Automatic Pre-processing of Images for Tree Drawing Test

Florentina A. Pintea, Dan L. Lacrama, Tiberiu M. Karnyanszky and Corneliu Ioan Toma

Abstract — **This paper try to demonstrate the usefulness of image processing techniques in order to measure some relevant features of Tree Drawing Test's images. The segmentation of the trunk from the crown & roots is performed using profilograms. Then the length and height of each part are measured, and the data are employed for the computations of the standard TDT formulas. This automatic process can be a real help for large groups of under aged children psychological screening.**

***Keywords* — Image processing, Tree Drawing Test, profilograms**

I. Generalities

THE psychological literature widely agrees that the projective methods (i.e. the Tree Drawing Test, the Rorschach Test, the House–Tree–Person Test etc.) are used in many clinical settings, and their usefulness had been repeatedly proved [1, 3, 4]

The Tree Drawing Test (TDT) also known as the "Baum Test" ('Baum' means tree in German) is a projective method developed by the German scientist Charles Koch in 1952. TDT is a noninvasive technique and can be presented to children/patients as a drawing game, consequently it is quite easy to administer. The drawn tree sketch is an indirect way of expressing oneself, thus subjects can non-verbally communicate their latent state of mind, with almost no opposition. Thus, the TDT is usually employed to evaluate aspects of personality, self-image, and emotional states [7] that might not be seized by the quiz tests. [6]

Various papers determine the patients' psychological features using written questionnaires, other studies implement projective techniques. An extensive investigation usually employs both because quiz tests and projective ones are complementary to each other. Each category can clarify aspects where the other cannot. Therefore, doctors merge both in order to obtain a deeper perception of the patients' illness.

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Even if the usefulness of projective methods is largely demonstrated especially with under aged children, there are some important weaknesses in employing these techniques. The most important disadvantage is the fact they are very staff & time consuming. On another hand the results' understanding is rather subjective and can be highly influenced by the clinician's expertise. These drawbacks practically make the employment of projective tests in screening large groups of individuals an economically fruitless approach. Nevertheless such "game like" investigations are the unique alternative for the early detection of psychotic under aged children. Consequently a method for the automatic pre-classification of potentially ill kids is a valuable benefit for doctors.

Essentially, the TDT technique is based on a set of measurements performed over a patient's free drawing of a tree. There are several ways to administer the Baum Test, but the typical procedure is to use for the tests samples white A4 sheets and a pencil. The subjects receive the following instruction: '***Draw a tree in any way do you like***'.

The main parts of the tree are the crown, the trunk and the root. There is a wide range of automated methods for the segmentation of an object from the background [10], but trees drawn for psychological tests do need specially adapted techniques.

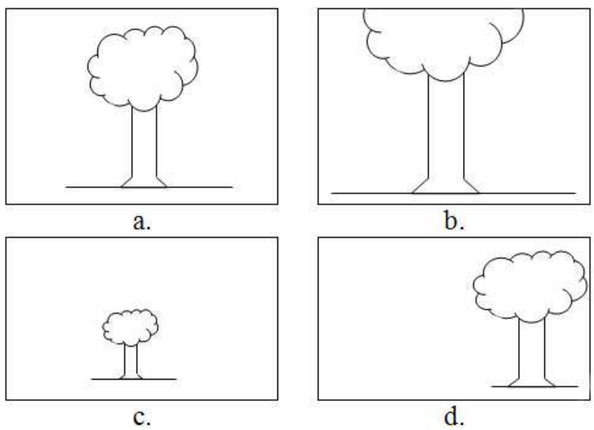

Fig. 1. The tree size and position relatively to the page

a. Normal drawing;
b. Oversized crown exceeding the page top;
c. Too small tree;
d. Geometrical center of the drawing is far from the page's center

A TDT image must be analyzed in terms of:

a. *Morphological analysis* – evaluation of the drawing's quality and details. For example it is important to notice if the ground and the roots are figured in the sketch or if the crown is designed as a simple circle or as a multitude of brunches with just a few leaves,

b. *Structural analysis* – ratios computed from direct measurements of size. The position and the main parts' size relatively to the page as shown in Figure 1.

The Structural analysis of a tree sketch is based on the evaluation of the following three quotients employed to quantify the test's results:

- Ratio of trunk to crown = trunk length/whole length of tree [mm or pixels];
- Ratio of left side to right side = left width of trunk/whole width of trunk [mm or pixels];
- Ratio of tree size to page space [whole length of tree*whole width of tree /paper area].

These three features mainly describe the entire structure of the drawing and need to be computed in order to quantify the spatial and location of the tree. They are the main criteria in the clinician's decision in the subject's classification as normal or affected of psychic problems. For example, in the case of Figure 1.c. where the area of the drawn tree is significantly smaller than those of the healthy subjects the patient is a potential schizophrenic.

