The Using of Thresholding and Region Merging Algorithm for Correcting the Multiple Choice Answer Sheets

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Abstract. Increasing technology in digital encourages the human to create computer application to process two-dimensional data (Citra). Image retrieval that is the form of test files uses CCD cameras with a fairly expensive price, such as CCTV cameras. In this research, the author uses the methods thresholding and region merging to correct the answer sheet with a tool Webcam that the form of Image and it is processed for correction the answer multiple choice. In this study, the author focuses on the application of the thresholding method in which the purpose is to classify the gray degree value into two, namely black and white. The application of the region merging method is the process of combining regions less than the threshold. The use of webcam, thresholding methods and merging region is expected to facilitate all circles of agencies, especially in the education field in the correction sheet answer. It can increase the output of quality teachers.

1. Introduction

The development of electronics technology both analog and digital technology is very rapid. This is evidenced by the production of innovation in the field of optics. The optical technology in modern times is now developing in digital form. This digital form offers stimulates scientists to keep innovating. This ease of technology in digital form that encourages the creation of computer applications to process two-dimensional data (image).

There are references from a paper written by Purwoko, Safuddin Madenda, and Hayet Laggoune entitled "Pengolahan Berkas Ujian Berbasis Pengolahan Citra". The researcher will research the same title, but the concept of designed system design has a significant difference. In this research, the researcher takes Citra in the form of test files using CCD cameras that belong to the camera with a fairly expensive price, such as CCTV cameras. The concept will be an application that uses a simple optical tool and the price is relatively affordable by using the type of CMOS camera, for example webcam. It can be implemented by many users without being limited by cost.

Therefore, the author initiative to design an application for correcting multiple choice answers with webcam. Based on the economic side and compared with scanners, webcam is considered as affordable prices and easy to obtain. The correction of answers, not only webcam hardware is required but also software which is able to solve the problem of correction and value calculation.

To solve this problem, it takes a method or algorithm that matches with the software used. It is done because the webcam produces the output of image / Citra and the processing technique used is thresholding algorithm and region merging. In a journal written by Lukman Talibo and Nana Juhana entitled "Real-time Object Recognition System with Artificial Neural Networks Using the
Backpropagation Algorithm", explains that there is also a thresholding process and it is evident the thresholding process can be used for Citra processing that comes from the camera portrait. Eril Mozef in his Journal entitled “Algoritma Labeling Citra Biner Dengan Performansi Optimal Processor Time” explains about the process of merging region used for the processing of Citra.

2. Methodology

2.1. Image (Citra)

Citra (image) is an image in the two-dimensional or matrix plane. Based on mathematical point of view, where the image is a definition as a two-dimensional lighting function where we can formulate \( f(x, y) \) where \( x \) and \( y \) indicate a point of spatial coordinates, and the value of \( f \) at the point \( (x, y) \) of the image gray level at that time. Digital images of the size of \( m \times n \) are commonly represented by the matrix of the row size \( m \) and \( n \) columns as follows:

\[
\begin{pmatrix}
  f(0,0) & f(0,1) & \ldots & f(0,n) \\
  f(1,0) & f(1,1) & \ldots & f(1,n) \\
  \vdots & \vdots & \ddots & \vdots \\
  f(m-1,0) & f(m-1,1) & \ldots & f(m-1,n-1)
\end{pmatrix}
\]

On reflection this light can be captured by optical devices, such as the human eye, the scanner camera (scanner), the web cam, etc, so that object images called recorded images. Visually, the image is divided into two part, namely color images and grayscale (black and white images). the coloring that has been received by the human eye is a result of combining light with different wavelengths. The color combination is red (R), green (G), and blue (B). combining The three colors above are the most important, and are often abbreviated as the basic colors often called RGB. Other colors can be obtained by mixing three main colors with a certain ratio (although not entirely true, since not all color possibilities can be produced with RGB combinations only).

2.2. Image Digital Process

Image has many information and sometimes decreased quality (degradation), for example containing defects or noise, the color is too contrast, less sharp, blurring. This kind of Citra becomes more difficult to interpret because the information submitted by image becomes lessened.

In order for the impaired image to be easily interpreted (both by human and machine), the Citra needs to be manipulated into another Citra of better quality. This is related to Citra processing. Citra processing is image processing, especially with the use of computers with a better quality image. In general, operation of image processing will be applied to the image when:

a. Improvement or modification of images is very necessary, to improve the appearance or Highlight some aspects of the information contained in the image,

b. The elements in the image must be grouped, then matched, maybe measured.

c. the whole picture must be merged between other parts of the image.

