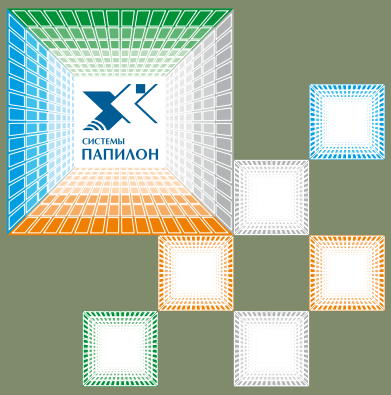
PAPILLON SYSTEMS

PAPILLON RASTR

Application Program

for Preparing Examination Reports, Illustrations, Charts

TABLE OF CONTENTS



Conducting a wide range of examinations and investigations, forensic experts today must deal with the necessity of acquiring, processing and exploring images of subjects under study.

Another no less considerable part of the expert's work is taken by the process of executing the results of conducted investigations.

The software and hardware complex of PAPILLON RASTR brings together the modernization and maximum automation of experts' tasks, providing them with state-of-the-art digital technologies of imaging and image analysis as well as with powerful capabilities of up-to-date computing machinery and other equipment.

LEADING PARTICULARS OF PAPILLON RASTR

- Organization of specialized, protected databases for storing collections of images, documents, expert reports in electronic form
- Acquisition and database insertion of images relevant to investigated objects from various sources
- Non-destructive methods of transforming and examining digital images including comparative study, with the original image remaining intact and with its history of all processing steps saved in the database
- Creation of documents presenting both the original and processed images to evidence the results of conducted examination
- Printing hard copies of images and documents

PAPILLON RASTR is a dedicated system providing the solution for forensic experts, examiners and investigators who:

- want to use various sources and technical facilities to acquire images for examination
- concider any distortions and destruction of original data in admissible
- need tools for operation with complicated images the poor quality of which is caused by a variety of objectively unavoidable factors (time, dirt and other impurities, erosion damage because of environmental exposure, interference of surface texture, overlapping of several relevant images, etc.)
- require "transparency" of all steps in the course of image processing to ensure the possibility of checking the validity of examination results and unambiguous reproduction of any of the processing steps
- need to conduct comparative study of images
- observe prescribed rules for executing examination worksheets and expert reports
- care about the confidentiality of information, its protection against unauthorized access, corruption and deletion.

The software, the architecture and operation logic of the system ensure the strict fulfillment of above-mentioned requirements. This is the main point by which RASTR advantageously differs from other widely known but nonspecialized graphics and text packages designed for common use.

Having analyzed the tasks and needs of forensic experts, the developers of RASTR combined in one system all tools needed for acquiring, processing and analyzing the images, for preparing and printing documents, for organizing and maintaining specialized databases.

PAPILLON RASTR brings together the capabilities of a raster editor in regard to the image processing, the functions of a comparative microscope, the tools provided in various vector and text editors within the scope needed for the expert to prepare conclusions of examinations.

The Resolution adopted by the Criminal Expertise Centre of the Russian Ministry of Interior, on December 8, 2004, states the following:

«Taking into consideration the results of trial operation, the software and hardware complex of RASTR, manufactured by the PAPILLON Company, is recommended for being deployed at forensic expert divisions of the Russian Ministry of Interior, as an advanced instrument-analytic base for executing trace, fingerprint and other types of examination, and for drawing up illustrative materials of conducted investigations».

Besides a broad spectrum of universal facilities, PAPILLON RASTR provides some special tools for processing finger and palm print images and for drawing up relevant examination worksheets and reports. For this very reason, the RASTR module is commonly included into the software package of PAPILLON AFIS systems, which among other identification tasks operate with latent prints lifted at crime scenes. Processing a latent print image prior to its input into an AFIS improves its quality through amplification of the ridge pattern while suppressing noises caused by other overlapping latents and extraneous images, by interference of background texture (i.e. a contour of surfaces the latents were found on), contamination and other negative factors. Thereby, it considerably simplifies the operator's task of coding and inputting latents into the AFIS, enhances the quality of latent print collections which directly affects the search performance of AFIS.

COMPLEX ARCHITECTURE DATABASE ORGANIZATION

Hardware and software configuration of the PAPILLON RASTR workstation:

- *Personal computer*
- *PAPILLON video equipment:*
  - *– PAPILLON TVC-9.1 USB high-resolution camera*
  - *– lens with a set of extension rings*
  - *– PAPILLON camera-and-object holder.*
- *Digital camera*
- *Flatbed scanner (minimum optical resolution: 1200 ppi)*
- *Laser printer (minimum printing resolution: 600 dpi)*
- *MSP-2 microscope with triocular attachment (Option)*
- *Infra-red lighters and IR-PASS filter (Option)*
- *OS Windows, PAPILLON RASTR license software.*

The number of RASTR workstations is determined by the needs of a particular agency or expert division. In case of a multi-computer configuration, all workstations are networked by a LAN and, for reasons of saving money, fitted with a limited number of video input kits accessible for common use, though all of them have the PAPILLON RASTR software installed.

PAPILLON RASTR is designed for running the MS *Windows* operating system and has an integrated database management system, the number of databases being restricted only by the amount of disk space available. Each of the said databases can have an arbitrary number of partitions (folders).

The system imposes no constraints on the database structure thereby allowing users to choose a way of information storage that is most convenient for them.

The system enables the maintenance of both shared and individual user's databases. The shared database can be simultaneously accessed by several experts, each using his workstation. Access privileges can be established as for the entire database so as for particular partitions and folders therein. Only one of the available databases can be activated at a time.

RASTR enables the database storage of the following objects: ***images***, ***documents***, ***examination reports***.

