The Proposed Solution to Some Issues of Optical Mark Reader

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Abstract – **The aim of this work is to develop optical mark recognition technology to overcome common students' mistakes during filling answers sheets that caused students to fail their exams. OMR cannot process some common the different issues. Such as if the bubble is not dark enough pencil, marks touch adjacent bubble, incomplete mark covering and if any scribbling is found, that answer sheet will be strictly rejected. They may not be read correctly. All these above issues that matter of the students to avoided by a new technique that overcomes the limitation of OMR process. The method is based on drawing grid the regions of interest, key points detection algorithm and bubbles detection algorithm. In the bubbles detection algorithm based on three factors (bubble size, threshold value, percentage of filling the bubble). The implementation helps us to identify errors and how to solve them. The proposed system consists of an ordinary printer, scanner and a computer.**

Keywords – **Image Processing, Bubble Detection, Optical Mark Reader.**

I. INTRODUCTION

The Optical Marking Recognition (OMR), or optical mark reading, is an automated data input process of capturing presence or absence of marked data (crosses, ticks and filled regions) on printed papers such as multiple choice examinations (MCQs) and surveys [1].

The students marked the answers on the bubble sheet by filling the corresponding area of the paper and the marked paper is put through a scanner (optical mark reader) to read the data from the marked space. The OMR can judge the existence of written marks by recognizing their depth (darkness) on the sheet [2].

But it is a cons of OMR software If the marks do not fill the space completely, or are not in a dark enough pencil, they may not be read correctly [3]. This paper presented a new method of mark detection for software-based optical mark recognition. This method able to solution the issues of OMR process. Firstly, saving the straighten template image using any ordinary scanner, the next step is to select region with all correct answers on the printed paper separated manually and will be used as a template image in the matching process to extract the answered region of the student answer script, then the answers will find by factors (bubble size, threshold value, number of black pixels for each answer). By using the factors we found that we can automatic change value of the threshold and limit for number of black pixels for each answer. Finally, we consider the different cases as shown in section the experimental results. The literature review and the proposed system are presented in this paper.

II. RELATED WORKS

Many methods have been implemented based on different technologies have been proposed in literatures. In this paper is discussed some of these works similar for our study.

Nirali et al [3]. Proposed a paper on various Techniques for Assessment of OMR Sheets through Ordinary 2D Scanner. This paper discussed two recognition modes-Alternative Mode and Bit Mode. Alternative mode is used

when only answer is expected for a question. The OMR accepts the only one entered mark in the block of mark positions on the sheet then changes over the mark to a code and produces it. Just in case, two marks are found in one block, depth comparison among the marks is carried on and the deepest mark is selected. If no dissimilarity in depth is found among the marks, a read-error is to be generated and accounted. Bit mode is used when there are plural answers for one question. All the information in the block of mark positions on the sheet are recorded and coded as a series of bits.

Divya et al [4] proposed a paper on efficient system for evaluation Of OMR Sheet. This paper aims to develop Image processing based Optical Mark Recognition sheet scanning system. The proposed system consists four phases. Image Pre- processing, feature detection , feature recognition and comparison with Answer Key in this phase we will compare the detected answers with already stored template or answer key and retrieve the output in an Excel file. In experimental results have applied on the different cases such as if multiple answer marked, if answer is not given, if answer is not given & multiple answers marked and if OMR sheet is tilted.

Hamad et al [5]. Proposed a paper on evaluation of OMR (with simple scanner). In this paper have used Open CV libraries and webcam. By using Open CV libraries and webcam they can discover all the answers and solve the OMR Sheet calculate area of the mark and have confidence level of point nine which will cater accurate judgments. If they come to the opposite side, a value that is less than that of the estimated, the mark will be conceived to be partially filled and this will be conceived as a wrong answer.

Akhilesh Patil *et al.* [6]. Proposed a paper on Reconfigurable Technology FPGA for computational purpose in evaluating the answers of OMR sheet. The array of IR sensor is used to scan the answers which is in the form of black bubble. The drawback in technology is that it needs a lot of time for scanning and subsequently checking through desktop application via image processing. The results of paper based on speed and minimum detectable diameter of answer bubble. In minimum detectable diameter of answer bubble, it is found that minimum black bubble diameter that can be detected by this system is 1 cm.