Citra processing techniques transform images into other imagery. So, each input must be an image and the output is also an image, but in this problem the output image has a very better quality than the input image itself. try to look at the block diagram processing image below, are as follows:

![Figure 1. Block image processing diagram](image)

2.3. Algorithm Thresholding

When doing Converting from black and white images to binary imagery the thresholding algorithm is very much needed, because the conversion process is carried out by the threshold algorithm operation.
the use of the thresholding algorithm it self can classify the gray pixel values of each pixel and convert it into two classes, namely black and white. use this method to convert images to binary numbers with the aim that the next process will become easier. Both of these approaches are used in the operating threshold:
a. In global image uploading Each pixel in an image is mapped with two values namely, 1 or 0 using the mining function:

\[
f_{g}(i, j) = \begin{cases} 
1 & \text{if } f_{g}(i, j) \leq T \\
0 & \text{if } f_{g}(i, j) > T 
\end{cases}
\]  
(2)

Notes:
- \(f_{g}(i, j)\) = black-white Image
- \(f_{b}(i, j)\) = binary Image
- \(T\) = specified threshold

The specified threshold will make the object is black (0 is black) while the background is light (0 is white). The T threshold value is chosen such that the error obtained is as small as possible. The common way to determine T is to create an image histogram. If the image contains one object and the background has a homogeneous intensity value, then the image generally will have a bimodal histogram (has two peaks or two local maximums). The T value is selected at the local minimum value between two peaks. In this way, not only convert black-and-white images to binary images, but at the same time do object segmentation from the background.

![Figure 2. The determination of T value](image)

2.4. Region-Based Techniques

These techniques include the growing region, region splitting, and merging region. The Growing Region is used to group pixels in regions. This process produces a regionmap which is a grouping of pixels in each region. Region splitting is the separation of territory. Regional merging algorithms are processes which combine regions which are deficiencies of threshold values. i.e. Region (area) closes to a combination at the minimum distance. then it will continue until the smallest distance between the closure area which is greater than the threshold value. After merging the region, the final segmentation results will be obtained. The regional merging algorithm is grouped between black which is equal to 1 and white 0 is white which is not processed again. While the black color value of 1 will be counted. So it will be known that the black color (value 1) is the dominant answer

3. Results And Discussion

In this chapter will be discussed about the design and design plan system of detection of multiple choice questions using thresholding algorithm and merging region. The design and design plan system include system analysis, system design, and interface design.
Figure 3. The form of multiple choice answer sheet

Figure 4. USB Cam

Figure 5. Tool of computer answer sheet

Figure 6. Flowchart System
Data readings from blackened areas are calculated by the average number in each region, i.e.; the average threshold calculation of the answer section. There are five regions of options including regions A, B, C, D, and E. Each region has a magnification of 6 x 6 pixels. In a gray image, each pixel has an intensity value on pixels. To find the average threshold value per region, it needs to be done by calculating the number of pixel intensity values in an area, then divided by the number of pixel values in an area. The pixel intensity value and the average threshold value in each region of answer options are:

Grayscale image \((x, y)\) = \(\text{Red} \times \text{Grey} + \text{Blue} : 3\)

The result obtained from the formula is the intensity value of a pixel. On the third line there is a pixel intensity value of 49 pixels. The pixel intensity values in one region are used to find the threshold value (th per region) by summing the pixel intensity value in an area which is then divided by the number of pixels in that area. Then get th value on the fourth row of the table above.

After knowing the average threshold value of each pixel (th), the next step is to calculate the average of the first row number (thr) by the total number of options then divided by the number of options area, then the result will be multiplied by the limit of the percentage.

\[
\text{Thr} = \frac{(80 + 149 + 151 + 159 + 148)}{5} \times \frac{90}{100} = 123.66
\]

Then compare between th value per region option with thr.
- \(\text{th opsi A} \leq \text{Thr}\) ? Yes, so the answer is A
- \(\text{th opsi B} \leq \text{Thr}\) ? No, so the answer is A
- \(\text{th opsi C} \leq \text{Thr}\) ? No, so the answer is A
- \(\text{th opsi D} \leq \text{Thr}\) ? No, so the answer is A
- \(\text{th opsi E} \leq \text{Thr}\) ? No, so the answer is A

Comparison of th value with thr is the calculation of merging region by using the average threshold

4. Conclusion
Based on the research and trial implications of this application, it can be concluded that the accuracy of the software in detecting multiple choice answers using thresholding algorithm and merging region runs well as expected (30 data can be detected from 30 data using tolerance value 90). This application is also able to detect Computer answer sheet form (LJK) charging using 2B pencil stationery, black pen, blue pen, and green pen and able to detect blacked options with all forms of filling including thickness using 2B pencil, partially blacked option using 2B pencil, beyond the blacked option area with 2B pencil, and the use of pen erasers. This application is also able to match Computer answer sheet form (LJK) participants with key answers so that the output appears in the form of the final value.

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