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Automatic Evaluation of Scanned Multiple Choice Tests

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Abstract

Although on-line or off-line multiple choice test are used, in many cases, traditional on paper tests are still in use. If we deal with large amount of tests, their evaluation becomes a problem. The paper presents a technique of digitization of scanned multiple choice tests, including their evaluation. A three steps approach is considered: first, the scanned image is preprocessed in order to improve its quality, then character recognition phase assures the acquisition of the data that identifies the applicant and reads, and the final phase scores the test. A test by test processing or a batch procedure is possible. The method produces accurate results and has many applications in day by day activities.

Keywords: *scanned tests, evaluation*

The context

Evaluation of the paper based multiple choice tests could be quite a cumbersome task if one speaks about large number of tests. The paper proposes an application that processes scanned multiple choice tests, in the sense that in reads the data pertaining to the person that filled in the test and calculates the score. The application can process individual scanned multiple choice tests, but also can process series of multiple choice scanned tests. The first stage of the application is to process the scanned images (tests) in order to improve their quality though assuring better results for the evaluation process [1].

Related work

Generally the attention has been focused on on-line multiple choice test, where the evaluation is a simple matter. On-line tests are a very good option, but quite often it is not possible to provide access to a PC for every student. In situations like this, the classical solution is the paper tests.

Eftimie, Iordache and Rughiniş for example developed an application that not only automatically evaluates the paper based multiple choice tests, but also provide an environment for test generation, questions management, storage and other features.

The technology used for the paper based tests is different from the one we propose here, in terms of how the regions of interests are detected [2][3].

The application

The application is structured in three levels:

- Image acquisition and processing
- Character recognition (to extract the information pertaining to the person that filled in the test)
- Test evaluation.

The whole process is described in Figure 1.

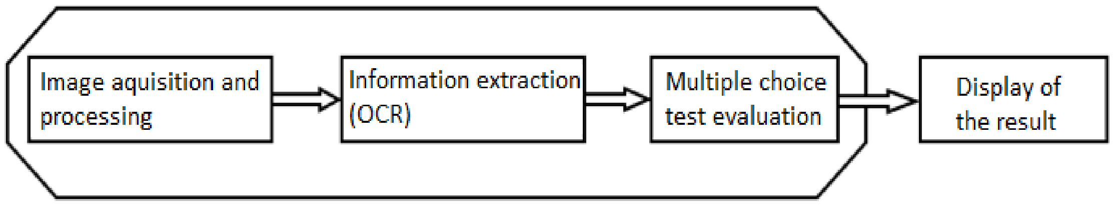
Image aquisition and processing
Information extraction (OCR)
Multiple choice test evaluation
Display of the result

Figure 1: The application structure

Image acquisition and processing

Reading the test

The first step is the scanning of the test. This has to be done at the resolution of 200 dpi. This resolution has been chosen after a number of tests with different resolutions. It is a com promise between the quality of the acquired image and the dimension of the resulting file. It is not relevant if the image is colored or not, because the original image will be transformed so as it will end as a binary one.

Enhancing the image quality

Basically the image enhancement can be done either through adjusting the intensity of the pixels, or the histogram equalization. The two operations have been implemented in the GUI of the application, as can be seen in Figure 2.

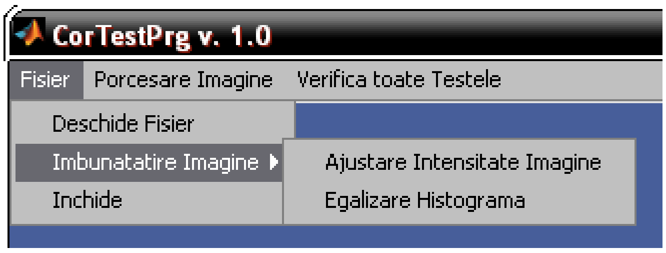

Figure 2: Enhancing the image

Clipping the regions of interest

The clipping produces two separate images. The first one is the upper left corner that contains the information about the person that filled in the test, while the second one contains the area with the choice rectangles .

The 200 dpi resolution is compulsory and if not respected can produce results like the ones depicted in Figure 3.

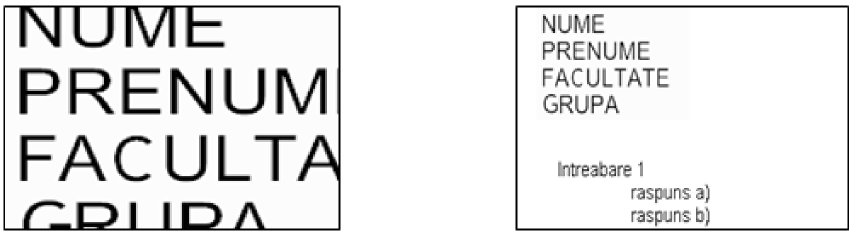

Figure 3: The influence of the resolution on the result of the scanning process

Character recognition

The character recognition itself is preceded by a noise filtering. After the noise filtering the image is binarized.