Nikita Kakade and R.C. Jaiswal [7]. Proposed a paper on OMR Sheet evaluation using image processing. The proposed work consists three phases creation of database, processes performed on an input image and block diagram of the system. This system has an accuracy of 88% and can successfully detect the marked circles or bubbles in the OMR (Optical Mark Recognition). The threshold of 150 the bubble will be treated as a marked answer, if not it will be treated as zero or unmarked. The time taken by the proposed system is approximately 60 seconds max. The drawback of the system could be the tilt in the sheet while placing on the conveyor belt which can later be corrected.

Finally, Rahul Patel *et al.* [8]. Proposed a paper on technology a mobile phone based optical mark recognition (OMR) system .The proposed system is based on a client-server architecture. A mobile phone is used to capture an image which in turn is uploaded on the server. The algorithm proposed by this system achieves high accuracy along with the speed. The algorithm was tested on 310 images with the average processing time of 3 sec per image. In future, they look forward to counter the challenge of correctly evaluating the partially filled bubbles and making the system more student centric.

III. PROPOSED METHODOLOGY

In proposed system we are building a system which processes detection of marks it to get a perfect result. Fig.

1 shows the methodology of system.

The algorithmic steps of OMR recognition are as follows:

Step 1: Input scanned images of OMR.

Images of OMR are transferred from scanner to computer and stored in memory of the computer with JPG image format.

Step 2: Creation of OMR answer sheet.

The location of the regions on the template is very important for the success of the methodology, selecting the coordinates are done by click mouse to drag a box around an OMR region.

Step 3: Key points detection.

After creating the template and storing the coordinates of the template in the file, the algorithm will detect the main points of the answer key. These points are divided into two parts. The first part is to apply the detection algorithm to the starting point. The second part is to apply the detection algorithm to the end point.
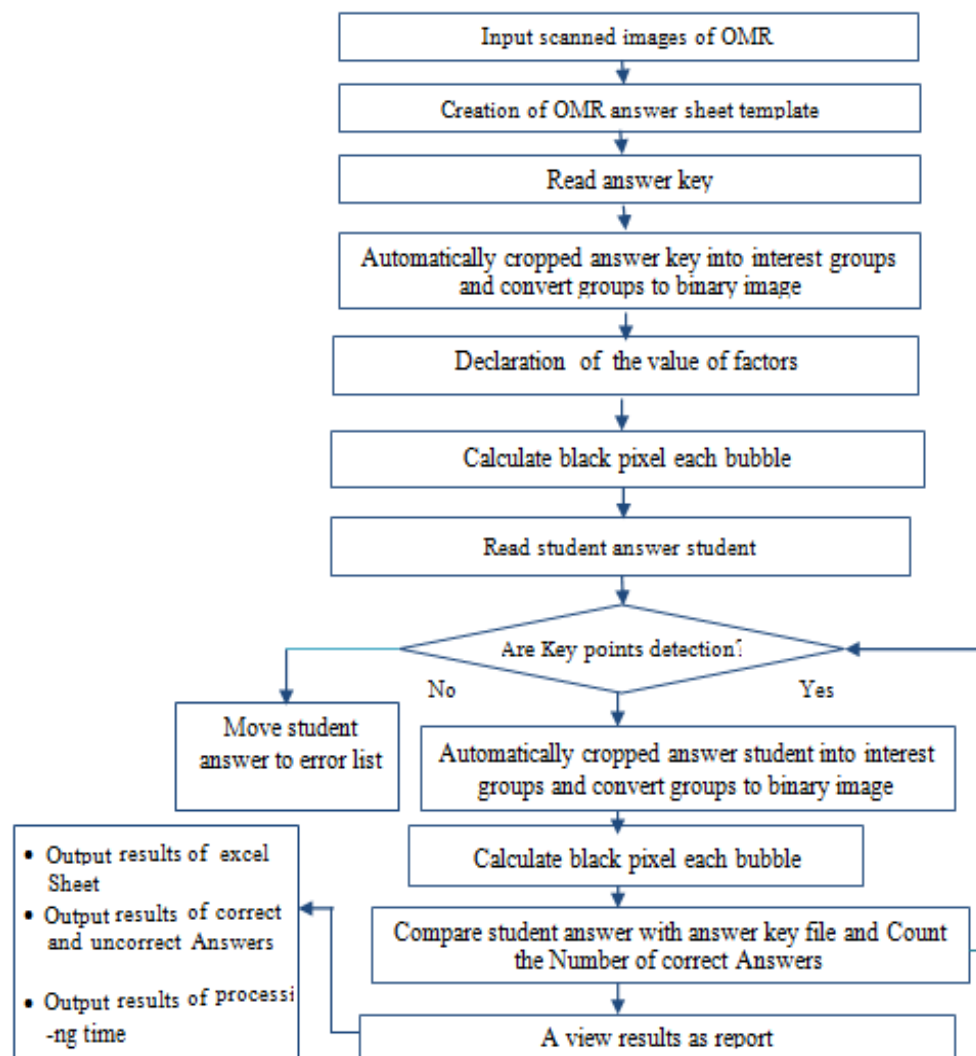
Step 4: Cropping OMR sheets into interest groups.