- ***image***

  The RASTR system provides two ways of how to store images in the database – in the form of a graphics file or as a tracking (besides the image, the tracking file contains also a step-by-step history of its transformation since the source image first appeared in the system). Any of the described ways of saving a processed image ensures that its original image remains intact being automatically stored into the database.

  The source image never undergoes changes and cannot be removed from the database unless all results of its processing are deleted!

- ***document***

  Actually, a document therein is a layout prepared for printing out with images, inscriptions and other elements of design arranged in a particular way. Multipage documents can be created as well.

- ***examination report***

  Examination report is a more complex variant of the document, containing images with points or areas of significance being charted. Generally, examination reports (or worksheets) are created when two objects are compared or when making analysis the expert needs to present a report showing all singularities on the image under study to substantiate his opinion (such as, for instance, fingerprint, handwriting or trace evidence analysis).

The operations manual on “Acquisition, Processing, Storing and Representation of Digital Images Using the RASTR System When Performing Expert Examination in Internal Affairs Departments of the Russian Federation”, elaborated by the Criminal Expertise Centre of the Russian MOI, recommends to organize and to store objects in the database as:

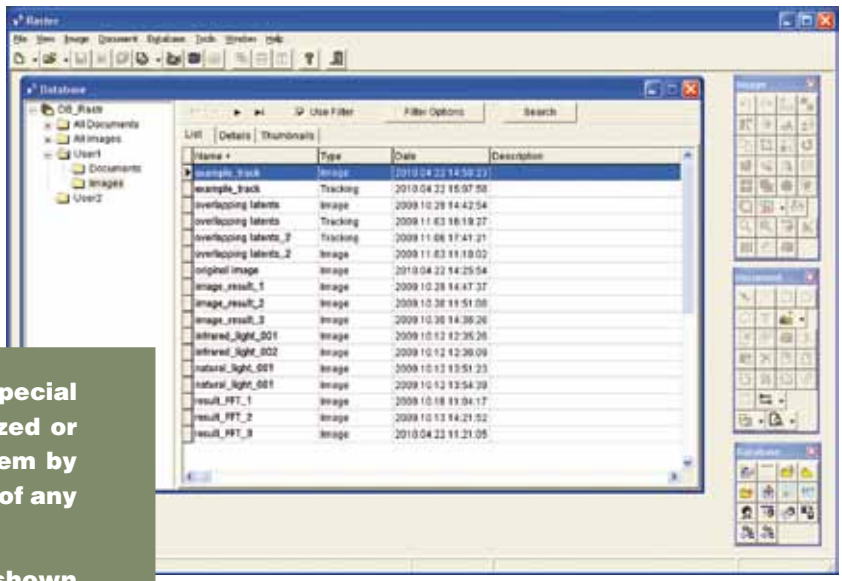
- ***collections of images*** needed as templates for performing different types of expert examinations.

  For example, images of slips, documents, banknotes, etc. (both authentic ones and those having identified signs of forgery), which can be used as specimens for comparing them with objects under investigation with a view to either prove or to doubt their authenticity.

- ***collections of file-trackings*** presenting typical image processing methods provided with examples of the most successful transformations and those of the most complicated investigations carried out by highly experienced experts.

  The said collections allow you not only to reduce the time of examination in similar cases (performing operations by analogy) but they also furnish perfect visual aids for improving professional skills of the staff who have not got yet sufficient experience to work with the RASTR system.

Every object stored in the database is supplemented with detailed information about it: name and type of the object, who and when created it, who and when made the latest changes, textual description, information about associations with other objects (an associated object, or linked one, e.g. an image inserted into the document, cannot be deleted from the database).



All files in the database are stored in a special format of RASTR and cannot be visualized or somehow read beyond the RASTR system by using the *Windows* facilities or features of any other software product.

The RASTR system main window, as shown on the right, contains toolboxes allowing you to access all operations relevant to images, documents and the database.

All information available in a selected database is accessed through a built-in “explorer” in the RASTR system, enabling you to access any operations with folders and objects within the scope of certain permissions, of course, assigned by your system administrator:

- navigation throughout the database and creation of new partitions thereof
- renaming, copying, relocation, deletion of the database partitions and objects
- filtering and sorting of objects according to specified criteria
- searching for objects stored in the database
- loading of an object from the database to the window for image processing or to that one for creating a document/examination report.

The RASTR system provides a full-featured module for administrating the databases that enables:

- creation of a new database, selection, relocation and deletion of an existing one
- archiving of the database (archived files can be only unpacked with the RASTR tools)
- defragmentation of the database
- user management, partitioned mode of access to the database and other user permissions
- logging of client connectivity to the database (log-in and log-out time of every user session).

Exemplary sequence of operations when performing an expert examination using the RASTR system:

1. Enable connectivity with a database needed

2. Create a folder for saving examination data

3. Load images for examination from a source selected

4. Carry out spatial calibration of the images (if necessary)

5. Initiate processing and then conduct comparative analysis of the resultant images

6. Save the original and processed images in the relevant folder in the database

7. Draw up a document showing the examination findings

8. Print a hard copy of the examination report, having saved the report into the database folder.

IMAGE ACQUISITION

PAPILLON RASTR can operate with any type of images – color, grayscale, black-and-white, acquired from various sources as listed below:

- files of standard graphics formats: GIF, TIFF, BMP, JPEG, PCX, TGA, PNG
- files compressed with WSQ processing method
- PAPILLON-formatted finger and palm print files:
  - "raw" tenprints or latent prints scanned in the PAPILLON AFIS (before they are inserted into the database)
  - tenprints generated in the PAPILLON LIVE SCANNER system
  - tenprints or latent prints stored in the PAPILLON AFIS database format
  - tenprints and latent prints compressed for interchange via telecommunication channels
- images captured with PAPILLON TVC-9.1 USB high-resolution camera (or any other USB digital camera)
- images acquired with digital cameras

  At present, PAPILLON RASTR enables the use of Panasonic Lumix DMC-FZ30 and more than 100 models of Canon digital cameras. For all of the Canon cameras, the mode of video input is supported.
- RAW images obtained right from the digital camera sensor

  This capability is very useful for forensic experts. With the RAW format, the original images are obtained without any loss of information while unavoidable when the image data are processed in the camera to a TIFF or JPEG format file. The RAW format renders complete information on the image over the maximum dynamic range. This is especially important when an object under consideration has been shot in over- or underlighting conditions.

