Edge image detection combines Laplace operation with convolution technique to produce drawing materials for children

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Abstract. The image object is a very interesting object. It is interesting as it can be processed even manipulated. The image cannot be separated from the computer. Computer can process images so that the value increases. There are many computer applications that can be used to process images. The development of the image is so rapid but does not touch the world of children yet. Although there are a lot of books that can be used as references for children, but there are not very interesting ones. By using computer technology, the image will have higher quality and beneficial for children. Of course there must be innovation to change the dynamics. The concept of edge detection combined with computerized based methods can be a good solution. Edge detection can be used to recognize patterns from an image. It can identify the edge in the image. In this study an edge detection system will be designed and implemented by using Laplace operators and convolution techniques. The initial image will be constructed so that a pattern in the form of dots will be formed.

1. Introduction

Current technological developments have indeed produced products that are child friendly. But in intense observation, then it is found that the majority results are pure machine products without any variation that can improve children's creativity. Of course there must be an effort to overcome this problem. At present there are many computerized methods that can be combined in such a way as to produce attractive products and increase children's reasoning power. One of them is by doing edge detection using Laplace operator with convolution technique [1,2].

Image edge detection is one of the interesting things to recognize patterns from an image. This process is often placed as one of the steps in segmentation, which aims to recognize objects contained in image or image content [1,2]. Edge detection functions to identify the boundary of the object contained in the Image. The edge of the image can be viewed as a pixel location with extreme values different of intensity. In general, the edge detecting process of an image will change the geometric shape of the object and other behaviours such as the creation of attributes that arise due to segmentation activity in that image [1,2].

The Laplace operator is the second derivative operator that has a 3x3 mask. Convolution is a fundamental operation in image management. Convolution which is part in image processing operations is to multiply the matrix value of an image with a mask or kernel. With a combination of both, it is
believed that a new image will be produced in high scientific value so that it will be benefit for children [3,4].

Previous research is conducted by Febri Liantono, in his research entitled Detection of Edge of Mango Leaf Image Using the Ant Colony Optimization Algorithm, doing edge detection on the object image of mango leaves [5]. Febri uses the prewitt operator in the detection process. Erick Wijaya in his research entitled Analysis of the Intensity of the Sobel Edge Detection Method [6], Erick used the sobel operator in the detection process. Handini in her research entitled Detecting Irises to Determine Cholesterol Strengths Using Characteristic Moment Invariant Extraction with K-Means Clustering, Handani used invariants in the detection process [7,8]. There is no previous research at all has specifically study addressed the edge pattern drawing for drawing training of the children.

In this study the author will do edge detection for drawing training for children. This research will construct a new image and convert it into a grayscale image in the form of a wireframe. Research will also do segmentation / filtering of a number of existing patterns. It will also select new image forms to form wireframes, and design applications to form wireframe construction, segmentation / filtering and make them into image points. The processes that can be carried out: 1) Conducting Blurring, it is an effort to improve the performance of an edge tracker in relation to noise. 2) Strengthening, It is a process of transforming the function of intensity into its derivative function so that the pixels located around the edges of the object will be strengthened, while the pixels in other locations will be weakened. 3) Tracking, it is a way to determine which points are the edges points of an object [9].

2. Discussion

2.1. System analysis

System analysis is the decomposition of an intact system into its component parts with the intention of identifying and evaluating the problems, obstacles and the expected needs so that improvements can be proposed. The things that analysed at system analysis stage are problem analysis, functional analysis, ongoing system procedure analysis, information flow analysis, coding analysis, database analysis, and non-functional requirements analysis [10].

2.2. System requirements analysis

In this part of the analysis we will explain the description of the system to be developed, namely:

- The system to be built is a system that is capable of processing images by using the Laplace operator.
- The system must be able to facilitate users to provide face image input in file format with jpg extension.
- The system must be able to construct imagery in the image database as a medium for detection.
- The system must be able to detect images with gray values for the input image.

The image edge detection system that will be developed can be illustrated in Figure 1.

![Figure 1. System architecture [8].](image-url)
The Interface Unit is a subsystem that is responsible for receiving the image used. This subsystem is also responsible for displaying a set of images which is sorted by their gray level values with input images provided by the user.

The Indexing Unit is a subsystem that is responsible for indexing images in the Database and storing indexing results in the Image Index. This subsystem performs feature extraction from images in the database.

Unit Database is a subsystem that is responsible for finding the set of images provided by the user. This subsystem uses the Image Index to determine images that have high gray values for the input image. This subsystem will send the search results image to the Interface Unit, which will then be displayed based on the gray value of the input image.

2.3. Image processing
The data used in this study is a testing image with a size of 256 x 256 pixels, then the image will undergo a process to get the edge and produce a new image with a size of 256 x 256 pixels which is the result image (Output Image). The image processing diagram which is used in this study is shown in Figure 2.

![Figure 2. Image processing flow [8].](image)

To simplify the image model, the first step that is often done in image processing is to convert the colour image into a gray-scale image. As is known, colour images consist of 3 layers of matrices, namely R-layer, G-layer and B-layer. So to do the following processes, the three layers above are considered.