Fig. 1. Shows the methodology of system.

Step 5: Apply an Image Processing Method to Convert RGB Image into Binary.

To convert the image from RGB to Gray scale image, we need to design algorithm for conversion color pixels to gray pixels using correcting for the human eye sometimes called luminance method [9] as in equation 1.

$$Color = (\text{Re} d * 0.3 + Green * 0.59 + Blue * 0.11) \tag{1}$$

Algorithm for Conversion Color Pixel to Gray Pixel

C ← Get Pixel(x, y): read value of pixel

C ← C.R * 0.2989 + C.G * 0.587 + C.B * 0.114 // Applying luminance method convert to gray pixel.

In the next step, Applying threshold value to convert gray pixels to black pixels.

Threshold technique is one of the important techniques in image segmentation [10]. The threshold value depended on factor, the pixel less than the threshold are turned to white and the remainder to black pixel.

Algorithm for Conversion Gray Pixel into Black and White Pixel

T ← Set value of factor // Declare value of threshold.

If C < T then

C ←0   //Set Pixel Classified as black.

Else C ←255   // Set Pixel Classified as white.

Step 6: Find the location of the center of bubble.

In this step will find the location of the center of bubble as shown in fig. 2.

Algorithm:

Cell w per ← factor size of bubble

Cellw←gridgw * cellwper // 2: Calculate the radius of bubble

For lbw←-cell w to + cell w : loop width of bubble

for lbh ← - cell h to + cell h : loop height of bubble.

New col ← pic.GetPixel (t.stpointcx + lbw + .gridx1 + v4 * .gridgw), (t.stpointcy + lbh + .gridy1 + v3 * .gridgh).

gry = gray (new col)

end for loop.

end for loop.

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Function gray (By Val c As Color) As Byte