  PAPILLON RASTR has an embedded converter of RAW files, containing special tools to compensate for lighting errors, to optimize the color rendition and image brightness parameters.

  After having been processed, the RAW file can be saved in the standard JPEG or DIP hardware-independent raster format that renders an image without distortions in 8-bit or 16-bit dynamic range. The DIP format is preferable in those cases when the captured image is expected to be examined by means of the RASTR tools.
- images acquired with video input devices driven by standard *DirectX* drivers
- images acquired with flatbed scanners and other TWAIN devices

- images extracted from media files (recorded with video surveillance cameras, home camcorders, digital cameras, etc.) supported by the standard *Windows Media Player* service
- images loaded from other applications through the operating system clipboard

Thus, PAPILLON RASTR supports an exhaustive list of possible sources from which images can originate or be obtained for examination.

Being a self-sufficient integrated hardware-software solution, PAPILLON RASTR minimizes for the user the necessity of buying any other auxiliary devices and that of installing any additional drivers, since the equipment thoroughly selected for RASTR features the most optimal technical characteristics and has been tested by the RASTR developers for compatibility, and the software package includes all drivers essential for effective functioning.

Available with the delivery set, the ad hoc high-resolution camera PAPILLON TVC-9.1 USB is capable of satisfying practically any need of the forensic expert in obtaining high-quality color/black-white images under laboratory conditions.

The reason for fitting the RASTR system with the PAPILLON TVC-9.1 USB camera is its ample capabilities including macro- and microphotography, as well as advanced software controls for the shooting process, e.g. adjusting the exposure, brightness, contrast, color, etc.

The RASTR software allows you to change the exposure over a wide range through accumulating signal on the camera image sensor. In comparison with standard video cameras, this feature makes it possible to enhance the signal-to-noise ratio or to reduce the lighting requirements.

The camera has a color sensor embedded and a programmable mode of black-and-white emulation embodied. The camera is simply attached to the USB port of the computer and it requires neither special video board nor individual power source.

For taking photos, a PAPILLON camera-and-object holder is used. The camera ensures the imaging in a wide rage of linear dimensions, including the shooting of close-ups of small objects by means of extension rings that maximize its focal distance up to 30 mm (when using all the 3 extension rings), providing thereby the image capture with ten times magnification.

Capturing microimages is available through a microscope attached to the camera via special connector and equipped with a photomicrographic unit.

Color shooting is also available through an embedded infrared-cut filter that cuts the infrared component of light. This method of image capture enables the color images of higher quality than those captured in standard environment.

The PAPILLON TVC-9.1 USB camera is capable of taking pictures in infrared light, i.e. with infrared backlight or in conditions of natural or artificial light sufficiently intensive. Infrared lighters and an infrared-pass filter are not included into the standard delivery package of RASTR, and are purchased optionally, if necessary.

PAPILLON TVC-9.1 USB mounted on camera-and-object holder

Specifications:

Scan Type	Progressive
Sensor Format	1/2”
Sensor Size	6,59 x 4,9 mm
Number of Pixels	2048 x 1530
Pixel Size	3,18 x 3,18 µm
Frame Rate	7,5 frame/sec
Line Frequency	11,5 kHz
Dynamic Range	60 dB
Exposure	150 µs to 10 sec
Exposure Discrete Control	150 µs
Signal-to-noise Ratio	46 dB
Interface	USB 2.0
Power Source	USB 2.0
Dimensions	52 x 52 x 38 mm
Weight	150 g

EXAMPLE:

1 – a latent fingerprint detected on a colored postcard

2 – the latent image captured in infrared with TVC 9.1 USB fitted with IR-PASS filter

3 – the resultant image after it is processed with the RASTR tools (brightness/contrast adjustment, edge enhancement, Gaussian filtering)

The PC-controlled operation of capturing images with the PAPILLON TVC-9.1 USB camera and other video input devices supported by RASTR as well as obtaining them from media files is initiated through the relevant application window. The GUI and the widget set depend upon the source selected.