Since the main purpose of our application is not the OCR process itself, a number of limitations have been accepted:

- Only one word per text line is accepted
- The identification elements are positioned in the upper left corner of the sheet of paper, in a precisely defined area
- The text in this are is a special one: Font_OCR.ttf, derived from the common Arial typeface, and has the dimension of 14 points
- Only capital letters are accepted

With these limitations accepted, the success rate in the OCR process is at least 95%.

The idea behind the character recognition is that a template with characters 0-9 and A-Z has been created. The template is a matrix of [sub]matrices. Each [sub]matrix is a bitmap of one character. The total number of [sub]matrices is 36 (the 10 figures and the 26 capital letters).

The next step is to detect and isolate the text lines. This is done by “reading” each line of the region of interest of the binarized image. When a line with only zeros is encountered, all the lines read up to that moment are saved in a matrix, while all the other ones in another matrix. This process is illustrated in Figure 4.

The following step is the segmentation of each line of text. The result of the segmentation is to obtain the individual characters.

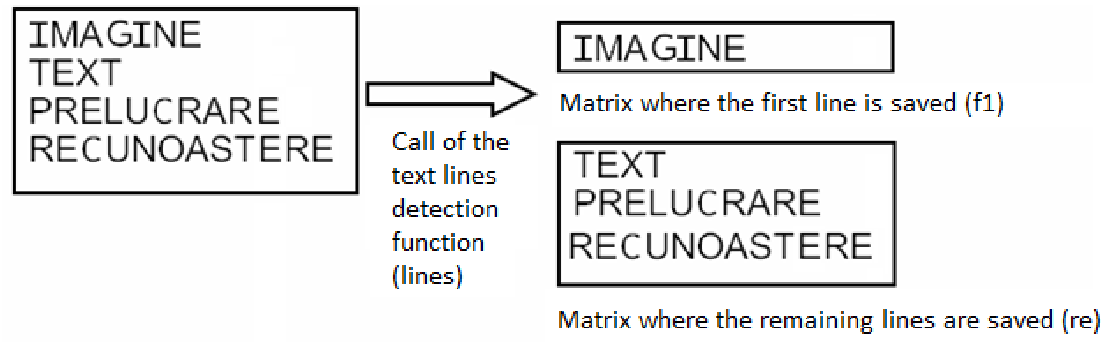
IMAGINE
TEXT
PRELUCRARE
RECUNOASTERE
Call of the text lines detection function (lines)
IMAGINE
Matrix where the first line is saved (f1)
TEXT
PRELUCRARE
RECUNOASTERE
Matrix where the remaining lines are saved (re)

Figure 4: The text lines detection

Each object obtained after the segmentation process is labeled. All the lines and columns around each labeled object are eliminated, thus obtaining a matrix than comprises only the character, as can be seen in Figure 5.

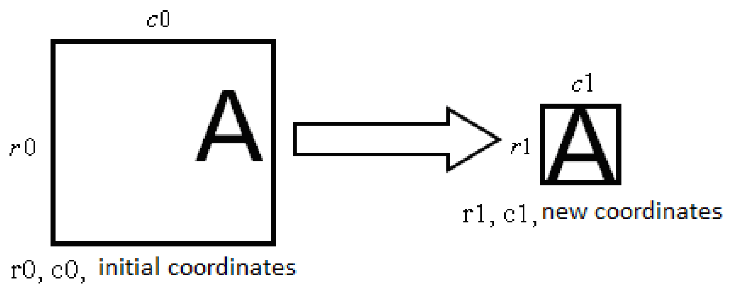

Figure 5: Character detection

The detected characters are scaled at the 30 by 40 pixels dimension in order to be compared with the templates. The recognition itself is done by calculating the correlation coefficient between the template matrix and the isolated character matrix.

The test automatic evaluation

This stage implies the steps presented in Figure 6.

In the event of multiple tests, the application has a module that works with all the test located in certain folder, and calculates the scores for all of them.

