Automatic Pre-Classification of Baum Test Images

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*Abstract:*This paper is focused on the use of image processing techniques and pattern recognition methods to pre-classify Baum test results and therefore to make large groups underage children psychological screening less time and staff consuming. The authors propose some practical solutions to preprocess images and then measure useful features for the analytic and morphological analysis of the drawings.

Key Words: Baum test, Image processing, Pattern recognition

1. Generalities

Many studies examine the psychological & psychopathological characteristics of patients using quiz tests; some others adopt projective methods (i.e. the Tree Drawing Test, Rorschach Test, House–Tree–Person, Kinetic Family Drawingsetc.). Nowadays advanced investigations try to employ both becausewritten questionnaires and projective tests are complementary to each other; the first ones can illuminate areas where the second cannot, and vice versa. Hence, many clinicians combine them to acquire a deeper understanding of the patients’ psychological problems [1].

Even if the scientific literature largely considers that the projective techniques are very useful especially with children and teenagers, there are some major drawbacks in using projective tests; they are time & staff consuming and the results’ interpretations are considered to be rather subjective. These weaknessesmake, for instance, the use of projective methods in testing large numbers of subjects an economically ineffective strategy. Still the need to employ such “game like” investigation as an early detection of psychotic underage children is obvious, thus a solution to automatically pre-sort potentially problem kids is a valuable asset both for clinicians and scientists.

The TreeDrawing Test is largely known as the Baum Test (‘baum’ meaning tree in German language), and it is aprojective method developed by the German psychologist Charles Koch in 1952. TDT is a noninvasive test and can be presented to children/patients as a drawing game, thus it is relatively easy to administer. The tree sketch is an indirect mean of expressing oneself, thus subjects can non-verbally communicate their latent state of mind, with almost no resistance. Consequently, this methodisemployed to evaluate aspects of personality,self-image, and emotional states that might not be seized by quiz tests alone.

Scientific literature shows that TDT is used in a variety of clinical settings, and its utility has been repeatedly demonstrated [2].

There are several ways to administer the Baum Test. The most frequent recommendation is to use for the tests samplesA4 sheets and 4B pencil. The subjects receive the following instruction: ‘Draw a tree which bears fruits in any way you like’. Each drawing must be analyzed in terms of:

a. **Structural analysis** – ratios computed from direct measurements of size,structure and position of the tree in page;

b. **Morphological analysis** – evaluation of the drawing’s quality and details.

The Structural analysis of a drawn tree is based on the following three fractions employed to quantify the test 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 proportions roughly represent the whole structure of the sketches and are recommended to be computed in order to understand the spatial and location character of the tree. They are the fundamental criteria in the clinician decision over the classification of the subject as normal or suspect of psychic problems. For

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example the areas of the trees drawn by the schizophrenic subjects were significantly smaller than those of the healthy subjects.

The morphological analysis of a drawn tree is performed based on the following evaluations [2]:

- Shape of the trunk (0 pts – the trunk is a double line, 1 pt – the trunk is a single line);
- Width of the trunk (0 pts – the trunk width ≥ two fingers, 1 pt – the trunk width ≤ one finger, 2 pts – the trunk is a single line);
- Top-end of the trunk (0 pts – the top of the trunk is closed, 1 pt – the top of the trunk is open, 2 pts – if the trunk is a single line);
- Base-end of the trunk (0 pts – the base of the trunk is natural, 1 pt – the base of the trunk is open or closed, 2 pts – if the trunk is a single line);

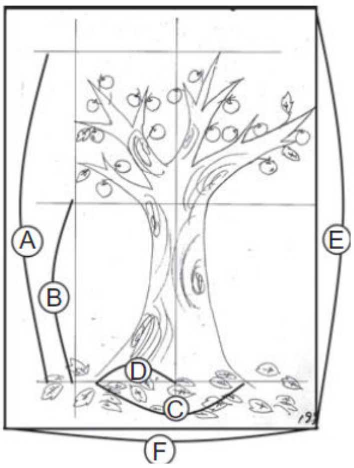

Figure 1.1TDT: Calculation of structural analyses [2]

- Shape of the branches (0 pts – thebranches are double lines, 1 pt – the branchesare single lines);
- End of the branches (0 pts – the branch ends are closed or hidden in thecrown, 1 pt – the branch ends are open, 2 pts – if the branches are a single line);
- Branch crossing(0 pts – the branches are diagonally, 1 pt – the branches are at a right angle);
- Root visibility (0 pts – the underground roots aren't visible, 1 pt – the underground roots are visible).

Literature shows that there aresubstantial differences in the frequency of several morphological features between the schizophrenic and healthy groups. The trees drawn by the schizophrenic subjects usually 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 [3].

Experienced clinicians also look for some drawing details such as the use of an eraser, thestrength of the lines, repeated drawing, the twodimensionaldisplay, transparency of the parts (e.g. a branchbeing seen through a fruit; horizon being seen through the trunk), slanting of the trunk etc. [4]

The authors of this paper tried to use the image processing and pattern recognition methods in order to develop a program able to classify the Tree drawing tests' images in 'Normal' (N) and 'Potentially anomalous' (PA). Second category is subsequently sent to the psychologist, who finally decides if the suspect subject is really in need for special care or not.

Therefore the software environment needed for the automatic selection must perform three major tasks:

a. Preprocess the image to acquire best quality;
b. Construct a description vector for the drawing tree containing it's structure, size, form and location in page and morphological features;
c. Discriminate cases between N or PA class.