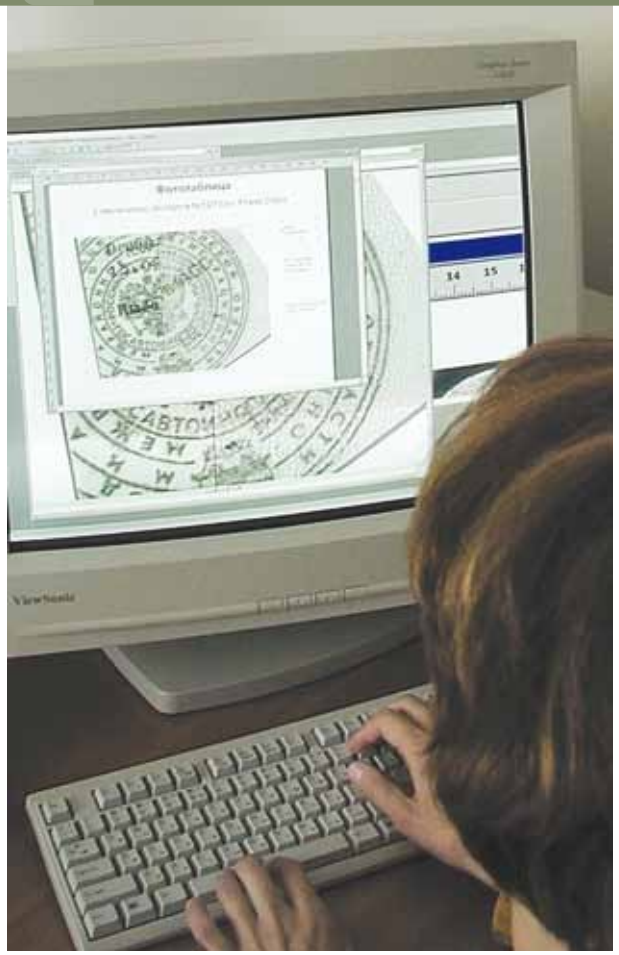
When using the PAPILLON TVC-9.1 USB, the following image parameters can be adjusted through the application window:
● image scale in the preview window ● image size to be recorded (2048 x 1536 or 1024 x 768 pixels) ● dynamic range of the image (8 or 10 bits) ● chromatic level (color or grayscale image) ● exposure (program auto-exposure or manual exposure control) ● brightness and color balance.

RASTR delivers also a tool used to control and to compensate for improper lighting conditions allowing you thereby to avoid underexposure (when the image is too dark) or overexposure (when the image is too bright), which makes white or black image elements respectively appear gray.

To shoot moving objects, the mode of recording a number of frames into the accumulation buffer is used. Then a needed frame is selected for further operation. Live video of the object on the computer screen helps the user to achieve a better quality of the image by applying various adjusting tools available in RASTR.

To operate with a digital camera, a special program interface has been designed to carry out the on-line input of images to the system (for *Canon* cameras) as well as the download of images recorded onto the camera card.

WORKING WITH IMAGES



The sole purpose pursued when processing images with PAPILLON RASTR is to improve the subjective visual perception, to expose available but not clearly visible details and particulars, to exclude the probability of erroneous findings at examination because of the poor quality of initial information.

These are the reasons why RASTR offers no instruments for introducing any new raster data or deleting the existing information. There are no tools for drawing and erasing, for copying and pasting fragments within the image, and no other facilities for artistic creativity either, i.e. all those capabilities that are so characteristic of raster-based editors designed for wide public use.

All tools provided by RASTR have been developed exclusively for nondestructive transformations aimed at refining the image quality, at amplifying or depressing some particular information components and at visualizing faint or scarcely visible details.

Thus, for instance, a highly skilled expert using the RASTR instruments is able to “develop” ridge patterns of fingerprints of so poor quality that under other circumstances makes those prints unidentifiable in both manual and automatic mode using an AFIS.

SPATIAL CALIBRATION

Since the images of objects under examination can be entered into the system from different sources, and generally in an arbitrary scale, RASTR allows for the procedure of *spatial calibration* for correct correlation between images (e.g. to conduct comparative analysis) and for adequate representation of examined objects on printouts.

The operation of spatial calibration correlates the image raster size (rectangular array of pixels forming a digital image) with real geometry of the object being examined. In other words, it determines the image resolution (number of pixels of the image per unit linear dimension of the object).

Spatial calibration enables the more informative use of measuring tools available. When measuring a calibrated image, all the results are output not only in pixels but in the metric system units (mm, cm, etc.) as well, which is more convenient for the expert in most cases.

The RASTR system offers four methods of calibration. The more preferable and habitual way of calibration for multidiscipline experts is that one by “photo evidence ruler” that presupposes that a graduated bar of known size is available on the photo. To calibrate fingerprint or palmprint images, the distances between friction ridges are used. The algorithm of this method is borrowed from the PAPILLON AFIS where it refers to the *AutoScaling* patented technology that ensures the independence of the system from any scale-related changes of fingerprint patterns.

GEOMETRIC TRANSFORMATION

The RASTR system automates the following tasks: ● scaling an on-screen image ● rotating an image by any number of degrees ● mirroring an image horizontally or vertically ● cropping a specific fragment of the image for being displayed and processed in another window (it can be a free-form fragment) ● sizing the image raster (by any of two ways of interpolation available in the system).

IMAGE PROCESSING

RASTR provides a lot of powerful processing tools to enhance images and to extract useful components:

EXAMPLE:

1 – original image

2 – after adjusting the brightness and contrast, the color image has been converted to a grayscale one

3 – inverted image

- ***Color to grayscale conversion***

- ***Positive-negative inversion***

  In some cases, the image inversion lets you improve your subjective perception of the image under study.

- ***Histogram function***

The histogram is a graph that displays the number of pixels at each brightness level, as well as contrast and dynamic range of the image. The subtle analysis of the histogram allows you to judge the necessity of further processing and to devise the direction of that processing or sometimes makes you capture another image with the input parameters properly changed.

The sharp bias towards the right in the graph represented on the histogram means that the picture is over exposed (except for the cases of shooting really light objects) featuring low contrast and information loss in bright areas on the image. When the values are concentrated to the centre, this is indicative of low contrast of the whole image.

For color images, it is accessible to view individual histograms for each of color channels.

- ***CMYK channel separation***

This feature is handy for forensic experts who examine paper documents. It enables the operation with an individual color channel separated out from the CMYK color model.

As it is generally known, the CMYK color model is used for imaging at color printing.

At that, copying machines (color printers and copiers) of many manufacturers insert into every image yellow-marked points invisible to the naked eye, but making it possible to identify the used printing device when needed.

