Shape Feature Analysis for Different Shape Detection of Computer Sketch

Christina Caraswati Liantara
Aichi Prefectural University
Nagakute, Japan
im172005@cis.aichi-pu.ac.jp

Kazuhito Murakami
Aichi Prefectural University
Nagakute, Japan
murakami@ist.aichi-pu.ac.jp

Abstract --- Shape feature analysis is one of well-known research topics in image processing and can be implemented in many fields. This paper proposes a method to find a shape which is different from the other shapes of computer sketch. First, the input image will be preprocessed, such as gray scaling and blurring. After that, edges are detected using Canny algorithm and contours of the image are traced. From found contours, sorting and segmentation will be done. Finally, discrete Fourier transform is calculated and dissimilarity measurement with a template will be done using 4 different calculations such as Euclidian distance, cosine similarity, correlation method and Manhattan distance. The goal is to find the most different object.

The proposed method is not only trying to deal with simple computer sketch but also more complex computer sketch such as overlapping objects in handwritten computer sketch and noise image. From the research, the most different object can be found in simple image, but it is still hard to be found in complex image. As future task, the research will be improved to deal with more complex image.

Keyword --- shape feature analysis, image processing, overlapping object separation, segmentation, dissimilarity measurement.

I. INTRODUCTION

Image processing is one of ongoing research in computer science field. One subtheme of image processing is shape features analysis. Shape features analysis is a process of analyzing geometric shape features which later can be used for shape matching [1]. There are many applications which implement shape feature analysis such as factory product inspection, biomedical engineering, finger print recognition, and content based image retrieval, etc. Shape features analysis is still one of interesting researches in image processing because there are a lot of methods which can be used and different applications which can be created. Human eyes can distinguish different object out of several objects but take a little more time when there are so many objects. It is also a bit harder to distinguish different object when it has similar shape, color or texture with another objects. Computer or robot can help human to make the job easier and faster, by detect that different object automatically.

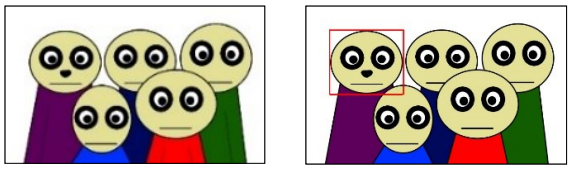
In our research, computer will find a shape which is the most different from the other shapes in the computer sketch image automatically, by comparing one shape to another shapes within the image. Computer sketch is a sketch that was created using computer applications, which are combination of shapes that are provided at computer. Handwritten computer sketch is computer sketch which is drawn manually by human using mouse or another drawing devices. The research is limited to distinguish panda face from many human faces, but it can be expanded to another applications or objects.

The program can distinguish the different shape successfully in a simple computer sketch, but it becomes challenging when dealing with more complex image such as when the image has so many objects with similar shape, there will be many overlapping objects in the image or handwritten computer sketch where the shape of the objects are different one into another because it was drawn by human, and also when there is noise in the image. Later, some experiments are also done to test if the proposed method can also deal with those complex images.

II. PROPOSED IDEA

The proposed idea is explained as follows, suppose that there is a sketch of upper body of a group of people consist of some bald people in white background who are looking straight to the camera. The shape of the faces are irregular round or slightly different one into another. Also, the face of the person who is standing at the back sometimes cannot be seen entirely, which is categorized as overlapping problem in segmentation process. Among them, there is a person who is wearing a panda mask. The computer will detect the panda mask as the most different one.

The panda face is assumed to have different shape features out of all other human face. For example, the panda face has small circle around the eyes which humans don`t have and the nose is also bigger than human nose. Although between human faces also has different features, such as wink eyes and not wink eyes, smile or not smile, or oval and round face which also give some different values in dissimilarity measurement, those panda shape features should also help to differentiate between panda and human in the dissimilarity measurement. In those calculations, bigger value will show the more difference of an object into another. The simple illustration of the idea is shown in Figure 1.



(a) (b)

Figure 1. Research illustration – (a) computer sketch of 5 persons. There is a panda masked person which is different from the other human faces; (b) the panda mask is marked as the most different object.