If c.R * 0.2989 + c.G * 0.587 + c.B * 0.114 < T.sholds

Then Return 0 Else Return 255
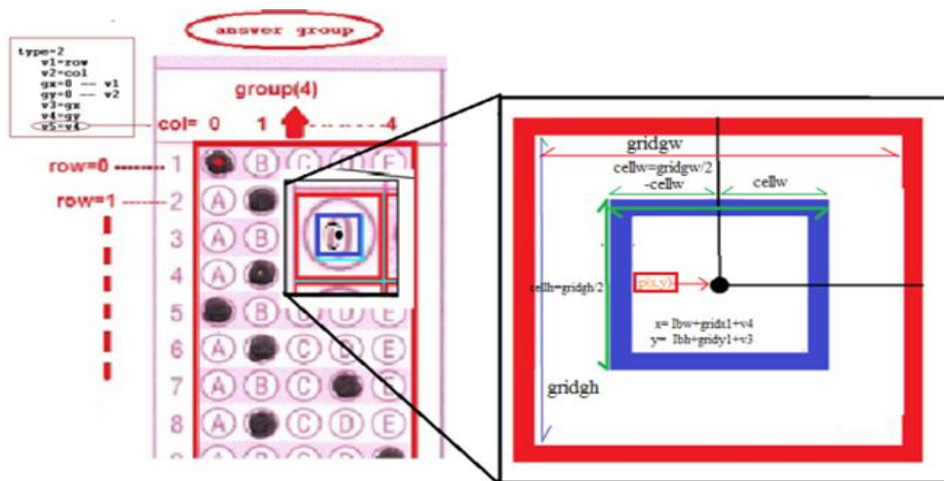
End Function.

Fig. 2. Shows the location of the center of bubble.

Step 7: Declaration of the value of factors.

The declaration of the value of the factors is made by the user as shown in the experiments.

Step 8: Calculate a black of pixel in each the center of bubble.

To calculate a black of pixel in each answer we need to limit for number of black pixels (dark-count factor). If number of black pixels each bubble Above dark-count the bubble will be treated as a marked answer, if not it will be treated as zero or unmarked.

Step 9: Compare answer with answer key and Count the number of correct answers.

In this step the algorithm automatically read each exam paper and compare the detected answers of exam paper with already stored file answer key.

Step 10: Repeat the steps 3 -9 until read all exams papers.

Step 11: Output results of excel Sheet File.

After processors all exams papers will be output within the excel sheet. These results contain all information for each student such as student number, student name and scores.

IV. EXPERIMENTAL RESULTS

By using the proposed software above we tested consider the different possible cases of answering the answer item and the various cases are successfully conducted. Correct answers are marked in green, while wrong answers are marked in red as shown below:

Testing with Case 1:

If the bubble is not completely filled. The proposed system has been tested different answers contains tick mark and half-filled answers as illustrated in Fig. 3.
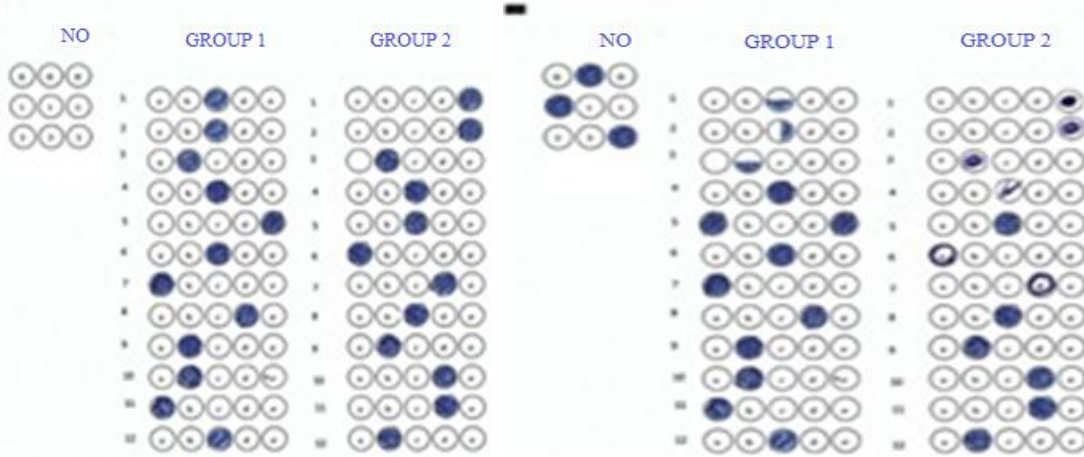
Fig. 3. (a) Shown sample of the answer key.   Fig. 3. (b) An example of mark recognition cases.

The application of the system comprises main steps:

A. *Check the Answer Sheet Scanner*

After entering scanned images for OMR and creating answer sheet. The application will find out the answer to each question using the factors (threshold pixel value 128, bubble size 50 pixels and black pixel count 40 pixels) as shown in Fig. 4.

