CHAPTER IV

ANALYSIS AND DESIGN

4.1. Analysis

Sometimes, there can be confusion between one and another money because of the same color and the lack of precision of the seller or buyer. The confusion can also occur if the money is not grouped by color or nominal. Detection of nominal money is useful to detect the nominal of money. Program will read the input image scan by histogram and correlation between image scan and image in database.
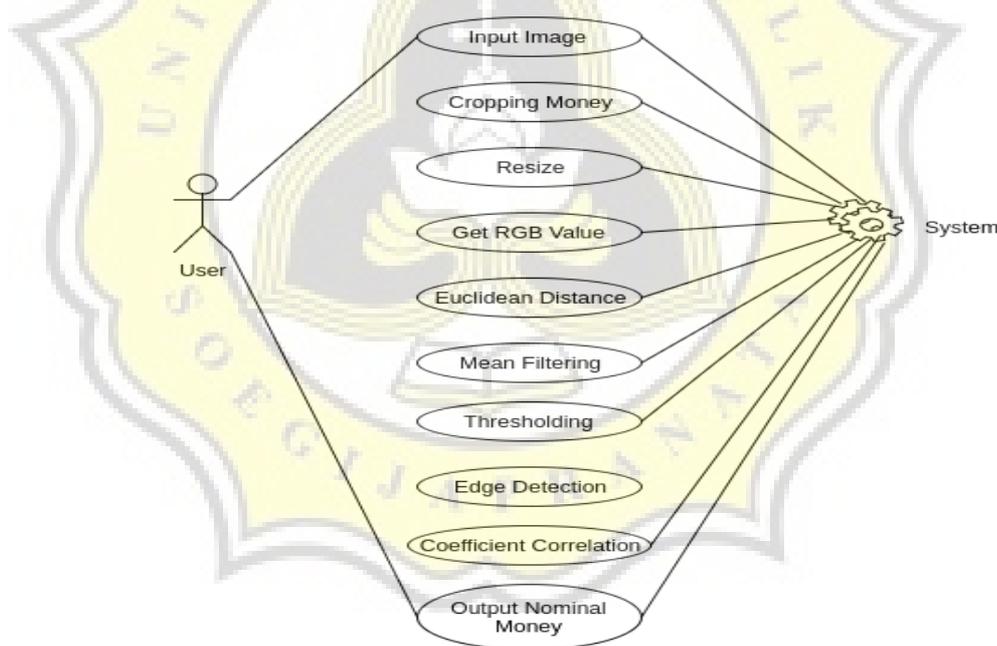
4.1.1. Use Case Diagram

Figure 1. Use Case Diagram

Based on the diagram above, the program will wait for input images from a user. The input image is .PNG. Without any input from the user images, then this program does not run. After the input received by the system, then the system starts to process the

input images. After doing some process by the system, then the system will produce output results of the process. The result of the process in the form of a nominal value of money based on the inputted money image by user.
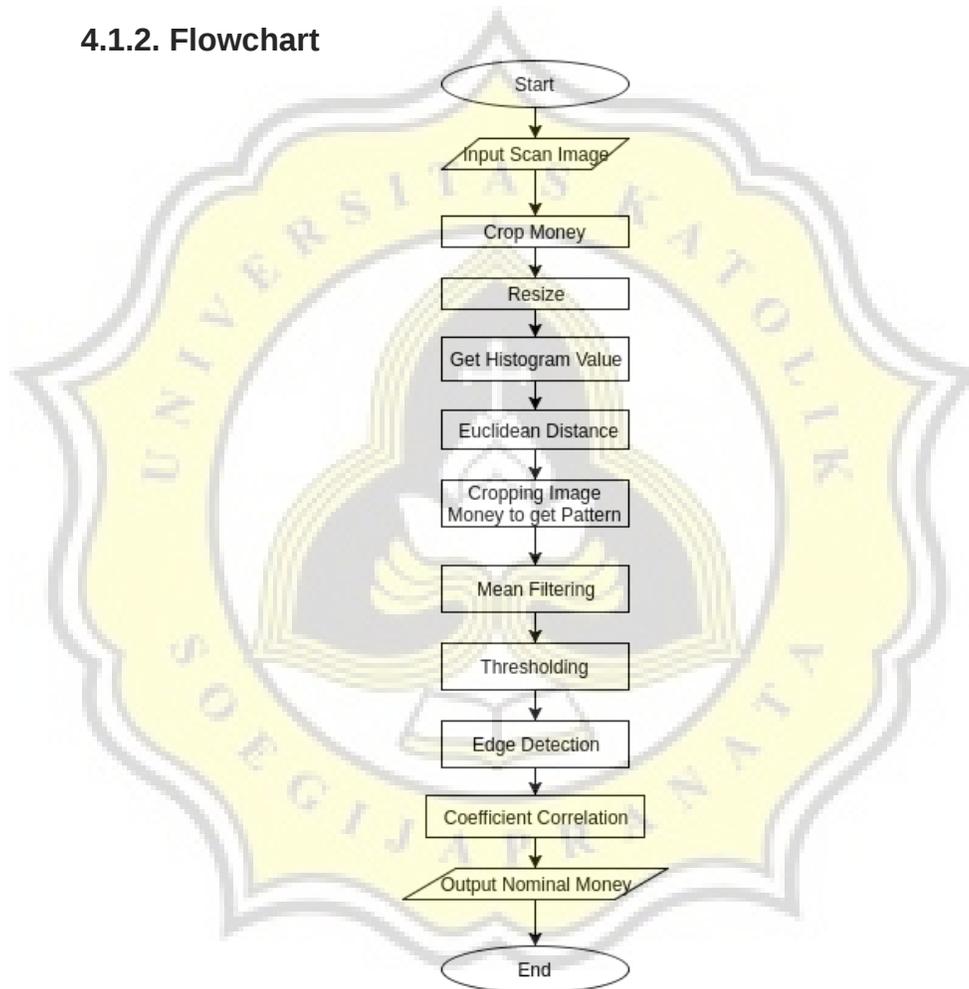
4.1.2. Flowchart

