AUTOMATIC SEGMENTATION OF TREE DRAWINGS FOR PSYCHOLOGICAL TESTS

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ABSTRACT: In this paper we present a segmentation method of trees drawn on paper for psychological tests. The crown and trunk of the tree can be individually identified. After obtaining the two regions, the data found will be used in the future to achieve an algorithm that helps the psychologist to detect some profile significances of the person who drew the tree.
KEYWORDS: binary segmentation, the Tree Drawing Test, image processing

1. INTRODUCTION

The computer has become an integral part of many people's everyday life and one can hardly imagine future without this technology. Nowadays the computer is used in various domains through scientific and military applications, in business, accounting, tabular calculation, or weather forecasts.
In medicine the computer is used to storage a large collection of data - containing personal data, additional important dates, images obtained by echo, EKG interpretation - for a large number of patients, being quickly accessible to doctors.
The image processing requires a series of processes applied to an image: intensity adjustment, filter elements, morphological operation, and segmentation [Tar10].
In this paper we aim to demonstrate that image processing can be useful in psychology, namely in psychological tests. Psychological tests based on drawings can be automatically processed and used to come to the aid of a psychologist. Among the projective tests used for the detection of emotional disorders we name: the star-waves test [Dum10], the man (person) test, and the Tree-Drawing Test – TDT [Koc06], a psychological test designed to reveal character or profile traits of an individual. The TDT was developed and standardized by Charles Koch, swiss psychologist, between 1952 and 1957. Further studies showed that the results of the test could be use as evidence of children's personality and intellectual progress. The tree test is the most frequently used personality test in school [WG08].
This test is useful if you are enrolled in an interview for a high position in a company, being classified as special as opposed to other psychological tests, but is also very effective in children, who sometimes can express themselves better by drawings than by speech.
If employed in recruitment, the psychologist has to review several tests and therefore an automatic algorithm to help him detect the profile of the future employee could be useful, particularly since it can be influenced by its current state of mind or lose sight of certain important characteristics of the reflection of feelings.
The test consists of drawing a tree with a pen or pencil on a sheet of A4 paper (Fig.1). For the examination of details, Charles Koch recommended studying the drawn line – if it is pressed or light, continuous or discontinuous or if spasmodic, as well as the thorough analysis of all constructive elements of the drawing.

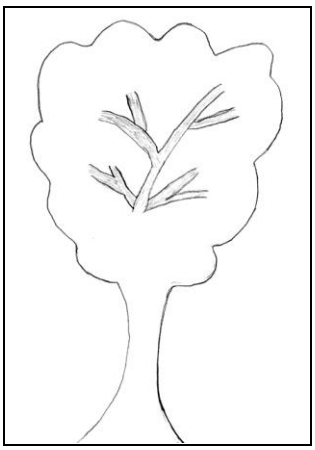


Figure 1. The image of the Tree Drawings Test

Hermann Hiltbrunner noticed the affinity between tree and man, considering man as a closed and the tree as an open system, and an encounter with the tree is an encounter with him [Koc06, RS00].
TDT has been used for detecting the characteristics of patients suffering from schizophrenia, as it is perceived as non-stressful and easy to manage. Morphological differences were observed between trees draw by healthy patients and those drawn by schizophrenia patients. This has driven to the conclusion that TDT is useful for investigating brain functioning in different patients [ITO03], [M+02].
The main parts of the tree are the crown, trunk and root. In the present paper several images from a psychologist were processed, and presents in the first stage the automatic binary segmentation of the tree. There are automated methods for the segmentation of a tree in nature [TCH05], but in this work is presented a new method for the segmentation of trees drawn for psychological tests.
The handmade drawings were scanned and then converted to images in order to be processed with the algorithm developed.
After scanning, the images were processed with software used for digital image editing to correct any noise arising with the scanning. In the future we consider the development of processing algorithms to solve this problem.

2. METHODS AND MATERIALS

In order to apply the test, an A4 sheet of white paper and a pencil are needed. The children are given the simple instruction: "Draw a tree". The piece of sheet is placed in a vertical position.
Segmentation is one of the most important steps in the processing of an image [Bra03]. The image segmentation refers to the partitioning of an image into its various components. As a result of segmentation distinct objects are extracted from the image, regions that satisfy certain criteria of uniformity, or other elements.
To illustrate the concept of segmentation in images taken from a psychological test - Tree Drawing Test - we realized an algorithm that processes binary images but also color images.
The application of segmentation of trees includes the following steps:

- Acquisition of images;
- Inversion of the image;
- Calculation of all the pixels on each line, maximum and minimum;
- Determination of a profile;
- Segmentation of the profile.

The block model of the application realized for the segmentation of an image containing a tree drawn in a psychological test is described in Fig. 2.

