognition structure of **ECTtracker**. All information is updated in real time with every new frame.

65 – **Show channels intensity diagram**. This parameter is enabled by default. A special window with intensity indicators for each of the channels is shown during every launch of the program (3 RGB channels, 3 delta RGB and 3 HSL). All information is updated in real time with every new frame.

PRO66 – **Show events log window**. The events log is visible by default in order to show the main actions of the program.

PRO67 – **Show structure editor window**. This parameter controls the visibility of the recognition structure editor window. The editor is not available in the actual public version of the program.

Receiving software keys and actions setting



(Fig. 36. The settings window, parameters 100-115)

100 – **Name of receiving software (to receive emulated keystrokes)**. During its operation, **ECTtracker** emulates key strokes, based on samples corresponding with the analyzed image and their position in the Matrix of Samples. Such keystrokes are transmitted into receiving software, which is going to use the received codes and perform specific actions. In this field of the settings window, the user can specify the name (caption/title of the main window) of the receiving software. The following value is used by default: '**ECTkeyboard by www.eyecomtec.com',** which is the name of the matrix of symbols (the virtual keyboard) from the **EyeComTec** assistive software complex.

101 – **Method of sending data to the receiving software (S-sendmessage, P-postmessage)**. The **ECTtracker** application supports two types of message transmitting to receiving software, i.e. SendMessage and PostMessage. The S value stands for SendMessage. In this case, **ECTtracker** sends messages to the receiving software and waits for an answer. The P value stands for PostMessage. In that case, **ECTtracker** sends messages to the receiving software without waiting for any confirmation. The PostMessage method is selected by default in the application.

The groups of parameters from 102 to 105 and from 110 to 115 allow the user to change the transmitted key codes and actions for receiving software. Key codes and actions are sent in accordance with the current corresponding sample in the video window of the program. Thus, the program emulates key strokes.

Codes transmitted by **ECTtracker** contain two numbers divided by spaces. The first number is the keyboard button code. Each button from the keyboard has its own unique number. For example, space button is 32, Enter is 13. The user can find the complete list of all codes through an internet search engine by entering 'keyboard button codes'.

The second number in the **ECTtracker** code determines a required state of the button: pressed or released. It can take the following values:

- 0 – no action performed (deactivate key);
- 1 – press and hold the key;
- 2 – release the key;
- 3 – press and release the key.

Parameters from 102 to 105 allow the user to set **ECTtracker** to control the cursor by moving the head of the user (if the value of parameter 9 is F). By moving an image that corresponds with a sample along the horizontal axis (X) and vertical axis (Y), **ECTtracker** can generate actions and send them to receiving software. Default codes and actions for these parameters are not defined.

PRO 102 – **Key and action for positive shift on X-axis (+X)**

PRO 103 – **Key and action for positive shift on Y-axis (+Y)**

PRO 104 – **Key and action for negative shift on X-axis (-X)**

PRO 105 – **Key and action for negative shift on Y-axis (-Y)**

110 – **Key and action when no sample found**. The key code and the action code which are sent to receiving software in cases where none of the samples from the Matrix correspond to the current image in the window of **ECTtracker**. This functionality allows the user to work with **ECTtracker** using only one sample in the Matrix. The default value is 32 2 (release space button). Let's look at one example. The user created a sample with a closed eye and added it into the second row of the Matrix of Samples. The user starts the recognition process. When the user closes the eye, the program registers a match between the image and the sample, and sends the key code and the action code to hold the space button (32 1). When the user opens the eye, **ECTtracker** can't find any matching samples and sends a code to release the space button (32 2). Thus, the user only needs one sample in the Matrix in order to emulate a keystroke. It's recommended to increase the wlim value (parameter 3) for this mode, making it higher than 30 in order to obtain a high level of recognition quality.

111 – **Key and action when sample is matching with row #0**. Row #0 – represents the first row of the Matrix of Samples. The default value is 32 2 (release space button).

112 – **Key and action when sample is matching with row #1**. Row #1 – the second row of the Matrix of Samples. The default value is 32 1 (press and hold space button).

113 – **Key and action when sample is matching with row #2**. Row #2 – the third row of the Matrix of Samples. The default value is 32 1 (press and hold space button).

114 – **Key and action when sample is matching with row #3**. Row #3 – the fourth row of the Matrix of Samples. The default value is not defined.

PRO 115 – **Key and action when sample is matching with row #4**. Row #4 - the fifth row of the Matrix of Samples. The default value is not defined.

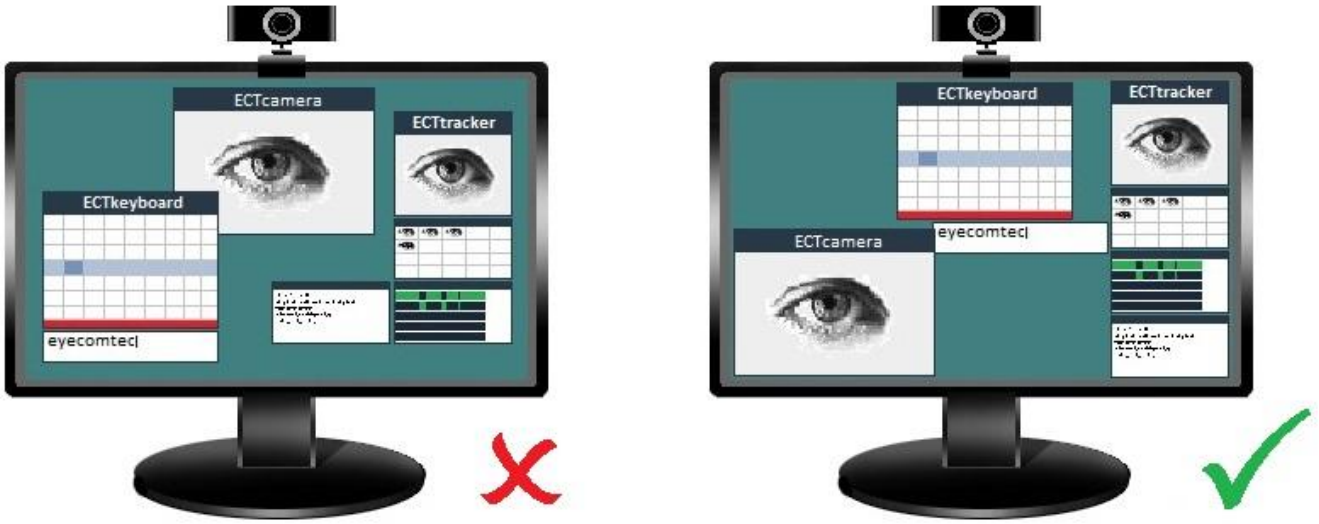
Hints and tricks

This section of the manual will help the user to reach the optimal recognition quality level and provide stable operation of **ECTtracker** in various conditions. It contains the most important information and tips about how to locate equipment (cameras and source of light) or program windows, and how to perform the initial setting procedure of **ECTtracker** and fill the Matrix of Samples. This section also contains some recommendations about the usage of contrast markers in situations where the user can't reach the proper level of recognition with traditional methods.