Figure 2. Flowchart of Preprocessing, Histogram and Specific Pattern

Program will be displaying a Graphic User Interface and ask the user to browse the image that will be tested. After choosing an image, user choose the image file to tested. After choosing the image, program will process the image and detect the location of the money and crop the money. Then, program will resize the money to get histogram value and counting the similarity of histogram by euclidean distance. Matching will be done by image input and image database of money. After getting the nominal value, testing of pattern will be done by program. First, program will crop an image input by cutting the specific pattern on the left side of money. Then, program will run a mean filtering to reduce some noise. After mean filtering, program will segment the image by thresholding to get a binary image. After that, sobel edge detection is done to get an edge of specific pattern. After getting the pattern, program will count the coefficient correlation to get a value of similarity of pattern of image and image database pattern. Finally, program will show the nominal of money by match the similarity of euclidean distance and coefficient correlation.

4.1.2.1. Preprocessing

The function of the preprocessing of the image is to get the identified image has the same image size.
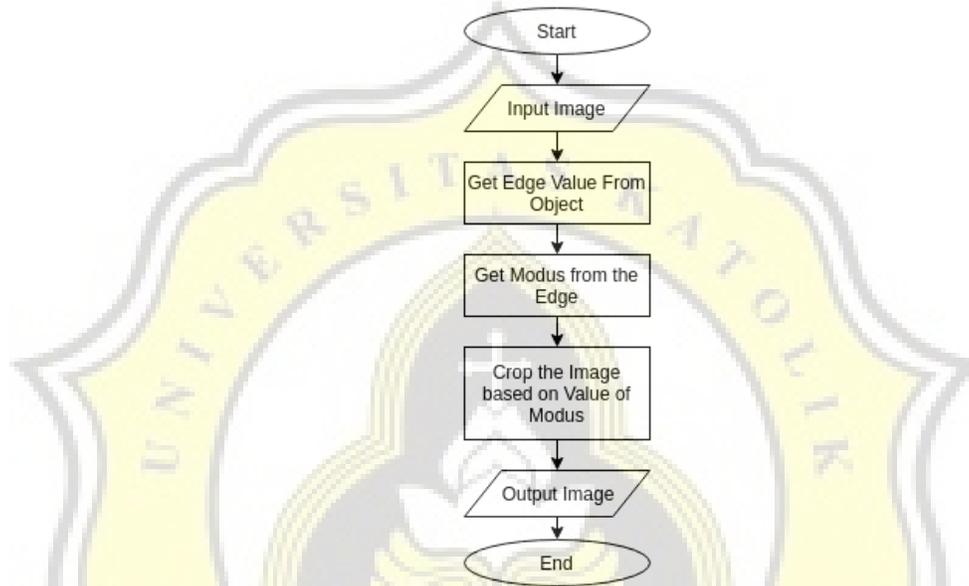
4.1.2.1.1. Cropping Money

