Scoring for Intelligence Quotient Test from Scanned Answer Form

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Abstract - **A counseling ministry that serves the request of personality and intelligence tests faces difficulties in scoring the answer of these tests. This is due to a small number of staff, while the programs they are doing are quite a lot. Until this recent, clients write their answers on the answer sheet. So the scoring is done by counting one by one the right answer. From the survey, the average time required to compute an answer sheet is more than 3 minutes.**

The major problem encountered in the scoring process is inaccuracies due to fatigue at the time of counting. To perform a re-calculation obviously requires a much longer time. Often, there is no re-checking the scoring process. To overcome these problems, we developed an application to read and scoring the answer sheets of the tests automatically.

The experiment result on our system shows that the average time required in scoring an answer sheet is less than 2 minutes. In addition to less time, a better accuracy is gained.

Keywords: intelligence test, automatic reader, rotation, pattern detection, scoring system

I. BACKGROUND

A religious ministry in Surabaya, East of Java in Indonesia has counsel department. They conduct many programs, such as kids nurturing home, marriage counseling and seminar, and kid problem counseling. One of its programs is organizing many kinds of intelligent quotient test and personality test. It receives clients from company, institution and personal. The test will be held by order. They don't arrange a schedule. Beside this program, this department has many programs to do. So, this department's staffs need a long time to score the intelligent test's answer.

In many cases they often scoring these test answer in their spare time only, pursued by the deadline and arrange some programs in the same time. These conditions cause many errors in the test scoring. Although they have an application to help them already, it doesn't work so much. They still want to input the answer one by one then the application will do the scoring process.

To improve the accuracy and speed up scoring process, it needs a modified system which can help them to read the answer automatically from the answer sheet. The answer reading result will be input for the scoring system. Commonly, people use DMR tools to score an answer sheet automatically. Sometime, they also use a specific answer sheet material.

II. MONOCHROME AND ROTATION

Monochrome is image of one color image [1]. Usually, white. This kind of image is easy to be manipulated, easy to be analyzed. In our developed system, it's easy to detect the target locations.

In many cases, the original image is colorful image. It needs a good method to transform the color image into monochrome image. In order to do an effective procedure, we combine the noise reduction method to transform the color image into monochrome image. We use mean filters as shown in eq. 1[1]. First, add together 30% of the red value, 59% of the green value, and 11% of the blue value to get the grayscale value. After that, count the mean of the grayscale value. If the grayscale value is below the mean, change to zero, otherwise, change to one.

$$mean = \frac{1}{NM}\sum_{i=0}^{N}\sum_{j=0}^{M} pixel[i][j] \quad (1)$$

In scanning an image, we cannot assure that the scanned image will be in straight position. To normalize this oblique position, we need to do rotation. First, we need to determine how many degree we want to rotate an image. To count the degree, we use dot product between two lines as shown in eq. 2 [2].

$$\cos\theta = \frac{\vec{u} \bullet \vec{v}}{\|u\|\|v\|} \quad (2)$$

III. ANALYSIS AND DESIGN

Demand for Intelligence Quotient and personality test to find out someone's ability and personality which has been held by the counseling department is coming from companies, schools, or private. Unfortunately, they have no fixed schedule for the tests. Thus, results of the tests are needed immediately. It causes a stack of scoring job in random time.

Assay contains a list of questions should be answered. Many kinds of assay can be used to perform both types of tests. Assay that we used as reference in designing this system is a series of questions that require answers include true-false type and multiple choice [3]. To answer the test, client should fill a cross mark in his selected answer. If the initial answer was wrong, then the client can make corrections by adding the sign "=" at the wrong answer and add cross mark in the other correct answer.

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During this time, to support the scoring process, this department uses a database system that stores all the answers input from the answer sheet and then perform automatic scoring. The system helps to speed up the scoring process and improve the accuracy of the scoring result. In this regulation, this system still requires answers input. In inputing this answers, it allows many human errors. In addition, the time required to perform the input process is also quite large. Moreover, they usually correct the answer input twice to ensure that they input the answers correctly. If a few clients demand the test, they able to check the input again. If the time is limited, they will just input the answer without checking. The increasing client requires a test from this department, then the database system has been used earlier becomes less effective and less efficient.