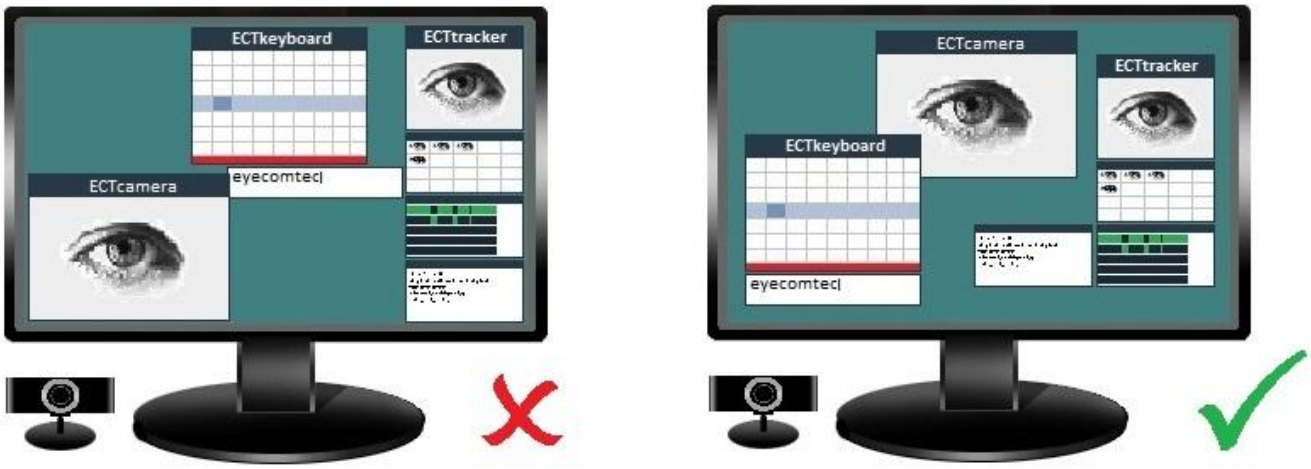
Positions of display, web-camera and program windows

The most important factor in order to provide correct **ECTtracker** operation is the positioning of the camera in such a way that the state of the eyes of the user can be clearly identified and tracked. In order to do this, the patient has to look at the camera (if possible) in such a way that the pupil can be captured almost completely. The exact center of the pupil has to be in the center of all the images from the Matrix of Samples with the user's eye open. Meeting this condition gives more than enough in order to provide guaranteed recognition quality of eye state in the majority of situations.

The proper position of all the windows of the **EyeComTec** program complex is also very important. The user works with **ECTkeyboard's** matrix of symbols, focusing attention on this window almost all the time. So it may be more expedient to put **ECTkeyboard** windows as close as possible to the position of the web-camera. This is vital in cases where the display has a high resolution, because the difference between the viewing position and the window position can be significant. Figure 37 shows the recommended layout for cases when the camera is located above the display. Figure 38 shows the recommended layout for cases when the camera is located under the display. Figure 39 shows the recommended layout for cases when the user is working on a laptop.



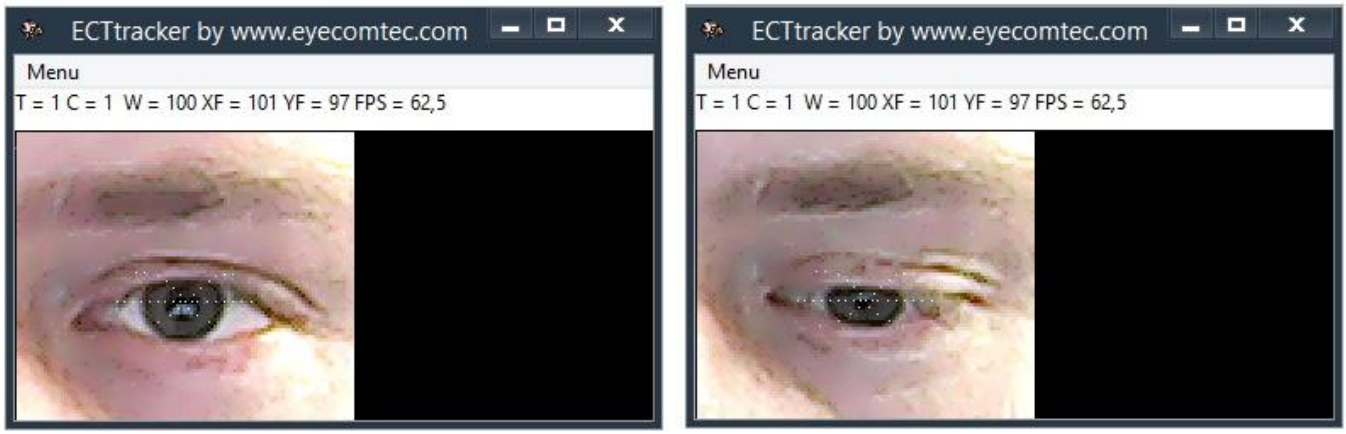
(Fig. 37. If the camera is located above the display, the widow of **ECTkeyboard** has to be located in the upper part of the desktop)



(Fig. 38. If the camera is located below the display, the widow of **ECTkeyboard** has to be located in the lower part of the desktop above the camera)

(Fig. 39. When **ECTkeyboard** is launched on a laptop the window has to be located in the upper part of the desktop)

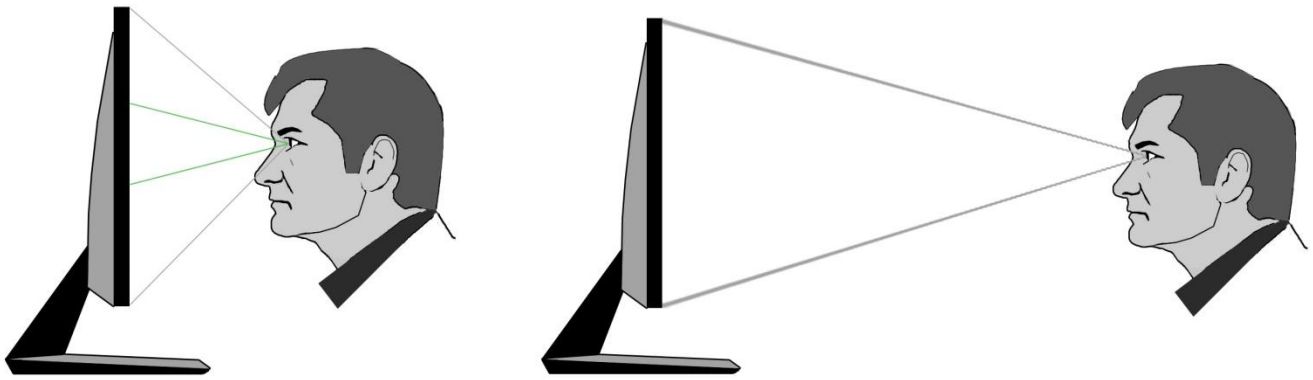
Figure 40 shows windows of **ECTtracker** in two different situations: when the user is looking at the matrix of symbols located in the upper part of the desktop (the left screenshot); and in the lower part of the desktop (the right screenshot). In both cases the web-camera is fixed on the upper side of the display. It's obvious that in the second case the user is looking down and the upper eyelid is more closed. Tracking quality is also significantly decreased by lowered lashes. All these factors result in an unstable image recognition by the program, thus **ECTtracker** will recognize the user's eye as closed more often.