Figure 3. Flowchart of Cropping Money

Cropping money from image scan is used to find the location of money and cropped of the image money. Program will detect the edge by scanning through left, right, top, and bottom of the image scan and get the modus of the money side. Then make a new buffered image by subtracting the left and right to get a width and subtract top and bottom to get a height of the money.
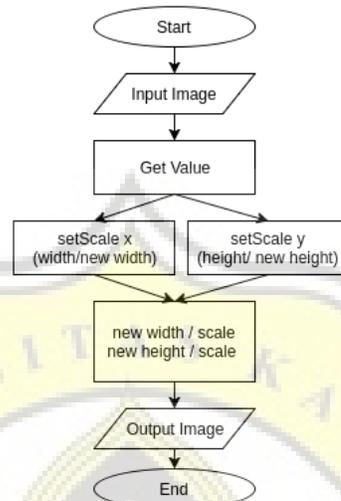
4.1.2.1.2. Resize

Figure 4. Flowchart of Resize

Resize is used to get the same size between image input and image in database. Resize is done by scaling which obtained by dividing the new width/height with original width/height of the image.

4.1.2.2. Histogram

Histogram is a graph that illustrates the spread of the intensity of the pixel values of an image. Get the value of histogram in the image by taking each pixel layer color of the image.
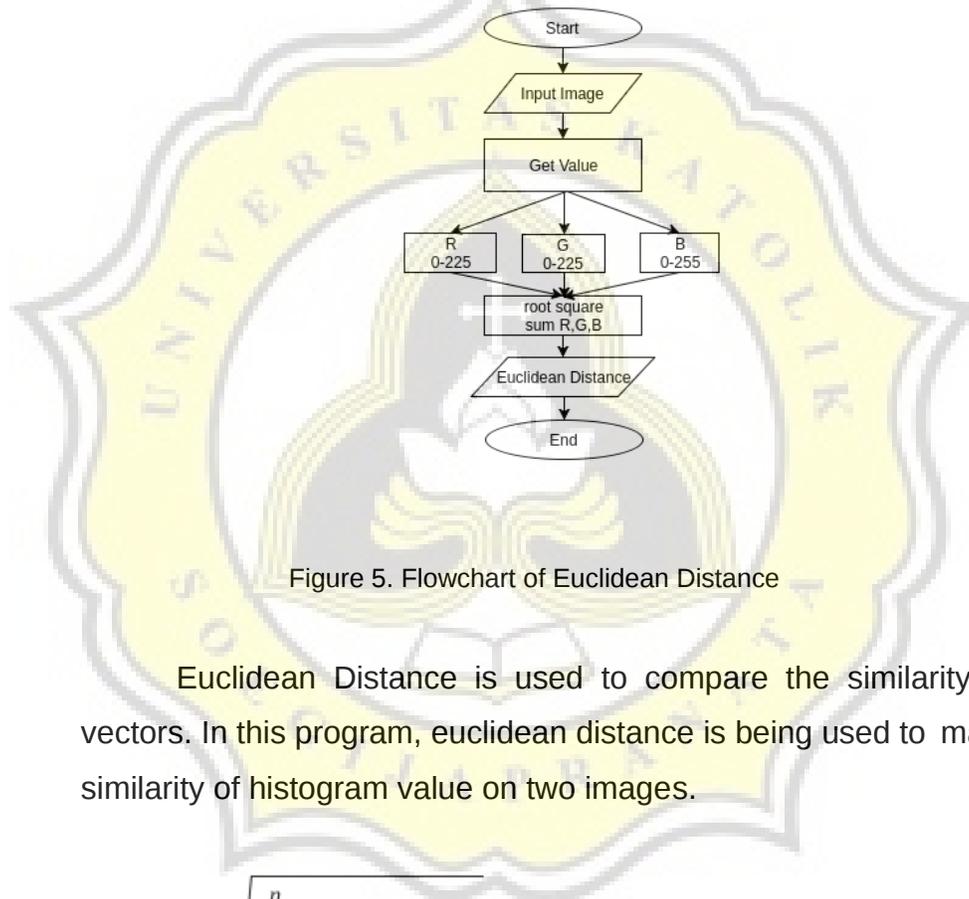
4.1.2.2.1. Euclidean Distance

Figure 5. Flowchart of Euclidean Distance

Euclidean Distance is used to compare the similarity of two vectors. In this program, euclidean distance is being used to match the similarity of histogram value on two images.

$$d = \sqrt{\sum_{i=1}^{n} \{(r_i^1 - r_i^2) + (g_i^1 - g_i^2) + (b_i^1 - b_i^2)\}} \dots (2)$$

Figure 6. Euclidean Distance Formula

4.1.2.3. Pattern Recognition

      Pattern Recognition is used to detect the pattern of the image. To get a pattern, some step will be used to get the best pattern to identify. Several steps that will be used in pattern recognition must be run in order from crop, to get the pattern image, filtering to eliminate the noise, thresholding to segmenting the foreground and background, and edge detection to get an edge of a pattern.