2. DTD tests' images preprocessing

Some of the scanned images of the drawn trees' must undergo a set of preprocessing phase before entering the genuine evaluation stage. These adjustments need to be done in order to correct problems like:

- Low contrast images,
- Tilt scanned images.

Low contrast images are the most frequent problem encountered and it is mainly due to the fact that some subjects do not push enough on the pencil. This insufficient pressure on the writing instrument is a significant evidence of the subject's inhibition for the psychologist, but still, for the engineers, it is a problem to be corrected.

Figure 2.1 Typical histogram for tree drawings scanned images

Tree sketches' images have imbalanced histogramsas shown Figure 2.1, thus the straightforward automatic threshold does not work. The authors have chosen among some alternative solutions: Histogram equalization, Automatic binarization, Contrast/brightest balance, Logarithmic transform

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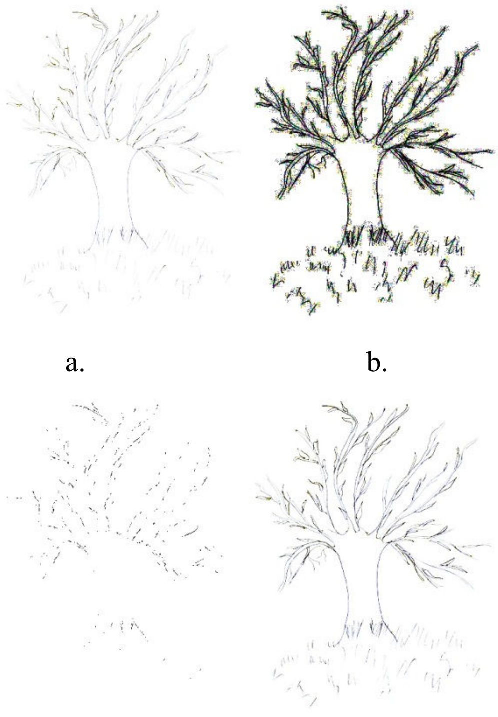
The low contrast images are detected because the percentage of black pixels is lower that a pre-established value. If this is the case image have to be enhanced.In Figure 2.2 is shown a low contrast image and the results of the above transforms. Tests proved that the best solution is the logarithmic transform because logarithm shape is best suited for the TDT images histograms.



a. b.

c. d.

Figure 2.2 Low contrast images enhancement

a) Original image
b) Histogram equalization;
c) Automatic binarization;
d) Logarithmic transform

The logarithmic transform is a point processing mapping source N×N image S ={s(i,j), $0 \leq ij \leq N-1$} to a result N×N image R ={r(i,j), $0 \leq ij \leq N-1$}. The gray scale pixels of source images stay in (0, S-1) range and the ones in the resulted image are in (0, R-1). The performed transformation is described by eq. (2.1).

$$r(i,j) = s(i,j) \times c \times \log(1+|r(i,j)|) \quad (2.1)$$

where constant c =(S-1)/logR.

Tilt scanned images are easily detected because A4 page edges are not horizontal and respectively vertical. This is important in TDT because angle drawing is a significant factor for the clinician's decision. The correction can be performed using the same page edges, but authors chose that the processing program give a warning and ask for rescanning. Any dropping of corner details could lead to final classification error, thus such a situation have to be avoided.

3. Structural analysis

After the logarithmic correction is performed for the low contrast images and the tilt scanned images are removed the TDT images enter the structural analysis stage. The measurements are performed using the structure shown in Figure 3.1.

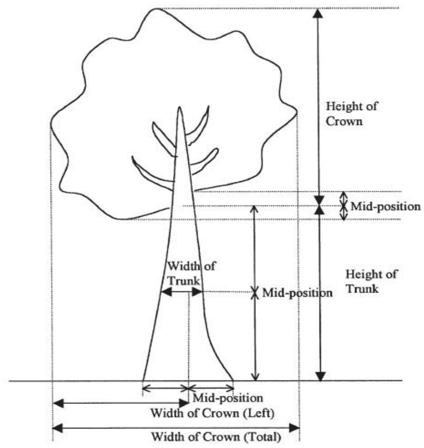


Figure 3.1 Measurements in TDT analytical analysis [1]

The tree and the crown height can be determined using horizontal profile histograms on the inversed image. The resulted graph is the number of non-zero pixels on each line diagram as shown in Figure 3.2.

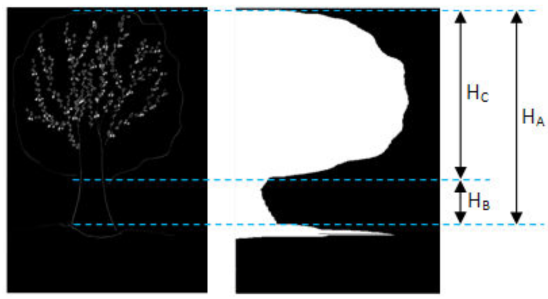


Figure 3.2 Detection of Crown height $H_C$and total tree height H_A

Hence the measurement of Crown height H_C and total tree height H_A is straightforward and a simple subtraction gives the Trunk height H_B.

The tree and crown width could be also determined using vertical profile histograms on the inversed image's

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segments (i.e. the trunk segment and the crown segment).

4. Concluding remarks

The above experiments were performed in order to develop a tool able to help clinicians in the process of large group screening. This processing methods and programs are now in testing stage and consequently some adjustments are still to be done. The structural analysis must be developed in order to give reliable results even in atypical cases. Also a morphological analysis must be built and added to the software environment as a final and more refined tool for the detection of PA subjects.

The promising results the authors obtained over the 152process samples of Baum test 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 Baum tests.

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