(Fig. 40. Direction of user's gaze is changing depending on the location of the matrix of symbols on desktop)

The smaller the range of motion of the pupil during work with the matrix of symbols, the more accurately **ECTtracker** will analyze the image. Pupil movement can be reduced in 2 ways (see fig. 41):

- decreasing the size of the matrix of symbols of **ECTkeyboard** (left image). This way can be useful for displays with low resolution and size;
- increasing the distance between the user and the display (right image). This way is recommended for displays with high resolution.



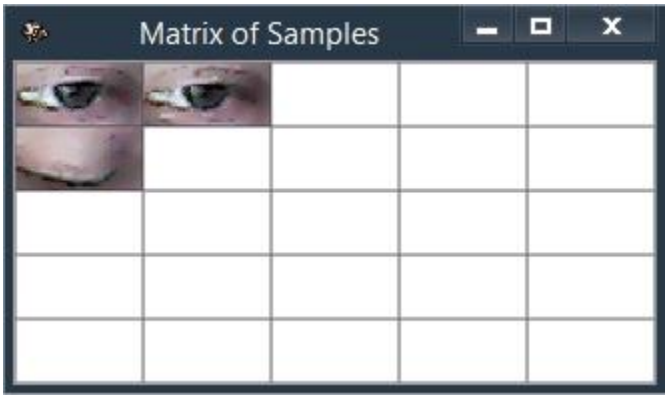
(Fig. 41. Decreasing the range of motion of the pupil during work with the matrix of symbols)

Proper calibration and initial setting of ECTtracker

The quality of image recognition of **ECTtracker** depends not only on external conditions (correct position of display, web-camera, light intensity and position of the light source), but also on correct filling of the Matrix of Samples by the user. There are several important rules for the proper calibration of **ECTtracker,** which are strongly recommended to use during the initial setting of the program:

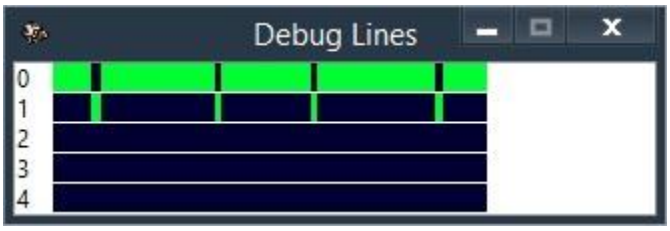
1. The user has to click exactly on the center of the pupil during the new sample adding procedure. The point of click is considered as the exact center of the sample and used for tracking stabilization.
2. Gaze of the patient has to be directed to the camera whenever possible. The distance between the patient and the display, as well as the size of the matrix of symbols, has to be selected in such a way that the pupil makes minimum movements during the text typing process.

3. During the process of the automatic or manual calibration, the user needs to ensure that the eyes are not open too wide (wider than during normal work with the matrix of symbols). During continuous work, eye muscles become fatigued; eyelids start to close, resulting in the possibility of a lower quality of sample recognition.
4. It's recommended to create no more than 2 samples for the open eye of the user and no more than one sample for the closed eye (see fig. 42).



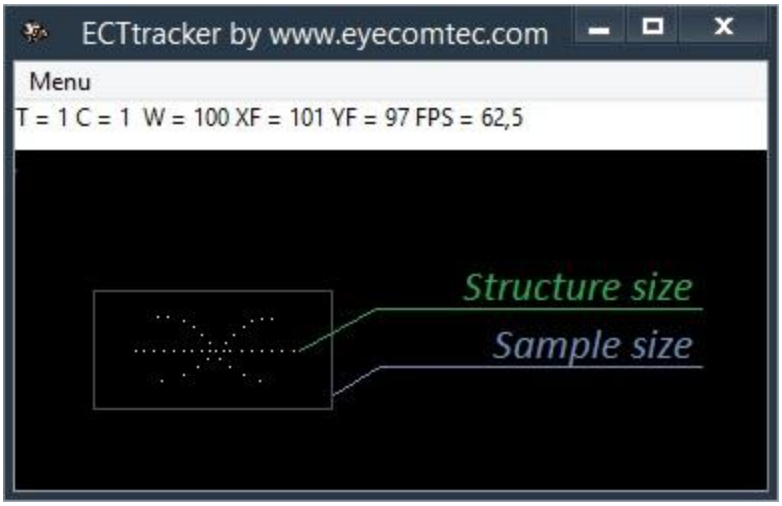
(Fig. 42. Proper filling of **ECTtracker** Matrix of Samples)

5. During work with the matrix of symbols, the user has to select a value for the wlim parameter that provides the correct recognition of only one row of samples at any selected moment of time. The schematic information about the quality of recognition can be seen in the Debug Lines window (see fig. 43).



(Fig. 43. Samples recognition quality)

6. The size of the sample should not significantly exceed the size of the recognition structure in use (see fig. 44). In fact, the zone of recognition is limited by the position of structure key points, and any increase of the sample size will not increase the size of the detection zone or improve its quality.

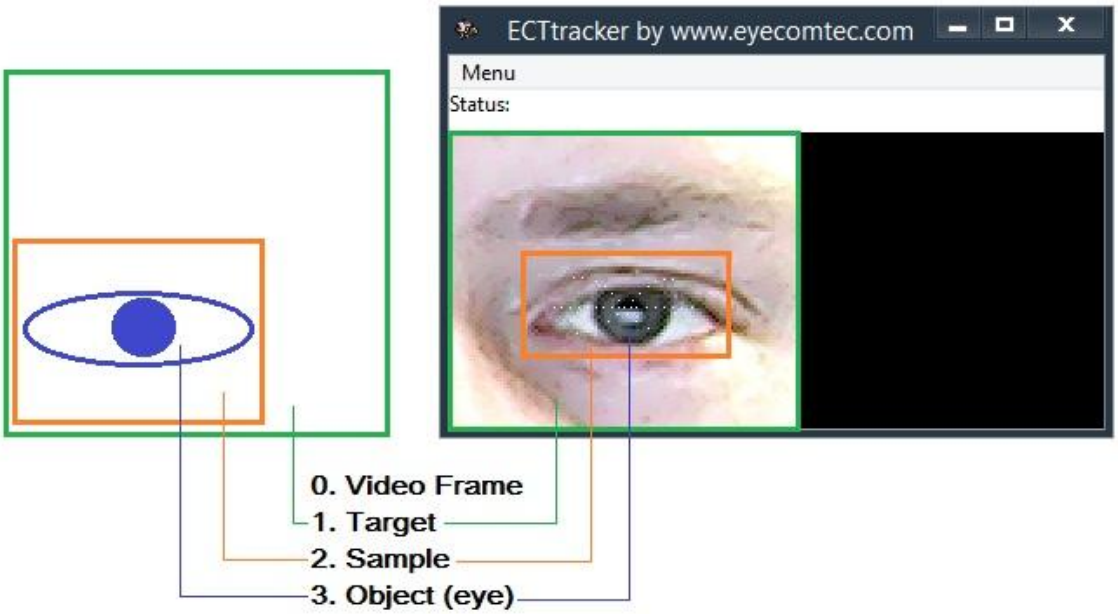


(Fig. 44. Size of the sample and real recognition zone, i.e. structure)

7. The main rule for the structure selection: the maximum possible points of the structure should be located above the area of the image with the most visually distinguishable changes. Key points of the structure, which are located above the static area of the image, will adversely affect the quality of recognition, as well as lead to an increase in the computational load on the system. E.g. if the patient has retained the mobility of only one of his eyes, the user has to select the structure for one eye and locate it above the changing area of the video source. It's worth noting that the exact center of the sample has to correspond with the exact center of the pupil.

