

## ABC – Alphabetical Computer-Based Handwriting Investigation System

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**Abstract.** *A computer-based handwriting analysis system is described. It realizes the so called alphabetical approach aimed at the description of a large number of letters and symbols from the text under investigation in order to detect specific features and evaluate their frequency. It diminishes significantly the operator's workload and could be used for supervised or self-training of forensic experts. The system is implemented at the Research Institute of Forensic Science and Criminology at the Ministry of the Interior.*

**Keywords:** *Handwriting, Graphometrics, Identification, General Features, Specific Features.*

### I. Introduction

The writing was brought to life from the needs of people for off-line communication and for preservation of the memory about important events. However, together with the enormous positive effect for the society, the writing conceived a new type of crime – handwriting forgery. Thus, writer identification became a very important problem. The first steps in this direction have been more than naive because it was thought that a visual comparison between two writings would be sufficient and every calligrapher, teacher or clerk would be able to do this. The lack of serious investigation of the handwriting process didn't allow creating a reliable system and principles for an objective evaluation. It was understood that a reliable identification features had to be used and a system of measurement and qualitative description had to be developed. The rational finding concerned the use

of measurement of some parameters like size of letters, slope, shape of the strokes, pressure change and evaluation of the off-set from a standard. On this base the German criminologist Schnikert introduced in 1918 systematic classification of identification features, dividing the features into two groups: primary which have had descriptive and guiding character, and secondary, being more specific. On this base the graphometric approach was set-up in the beginning of 20th century, aimed at the achievement of more objectiveness. The most profound formulation was given by L o c a r e [6]. He has suggested the following four types of measurable features: 1) size of letters, 2) direction, evaluated through the angle between the letter's axis and the basic line of the word, 3) number of interruptions, and 4) shape of the writing elements.

The present-day methodology for comparative investigation of handwriting was set-up by Russian criminologists, e.g. M a n t s v e t o v a, O r l o v a [7], and others, where the features were divided into two groups; general features, pointing at a particular group of handwritings, and private ones, allowing for writer identification. They suggested detailed classification of the private features based on their significance for the identification.

In Bulgaria V a k a r e l s k i [9] introduced the use of supporting mathematical methods in the forensic handwriting investigations. This stimulated the next investigations [2, 5, 8] aimed at the development of computer-based graphometric systems for the evaluation of the identification reliability of the measured features.

The aim of the computer-based handwriting investigation is to increase the objectiveness of the conclusion, on the one hand, and to diminish the expert's workload, on the other hand. One of the most laborious technique known as Alphabetical concerns the description of a large number of letters and symbols from the handwritten text in order to detect specific features and evaluate their frequency. Using modern computers it could be easily realized as an interactive system, decreasing significantly the workload and allowing for supervised or self-learning expert training. The purpose of this paper is to describe the system that has been recently developed and implemented.

## II. The alphabetical approach

The background of this approach was described earlier, see e.g. [1, 3, 4, 6, 9]. It is based on the statistical evaluation of the frequency of appearance of private features at every symbol from the questioned text. For this tables of occurrences are created with a qualitative description of the corresponding features. Such an analysis helps the expert to get better understanding of the individualizing capability of the observed offsets from the writing standard<sup>1</sup>. However, this technique of handwriting identification is not very popular due to the extreme expert's workload. To overcome this difficulty, the expert's involvement was analyzed thoroughly and the operations that could be fulfilled by a computer have been selected. As a result the system ABC has been developed. Its user-friendly graphical interface makes the

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<sup>1</sup> See for example the writing train course for the first grade

application of the alphabetical approach much easier than before. The system includes the following five possibilities.

1) Loading high quality scanned images of handwritten documents in different graphical formats (BMP, JPG, TIFF, PGN).

2) Selection of a particular letter, marking fiducial points on it and selection and description of specific features.

3) Automatic evaluation of the frequency of every feature and its occurrence relative to the occurrences of other private features from a specified symbol. Also, its frequency towards the total amount of features in the investigated text could be evaluated.

4) Automatic creation of illustrative documents of all variances of private features of the handwriting and their statistics (see Table 1).

5) Selection of a particular feature and display of its frequency in order to test the expert's ability for reliable identification.