With the said function, a digital image is converted from the RGB representation to CMYK, the yellow color channel being separated out and then visualized as grayscale.

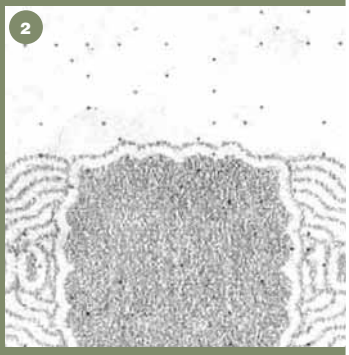
If the image contains the above-mentioned markers, they become clearly visible.

EXAMPLE:

1 – submitted for examination, a thousand-rouble note alleged to be fabricated with a printer

2 – the scanned image of the banknote (minimum scanning resolution: 600 ppi) processed with the CMYK channel separation tool

The markers apparent on the inverted and enlarged image testify that the given thousand-rouble note has been manufactured illegally.



- ***Latent imprint elicitation***

This feature is used for increasing the contrast of fuzzy color details against the background.

The operation converts the color image into a grayscale one.

Using some special tools provided in RASTR, the expert marks a point on the pattern that needs to be exposed and another one on the background.

All points, that are close in color to the fragment pattern, are converted to dark tones of the grayscale range, while those close to the color of the background become lighter.

EXAMPLE:

1 – a fingerprint developed with ninhydrin on paper tissue (ninhydrin dyes latent prints purple)

2 – latent print image after having been processed with the elicitation tool

Brightness and contrast adjustment

RASTR enables the automatic optimization of brightness-contrast parameters of the image at one keystroke, though there is a capability to adjust them in an interactive mode.

The interactive adjustment of brightness and contrast is carried out as for the entire image so as for its particular fragment. For color images, each of the color channels can be adjusted independently.

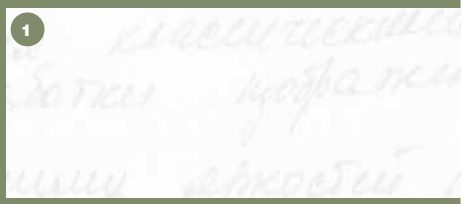
Besides the simple increase or decrease of brightness-contrast values, there is a capability of tonal correction – so-called Gamma correction. Gamma lets you change the image contrast in midtones without affecting the shadows and highlights.

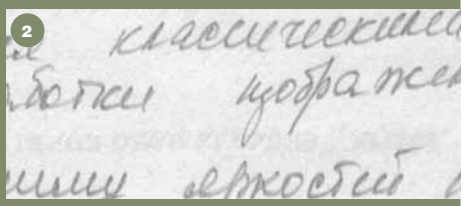
For example, there is a paper with a very faint, hardly readable text. The lower values of the Gamma effect darken the letters against the paper background without significantly affecting the background. It does not brighten or darken the entire image as it happens when adjusting brightness-contrast.

EXAMPLE:

1 – a sheet of paper with a handwritten text faint to read

2 – the same image after it has been processed using the Gamma effect





Filters

Filters are methods of processing which are used to transform digital images by specific algorithms designed to separate the valuable information from artifacts. The interactive user interface enables you to access options and commands that are relevant to an active filter and to view the results of processing immediately for on-line control.

The RASTR system brings together all the classical filters used for digital image processing which are widely adopted.

Equalization

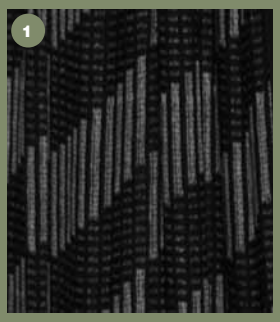
Equalization is a method of transforming the brightness histogram which improves the image sharpness and contrast making fine details legible.

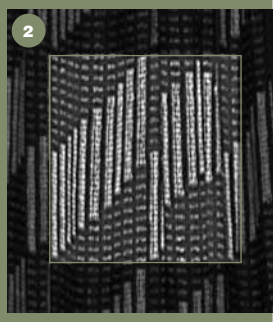
The operation of equalization deals effectively with dark and middle tone pictures, and it considerably emphasizes surface textures.

EXAMPLE:

1 – textile fabric (original image)

2 – the fabric texture becomes visible through equalization





Edge enhancement and its variation *Statistic normalization*

This filter is used for detecting and sharpening the edges of brightness jumps on the image.

EXAMPLE:

1 – the first photo of the car after a road accident makes the damage assessment difficult

2 – after applying the edge enhancement filter, all fractures of the car body are clearly seen

Homomorphic filter

This filter enables the solution of a contradictory problem concerning the compression of dynamic range for images having excessive spread of white and black levels. Besides, it makes the image more contrast by emphasizing details.

EXAMPLE:

1 – A photo of the garage inside was taken through open doors on a sunny day. The inmost details are not seen.

2 – After the image is converted to grayscale and processed with the Homomorphic filter, the garage inside becomes visible.

- ***Median and Gaussian filters***

  Both filters are used for smoothing over jumps in image brightness and for suppressing fine random digital noises.

  Using these filters helps to eliminate the image granularity and spot noises, to suppress the moir effect that can appear on scanned images, to make smaller defects less visible on images featuring brightness jumps.

EXAMPLE: Elimination of the moir effect by using the Gaussian filter

EXAMPLE: Elimination of stripes by using the Median filter

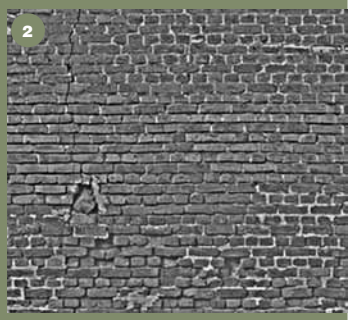
- ***High-pass filter***

  The high-pass filter suppresses low-frequency (slowly varying) image components, i.e. leaves fine image details intact, while smoothing changes of brightness appearing on a large area.