III. PROPOSED METHOD

The proposed method is shown in Figure 2. At first, a template is created which later will be used in dissimilarity measurement process. A face from the input image is chosen randomly and will be cropped manually. The cropped image is preprocessed such as gray scaling and blurring, and is resized in the same size as the compared image. Next, the first step is

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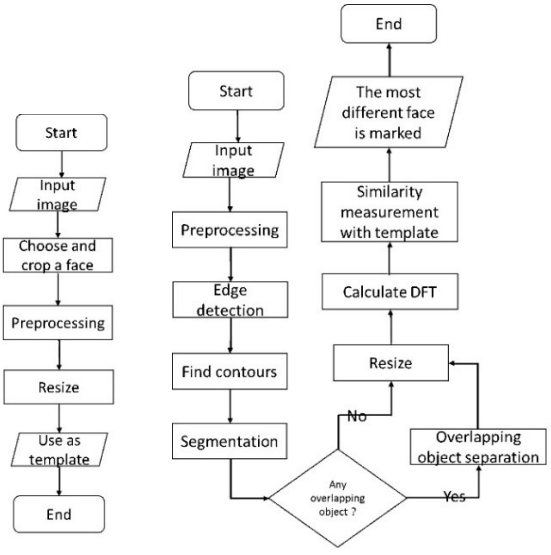
preprocessing the input image, where the RGB image will be converted into grayscale and blurred to reduce the noise. Canny edge detection is done to find the edge in the image and the contour of them will be found. Contour is list of points which have same color or intensity that created the shape in the image [4]. The contours are found using Suzuki-Abe border following algorithm [2][3]. There are so many contours which are gotten from the find contour method such as contour of the face, contour of the body, contour of the eye, etc., and its contour has its own size. Because only face contours that are needed in the dissimilarity measurement process, those contours will be sorted so that only face contours continue to the next process and the other contours will be eliminated. Before the sorting process, the face area contours are already defined manually, because it is still hard to detect face area automatically and the fix value cannot be set as the input images have different size.

Based on its contour, a rectangle bounding box is created which will surround the contour and will be used to segment the contours. If there are overlapping objects, those objects will be separated into its individual object. The segmented images will be resized. Last, discrete Fourier transform (DFT) and the dissimilarity measurement between template and segmented objects will be done. The shape dissimilarity will be measured using 4 different methods. There are Euclidian distance, cosine similarity, correlation method and Manhattan distance. In the measurement result, the bigger value means the objects are more dissimilar.



(a) (b)

Figure 2. Flowchart of the proposed method – (a) creation of the template, (b) find the most different shape

In the dissimilarity measurement equations, the first variable (A) is the template and the second variable (B) is the segmented face. The dissimilarity will be calculated between the template and all other segmented objects in the image. In Euclidian distance and Manhattan distance, the bigger the result, the more differences between the template and segmented object. However, in cosine similarity and correlation value, the bigger the result, the more similar the shapes one into another. So, 1/result is used instead, so that all 4 dissimilarity measurement methods show the biggest result for the most different object. The equations of dissimilarity measurement are shown in the Equation. Equation(1) is Euclidian distance, equation(2) is cosine similarity, equation(3) is correlation method and equation(4) is Manhattan distance.

$$\text{Euclidian} = \sqrt{\sum (A-B)^2} \quad (1)$$

$$\text{Cosine} = \frac{A\,B}{||A||||B||} \quad (2)$$

$$\text{Correlation} = \frac{covariance\ (A,B)}{\sigma A\ \sigma B} \quad (3)$$

$$\text{Manhattan} = \sum |A-B| \quad (4)$$

IV. EXPERIMENTS

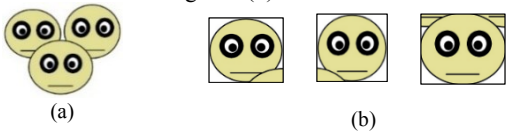
A template for comparison in dissimilarity measurement is cropped manually because it is still hard to detect face area automatically. Beside, because the images have different size which influence the size of face area, the size of the face area is also defined manually for sorting contour process. For example, the original image size is 728X610px, the face of template size is cropped around 24X37px, and the face area for sorting process is defined around 20X30px.

In the experiment, the program is tested in simple image, such as there is a sketch of a group of people consists of about 12 bald people in white background who are looking straight to the camera and one of them has a panda face with a bigger nose. The shape of the faces are irregular round or slightly different one into another, such as oval, round, rounded horizontally or rounded vertically. There is also overlapping faces in the image. The image was created using combination of shapes which are provided at computer. The experiment will also be conducted with around 300 faces image to see if the dissimilarity measurement can be calculated successfully although there are so many faces to compare. Later, 10 % noise is added to the image to check if the program can still find the panda as the different object and to check the robustness of the program.