### Description of the system

The system is intended to help the alphabetical investigation of the private features of handwritten text by an expert. It helps describing specific deviations of the letters shape from the standards. Also, their instances are shown in the screen. The results could be saved and investigated latter. A statistical table could be generated automatically if necessary.

The main screen of the system is shown in Fig. 1. It is divided into three parts, namely a menu with a strip of tools (Fig. 2), area for a document under investigation (Fig. 3), and letter and feature workshop (Fig. 4).

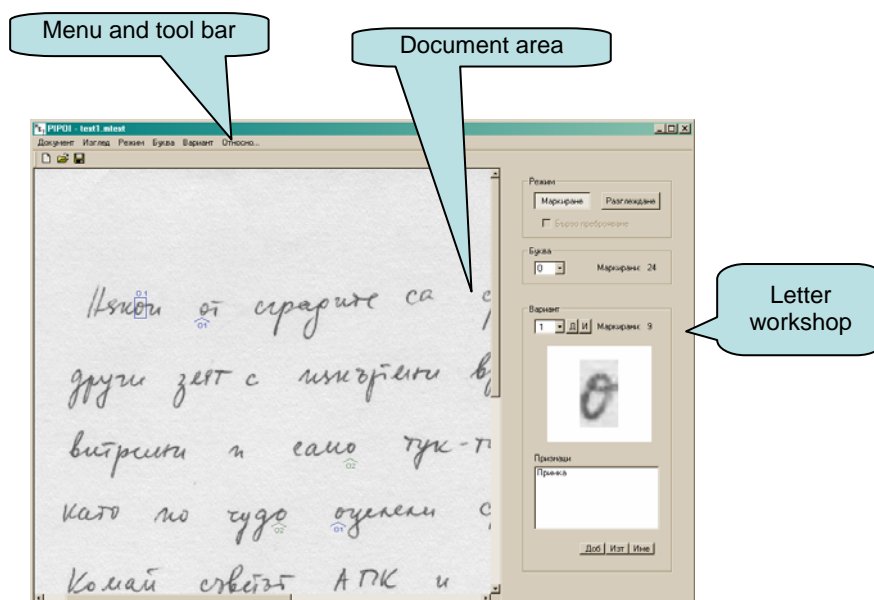


Fig. 1. Main screen of the system ABC

Menu **Document** is used for:

- **New** – creation of a new document with marked text.
- **Open** – open of a marked document.
- **Save** – saves of the currently marked document.
- **Create table** – creates a Microsoft Word table of the alphabetical investigation.
- **Exit** – exits the program.

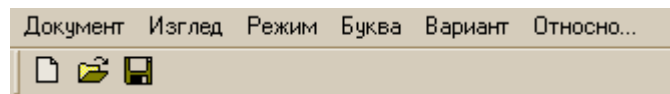


Fig. 2. Menu with a tool bar

Menu **View** is used to display or hide different elements:

- **Strip** – display/hide the tool bar.

Menu **Mode** establishes the type of work:

- **Mark** – place marks on the samples of the selected letter variant.
- **Fast count** – only the standard is marked and statistics is collected using the keyboard.
- **Viewing** – allows viewing of marked document only without chnging.

Menu **Letter** is used for processing of all variants of a particular letter that are found in the text:

- **New** – Allows involving the name of a new letter, e.g. “Lambda”.
- **Clear** – Clears all variants of a letter that have already been marked.
- **Attention!** – after this action marking can not be restored.
- **Rename** – Changes the name of the selected letter.
- **Variant** – Selects a specific variant of a letter.
- **New** – Adds a new variant of the selected letter to the list of its variants.
- **Clear**
  - *All* – clears the current variant completely.
  - *Null* – clears all marked samples of the current variant without changing the description and the standard.
  - *Features...* – Allows entering the names of the characteristic feature variances for the current letter variant.

Menu **About**

- submits information about the system version.

