Mieczysław Goc, PhD (corresponding author)
Associate Professor at the Gdańsk School of Banking, Vice-President of the Polish Forensic Association
mg@kryminalistyka.pl
Krystyn Łuszczuk, M.Sc. Eng.
IT specialist, member of the Polish Forensic Association
Andrzej Łuszczuk, M.Sc.
documents expert at the Polish Forensic Association

Graphic line extraction as an important element of handwriting analysis

Summary

The article presents the capabilities and operating procedures of a computer application EDYTOR, dedicated for easy separation of the handwritten text line from the background containing elements interfering with the examined object. The application, developed by a team of specialists from the Polish Forensic Association, is mainly used in handwriting analysis.

Keywords EDYTOR, background masking, transformation

Introduction

A handwriting sample (text, signature, initials) constitutes a basic object of handwriting analysis. The documents (surfaces) on which such entries have been made can exhibit various states of destruction, contamination and legibility. The samples containing legible handwriting with a distinct graphic line on homogeneous background and without any interfering elements are only rarely encountered. More typically, the samples are contaminated to a greater or lesser extent, i.e. they contain various kinds of table lines, printings, notes, stamps or even common stains. Such contaminations pose a challenge to experts in terms of how to present the results of sample analysis, how to extract graphic lines (actual object of analysis) from amongst a colorful tangle of inks making up the sample or, finally, how to present the object's graphic features, which are relevant for the final conclusions reached.

In this regard, the advanced computer graphics editors such as Photoshop, GIMP, Corel Draw, Adobe Illustrator, etc. are proving helpful. However, these programs are rather complicated and difficult to operate, and include multiple options and sub-options often incomprehensible to a non-professional user. On the other hand, one should not expect or demand that a handwriting analysis expert be at the same time proficient in the area of computer graphics. Bearing in mind the above issues, a team of specialists from the Polish Forensic Association, developed an application named EDYTOR (*background eraser*), which is a simple computer software, intended solely for the preparation of samples for the purposes of handwriting analysis. The application enables the extraction of the graphic line being the subject matter of the sample analyzed from the background, which can be even highly contaminated.

Digest of information on EDYTOR application

EDYTOR application comes with seven modes of image transformation (including six modes based on color filtration). The transformations have multiple applications, dependent on specific analytical circumstances. Considering the fact that in expert practice there are no ideal samples (as mentioned above), each background edition process should begin with a proper framing of a sample containing the text (signature) to be analyzed. If the framing was not performed earlier during the scanning, it can be done in EDYTOR by zooming the sample to the desired size and selecting option: "Save Selection". Next, the desired fragment of the document, containing handwriting (signature) of interest should be selected and saved. Only properly framed fragments can

be used as samples subjected to background edition. When handling real samples, the use of any of the filtering transformations in order to facilitate and accelerate the analysis is excluded a priori. Thus, the only transformation available is "Mask Fragment", which is easy to use, yet it requires precision and, frequently, multiple repetitions. However, this application usually delivers satisfactory results and, as such, it should be a starting point in the background edition process. The following sections describe step by step the procedures applied in order to "extract" graphic lines from contaminated background when using EDYTOR application.

Specifically, the test procedure includes the following actions:

1. Sampling. The samples to be processed in EDYTOR must be digitized by using a digital camera, digital camcorder or a scanner. The digitized area should be rectangular or square in shape, with a preference for rectangles with a width to height ration of 16:9 or 4:3, for reasons of user convenience. The samples can have the following formats: „jpg" (recommended), „bmp" or „tif".
2. Prior to selecting the mode of transformation, the sample can be zoomed in or out by using the + / - buttons or the mouse scroll wheel (more quickly). A zoomed sample can be cropped (by using the "Save Selected" option), and, subsequently, the cropped (and saved) fragment can be opened and analyzed as a new image.
3. While being zoomed, the image tends to slip away out of the screen, by moving towards the bottom right of the display. It can be freely moved into the desired position by holding down the left mouse button and dragging in any direction.
4. If necessary (in order to track the effects of work), the original sample image can be recovered by a single right mouse button click, which restores the original size (prior to zooming) and position on the screen.
5. The selection of the "Mask Fragment" option changes the functions of the mouse buttons. The first left-click marks a red point, whereas each consecutive click draws the next point as well as the line connecting it with the previous point.
6. If one or more points are considered to have been erroneously drawn, they can be erased and redrawn in the corrected position by clicking the right mouse button.
7. The selected area becomes masked (more precisely – covered with a color of the user's choice).