To improve the scoring accuracy and to save the required time in performing the scoring process, it would need a modification of the previous database system. The main idea of the improvement of this system is to replace the answers input by staff with an automatic one. The purpose of the addition of this system is to reduce the occurrence of wrong input that increases accuracy and reduces the time required to enter the answers.

This automatically answers readers module will notice several aspects, the answer sheets scanned process and the scanned image files storage, as well as the proper answer sheet design which increases the automatic reader accuracy.

In applying the automatic scanned answer sheet reader, the difficulties that may arise are rotating the oblique paper position, finding the position of the correct rows and columns, and removing noise in the scanned image file produced by the scanner. To overcome the difficulties that exist, the solution we implement is transforming a color image become monochrome one, based on equation 1. A monochrome color range is narrow, so it will be easy to distinguish the noise [1]. Meanwhile, to facilitate the search for rows and columns position as well as to ensure the answer reader accuracy, it uses a marker on the answer sheet. We inspired this kind of marker from OMR and IELTS [4],[5]. The US patent number 5102341, Apr 7, 1992, a kind of DMR used only row marker in between rows [6]. We make an improvement by adding column marker because we don't use specific reader equipment [7]. Many OMR and DMR tools assume the paper position is proper, no slope. To overcome the problem of the slope of the paper position, the rotation will be done first. To streamline the process, the rotation will only be made if the slope of the paper could not be tolerated. Maximum slope we use in our application is 1 degree. The reading process in general can be seen in Fig 1.

This developed application is started with inputting the scanned answer sheets file name. Before searching for the answers locations, there are some necessary preprocessing, resizing image, transforming RGB image into a monochrome image and rotating. Resizing image aims to create a standard image size. This standard size impacts on the finding answers locations. This finding method is based on the pixel coordinate of the image. So, it is very important to determine the reference size of the image width and height from the beginning. Monochrome image will ease the determination pixels that include noise pixels and then remove them. Rotation is necessary because the slope of the position paper would lead to an invalid answer.

After preprocessing has done, it will recognize where the position of each pixel row is. Having identified the position of the line, only then can find in which colomn the answers exist. If there are black pixels at least as much as half of the box, then that's the answer. Whereas if there are more than two-third black pixels then it is should be a canceled answer.

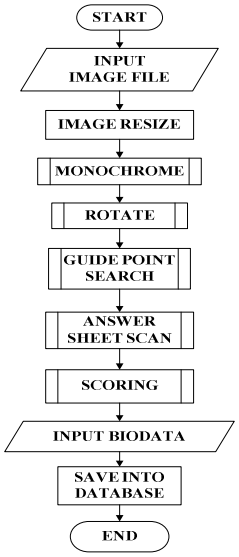

Figure 1. *General Flowchart*

To support some required preprocessings, the design of the answer sheet need to be considered. The design used answer sheets can be seen in Fig 2.