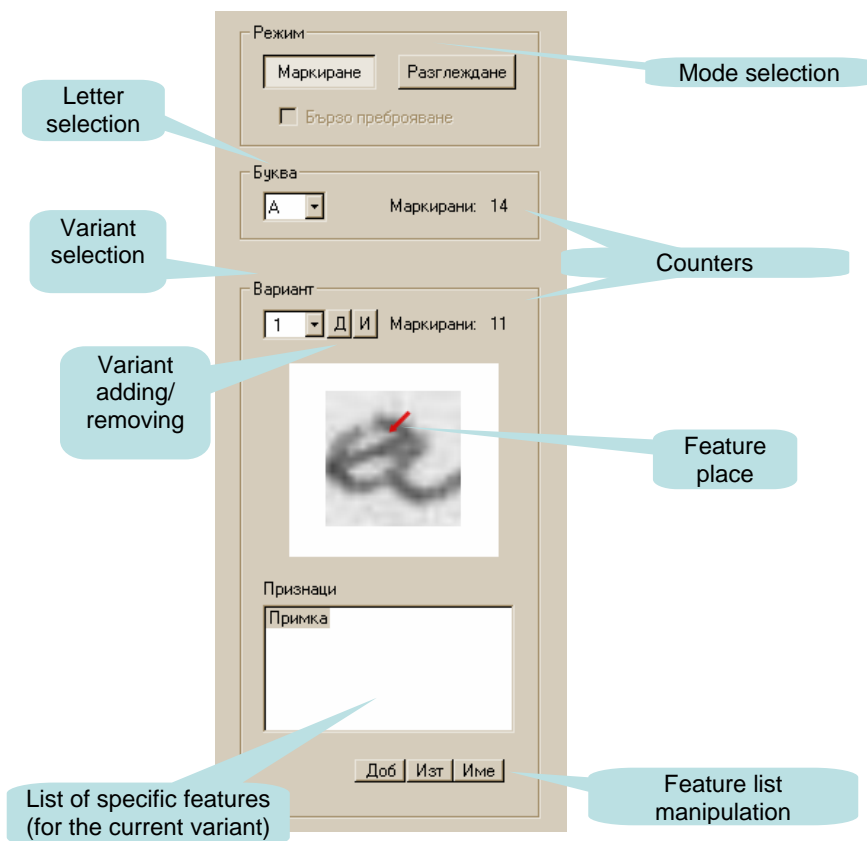





Fig. 4. Description of the letter workshop area

Some of the items in Fig. 4 are self explanatory. With the “Counters” the number of samples of the selected letter in the text and the number of the selected variant of it is evaluated. The field for the list of specific features includes textual description of the features by the operator. The three buttons in the bottom allows adding, removing or renaming features.

Table 1. A piece of generated document with final results obtained by the system ABC

Letter	Variant	Features	Frequency in %
H		Straight-line shape with angular connection	13 of 29 (45%)
		Straight-line shape, interval	9 of 29 (31%)
		Arc-like shape	7 of 29 (24%)

The system has been tested at RIFSC and other offices of the Ministry of the Interior. The results have shown that:

- 1) The obtained tables meet the requirements of the approach included in the methodology for forensic handwriting investigation.
- 2) The investigation is faster and saves the expert's time.
- 3) The statistical values are automatically obtained and objective.
- 4) The learning function is effective and flexible, giving the possibility for both self-learning and correction by a teacher.

The results from the above-described system have shown that the development of a fully automatic writer recognition system is not feasible for the time being, as it was in dactyloscopy or in DNA analysis. This is because significant changes in the handwriting may occur, depending on the psychophysical condition of the individual, on the one hand, and writing situation, on the other hand. This inference points at the development of a complex interactive system, incorporating the possibility for the evaluation of a set of measured general and private features, together with a qualitative description by an expert. Also, the final decision has to be complex, based on classification rules and the intuitive estimation of the expert. Fig. 4 shows a functional sketch of an exemplary computer-based system for handwriting investigation.

### III. Conclusion

The alphabetical computer-based system for handwriting investigation gives the possibility for objective analysis thus diminishing the operator's influence on the final decision, on the one hand, and the operator's workload, on the other hand. Nevertheless the objectiveness of the computer evaluation the final decision is made by the expert, i.e. the system is intended to be a supporting tool. ABC could be used for supervised training or self-training of handwriting experts. The investigation process is automatically archived which allows external evaluation of the accuracy and correction, if required. The system is designed as a separate module from a complex computer handwriting analysis system, including the possibility for the evaluation of general and private features, and pressure analysis.

ABC has been implemented in the Research Institute of Forensic Science and Criminology at the Ministry of the Interior and different Police Departments in the country.

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