Fig. 4. Detection bubbles by factors.

B. *Processor (Compare with Answer Key and a View Results)*

In this step the system automatically read each exam paper and compare with answer key as shown in Fig. 5.
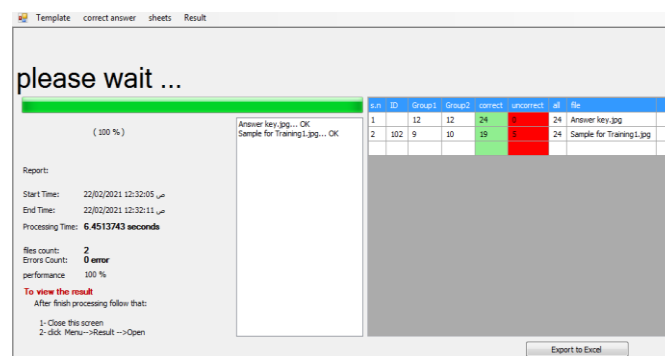
Fig. 5. Shows the results (Four marks are not detection).

We will get the following results. When change value of the factors (the threshold of pixel value is 128, size of bubble is 60 pixel and the count of black pixel is 30) as shown in Fig. 6 and Fig. 7.

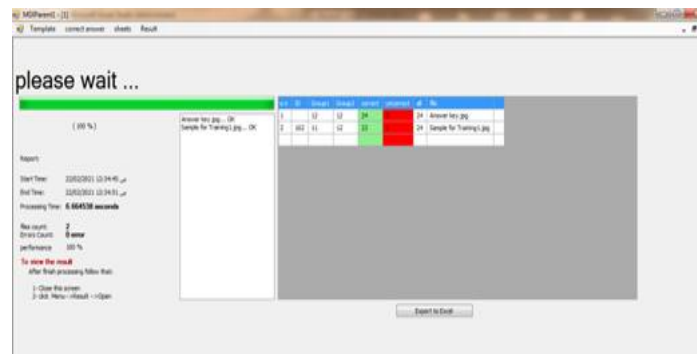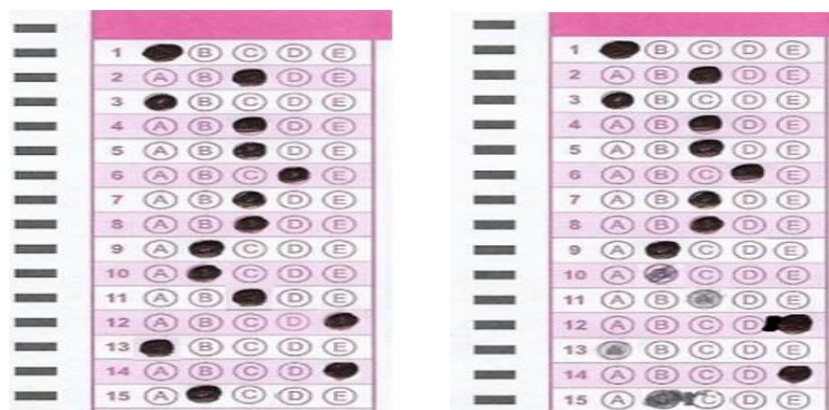Fig. 6. Detection of each bubble by factors.

Fig. 7. Shows the results after change factors.

Testing with Case 2:

If the bubble is not dark enough. In this case we will tested with different filling out answers or the bubble is not dark enough as shown at questions 10, 11, 13 and 15 in figure 8.

Fig. 8. (a) Shown sample of the answer key.   Fig. 8. (b) An example of mark recognition cases.