Later, the experiment is also done to more complex image such as handwritten computer sketch of 67 people, and one of them is the panda face as the different one. In handwritten sketch, the shape of faces are different one into another, it also has overlapping faces in it and color background, which are harder to calculate in dissimilarity measurement. Later 10% noise is also added to the images. In dissimilarity measurement process, the influence of size of the image to the detection result is also taken into the research, such as check the different resized image into 16X16px, 32X32px, 64X64px and 128X128px. Both of the template and segmented images will be resized into the same size. In the end, the result will be analyzed and checked whether the panda can be detected as the different object in the complex image. Beside, the correlation between size of the image with calculation time will also be checked. The program was created using Microsoft Visual Studio C++ and OpenCV library.

V. RESULTS

Sample overlapping face example in simple image is shown in Figure 3. After contours are found and rectangle bounding boxes are created to segment the image, those 3 objects in Figure 3(a) will be separated into its individual face and result is shown in Figure 3(b).

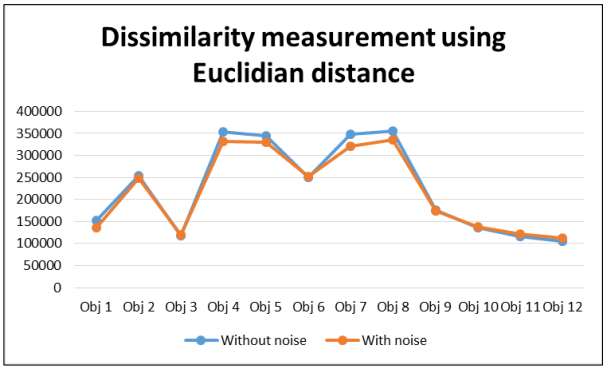


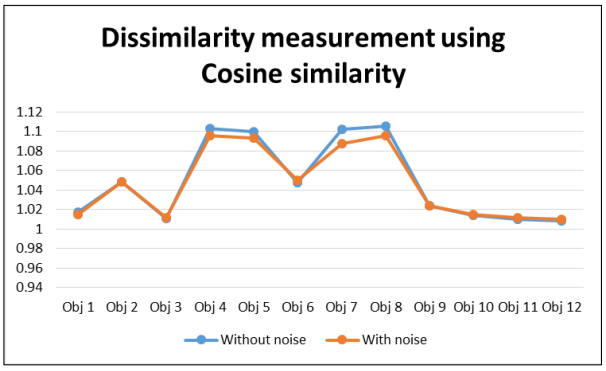
(a) (b)

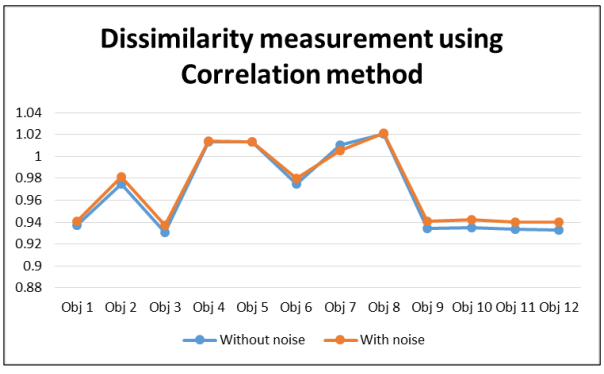
Figure 3. Example overlapping object separation – (a) overlapping objects; (b) separation result.

Sample dissimilarity measurement results in simple image using 4 different dissimilarity measurement methods; Euclidian distance, cosine similarity, correlation method and Manhattan distance are shown in Figure 4. Those samples are result of both image without noise and image with noise. There are 12 faces

and one of them is panda face as shown in Figure 6(a), the shape of the faces are slightly different and there are some overlapping faces. Sample image that are used at the graphs are also shown in Figure 5. From the result, it can be seen that panda has the biggest difference value in all dissimilarity measurement methods. Even if noise is added to the image as shown in Figure 6(b), panda still has the biggest value after compared with the template.