Exemplary graphic line extraction

Figure 1 presents a frequently encountered document containing a signature placed over a stamped background (fig. 2), which renders it practically illegible and reduces the possibility of carrying out the analysis and indicating identification characteristics.

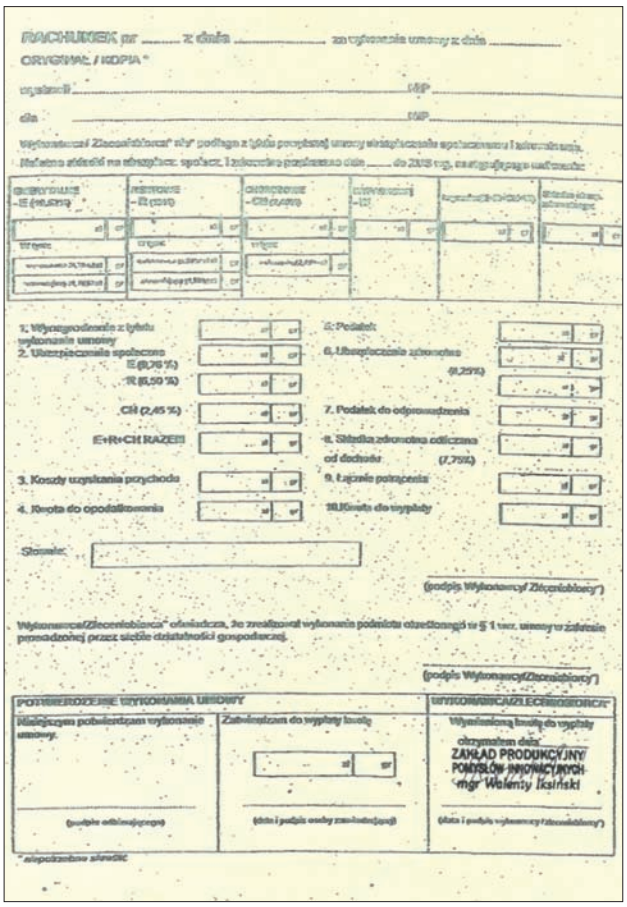

Fig. 1. Exemplary document with a signature in the bottom right corner placed over a stamped background. The signature's graphic line is to be separated from the stamp content.

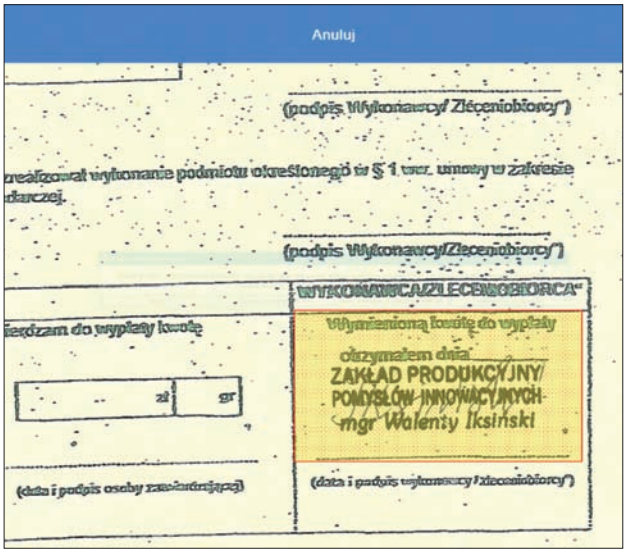

Fig. 2. After saving, the fragment marked in yellow will become a sample to be edited.