EXAMPLE:

1 – original image

2 – the high-pass filter eliminate the wide brightness variation leaving the image details intact



- ***Low-pass filter*** The low-pass filter suppresses high-frequency (quickly varying) image components, thereby smoothing sharp changes of brightness.

- ***User-defined filter*** The system enables the user to create his own algorithm for recalculating the raster values by entering needed coefficients to the filter transformation matrix (filter mask) or by making changes in the mask of an existing filter.

● *Fast Fourier transform (FFT)*

FFT is an effective instrument for processing images having a spatially periodic structure such as, for instance, fragments of finger or palm prints featuring continuous direction of ridge flows and constant periodicity of ridge lines.

This method is based on transformation of a spectral frequency-plane representation of the image.

When dealing with fingerprint images, the FFT lets you amplify the visibility of ridge flows, while weakening those regular patterns that appear on the backing, thereby separating the fingerprint ridge pattern from artifacts and noises.

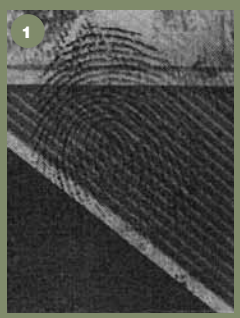
The FFT delivers a powerful tool for separating overlapping latents lifted at crime scenes. As a result, the expert will gain independent images for further examination.

EXAMPLE:

Suppression of periodic structure of the background using FFT

1 – original image of a latent developed on a pack of cigarettes

2 – latent print image processed with FFT

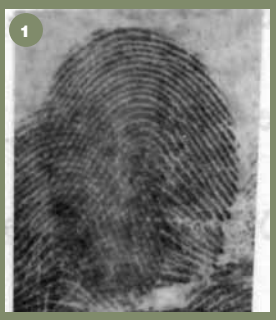


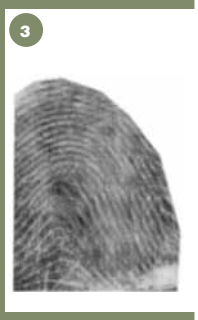
EXAMPLE:

Separation of overlapping latent prints using FFT

1 – original image of two overlapping latents

2, 3 – independent images separated with FFT





When setting parameters for any of the above-described transformations, the user can view online every effect produced by an active tool on the image and can reverse any action at any moment if he considers the operation yields no desired results.

IMAGE COMPARISONS

The PAPILLON RASTR system provides all the features necessary to compare two digital images by overlaying and superimposing them. RASTR combines a vast array of special tools like ***Subtraction***, ***Split Addition***, ***Comparator*** and ***Operations***. All of the listed tools allow you to move and position, to rotate and to scale each of the compared images independently, to align them reciprocally and to adjust their brightness and contrast. Any of these operations results in a single image available for further processing.

Subtraction

Since subtraction of two absolutely identical images from each other gives a radically black color (zero intensity of pixels), the Subtraction tool can be used in the most general case for comparing two images inasmuch as the availability of pixels with non zero intensity in the resultant image will indicate differences between the source images.

For example, subtraction of two images like “point out N differences between” will let you view these differences on the resultant picture. Thus, subtraction can be used for exposing document forgery, for revealing traces of photo and video montage and other suchlike cases.

In case of multiple images captured for one and the same object but under different conditions, the subtraction operation can help to discover or to amplify significant information while to weaken the impact of artifacts or background.

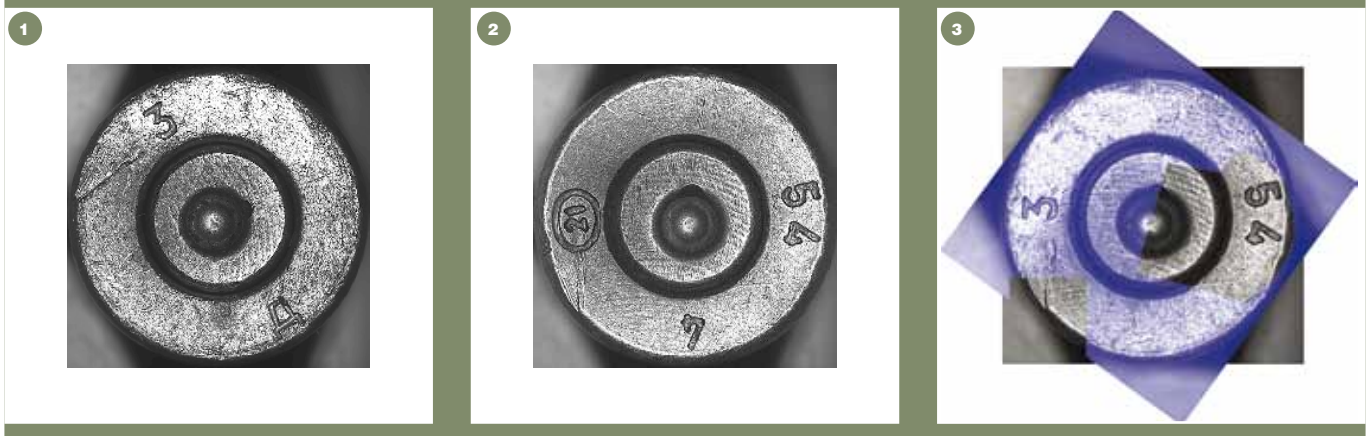
EXAMPLE: **1** and **2** are images of a latent fingerprint found on a coloured card, image **2** acquired after the latent was developed with a fluorescent powder. The ridge details are hardly recognizable on the dark multicolored background.