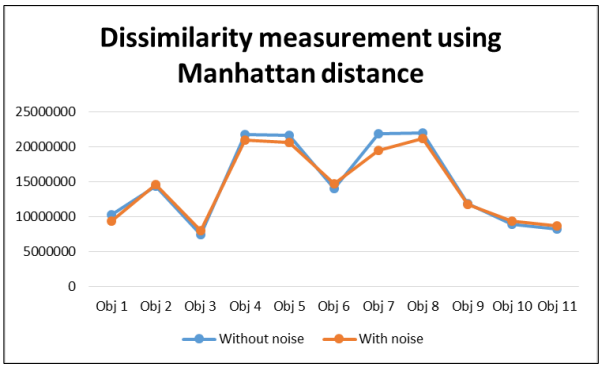


Figure 4. Example dissimilarity measurement result of image without noise with template using 4 different dissimilarity measurement methods.

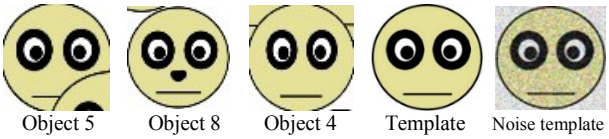
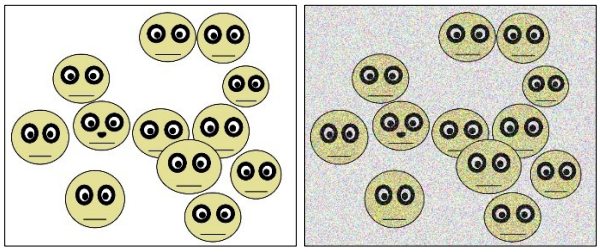


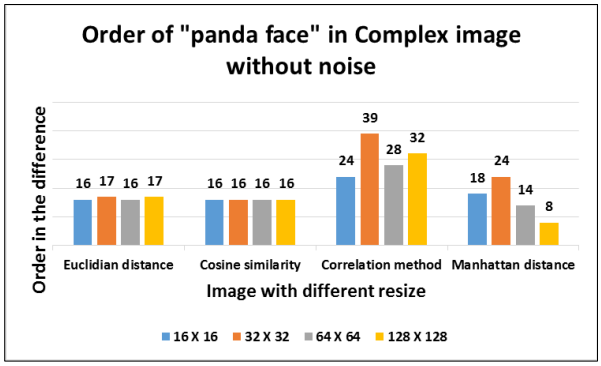
Figure 5. Sample 3 segmented objects out of 12 objects and template, some of them are overlapping faces.



(a) (b)

Figure 6. Sample image – (a) Image of 12 faces without noise, (b) Image of 12 faces with noise.

Figure 7 shows the result of the number of panda face as the difference object in complex image and the influence of different size of image such as 16X16px, 32X32px, 64X64px and 128X128px using 4 different dissimilarity measurement methods.



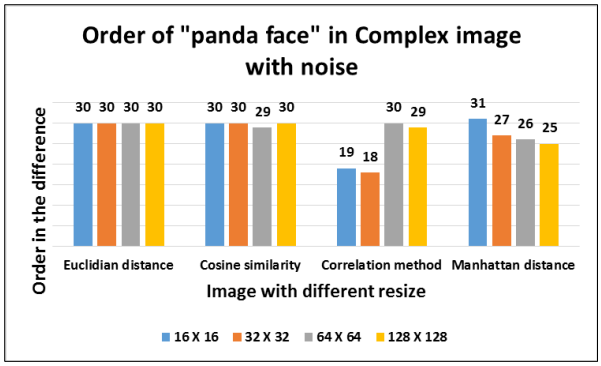


Figure 7. Sample correlation between order of "panda face" with 4 different type of resized image in complex image.

Figure 8 shows the result of time that is needed by the program for dissimilarity measurement in complex image. It shows the sample result of correlation between different types of similarity measurement method with different size of resized images.

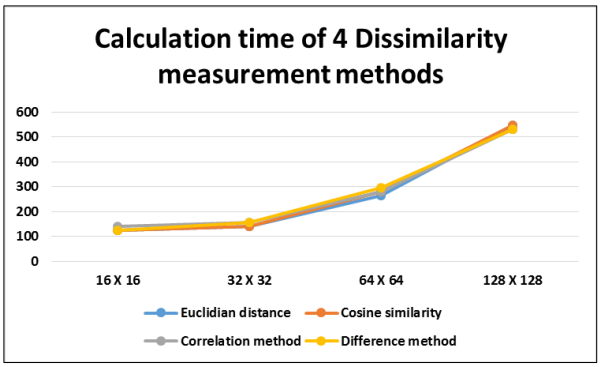


Figure 8. Sample correlation between calculation time and 4 different type of resized image in complex image.