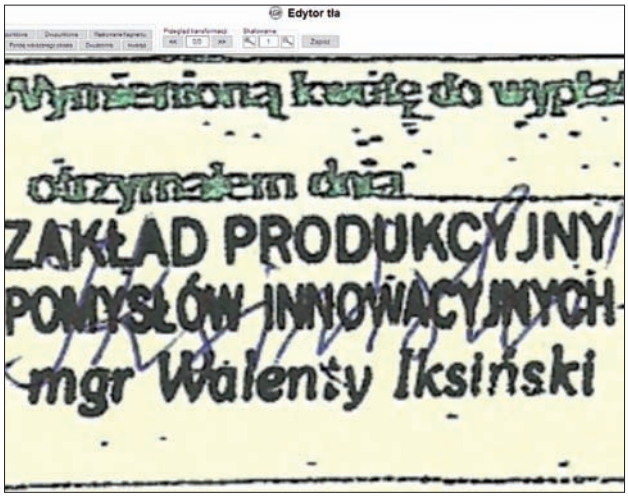

Fig. 3. Framed fragment opened in EDYTOR as editable image.

An additional difficulty stems from the fact that the color of the stamp is only slightly darker than that of the signature, which makes it impossible to use rapid transformations involving color filtration (fig. 3). The only transformation available is therefore "Mask Fragment", which should be used repeatedly for removing the unwanted fragments one by one (by means of masking) and adjusting the sample zoom level to the size of masked fragment. The first step is to frame the fragment carrying the signature by zooming it in EDYTOR and choosing the "Save Selected" option. The saved area constitutes a basic image submitted for background edition as shown in figure 4. The following scanograms shown in figures 5-13 present the paired sets of fragments selected for masking and the corresponding masking effects.

For the purpose of further editing, the sample needed to be zoomed. In this example a 2- or 3-fold zoom was applied during the edition as needed.

It is worth mentioning that in some cases, the path of a graphic line hidden underneath the stamp is so difficult to trace that it is practically impossible to reconstruct it. In such cases, the "Inversion" option can be used, which facilitates the tracing of the actual graphic line path by converting the saved image into a negative form. When a negative background is edited, the colors undergo inversion, i.e. white masking color in a positive image corresponds to black in a negative. In the presented example, negative image masking effects are presented in figures 14-17.

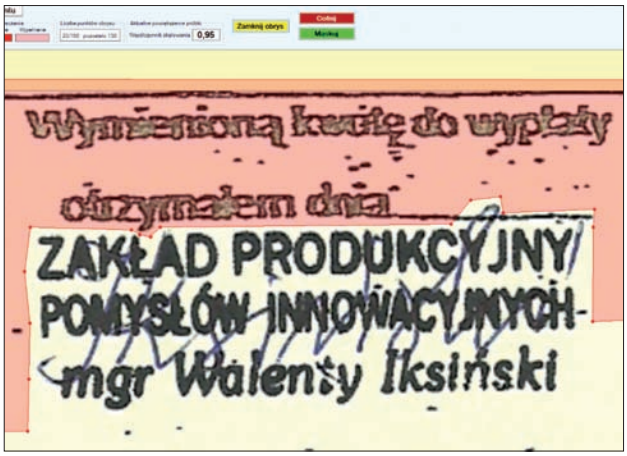

Fig. 4. First fragment selected for masking (marked in translucent red).

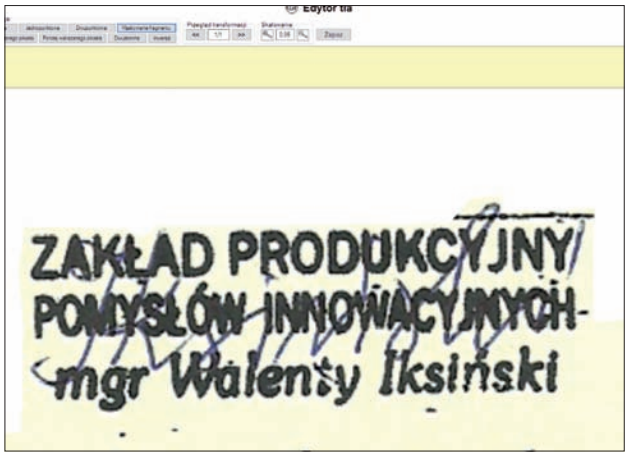

Fig. 5. First fragment masked with white color.