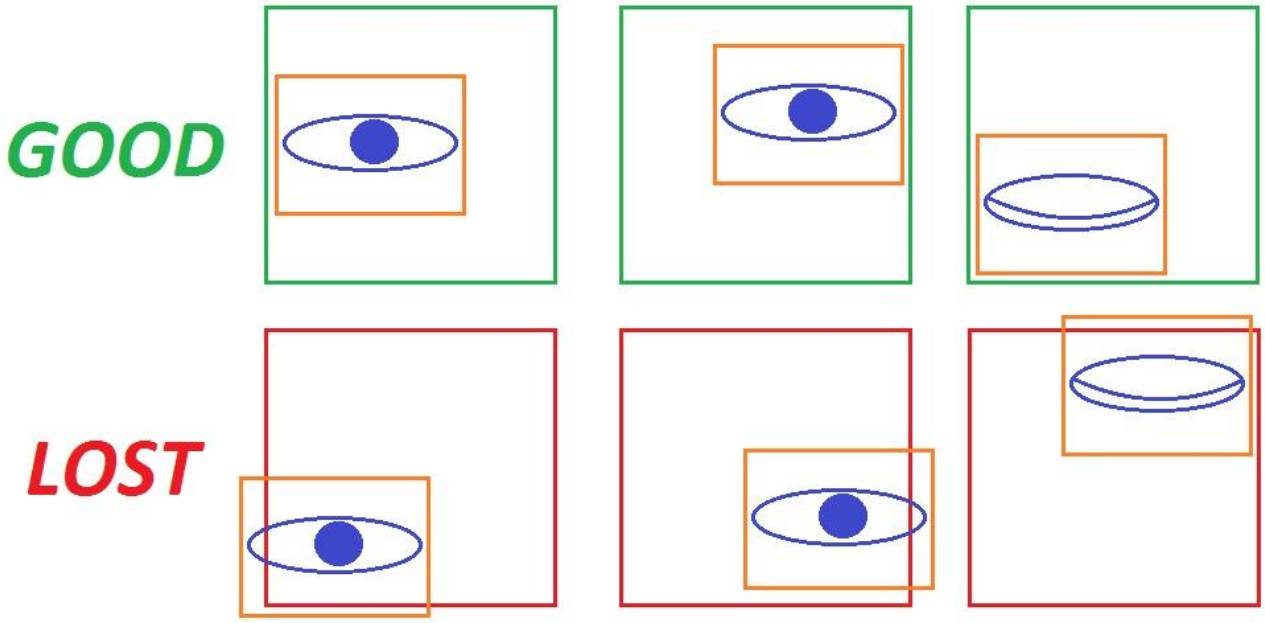
Improving recognition quality by changing grab-form size

The main window of **ECTtracker** shows the image captured by the grab-form ('target window' located above the video source). This image contains the analyzed sample. The schematic drawing of the grab-form, the sample and the object to be tracked (eye) are shown on figure 45.



(Fig. 45. **ECTtracker** positioning scheme)

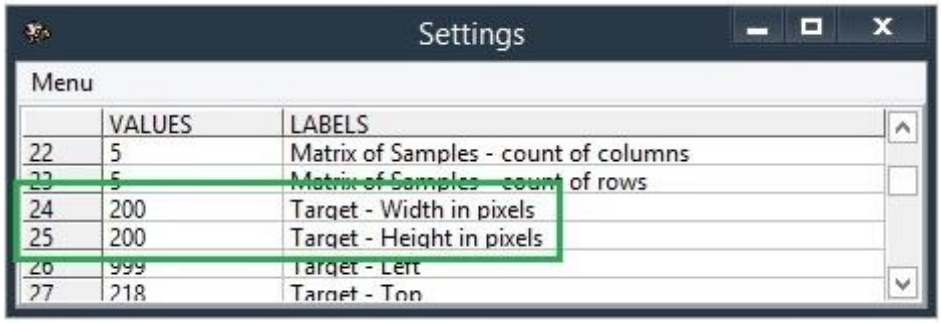
If the user of the **EyeComTec** complex retained partial mobility, head movements may occur during work with the program. **ECTtracker** follows such movements and moves the zone of tracking and the analyzing area. As the result, the analyzed zone can go beyond the borders of the grab-form in some cases. Figure 46 shows samples of correct recognition (upper row) and analyzed sample loss (lower row).



(Fig. 46. Correct and wrong positioning)

In cases where the analyzed zone partially leaves the grab-form, higher values of the wlim parameter may result in a total absence of sample recognition (simply because the program can't find any corresponding sample in the limits of grab-form). Lower values of the wlim parameter may result in recognition of similar zones inside the grab-form: thus, the recognition structure may sharply move above a wrong object, e.g. eyebrows. In this case, the program will identify user's eye as permanently closed.