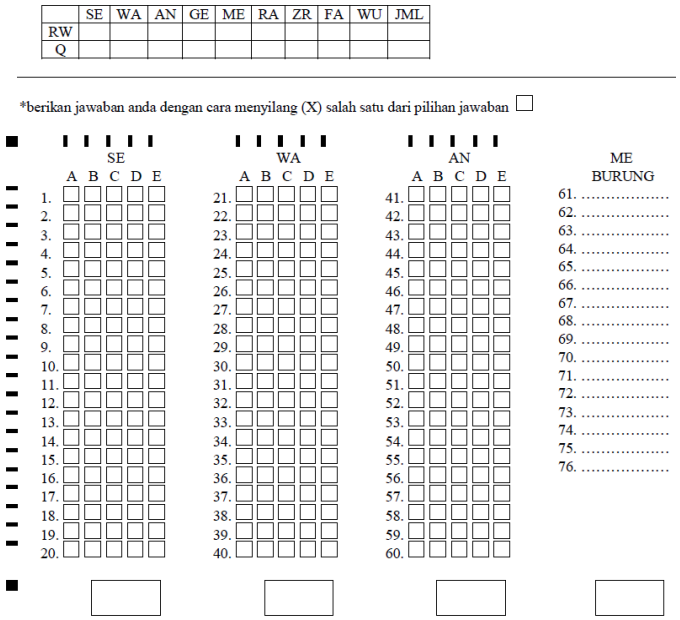

Figure 2. Answer Sheet Design

The essential element of the answer sheet design is a marker on each row and column. There are two types of markers, namely, rectangular black marker, called a corner point, and the rod-shaped marker, called guide point. Corner points are used to mark the start and the end of the initial barriers and constraints of the area to check the answers and the slope of the paper, while the guide points indicate each row and column where the answers are. Each answer is placed in a box. Client will put their answer by giving a cross in the considered right boxes. Suppose the answer to number 1 is "A", then the box in the first row first column will be filled with a cross. To change an answer, client can fill the box and then put a cross in another box considered as a more correct answer.

Here is shown flowchart of several preprocessing, namely changing the RGB image into a monochrome image and rotation. They also explain the process of looking for a guide point. The process of making monochrome image can be seen in Fig 3, the rotation procedure can be seen in Fig 4 and the process of finding guide points can be seen in Fig 5.

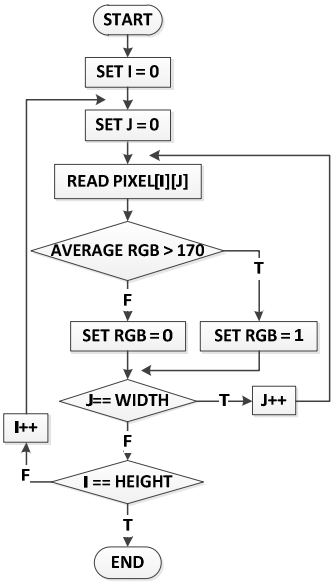

Figure 3. *Monochrome Flowchart*

In the monochrome process, all the color will be converted into two kinds of color, white and black. We use mean filters to determine the threshold [1]. In our experiments using the scanned file, we get 170 as the general threshold. Based on that result, if the average RGB values of more than 170 then the pixel will be changed to white, pixel value 1. Whereas if the average RGB is less or equal to 170, it will be changed to black, pixel value 0.

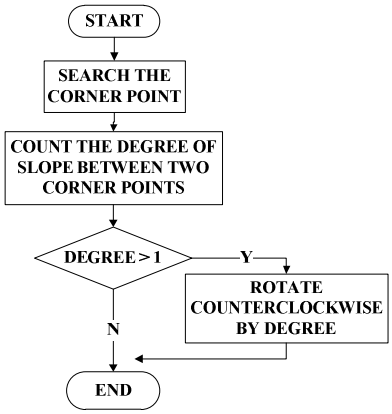

Figure 4. *Rotate Flowchart*

By detecting the position of the two corner points, then the slope of the paper can be sought by drawing a line between the two points and compared with a straight line from the pixel position should be. If the slope is more than 1 degree, rotation will be processed. We count the slope egree using equation 2.

Guide Points searching process will be done twice. First, checking horizontally, from the result, the search process will continue vertically.

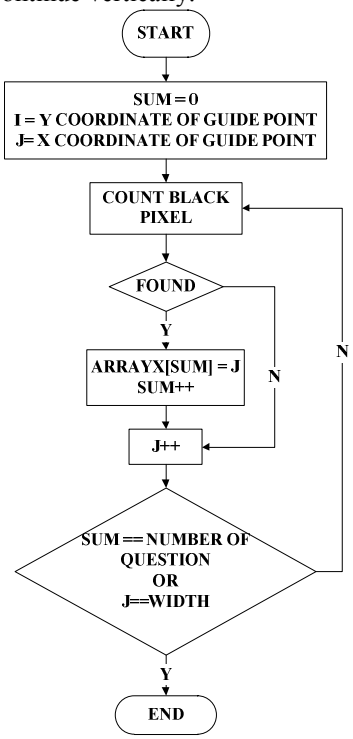

Figure 5. Searching Guide Points Horizontally

Guide points have a fix size, so to find its position we want to count the black pixel. If black pixel is found along the size of the guide point, then that's the point guide. The location of guide points are found will be stored into an array. The same process will be done to checking vertically. The difference is the pixel will be read from top to bottom, throughout its height.