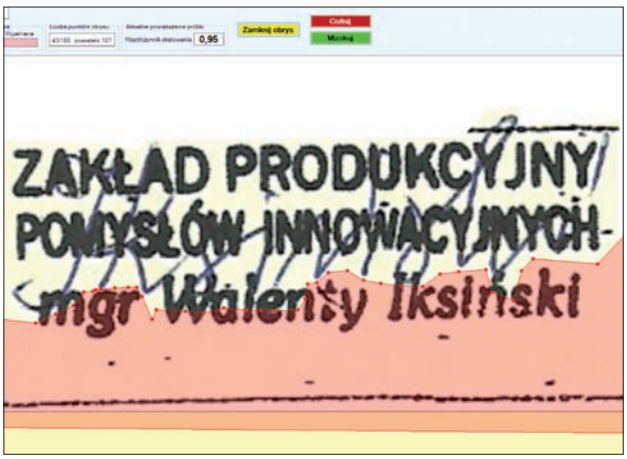

Fig. 6. Second fragment selected for masking.

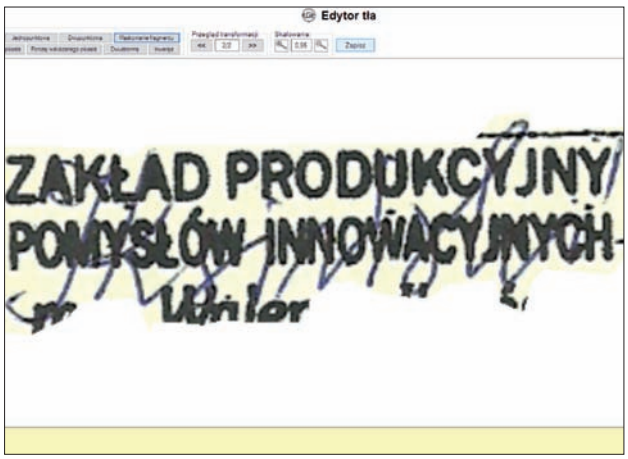

Fig. 7. Second masking result.

Fig. 8. Selection along the length of a graphic line requiring patience and precision.

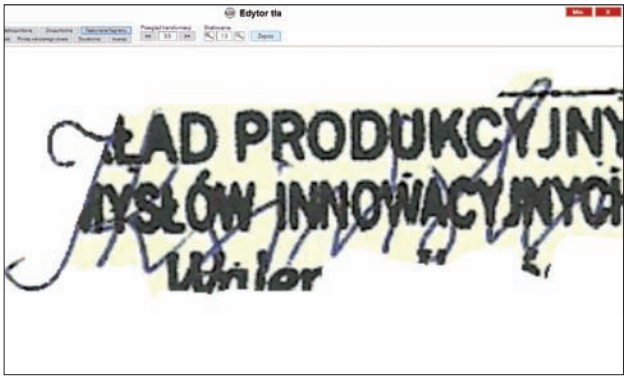

Fig. 9. Masking result.

Fig. 10. Another selection requiring precision.

Fig. 11. Masking result.

Fig. 12. Exemplary loop selected for masking.

Fig. 13. Loop after masking.

Returning to the positive image and original sample size. The use of a single-point transformation allows applying a pale yellow color of an original document to the background (fig. 18).

A two-point transformation enables the removal of discolorations, unification of graphic line colors as well as contrast adjustment. Since the transformation can be considered as an interference with the line's color scheme and it causes deformation of the shading pattern, this graphic feature cannot be subject to analysis or, at most, it can be analyzed to a limited extent, i.e. only within the parts of the signature which have not undergone

Fig. 14. Inversion into a negative facilitates the line tracing and the selection of fragments for masking.

Fig. 15. Image after masking.

Fig. 16. Another fragment of a negative image selected for masking.