VI. DISCUSSIONS

From the experiment which have done in simple images, panda can be detected as the most different object. Panda which is the Object 8 has the biggest value or the biggest difference out of all other faces when compare with a template using 4 different dissimilarity measurement methods. The values are $3.547X10^5$ when using Euclidian distance, 1.106 when using cosine similarity, 1.021 when using correlation method and $2.192X10^7$ when using Manhattan distance. Even if there is noise in the image, the panda can still be found using the proposed method.

In the research, the dissimilarity in noise image is expected to be higher than image without noise, because the pixels in the noise image has more difference compare to image without noise. But, from the experiments which were conducted, there are some cases where the image without noise has higher dissimilarity than noise image. Simple example is shown in Figure 9. Figure 9(a) and 9(b) show the 2X2 matrices of template and sample face of Figure 9(c), Figure 9(d) and 9(e) show the 2X2 matrices of noise template and sample face of Figure 9(f). If those matrices were calculated manually using cosine similarity, image without noise has value of 1.068 and image with noise has value of 1.058.

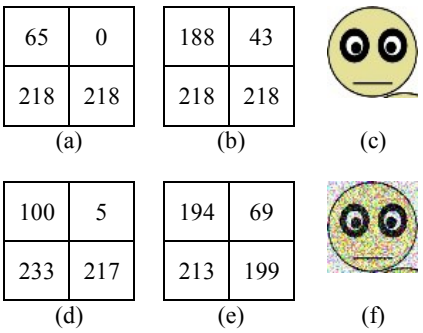


Figure 9. Sample 2X2 matrices of segmented faces – image without noise (a)template, (b)face 'c', image with noise (d) template, (e) face 'f'.

But, from the experiment which is done to handwritten computer sketch, it can be seen that the proposed method is still hard to find the panda as the most different one. The best result of panda face detection is panda face becomes 8th most different of 67 faces using Manhattan distance at size 128 X 128px. It can be seen that resizing the image will affect the dissimilarity measurement calculation which then will affect the detection result. Especially correlation method and Manhattan distance have fluctuated changes when the size of the image is changed, but sometimes give the best result out of 4 dissimilarity measurement methods. On the other hand, Euclidian distance and cosine similarity has a more stabile result although the image size is different.

The calculation time in the dissimilarity measurement process are also influenced by the size of the image, if the image is small the computation time is fast, and on the other hand, if the size of the image is bigger, the calculation time is longer. It also can be seen that noise image makes the detection result lower. For example, from the 20th biggest different shape of panda face in image without noise, it become the 30th biggest different when noise is added.

There are also another factors which influence the dissimilarity measurement result which lead to hard in detecting the panda as the most different one. First, in find contour process, it is still hard to distinguish between edge of face area, edge of eyes, edge of the body and thus influence the segmentation result. Second, in the segmentation process, it is still hard to segment the image completely when there are overlapping faces, so that the uncompleted segmented face area has quite bigger dissimilar with the template than completely segmented face area. Third, it is still hard to differentiate when panda has similar or a bit different features from the other faces. Last, the chosen face as the template will also affect the dissimilarity measurement result, because the template is sometimes have more dissimilar features with another faces than the panda face.

VII. CONCLUSION

In this research, panda face as the different shape of computer sketch has been detected by comparing them with a template and measured the dissimilarity using 4 different methods namely Euclidian distance, cosine similarity, correlation method and Manhattan distance. The panda face can be found as the most different shape with the biggest value in simple image. This research can also deal with overlapping objects problem, hundred objects in the image and noise image. The influence of different size with the detection result and calculation time that are needed in dissimilarity measurement are also calculated.

But, the proposed method is still hard to find the panda as the most different one in complex image. In the future, the result will be improved using another method. The research will also be done to a more complex computer sketch, such as if the face of the object does not have border, there is more people in the sketch, or if the different shape is not panda face, or better segmentation of overlapping objects and try another dissimilarity measurement method. The usage of machine learning for better result is also taken into consideration.

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