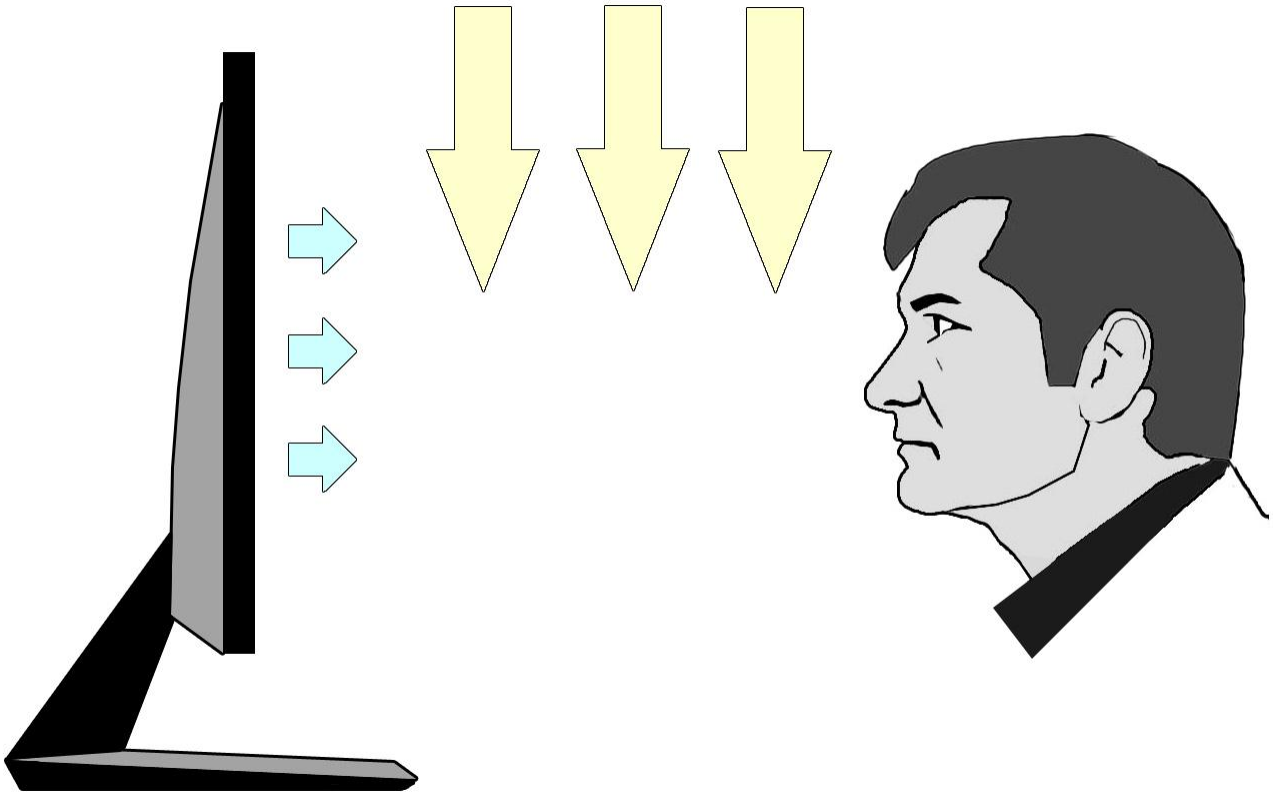
In order to avoid described situations, it's recommended to increase the size of the 'target window' to keep all possible movements of the user's eye within the frame of that window. This approach will not allow **ECTtracker** to lose a tracked object. The grab-form width can be changed by using parameter 24 of the settings window of the program, and the height by using parameter 25 of the settings window of the program (see fig. 47).



(Fig. 47. Setting the size of the grab-form)

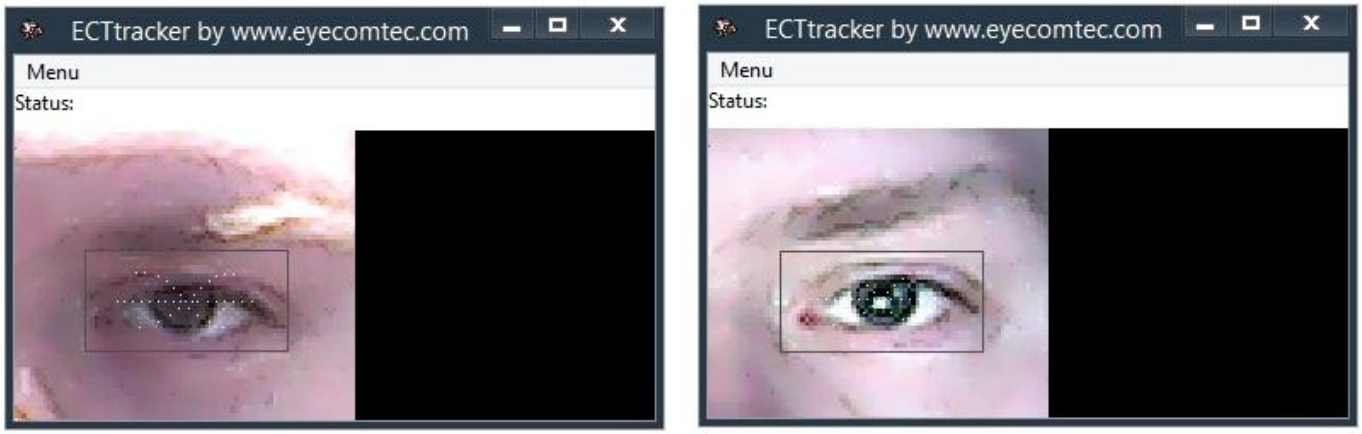
Recommendations about source of light positioning

Proper lighting is really important for normal operation of **ECTtracker**, because it allows the user to obtain more stable sample recognition. In the majority of cases, the source of light is located above the user during work, giving the most of the light, while the rest comes from the display (see fig. 48).



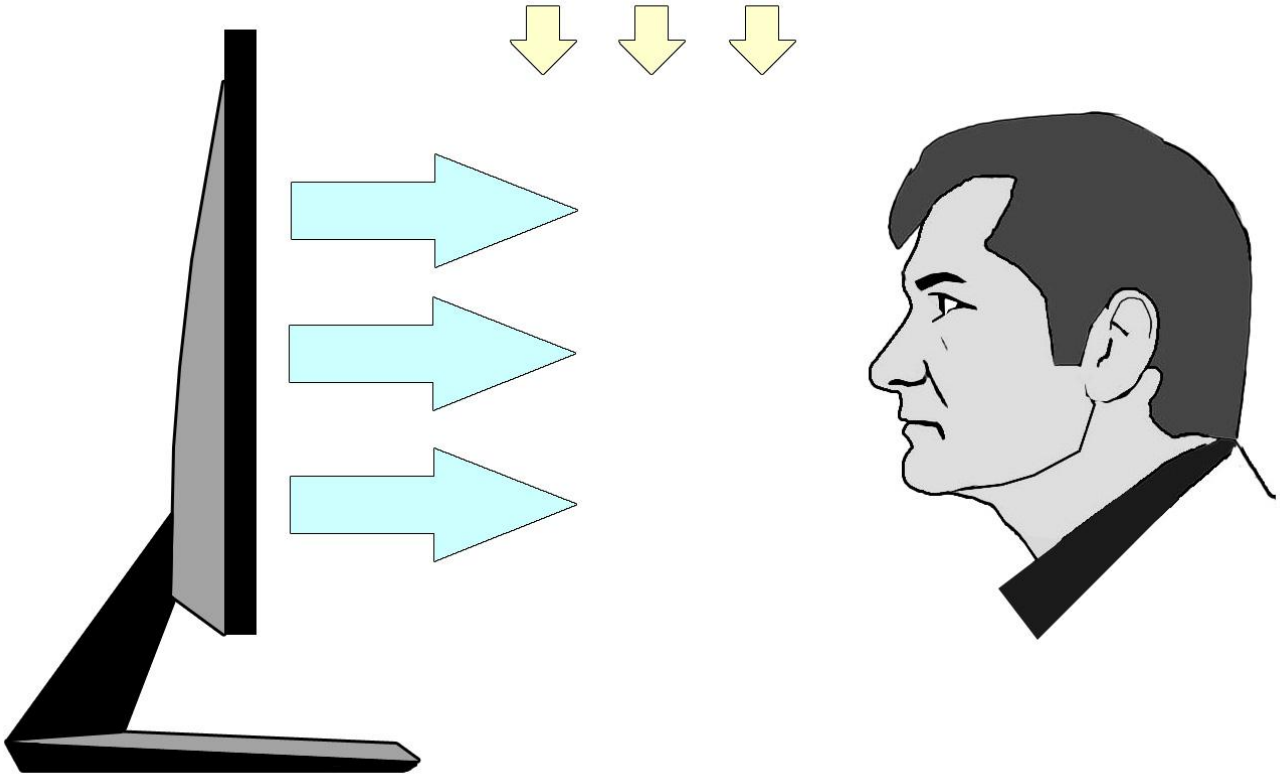
(Fig. 48. Working in normal lighting conditions of the room)

When a source of light is located above the user, all the colors are significantly smoother, the eye zone is shaded and contrast is decreased. The recognition quality also decreases, because colors of pixels are less different. At the same time, by working with the contrast image, software can recognize samples even if the user makes head movements. Figure 49 shows the **ECTtracker** window in a situation with an upper source of light (on the left screenshot) and another situation when the majority of the light comes from the display (on the right screenshot).