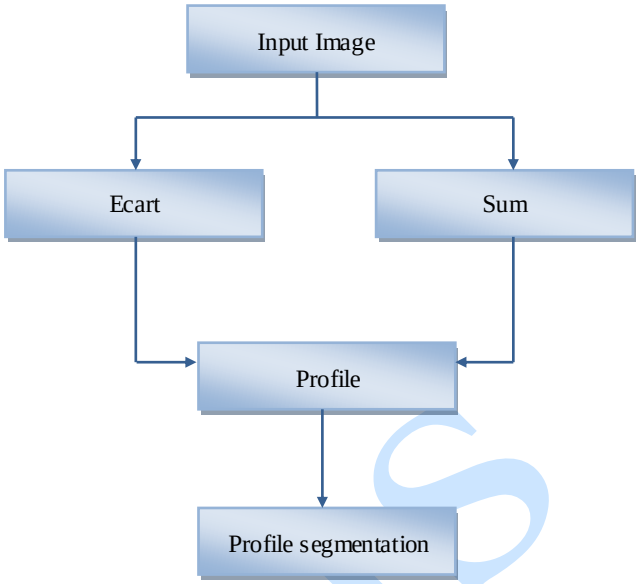


Figure 2. Block diagram of the profile segmentation

The image is loaded into a window and then is performed the operation of reversing the image, which is obtained through the following transformation:

$$V = f(u) = L - u \quad (1)$$

The crossing of the image is made through 3 channels (r, g, b) and each pixel is reversed by calculating its negative using the equation (2):

$$p[i] = 255 - p[i] \quad (2)$$

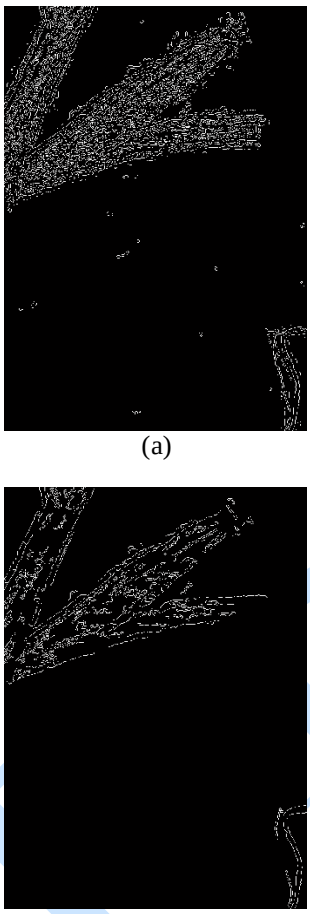
where p[i] represents the current pixel at the time of the image crossing. The result of the inversion of an image is presented in Fig. 3.

Figure 3. Negativization of the images

After the image inversion method we must eliminate the noise from the image. The noise in the obtained images occurs as pixels that are not part of the details of the drawing. According to [GW02] it is defined as a process (P), which affects the acquired image (Im) and it is not part of the initial signal (I). This process can be written in equation 3.

$$Im(i, j) = I(i, j) + P(i, j) \quad (3)$$

For the total elimination of the noise was used the Canny edge detector [Can86], that was applied by using a high sensibility threshold so that we should not miss the details of the drawing image.



(a)

(b)

Figure 4. Remove noise in the image
(a) Input images, (b) Removed noise

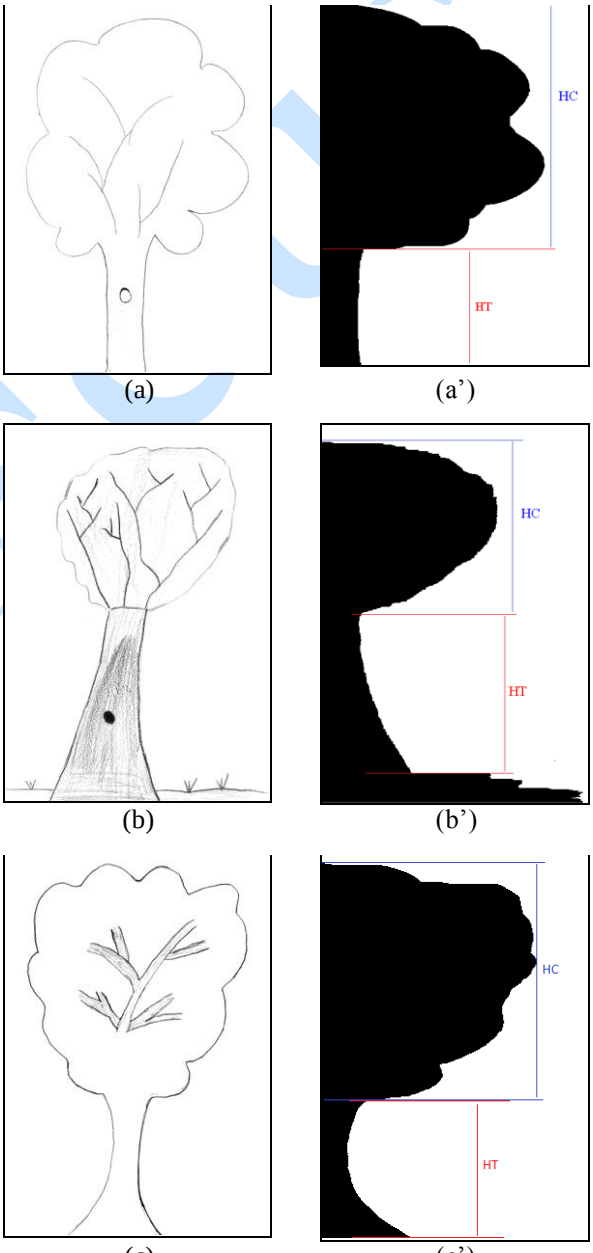
In the next step is calculated the amount of pixels with value on each line (equation 4), then the maximum and minimum of each line of the processed image and each stored in a representative vector.