2.4. Determining RGB values
To determine the RGB value, the initial image is inputted into the system, so that RGB values will be generated, as follows:

![Figure 3. First image.](image)

| Pixel | R   | G   | B   |
|-------|-----|-----|-----|
| 0     | 222 | 220 | 204 |
| 1     | 220 | 220 | 212 |
| 2     | 237 | 207 | 192 |
| 3     | 220 | 220 | 212 |
| 4     | 220 | 228 | 220 |
| 5     | 220 | 220 | 212 |
| 6     | 220 | 228 | 220 |
| 7     | 228 | 228 | 218 |
| 8     | 220 | 228 | 220 |
| 9     | 228 | 230 | 228 |
| 10    | 212 | 220 | 212 |
| 11    | 220 | 220 | 212 |
| 12    | 220 | 220 | 212 |
| 13    | 212 | 212 | 196 |
Table 1. Cont.

| Pixel | R  | G  | B  |
|-------|----|----|----|
| 14    | 220| 220| 212|
| 15    | 204| 204| 188|
| 16    | 152| 157| 152|
| 17    | 190| 187| 190|
| 18    | 179| 181| 168|
| 19    | 187| 202| 197|
| 20    | 187| 202| 197|
| 21    | 204| 204| 188|
| 22    | 212| 220| 212|
| 23    | 212| 212| 204|
| 24    | 221| 212| 212|

Based on the RGB value in the table above, the gray level colour value is calculated, the results are as follows:

Use the formula [9]:

\[ s = \frac{r + g + b}{3} \]

Will be obtained:

Table 2. Gray level values.

| Pixel | R  | G  | B  | Grey level |
|-------|----|----|----|------------|
| 0     | 222| 220| 204| 215        |
| 1     | 220| 220| 212| 217        |
| 2     | 237| 207| 192| 212        |
| 3     | 220| 220| 212| 217        |
| 4     | 220| 228| 220| 223        |
| 5     | 220| 220| 212| 217        |
| 6     | 220| 228| 220| 220        |
| 7     | 228| 228| 218| 225        |
| 8     | 220| 228| 220| 223        |
| 9     | 228| 230| 228| 229        |
| 10    | 212| 220| 212| 215        |
| 11    | 220| 220| 212| 217        |
| 12    | 220| 220| 212| 217        |
| 13    | 212| 212| 196| 207        |
| 14    | 220| 220| 212| 217        |
| 15    | 204| 204| 188| 199        |
| 16    | 152| 157| 152| 154        |
| 17    | 190| 187| 190| 189        |
| 18    | 179| 181| 168| 176        |
| 19    | 187| 202| 197| 195        |
| 20    | 187| 202| 197| 195        |
| 21    | 204| 204| 188| 199        |
| 22    | 212| 220| 212| 215        |
| 23    | 212| 212| 204| 209        |
| 24    | 221| 212| 212| 215        |
The gray level value in Table 2 is converted into a matrix as follows:

\[
\begin{bmatrix}
215 & 217 & 215 & 199 & 195 \\
217 & 220 & 217 & 154 & 199 \\
212 & 225 & 217 & 189 & 215 \\
217 & 223 & 207 & 176 & 209 \\
223 & 229 & 217 & 195 & 215
\end{bmatrix}
\]

After that the convolution process is carried out with Laplace:

\[
f(x,y) =
\begin{bmatrix}
215 & 217 & 215 & 199 & 195 \\
217 & 220 & 217 & 154 & 199 \\
212 & 225 & 217 & 189 & 215 \\
217 & 223 & 207 & 176 & 209 \\
223 & 229 & 217 & 195 & 215
\end{bmatrix}
\]

\[
g(x,y) =
\begin{bmatrix}
0 & -1 & 0 \\
-1 & 4 & -1 \\
0 & -1 & 0
\end{bmatrix}
\]

Then the convolution process will be carried out as follows:

- **Step I**: Place the kernel in the upper left corner, then calculate the pixel value at the position \((0,0)\) of the kernel.

- **Step II**: Slide the kernel one pixel to the right, then calculate the pixel value at position \((0,0)\) of the kernel

- **Step III**: Slide the kernel one pixel to the right, then calculate the pixel value at the position \((0,0)\) of the kernel

- **Step IV**: Slide the kernel one pixel to the right, then calculate the pixel value at position \((0,0)\) of the kernel.

So next steps until the convolution process can no longer be done and a new matrix can be formed:
2.5. Testing process
Testing is done by calculating the sum of the final value of the image to be tested. This testing phase is like a stage that produces value. The output value that has been activated is compared to the threshold value.

![Flowchart for Testing Process](image)

Figure 4. Testing process [10].

After that, do an analysis of the software system that will be designed, then do the design of the software. The design stages that are carried out include the design of the process, and the design of the program interface.

2.6. Test result
The results of the tests that have been carried out are as follows:

![Test Results](image)

Figure 5. Test results.
3. Conclusion

From the research that has been done, it can be taken some conclusions:

- From tests carried out of 4 reference image data, the result is the output of edge detection is highly dependent on the level of grayness and quality of the image being trained.
- The results of the edge detection test on the colour and colourless image, the difference in the detection results are not very significant.
- The amount of noise in the image, greatly affects the results of image edge detection, if it gets bigger, then the results of edge detection become unclear.
- The size of the detected image is greater than the size of the original image.
- Image of edge detection results can be used as references for children.

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