Thus, the main features' measured for the structural analysis of a tree's sketch are:

- Shape of the trunk;
- Width of the trunk;
- Shape of the branches;
- End of the branches;
- Branch crossing;
- Root visibility;
- Top-end of the trunk;
- Base-end of the trunk. [4]

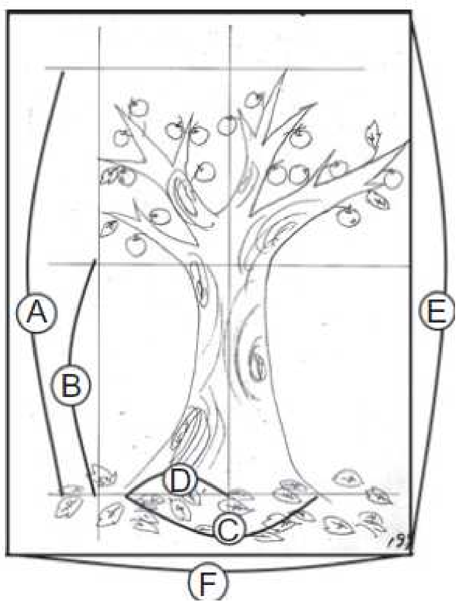

Fig. 2. TDT: Calculation of structural analyses [4]

In Figure 2 the tree is described using some basic measurements: A = total tree height, B = trunk height, C = root's width, D = left half of the root's with (the sketch is not always symmetrical), E and F = page height and width. These are the main features used by clinicians in order to analyze the drawings and decide over a diagnosis.

The psychologists consider that there are notable differences in the frequency of several features between the schizophrenic and healthy subjects. The trees drawn by the schizophrenic patients frequently have: a single line trunk, a narrow trunk width, a trunk with an open top, an unnatural expression of the base of the trunk, single line branches, or right angle between the branches and the trunk. [9]

Experienced clinicians also search for certain drawing details such as: the bi-dimensional display, , the strength of the sketch's lines, the slant of the trunk, the employment of the eraser, the repetitive drawing, the transparency of the some parts (e.g. a branch being seen through a fruit or horizon line being seen through the trunk), etc. [5]

The authors of this work advocate the use of the image processing methods in order to develop an automatic system capable to divide the Tree drawing tests' images in 'Normal' (N) and 'Potentially anomalous' (PA). The drawings from the second class are afterward sent to the psychologist, who lastly decides if the potential patient is really in need for special care or not.

Therefore the software environment able to execute the automatic selection must carry out three major tasks:

- Preprocess the TDT image to acquire best possible quality;
- Construct a description vector containing good evaluations of the three structural analysis's ratios and some of the morphological features of the drawing tree;
- Divide cases between N and PA classes.

II. TDT IMAGES' PREPROCESSING

Some of the scanned TDT images have to be pre-processed before entering the genuine evaluation phase. The necessary adjustments are performed in order to correct technical quality deficiencies like:

- Low contrast images,
- Tilt scanned images.

Low contrast is almost a regular correction and it is needed by the fact that many subjects do not push strong enough on the drawing pencil. This inadequate pressure on the writing instrument is a relevant proof of the subject's inhibition for the clinician, but still, for the computer science engineer, it is a problem to be corrected.

TDT images have imbalanced histograms, thus the straightforward automatic threshold [8] does not work properly. The authors have chosen among some alternative solutions:

- Histogram equalization,
- Automatic binarization,

- Logarithmic transform.

The low contrast images are detected because the black pixels percentage in the histogram is less than a pre-established threshold. Such images have to be enhanced. Figure 3 show a low contrast scanned image together with the above mentioned transforms' results. The tests performed over our set of TDT images demonstrate that the best solution is the Logarithmic transform because logarithm shape is best suited with this images' histograms.

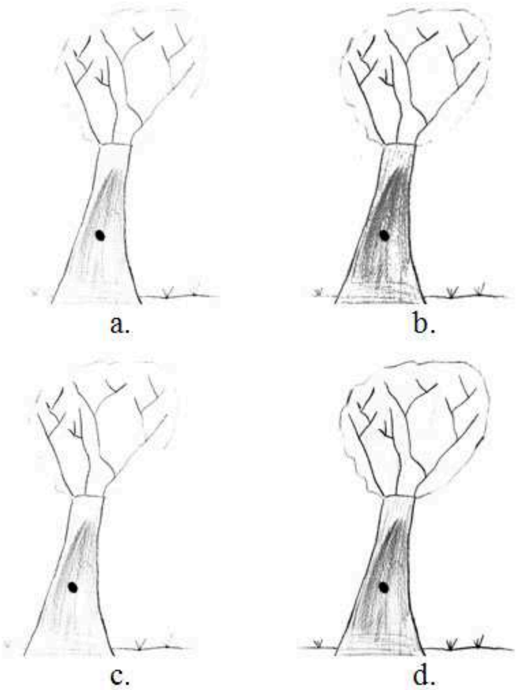

Fig.3. Low contrast TDT image correction
a. Initial low contrast image
b. Histogram equalization,
c. Automatic binarization,
d. Logarithmic transform