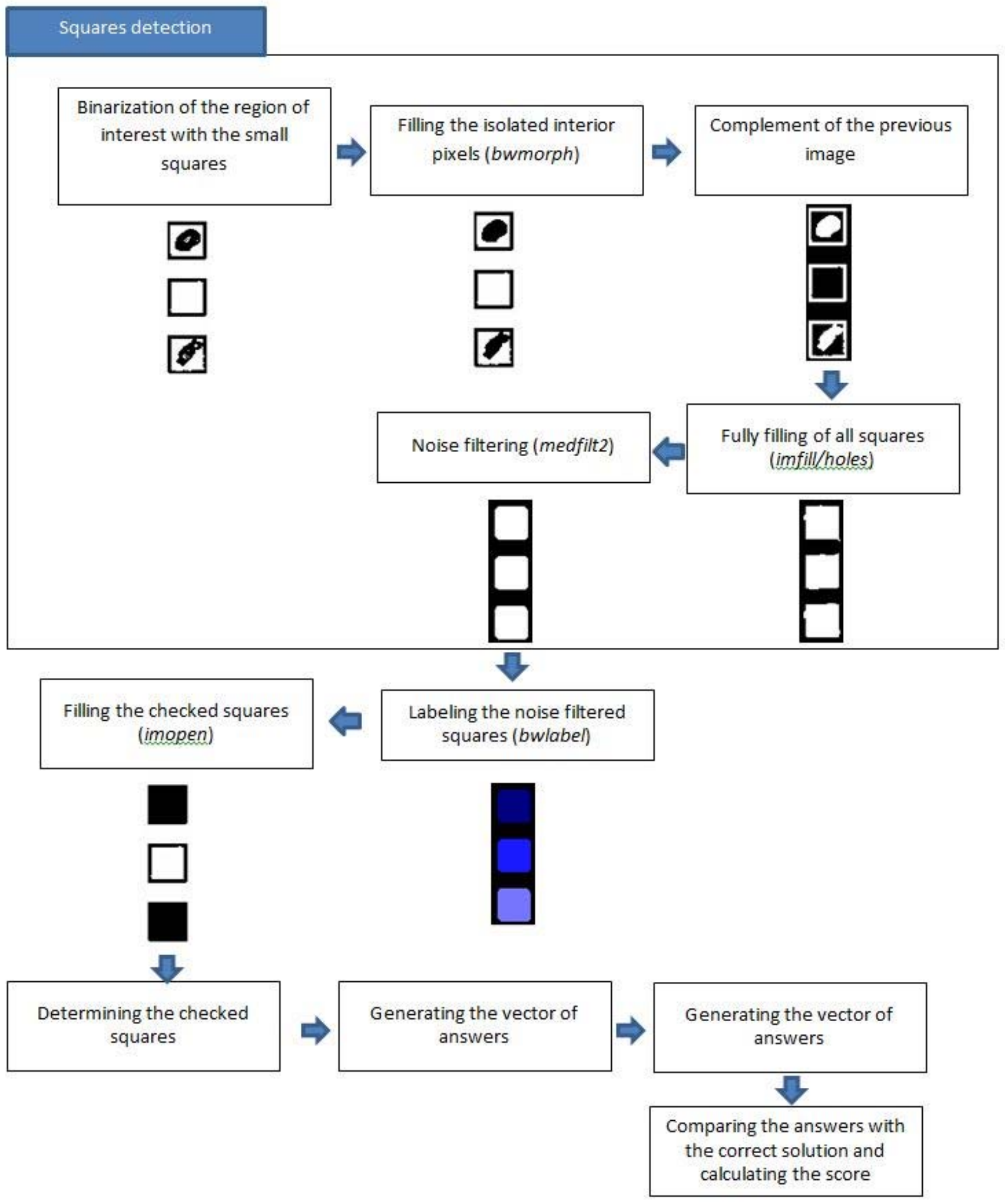
Squares detection
Binarization of the region of interest with the small squares
Filling the isolated interior pixels (bwmorph)
Complement of the previous image
Fully filling of all squares (imfill/holes)
Noise filtering (medfilt2)
Labeling the noise filtered squares (bwlabel)
Filling the checked squares (imopen)
Determining the checked squares
Generating the vector of answers
Generating the vector of answers
Comparing the answers with the correct solution and calculating the score

Figure 6: The automatic evaluation

Conclusions

The application is very straightforward to use, the human operator interaction with the application being quite small. The menus are clear and do not produce confusion regarding the steps to be followed.

The main steps are the following:

- Loading the test
- Enhancing the scanned image (optional)
- Clipping the regions of interest

- Extraction of the information about the person submitting the test
- Automatic evaluation of the test.

The answering time is dependent of the power of the machine the application in run on.

Further development could be the possibility to process in parallel many tests, thus enhancing the efficiency of the application.

References

[1] Gonzales, R. C., Woods, R . E . – *Digital image processing, second edition*, Prentice Hall, Upper Saddle River, New Jersey 07458, 2002
[2] Eftimie A., Iordache S., Rughiniş R., Korect : *A system for automatic test paper generation and evaluation*, Systems.cs.pub.ro, 2010
[3] Vertan, C., – *Prelucrarea şi analiza imaginilor,* Printech, 1999
[4] * * *, *Matlab documentation*

Evaluarea automată a testelor grilă scanate

Rezumat

Deşi testele grilă on-line sau off-line sunt utilizate, în multe cazuri, testele tradiţionale pe suport de hârtie sunt încă în uz. Dacă avem de a face cu o cantitate mare de teste, evaluarea lor devine o problemă. Lucrarea prezintă o tehnică de digitalizare a testelor cu variante multiple de răspuns, scanate, inclusiv de evaluare a acestora. S-a folosit o abordare în trei pași: în primul se face o preprocesare a imaginii cu scopul ameliorării calității acesteia, apoi, în pasul al doilea se identifică aplicantul (cel care completează testul), pentru ca în final să se facă afectiv corectarea automată a testului. O abordare test cu test este posibilă, dar şi una care prelucrează mai multe teste în serie. Metoda produce rezultate precise şi are multe aplicaţii în activităţile de zi cu zi.