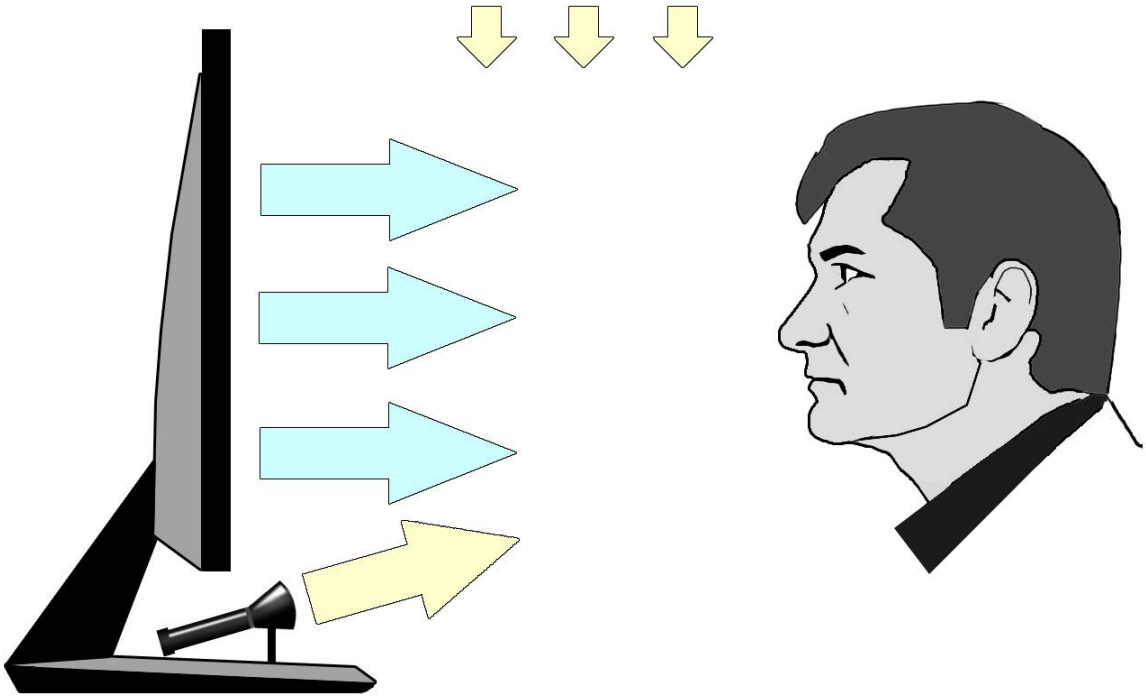
(Fig. 49**.** Location of source of light may significantly affect the contrast)

Thus, in order to provide higher contrast for the image and improve the quality of tracking, the user has to decrease or turn off light from all sources that are located above the user. The user can also try to increase the brightness of the display, creating an additional direct light (see fig. 50).



(Fig. 50. Using the display as a direct source of light)

In cases where the level of display brightness is not enough to create the proper level of lighting, the patient can use a small LED-light as an additional source of light. The best way to do so is to fix such an LED-light in the upper or lower part of the display, directing it in such a way as to avoid dazzling, but where it still creates additional lighting (see fig. 51).

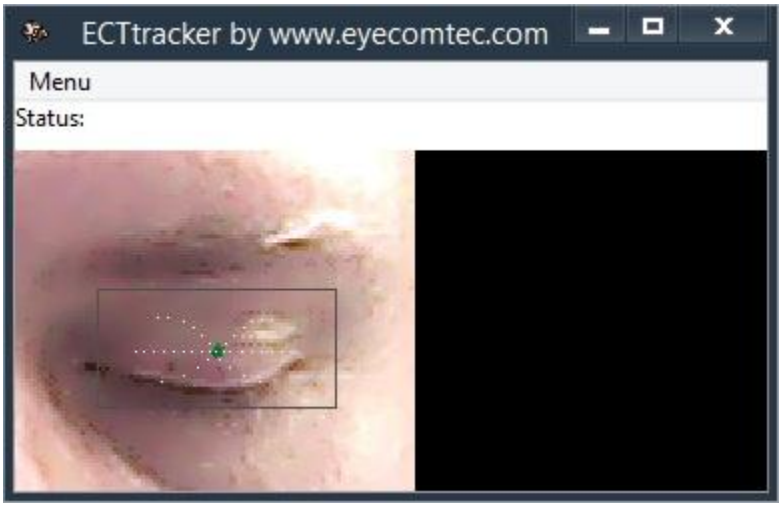


(Fig. 51. Using an additional source of light)

Using contrast marker

Sometimes obtaining a proper level of recognition and tracking can become more difficult due to various physical damages of the patient's face. Such damages may include different injuries, burns, burnt eyelashes, postoperative states of the eye and many others.

In such situations, **ECTtracker** calibration can be performed by using a marker of a contrast color (bright red, green) or any other paint (e.g. brilliant green). A small dot is applied to the center of the eyelid of the patient, followed by clicking on that dot during calibration of the program and creation of the sample with the closed eye (see fig. 52).