The application of the system comprises main steps:

A. *Check the Answer Sheet Scanner*

After entering scanned images for OMR and creating answer sheet. The program will find out the answer to each question using the factors (threshold pixel value 128, bubble size 50 pixels and black pixel count 30 pixels) as shown in Fig. 9.
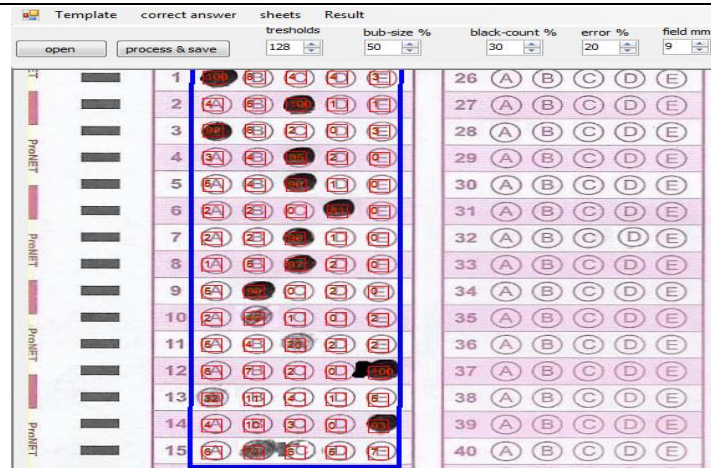
Fig. 9. Detection of each bubble by factors.

B. *Processor (Compare with Answer Key and a View Results)*

The system automatically compare exam paper with answer key as shown in Fig. 10.
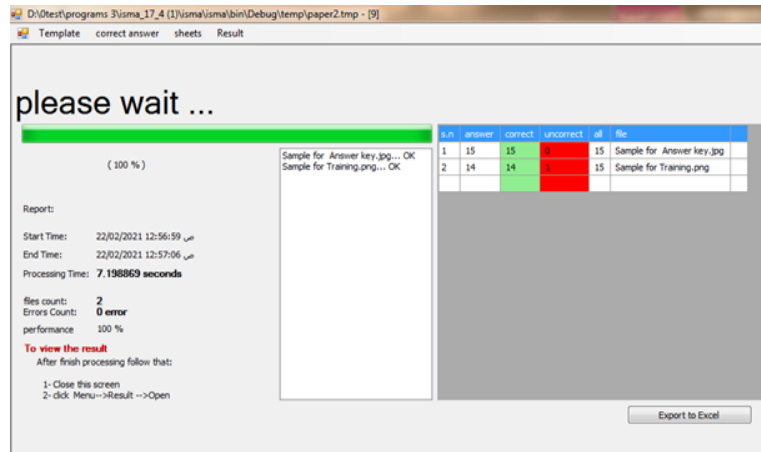

Fig. 10. Shows the results.

When we change the value of the factors (The threshold of pixel value is 150 , size of bubble is 50 pixel and the count of black pixel is 30 pixel), you will get the following results as shown in Fig. 11 and Fig. 12.

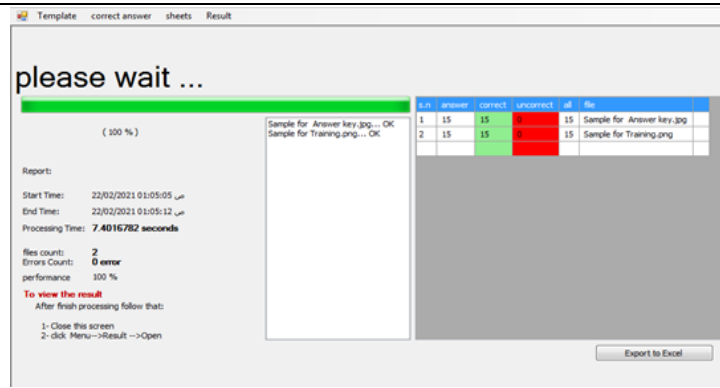

Fig. 11. Detection of each marks after change factors.

Fig. 12. Shows the results after change factors.