Operations of subtracting image **1** from image **2**, inverting the resultant image and enhancing the edges have eliminated the background and produced a legible image (image **3** shown scaled).

Split addition

This tool allows you to specify arbitrary transparent regions (so-called transparency mask) on one of two images to create ‘clipping holes’ that allow you to see what is underneath when the two images overlap.

EXAMPLE: **1** – image of cartridge case head N1; **2** – image of cartridge case head N2; **3** – the result of split addition – the images are superimposed in a complex curve formed by the transparency mask assigned on image **1**.



Comparator

Comparator is a universal instrument for conducting comparative examinations that allows:

- aligning images vertically
- superimposing images by two characteristic points specified on each of them
- overlapping images having specified the size and position of the overlapping area
- creating a transparency mask within the area of overlap to paste the image fragments together.

EXAMPLE:

Two photos were submitted for RASTR examination to investigate a case of illegal deforestation: one of a stump left at the scene of deforestation, and another one of a tree trunk allegedly sawed down at that place.

The images of both cross sections were calibrated by 'a photo evidence ruler'.

One of the images was mirrored (reversed), and then both images displayed on the same scale were superimposed on the Comparator screen.

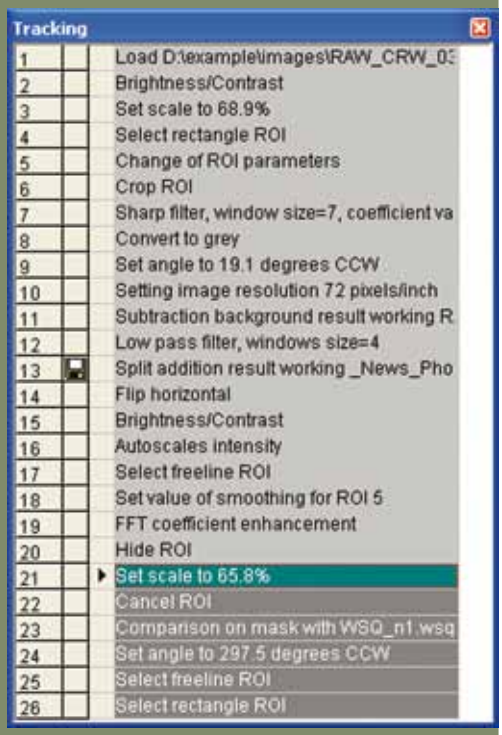
It was ascertained that distinctive features of tree structure (size and form of annual growth rings) of the two articles of evidence matched.

Operations

RASTR gives you the option to fuse two images by superposing and allows you to combine pixels of the foreground image with those of the background using any of 14 modes available in the system: ● alternation of foreground and background pixels ● averaging of foreground and background pixels intensity ● subtraction of pixel values "foreground minus background" and "background minus foreground"● 10 various logic operations over pixel values of both the foreground and the background.

CHOOSING OPTIMAL METHODS FOR PROCESSING IMAGES IN RASTR

Every digital image, particularly in forensic practice, is unique with regard to choosing an optimal algorithm for its transform. Owing to this reason, one cannot and will never offer any universal all-in scenario of an image processing that can be applicable to all or at least most images and their fragments under investigation.



Nevertheless, RASTR can help greatly to optimize the way of processing every particular image through providing an instrument for monitoring the reasonableness and efficiency of any step you perform when transforming the image.

The said instrument in RASTR is tracking consisting in the recording of every step of image processing and parameters of every transform. The tracking is created for every image somehow transformed and saved together with it.

The tracking feature allows you to analyze the progression of changes at any moment of the current or any subsequent session, to repeat it step by step, to estimate the reasonableness of every step, to undo if needed any number of actions you performed and to process the image again but differently in order to achieve better results by more effective means.

RASTR allows you also to create several copies of an image and then process them in different ways. Having compared their trackings and the resultant images, you can select the best one.

Thus, the maintenance of trackings encourages the user to safely act by trial and error with no fear to lose the source image or any intermediate result of transforming because he has the ability at any moment to reverse any number of changes.

The use of tracking lets the user quickly acquire necessary practical skills at processing images in the PAPILLON RASTR system even if he has no fundamental theoretical knowledge and no prior experience in dealing with digital images.

CREATION OF DOCUMENTS

In PAPILLON RASTR, you can create expert reports and store them in the database in the form of a ***document*** or ***examination worksheet***.

Both the document and the examination worksheet are layouts of a page (or pages) to be printed, with text, pictures and elements of drawing up (like lines, arrows, geometrical figures, etc.) arranged or set out in a particular way.

RASTR's document-creating capabilities that let you make layouts of any kind are as follows:

- Adding or deleting pages
- Numbering the pages and inserting running headers and footers
- Pasting, selecting, copying, cutting and deleting objects
- Working with object properties (position on the page, size, color and types of lines, fill and character properties, etc.)
- Aligning and distributing objects
- Assigning a sequence to be followed when drawing objects.

Images inserted to the layout are taken from the operating system files, from the RASTR database as well as from other Image Processing windows open on the RASTR screen.

The only principal difference between the examination worksheet and the document is that the former has an option of inserting specially prepared illustrations (pairs of images) with a graphic chart of characteristic points (pairs of points) as indicated by the expert.

With RASTR, you can start a document using previously created templates.

For generating fingerprint examination worksheets, there is a function provided in RASTR that automatically extracts and marks minutiae on fingerprint images and automatically determines matching minutiae when comparing two images.

EXAMPLE:

Images are prepared for being inserted into a fingerprint examination report.