The Logarithmic transform [2] is a point to point pre-processing that map a source N×N image S =s(i,j), 0 ≤ ij ≤ N-1 to an outcome N×N image O =o(i,j), 0 ≤ ij ≤ N-1. The gray scale pixels of source images stay in (0, L_S-1) range and the ones in the resulted image are in (0, L_O-1). The performed transformation is described by equation (1).

$$o(i,j) = s(i,j) * c * \log(1 + |o(i,j)|) \tag{1}$$

Where constant c =(L_S-1)/log L_O.

A tilt scanned TDT images is easily detected because the page's edges are not horizontal and respectively vertical. In Baum Tests this is really important to correct while angle drawing is a significant factor for the clinician's decision over a subject.

The correction can be performed using the same page's edges, but authors preferred a simple solution: a warning message asking for rescanning is printed on the computer screen. Such mistakes could lead to lost corner details and finally to classification error.

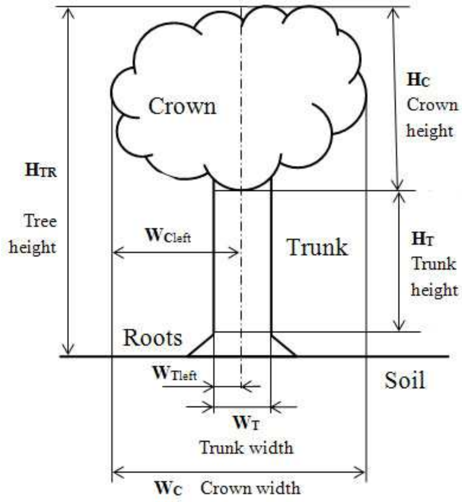

Fig.4. Measurements used by the proposed computer aided analysis

III. TDT IMAGES' STRUCTURAL ANALYSIS

After the pre-processing is over TDT images undergo the structural analysis stage. The important features are the ones shown in Figure 4.

The authors selected the Vertical & Horizontal profile histograms method (profilograms) in order to detect and measure the principal sizes of the tree. Figure 5 clearly show that size estimations can be done straightforward.

The tree and the crown height H_C and the total tree height H_{TR} can be easily determined using the horizontal profilogram on the inversed image. The trunk height H_T is heavier to measure and its correct evaluation is dependent on the good selection of a threshold over the local variations in the profilogram. Experiments on our set of TDT images proved that a 12% increase/decrease signify crown-trunk and respectively root-trunk border.

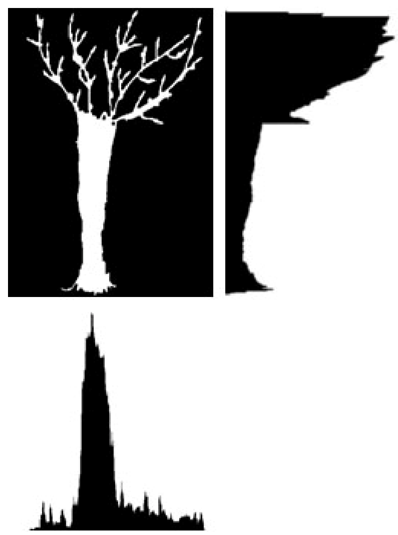

Fig.5. Detection of tree features using profilograms

Figure 5 shows a tree image pre-processed in order to reduce the noise together with its vertical and horizontal profilograms. The horizontal profile is computed using the distance between first and last tree pixel on each row, while the vertical one is the count of black pixels on each column.

The measurement of Crown width W_C and trunk width W_T can be done using the same procedure on the vertical profilogram of the image. All this measurements are then used to compute the three ratios and the results are compared to a table of standard values.

IV. Conclusion

The experiments were performed over a set of a hundred Baum Test images in order to develop an automatic system able to help clinicians quickly process large group TDT screening.

These processing techniques are still in testing phase and consequently adjustments will be probably done in the near future. The software must be developed in order to give more data about the tree sketches and the results must be trustworthy even in atypical cases.

The promising results obtained until now shows that this approach to automatic classification is feasible and the research could end with a useful and reliable tool for processing and pre-classification the TDT images.

Acknowledgment

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