Testing with Case 3:

Checking the partially filled of bubbles or filled on border of the bubbles. In this case we will tested with different cases as shown Fig. 13. (b). In group1 at questions 2, 3, 5 the bubbles were partially filled. In group 2 at questions 8, 9, 10 filling out on border of the bubbles. In group 3 at questions 1, 2, 3 the answers were incorrect.
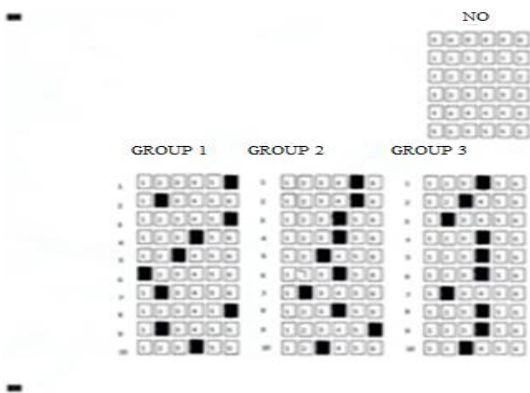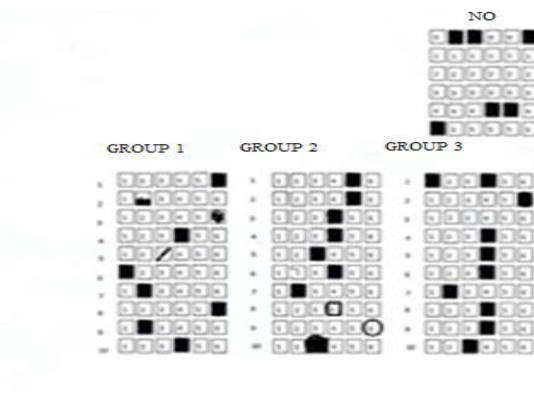

Fig. 13. (a) Sample of the answer key.   Fig. 13. (b) An example of mark recognition cases.

The application of the system comprises main steps:

A. *Check the Answer Sheet Scanner*

After entering scanned images for OMR and creating answer sheet. The program will find out the answer to each question using the factors (threshold pixel value 128, bubble size 60 pixels and black pixel count 25 pixels) as shown in Fig. 14.
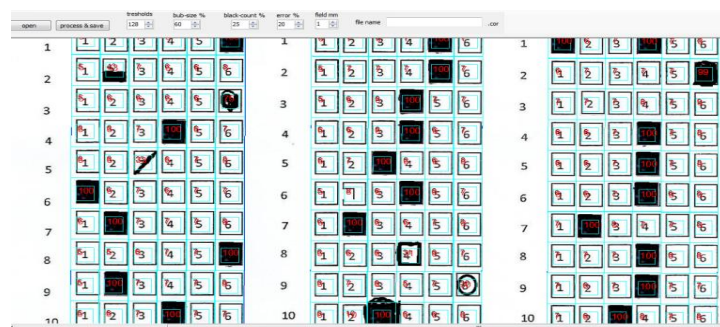

Fig 14. Detection of each bubble by factors.

B. *Processor (Compare with Answer Key and a View Results)*

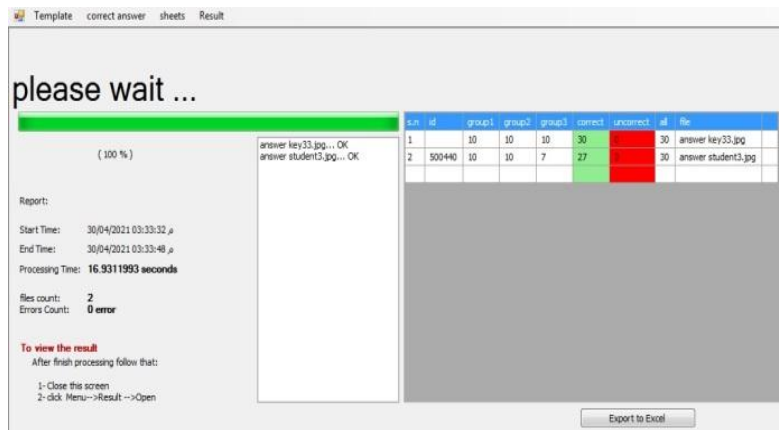In this step the system automatically read each exam paper and compare with answer key as shown in Fig. 15.

Fig. 15. Shows the results.