Minutiae points are automatically marked on both the latent print and the fingerprint candidate images.

Matching minutiae (marked blue) selected by the expert as evidencing that these prints are mates are automatically numbered and charted.

Quoting the Resolution "On Operation Testing of the RASTR System" adopted by the Criminal Expertise Centre of the Russian Ministry of Interior on December 8, 2004:

«... The RASTR system has been tested by experts of the Fingerprint Examination Department who used for that testing materials of real criminal cases submitted for expert examination.

Images of fingerprints were acquired from specimens on what they appeared, from fingerprint lifting tapes and photos of different scale, with a flatbed scanner or PAPILLON TVC-9 high-resolution camera, from files of PAPILLON AFIS format, standard graphics files or system clipboard.

... The trial operation has shown the following positive properties of the tested system:

1. *It enhances the facilities for conducting expert investigations owing to implementation of the new methods of image processing.*
2. *It provides an improvement in quality of materials submitted for examination.*
3. *It makes the forensic expert's work more efficient.*

During 2003-2004, the RASTR system was also tested by the Criminal Expertise Centre at the Main Internal Affairs Directorate of Chelyabinsk Region, where it received approval and was highly appreciated by experienced forensic experts.

... By its composition and functionality, the RASTR system fully complies with the requirements put forth by law enforcement agencies of Russia for drawing up investigation findings.

The system can be used by forensic expert divisions of the Russian MOI for image acquisition and processing, comparative examination, preparation and printing of expert reports and illustrative materials of conducted investigations.»

(The full text of Resolution is available at: http://www.papillon.ru/files/image/content/za/zakrastr.pdf)

Quoting the Report on Findings by the Criminal Expertise Centre of the Main Internal Affairs Directorate of St.Petersburg and Leningrad Region, May 12, 2006:

«... The RASTR software, Version 5.14.1, has been in trial operation at the 4th division of the Criminal Expertise Centre since July 2005 up to date, according to agreement of cooperation.

... In the course of operation, more than 450 objects have been inserted into the system database: source images, results of their processing, examination worksheets with matching characteristics charted.

As data to be used for exploring the system functionality, the experts utilized the real evidence submitted for examination.

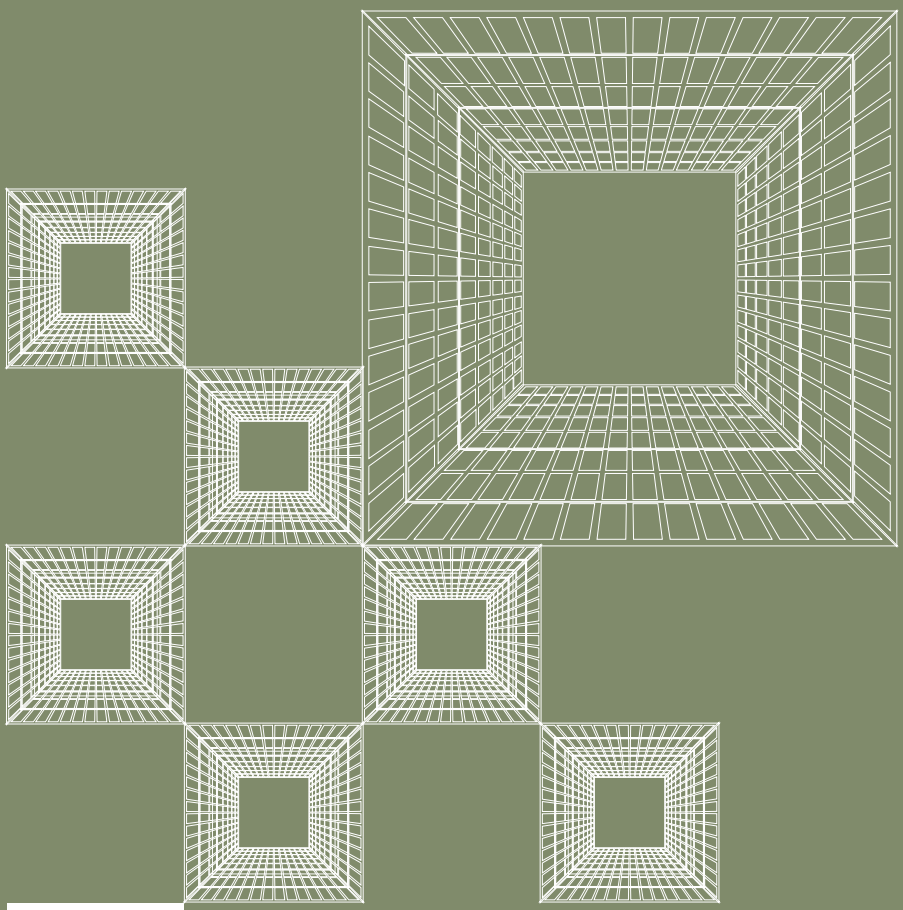
... Together with the developer's representatives, some experimental research has been conducted regarding the use of infrared spectrum to expose latent prints on multicolored surfaces.

... The conducted research has shown considerable potential of that shooting range for exposing latent prints on coloured surfaces.

... Findings:

1. *Despite some certain critical comments, the RASTR system has been positively appreciated.*
2. *The system makes it possible to considerably abridge expenditures of time and efforts taken for performing such laborious tasks as duping, brightness-contrast adjustment, creation of phototables, superimposition of images with respect to a complicated section line.*
3. *The use of special light sources and digital cameras enables the results that can hardly be achieved in case of traditional methods of examination.*
4. *Network-oriented capabilities of RASTR provide a substantial increase of its efficiency.*

(The full text of Resolution is available at: http://www.papillon.ru/files/image/content/2010/zak/zaklspb.pdf)



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