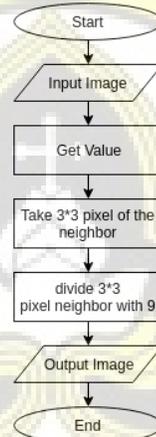### 4.1.2.3.1. Mean Filtering

Figure 7. Flowchart of Mean Filtering

      Mean Filtering used to reduce some noise in the image. Noise usually appears because of the result of digital process of an image. Some step that is used to filter with mean is get the pixel 3*3 neighbor and find the average of the pixel by dividing it by 9.

Figure 8. Mean Filtering Formula
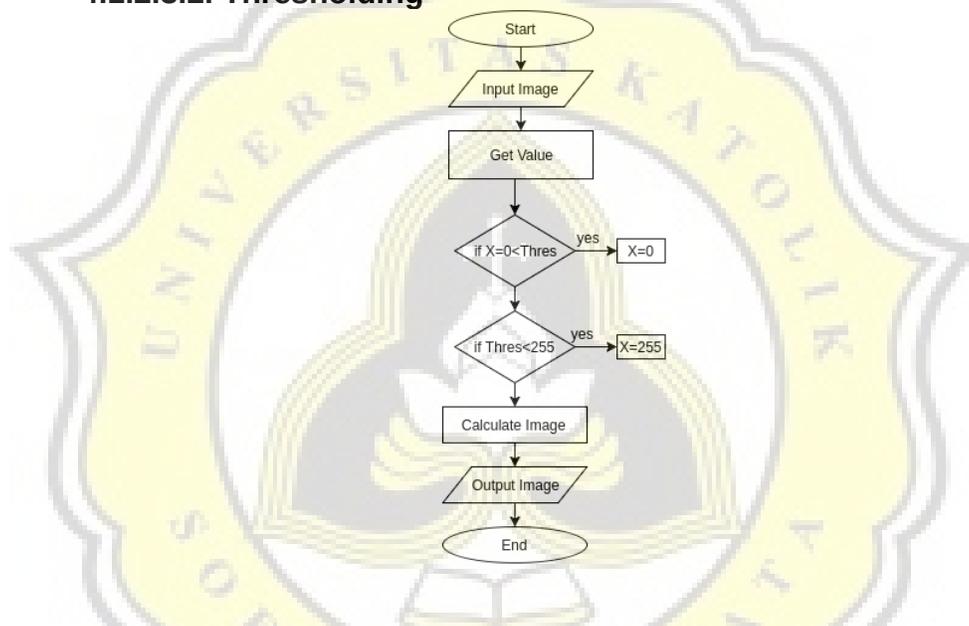
4.1.2.3.2. Thresholding

Figure 9. Flowchart of Thresholding

Thresholding use to segmented an image from background and foreground. Thresholding isolated image become two binary images.

$$g(x,y) = \begin{cases} 1 & if \quad f(x,y) > T \\ 0 & if \quad f(x,y) \leq T \end{cases}$$

Figure 10. Thresholding Formula
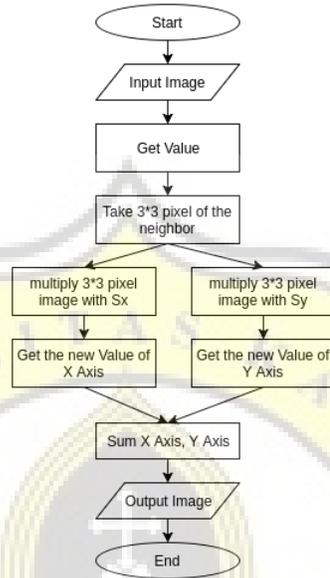
4.1.2.3.3. Edge Detection

Figure 11. Flowchart of Edge Detection

Use to get an edge of the image. Edge Detection works by detecting points that have a high difference of pixel values to neighboring pixel values. To get an edge, use the formula of sobel edge detection, take the 3*3 value of neighbor pixel image, then multiply by X to get an X Axis of the new image, and multiply with Y to get a Y Axis of the new image. Sum the new X Axis and Y Axis to get a new edge detection image.