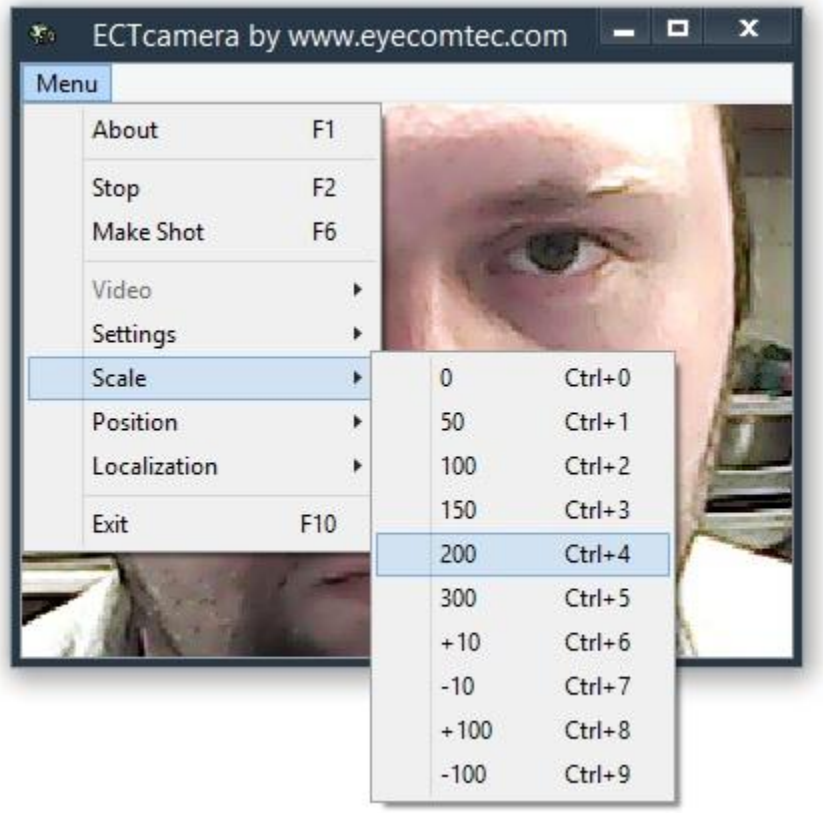


(Fig. 52. Using a contrast marker)

Thus, **ECTtracker** gets an additional element with high contrast, which allows it to identify the sample with the closed eye of the user more clearly.

Proper scaling of the image

To improve the recognition quality during work with the **EyeComTec** program complex, the user may need to use additional scaling of the image (increasing or decreasing). It's recommended to perform such scaling only with **ECTcamera** functionality. The user can change the scale by using the Scale submenu items or corresponding hot keys (see fig. 53).



(Fig. 53. Changing image scale in **ECTcamera**)

Downloads

The latest version of the program can be downloaded from the EyeComTec website, using the following link: https://eyecomtec.com/ECTtracker.zip

Registration and activation of EyeComTec software products

In order to complete the registration process, it's required to fill in a short form, which contains contact information and reasons to use assistive technologies.

- The registration form for private users (non-commercial use). For people having a physical need for our products*
- The registration form for medical companies (commercial and non-commercial organizations: hospitals, rehabilitation centers and doctors)**
- The registration form for commercial customers from non-medical fields (involved in the processes of production, assembling, quality control and manufacturing)**

** The registration is not obligatory for private users, however, it's still recommended.*
*** The registration is obligatory for any legal entities and commercial customers.*

Attention! *Free licenses for EyeComTec software products may be issued for customers with a real physical need of assistive technologies of this type (to get more information, please check the '**Free license**' section of the '**License agreement**' chapter). The more information is provided about a disease that caused full or partial loss of mobility, the higher the chances of getting approval and receiving a free license for EyeComTec products. All the information received from customers is thoroughly checked by our staff, thus all application forms with no information about the disease of the patient (C1 and C2) will be rejected.*

The registration form contains several blocks with various questions:

A. Information about the patient: the full name, an e-mail address, a phone number, a country and a city of residence;
B. Information about an assistant or a caregiver of the patient: a full name, an e-mail address and a phone number;
C. Information about the disease or situation that caused reduced mobility. It's recommended to use the C2 field to provide some additional information (e.g. possible reasons of the disease, current state of the patient, chances for rehabilitation and so on);
D. Additional information: the date of birth of the patient, sex, native language (if the patient knows any other language, it can be indicated in the D3 field);
E. In this section the customer has to select one or several EyeComTec program products required for the patient;
F. Feedback section. In case the customer had already used EyeComTec program products, he or she is offered the chance to evaluate their usability. The customer can also indicate how they first heard about the EyeComTec Company, as well as provide us with any other information that is considered important according to the user.

It's recommended to fill in all the fields of the form.

Registration verification

After submitting all the information into the registration form and providing all required data, the customer will receive a verification request to the e-mail address that was indicated on the registration form.

Attention! *It's required to confirm this verification request; otherwise the registration process will be stopped.*

After completing the verification process, the EyeComTec staff will check the completeness and accuracy of the provided information. After that, the customer will receive a serial number for the required software to the e-mail address that was indicated on the registration form.

Serial number activation and key obtaining

It's required to activate the received serial number. In order to do that, the user has to follow the following link: https://eyecomtec.com/25-Activation.

A page with the activation form will be opened. The user has to indicate:

- User Name – the full name of the user (this name can be different than the name of the serial number owner);
- User E-Mail – an email address, which will be used to link the license;
- Serial Number – the serial number that was received by the e-mail address indicated during the registration process;
- Hardware ID – a hardware code, which can be obtained directly in the program.

Attention! *It's really important to indicate a correct and working main e-mail address, because all technical support will be provided exclusively to this address. We kindly recommend you to check all the provided information. Mistakes in the e-mail address can be changed only once and such a change will be considered as a hardware change (in order to get more information, please check the '**License hardware linking**' section).*

Attention! *In case an expected email from EyeComTec hasn't arrived within a reasonable period of time (usually up to 48 hours), it is recommended that users check their 'Spam' folder, as the email might have been directed there in error.*

Attention! *Only Latin symbols can be used in order to fill this form in (A...Z, a...z)! All non-Latin symbols will be automatically filtered. E.g. the user has to write '**Strasse**' instead of '**Straße**', or '**Michele**' instead of '**Michèle**' and so on.*

In versions of programs that were published starting from July 2016, the hardware code can be found in the **About** window, within the **Hardware ID** section.

Attention! *The user has to check the hardware code by launching the program only on the very same computer and hard disk partition where the user is going to launch the program in future. If the user performs the activation on one computer, but wants to work on another, all program copies will work as non-registered applications and won't be considered as properly licensed software!*

After filling in all the fields of the activation form, the user has to press the button to submit the information. A new page with a key code will appear. An email containing this code will also be sent to the e-mail address that was indicated during the registration process. The user has to copy this code and save it to the folder of the program. The name of the key file has to be the same as the name of the main file of the program with the .key extension (e.g. the key for the **ECTkeyboard** application has to be saved as ECTkeyboard.key).

In versions of programs that were published starting from July 2016, the user has a more convenient way of key adding. The user can just copy the key code (including the following symbols ' === '), paste it into a text field of the About window and press OK. The program will automatically save the key file in its folder. After that, the user has to restart the program.

Attention! *If there is an old key in the program folder, it's going to be removed and replaced with the new one. A copy of the old key will be saved as a backup file with the .bak extension. The name of this file will contain the name of the program and the date and time of saving in the YYYYMMDD-HHMMSS format (e.g. ECTkeyboard.key_20160615-130722.bak).*

The registration of the user and program activation processes are considered as completed at this stage.

License hardware linking

A free license for a program is valid for 1 year from the moment of activation. The user has the possibility of re-activating the license in case of a hardware or hard disk failure. Such re-activation can be done only once. To do that, the user has to contact the technical support of the EyeComTec Company, indicating the reason of the required license re-activation. The user can also contact technical support in order to change mistakes in the e-mail address that was indicated during the activation of the program, however, in that case the user won't be able to re-activate the program in case of a hardware failure. In both cases, such requests will be processed by the company's staff on a first-come first-served basis.