$$\sum_{i=1}^{N} x_i \quad (4)$$

After saving these profiles it is preceded to the calculation of the difference between the maximum and minimum, as exemplified in equation (5).

$$\begin{cases} profil[i] = p_x[i] - p_n[i], \text{if } p_x[i] >= p_n[i] \\ profil[i] = \sigma, \text{otherwise} \end{cases} \quad (5)$$

After that, we can obtain the tree profile (see Fig.5). For segmentation the three regions of a tree: crown, trunk and root, must be taken into account. For the presented work we have considered so far only the crown and trunk.
We know that a tree is usually drawn in a vertical spatial order, thus data are succeeding in the same order.



(a) (a') (b) (b') (c) (c')

Figure 5. Segmentation of the profile
(a, b, c) Input images, (a', b', c') Processed images

3. RESULTS AND DISCUSSIONS

From the database we used several images of drawings representing trees and we tested each image using the segmentation algorithm.
The image is launched in the application and after performing all the steps described above, we can have the segmented image.
The parameters of the tree drawing and the placement of the drawing in the graphic space are the first priorities to be answered by our application. Both the position of the drawn tree on the page and the dimensions of its tree parts make important criteria in the clinician's decision concerning the classification of the subject as normal or suspect of psychic problems. For example, if the tree is placed on the left side of the page, this indicates self-censorship, adjusting difficulties and emotional conflicts. The application can signalize this to the psychologist automatically.
Another aspect of the drawing which represents criteria in identifying potential psychological disturbances is related to the shape of branches (one-line or tubular branches), the end of branches (open, closed), the branch crossing and the visibility of the roots. All these parameters identified through a structural analysis of the drawing could be calculated by developing the software application.

CONCLUSION

In this paper we have proposed a new method for the segmentation of a tree drawn in pen or crayon on paper. The algorithm described divides the image binarily and displays the crown in the end. This is useful for the identification of future characteristics in each region, thus aiming to be a real help for the interpretation of the psychological test by the psychologist.
In the future, the method presented can be improved and thus the image may be segmented in all three significant regions of the tree. A classification algorithm will be implemented through which can be highlighted psychological significances on the person who drew the tree in the psychological test.

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REFERENCES

[Bra03] **R. Brad** - *Procesare Imaginilor si Elemente de Computer Vision*, Editura Universitatii "Lucian Blaga", Sibiu, 2003.

[Can86] **J. Canny** - *A computational approach to edge detection*, IEEE Transactions on Pattern Analysis and Machine Intelligence, pp. 679-698, 1986.

[Dum10] **M. Dumitrana** - *Probleme de diagnostic - Depistarea copiilor cu tulburari emotionale cu ajutorul testului Stele-Valuri*, Revista Medicala Româna, Ed. Medicala Amaltea, vol. LVII, Nr. 3, Bucuresti, 2010.

[GW02] **R. C. Gonzalez, R. E. Woods** - *Digital Image Processing (2nd Edition)*, Prentice Hall, 2002.

[ITO03] **H. Inadomi, G. Tanaka, Y. Ohta** - *Characteristics of trees drawn by patients with paranoid schizophrenia*, Psychiatry and Clinical Neurosciences, vol. 57, pp. 347-351, 2003.

[Koc06] **K. Koch** - *Testul arborelui: Traducerea Sorinel Mocanu - Editia a III-a*, Editura Profex Bucuresti, 1978, retipărită în 2006.

[M+02] **I. Mizuta, Y. Inoue, T. Fukunaga, R. Ishi, A. Ogawa, M. Takeda** - *Psychological characteristics of eating disorders as evidenced by the combined administration of questionnaires and two projective methods: The Tree Drawing Test (Baum Test) and the Sentence Completion Test*, Psychiatry and Clinical Neurosciences, vol. 56, pp. 41-53, 2002.

[RS00] **A. Rozorea, M. Sterian** - *Testul Arborelui*, Editura Paidea Bucuresti, 2000.

[Tar10] **M. Tărâţă** - *Informatică Medicală, Cap. Analiza şi prelucrarea imaginilor medicale*, vol. I-II: Editura Sitech Craiova, 2010.

[TCH05] **C. H. Teng, Y. S. Chen, W. H. Hsu** - *Tree Segmentation from an Image*, in IAPR Conference on Machine Vision Applications, Tsukuba Science City, 2005, pp. 59-63.

[WG08] **I. B. Weiner**, **R. L. Greene** - *Handbook of personality assessment*, Hoboken, New Jersey: John Wiley & Sons, 2008.