$$Gx = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \quad Gy = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Figure 12. Edge Detection Formula
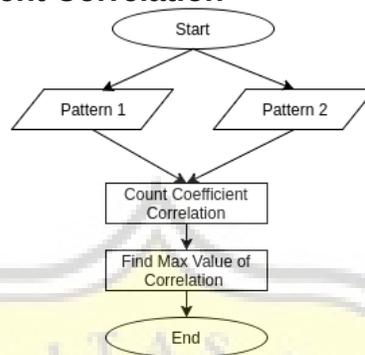
4.1.2.3.4. Coefficient Correlation

Figure 13. Flowchart of Coefficient Correlation

Coefficient Correlation used to compare the relationship between 2 variables. The result of the correlation is between -1 to 1. Image will be detected as a similar image if the result of correlation is >0.5.

$$r = \frac{\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}\left(x_{ij}-\bar{x}\right)\left(y_{ij}-\bar{y}\right)}{\sqrt{\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}\left(x_{ij}-\bar{x}\right)^2 . \sum_{i=0}^{M-1}\sum_{j=0}^{N-1}\left(y_{ij}-\bar{y}\right)^2}} \quad ..... (2.5)$$

Figure 14. Coefficient Correlation formula

4.1.3. Class Diagram

In this program, the first to run is a GUI class, then GUI class will run the preprocessing, class of cropuang to crop the money by the image scan that inserted by user, and resize class will be run to resize the image using the parameter value of crop result. After preprocessing, class matchinghistogram is run by GUI to matching the image of resize and image in database. After get the result of matching histogram, class GUI will check if the similarity color is > 50%. If the similarity >50%, then image money will be checked by using pattern, GUI class will use the crop class to get the pattern, mean filtering to reduce noise on pattern, thresholding to segment the image, and edge detection to get an edge of the image. After pattern has been detected by edge, GUI class will run the matchingpattern class to count the similarity of the pattern input and pattern image in database.
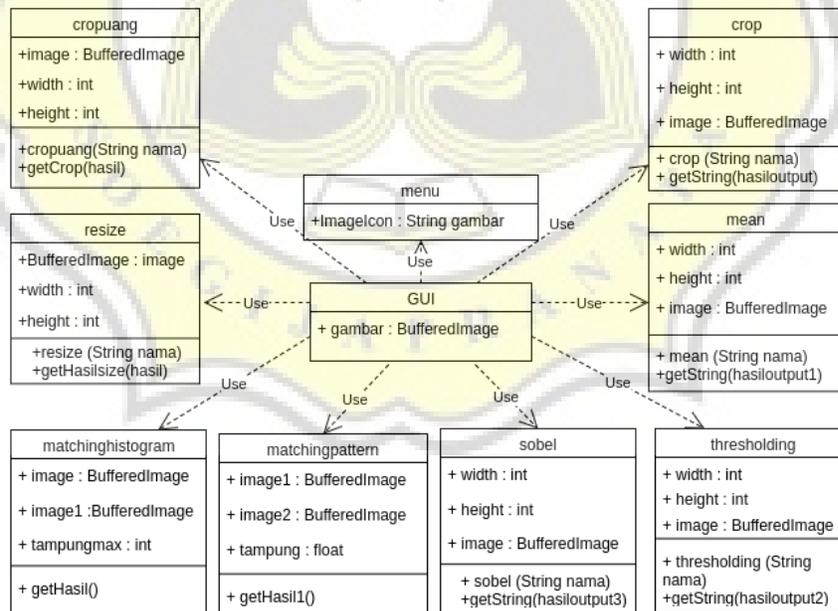

Figure 15. Class Diagram

Some class that is required to complete the program:

1. Class cropuang

    This class is used to get the cropped money from image scan.

2. Class resize

    This class is used to get the exact scale of an image to compare.

3. Class matchinghistogram

    This class is used to get the RGB value of each picture

4. Class crop

    This class is required for cutting specific pattern images from the left side of the money

5. Class mean

    This class is needed to smooth the image patterns that aims to reduce the noise in the picture.

6. Class thresholding

    This class is required for money being two binary images.

7. Class sobel

    This class is needed to get the edge of the pattern image.

8. Class matchingpattern

    This class is used to detect similarity pattern.

9. GUI

    This class is used for image display program/User Interface.

10 .Class menu

    This class is used to display the database of histogram and pattern.