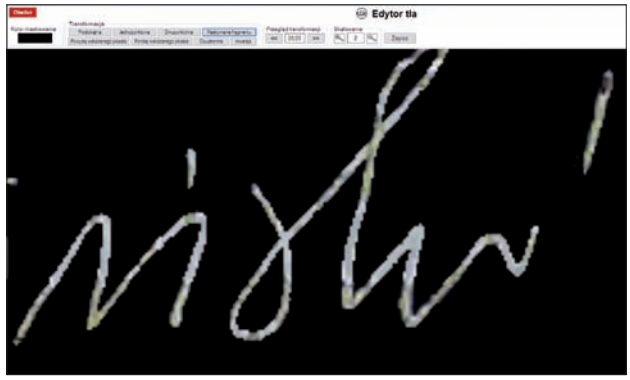

Fig. 17. Masking effect.

transformation. All the remaining sample elements are not only amenable to identification testing, but what is more, they may facilitate comparative analysis and the identification of the most relevant handwriting features.

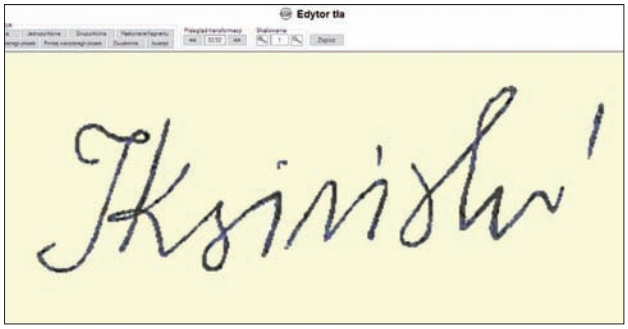

Fig. 18. EDYTOR interface displaying the final sample image (edition completed).

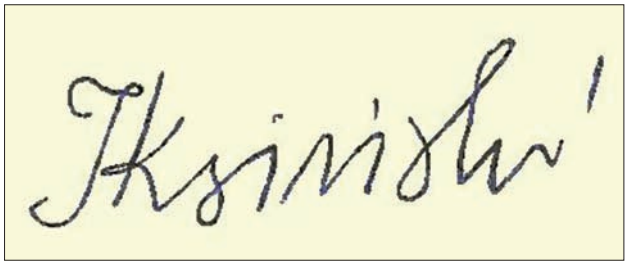

Fig. 19. Final image (saved in "jpg" format) used as a starting material in graphometric analysis.

The final images presented in figures 19 and 20 are the result of using a single-point and two-point transformation, both of which should be considered as the touch-up tools, i.e. not introducing any substantive changes but merely applied to improve the aesthetic appeal of the sample.

Concluding remarks

Due to the space limit, the number of masking examples (involving all image conversions occurring between the original and final stage) presented in this article was reduced. Additionally, some of the masking events were omitted for reasons of similarity in appearance. The exact number of masking events is impossible to predict before commencing edition as it depends on the particular analytical circumstances, including the level of sample contamination and graphic line path complexity. The presented example required 16 selections and 16 masking events (including 4 on negative images) to be performed in order to achieve the final effect shown in figure 19. Additionally, one single-point transformation was applied to give a background a pale yellow color as well as one two-point transformation to remove discolorations of the graphic line, unify its colors and adjust contrast.

This article describes in detail only a single basic EDYTOR transformation – "Mask Fragment". As mentioned in the introduction, EDYTOR application also offers other transformations, based on the filtering of user-defined colors. The following transformations are available:

1. Rectangular transformation.
2. Single-point transformation.
3. Two-point transformation.
4. Transformation above the indicated pixel.
5. Transformation beneath the indicated pixel.
6. Double-sided transformation.
7. Inversion (converting a positive image into a negative and vice versa).

The detailed description of the above transformations is beyond the scope of this article. A slide show containing a complete review of all transformation capabilities, including their practical applications, is available on the Polish Forensic Association's website[1]. It is worth mentioning that the application can be used to extract all kinds of entries (not only handwritten) as well as other objects, e.g. drawings or images from the interfering background.

Sources of figures: Krystyn Łuszczuk

Translation Rafał Wierzchosławski

1 http://kryminalistyka.pl/edytor/.