V. COMPARISON WITH OTHER WORKS

This comparison has been conducted by evaluating a paper work with other studies. Table 1 shows some papers that compare them.

Table 1. Comparison evaluating of test cases.

Author (s)	The Proposed System	The Evaluating of Test Cases Detection
J. Muangprathub et al (2018)	Automatic grading of scanned multiple choice answer sheets	Answer mark in more one question, the marked cross-line pattern for two answers in one question, the marked cross did not fill the box by accuracy was 62.42% and the marked cross overflow out of the bubble.
N. Sattayakawee (2013)	Proposes an algorithm for test scoring using non-optical traditional grid answer sheets	Answer mark, two select choices and no selected choices.
M. Alomran and D. hai (2018)	The proposed for automatic scoring systems for multiple choice questions.	Four possible cases for each answer item, no entry, single entry, multiple entries, and single entry with changing answer attempt.
Our work	The proposed solution to some issues of optical mark reader.	Selected more than one choice or no selected choice, partially filled of bubbles, checking filled on border of the bubbles and checking the bubble is not dark enough.

VI. CONCLUSION

The goal of the system is to solve Common Mistakes while filling OMR sheet that will cause the error of OMR recognition. The proposed system is tested with different cases as illustrated in the results. This system developed by Visual Basic 2015 with easy user interface. The system can also be applied in other different types of answer sheets. This system is easy to use with just a few clicks of the mouse can teachers correct their tests and allow to design OMR forms by themselves without the need for special pre-printed forms.

REFERENCES

[1] N. Karunanayake, "OMR sheet evaluation by web camera using template matching approach", International Journal for Research in Emerging Science and Technology, 2(8), Aug., 2015.

[2] Krishna G., Rana H.R., Madan I., Sahu R., " Implementation of OMR technology with the help of ordinary scanner", International Journal of Advanced Research in Computer Science and Software Engineering, vol. - 3, Issue- 4, April 2013.

[3] Nirali V. Patel P.G. and Ghanshyam I. Prajapati, "Various techniques for assessment of OMR sheets through ordinary 2D Scanner: A Survey", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181Vol. 4 Issue 09, September-2015.

[4] Divya Patel1and Shaikhji Zaid, "Efficient System For Evaluation Of OMR Sheet-A Survey", IJARESM 2016..

[5] Hamad, Karez Abdu lwahhab and Mehmet Kaya , " A detailed analysis of optical character recognition technology", International Journal of Applied Mathematics, Electronics and Computers September 2016 http://ijamec.atscience.org.

[6] Akhilesh patilmad husudhan naik and p.h. ghare , "Implementation for OMR answer sheet scanning using state machine and IR sensors", International Journal of Electrical, Electronics and Data Communication, Volume-4, Issue-11, Nov.-2016.

[7] Nikita Kakade and R.C. Jaiswal , "OMR Sheet evaluation using image processing", Journal of Emerging Technologies and Innovative Research (JETIR), 2017.

[8] Rahul Patel, Shashwat Sanghavi, Dhruv Gupta and Mehul S Raval, " CheckIt - A low cost mobile OMR system", Conference Paper, November, 2015.

[9] Kanan C. and Cottrell G.W., "Color-to-Gray scale: Does the method matter in image recognition (2012) https://doi.org/10.1371/ journal.pone.0029740.

[10] Salem Saleh Al-Amri1, N.V. Kalyankar and Khamitkar S.D" Image segmentation by using threshold techniques", Journal of Computing, Vol. 2, Issue 5, 2010.

[11] N. Sattayakawee, "Test scoring for non-optical grid answer sheet based on projection profile method," International Journal of Information and Education Technology, vol. 3(2), pp. 273, 2013.

[12] M. Alomran and D. Hai, Automated scoring system for multiple choice test with quick Feedback, International Journal of Information and Education Technology, Vol. 8, No. 8, (2018).

[13] Jirapond Muangprathub, Oatchima Shichim, Yuthaya Jaroensuk, Automatic grading of scanned multiple choice answer sheets, International Journal of Engineering & Technology, 7 (2.23) (2018) 175-179.

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