After the answer reading, the next process is the scoring. Each kind of test has its own scoring method. Answers and scoring results are saved into a database system. Relationship between tables in the database system is shown below.

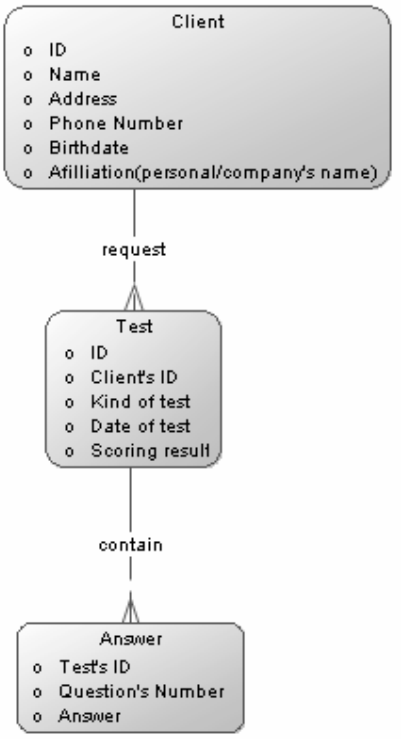

Figure 6. Database Design

IV. EXPERIMENTS

We try the accurance of our application in finding the answers location, so it will yield the valid scoring result. Fig 7 shows the result of corner point and the guide point searching (see the red boxes), while the position of each box is shown by red dots. Our experimental results show that the reading process always success.

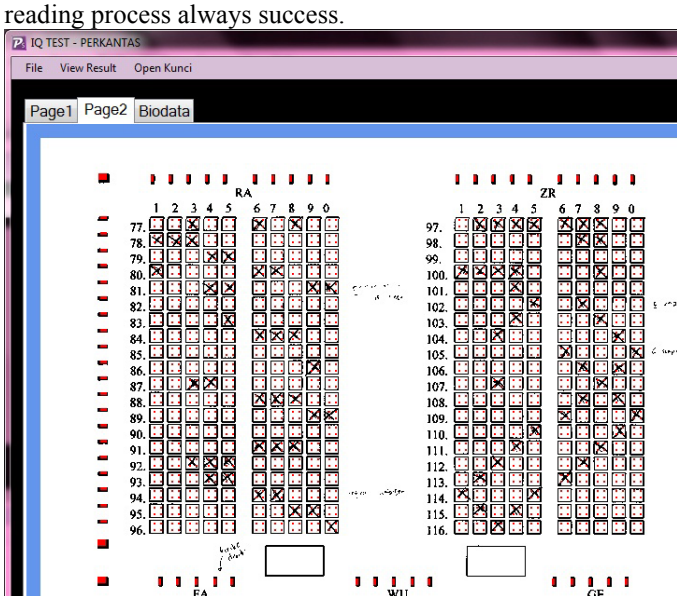

Figure 7. The Result of Scanned Answer Form Reader

After boxes location detection process, the next process is looking for a box which contains the answer. At this stage, errors can still occur, although very rarely. To anticipate if something goes wrong, we develop a manual correction tool.

V. CONCLUSION

This scanned answer form reader and scoring have been able to calculate the answer from the client with a relatively more quickly than previous systems and to input data more accurate.

Through the system trial, the only time consume process is scanning the answer sheet. It needs to be scanned and name the file properly, so we can input the right filename to the right client's scoring data.

REFERENCES

[1] R.C. Gonzales, R.E. Woods, "Digital Image Processing 2nd ed", Prentice Hall. Upper Saddle River. New Jersey. 2001.

[2] Howard Anton, "Elementary Linear Algebra 10th ed", Wiley. USA, 2010

[3] "Minnesota Multiphasic Personality nventory". http://en.wikipedia.org/wiki/Minnesota_Multiphasic_Personality_Inventory.

[4] "OMR Answer Sheet", http://www.omrtestsheet.com.

[5] "IELTS reading Answer Sheet Format", http://www.ielts.org/pdf/IELTS_Reading_Answer_Sheet.pdf

[6] US patent list http://www.google.com/patents/ US5102341

[7] DMR tool developed in ITB (Bandung technology Institute) Indonesia. http://digitalmarkreader.net