In case the user is trying to activate one serial number on a different computer, an error window is going to be shown.

The EyeComTec Company issues various types of software licenses. Depending on the license type, there can be the following options of the software use:

1. A license is linked to the serial number of the C: partition of a hard disk, the processor identification number, the computer name and the user name. This license has the strictest type of license hardware linking. It doesn't support the transfer of the program not only to any other computer, but even to a different partition of a hard disk. This type of license is offered for all patients who have a real physical need for EyeComTec assistive technologies.
2. A license is linked to the serial number of a hard disk and the processor identification number. This license type allows the user to transfer the program to any partition of the hard disk in the boundaries of only one computer.
3. A license is linked to the serial number of the storage device that was used during activation process. This option allows the user to link a program to a portable storage device and use it on various computers.
4. A partner license. In that case, the license is not linked to any computer parameters. Such programs will be considered and work as properly licensed on any equipment. There's no need to re-activate it. EyeComTec issues this type of license only for partners who are responsible for the safety of the license key and can guarantee impossibility of its compromising.

License agreement

General terms

This license agreement establishes substantive provisions, as well as describes the permitted and prohibited ways of use of the software developed by EyeComTec. The licensee has the right to use software products of EyeComTec only under the conditions described in this License Agreement.

All the software and all related intellectual assets (copyrights, algorithms, source code and technical documentation) are fully owned by the EyeComTec (LAZgroup SA) company. EyeComTec can provide a free exclusive and non-transferable license to any entities which are involved in charity or non-profit activities. In order to use software for commercial purposes, such a company has to contact EyeComTec directly and purchase a license. Any commercial use (with pecuniary interest) of the software developed by EyeComTec without license is strictly prohibited.

During the determination of the conditions and restrictions of use, the copyright holder provided all the information on a limited warranty basis as well as provided the rejection of any liability. This project is totally voluntary, and the parent company is not liable for any issued support packs or updates in front of those users who use software products of EyeComTec free of charge.

All users are obligated to observe and follow the requirements of this License Agreement.

Restrictions on use

The end user is not allowed to use or permit the use of EyeComTec software products in any manner that may affect their functionality, including: modification of program binary source code, or participation in any operation that aimed at reverse engineering (decompilation) of software for personal or professional gain.

Also, the end user of the software under no circumstances has the right to change copyright information or use the names of software products in an inappropriate manner in order to obtain financial or material benefits. The user has no right to change, make copies of, sell, sublicense, advertise or distribute EyeComTec software products in any manner that is not allowed by this license agreement. As a charitable gesture from the company, all users are allowed to share EyeComTec software product installation packages amongst themselves and with other people.

Upon receipt of the license, the user does not receive any right to own copies of the software, and the copyright holder may prohibit subsequent sales.

All licensees have no right to re-pack the software and distribute it by including the software in a huge variety of installation packages that contain malicious programs or advertisement in any form.

User registration

The registration of EyeComTec program products is mandatory for commercial customers and legal entities. Programs can be purchased directly from EyeComTec, as well as from partner companies. When the customer completes payment for software products, the company sends separate serial numbers for each copy of the purchased software. In case there are advanced versions available, the customer also receives links to download such versions.

Those users who have a physical need for EyeComTec assistive technologies can also complete the registration process. In that case, they can receive license keys for free versions of programs (to get more information, please check the '**Free license**' section of the '**License agreement**' chapter).

Private users can work with published versions of EyeComTec programs without registration or obtaining a license key. But in that case, such customers won't be able to use the technical support of the company. Furthermore, the 'About' window with various information will be shown during every launch of the program, offering the user to complete the registration process.

EyeComTec can issue free licenses for private or charity non-commercial use. Such companies are required to complete the registration process and indicate information about the planned use of the program products (field of use, aims and goals).

Any commercial use of published software without obtaining a license will be considered as an infringement of the User Agreement (to get more information, please check the '**Restrictions on use**' and '**Paid commercial license**' sections of the '**License agreement**' chapter).

User registration is the easy and safe way to provide feedback between the development company and consumers: patients and medical centers.

Collection of such statistical data is extremely important for EyeComTec, because it allows the company to get detailed information about the needs of specific users, and improve the software in accordance with these needs. The program complex is developed continuously and many features of current versions were invented due to feedback from users.

In addition, a database of contacts allows for informing patients promptly about new and yet unpublished software products and updates of the EyeComTec program complex. Furthermore, users are able to receive information on the functionality of basic and advanced versions in a timely manner.

Differentiation of commercial and noncommercial licenses

1. Noncommercial License

1.A. Noncommercial license for clients with physical needs.

(this type of license does not apply to customers, who are undergoing a paid rehabilitation course – see section 2.2, paragraph A)

EyeComTec software products are provided free of charge to all people who are experiencing a physical need in the use of such a category of programs. This group of people includes all those patients who suffer from various forms of paralysis or other muscular activity restrictions. All software products are free for non-

commercial use. E.g. when the patient uses our software for text typing, he or she is not obligated to purchase a commercial license.

1. B. Noncommercial license for charitable organizations.

Charity companies and rehabilitation centers can use all EyeComTec software products free of charge if they provide their services to patients on a free basis.

2. Paid commercial License

2.A. Commercial license for paid clinics and rehabilitation centers.

A commercial license for program products of EyeComTec is necessary in any case of paid services provided by medical companies or rehabilitation centers. Such a commercial license is required for each separate copy of the program in use. Only one copy of each licensed program may run at the same period of time.

All the assistants and third-party specialists who provide paid services to their patients and involve EyeComTec software products in their work are also obligated to purchase a commercial license.

In any case where the user is undergoing paid treatment, involved in a rehabilitation program in a commercial institution or uses the paid services of any third-party medical specialist, he or she is not allowed to use a personal non-commercial license. The user is strictly not allowed to use any EyeComTec software product to communicate directly with any paid healthcare specialist or representative of a commercial establishment. In such cases, the rehabilitation facility or attending specialist are obligated to use and provide to the patient their own commercially licensed copy of the software. This restriction extends over the entire period of treatment or rehabilitation of the patient.

2.B. Commercial license for software integrators and resellers.

All the companies and experienced specialists who provide paid services for the installation and integration of EyeComTec software products to third parties, as well as maintenance and technical support for such programs, are obligated to purchase a commercial license. The sale of software products to customers with a physical need of them is strictly prohibited (see section 2.1, paragraph A).

2.C. Commercial license for extended program versions that are intended to use in a non-medical environment.

The EyeComTec Company developed extended versions of their programs (in particular, ECTtracker), which are successfully used in factories, shops, automated assembly lines and quality control systems. Such program versions are distributed on individual licenses and are not intended for public distribution. In order to get the full information about features of programs, a full quotation including price of purchase and support, as well as the cost of specialist training, please contact the EyeComTec Company.

Furthermore, our company developed various additional applications that can significantly enhance the functionality of our programs. When such applications are in use with extended versions of our programs, they can be used for additional automation of analyzing and controlling manufacturing processes.

Specialists from the EyeComTec Company are ready to create an individual system that is best suited for your needs. The system is going to be created on software modules that were created taking into account all the distinctive features of the processes.

