H-055

A Comparison with 1D Four Descriptor and Generic Fourier Descriptor on Khmer OCR

Vanna KRUY† Wataru KAMEYAMA†
vanna@ruri.waseda.jp wataru@waseda.jp

1. INTRODUCTION

Feature extraction is an important part to Optical Character Recognition. Many shape descriptors exist. Among them Fourier Descriptors has proved itself to be efficient in term of computational cost and accuracy. However, Fourier Descriptors has the drawback of losing region information. To overcome this, Generic Fourier Descriptors has been proposed. In this paper, we make a study and comparison of Fourier Descriptors with Generic Fourier Descriptors to show their performance on Khmer OCR.

2. RELATED WORKS

There are only few research efforts on Khmer OCR. Two of which are Khmer OCR using wavelet descriptors and Khmer printed optical recognition using lagendre moment both by Chey et al which reaches 92.99% accuracy [1] and 92% accuracy [2], respectively. Ing L.I. experimented Khmer OCR for Limon R1 font, size 22 using Discrete Cosine Transform and Hidden Markov Model which reaches 98.88% accuracy [3].

3. METHODOLOGY

To compare Fourier Descriptor (FD) and Generic Fourier Descriptor (GFD) on Khmer OCR, we have built a Khmer character image database with different levels of noises. We test each feature against all noise levels and compare their accuracy.

4. FOURIER DESCRIPTORS

FD has been shown to be effective in shape discrimination [4]. It has translate, scale, and rotation invariant properties. To extract FDs, an appropriate shape signature needs to be obtained which in our case is the Centroid Distance. First we extract the contour from the input image, normalize it, and transform it to temporal domain using Centroid Distance.

4.1 CONTOUR NORMALIZATION

We used the Equal Points Sampling method as our contour normalization process.

$$S = \frac{T}{K} \quad (1)$$

S: Space between consecutive points
T: Total contour points
K: Number of candidate points

4.2 CENTROID DISTANCE

Centroid distance is the distance of the boundary points from the centroid (xc,yc)

$$x_c = \frac{1}{L}\sum_{t=0}^{L-1} x(t),\ y_c = \frac{1}{L}\sum_{t=0}^{L-1} y(t) \quad (2)$$

$$r(t) = ([x(t) - x_c]^2 + [y(t) - y_c]^2)^{1/2} \quad (3)$$

The fourier transform of the Centroid Distance is the FD. To achieve scale invariance, we use the first coefficient as our denominator as described in the following formula.

$$\mathbf{f} = \frac{|FD_1|}{|FD_0|}, \frac{|FD_2|}{|FD_0|}, \ldots, \frac{|FD_{N/2}|}{|FD_0|} \quad (4)$$

Fig. 1 summarizes the whole FD extraction process.

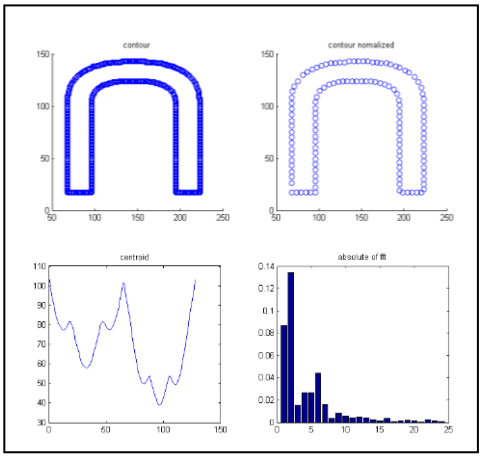

Fig.1 FD Extraction Process.

4.3 GENERIC FOURIER DESCRIPTORS

GFD has been tested and confirmed to outperform other common contour-based and region based descriptor. It has more abilities to be invariant with common geometric transformations.[4]

To extract GFD descriptor, an image is first converted to polar raster image. By using polar coordinate and setting the centroid of the shape as the origin, we can achieve translation and rotation invariance. Fig.2 below illustrates the process.

† GITS, WASEDA University

Fig.2 Original Image, Shape Silhouete, and the Polar Shape(Left to right)

The Fourier Transform is then applied to the polar shape. To achieve scale invariance, we use the following formula:

$$GFD(f) = \left\{ \frac{PF(0,0)}{aire}, \frac{PF(0,1)}{PF(0,0)}, \ldots\ldots, \frac{PF(m,n)}{PF(0,0)} \right\} \quad (5)$$

Where aire is the surface area of the circle encompassing the interest object, m and n are selected maximum radial frequencies and the number of angular frequencies respectively. The GFD is the Generic Fourier Descriptor.

5. CLASSIFIER

We use Root Mean Square Error (RMSE) as our classifier for both FD and GFD. The class with the minimum RMSE is chosen as the candidate.

6. EXPERIMENT AND RESULT

We test the feature with 2323 Khmer characters. The test images are applied with different noise levels: 0%-40%. The FD number of coefficient is 50. The GFD number of coefficient is 80 (8 radian resolution by 10 angle resolution).

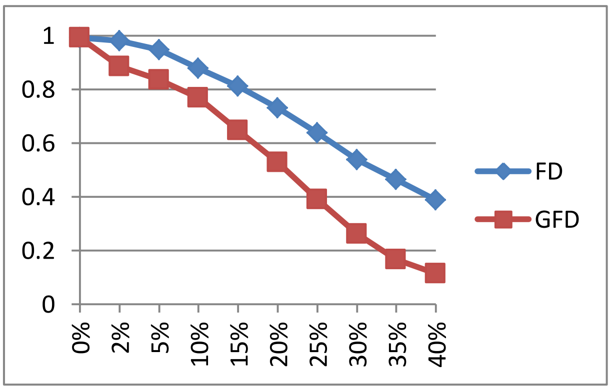

Fig.3 Noise-Accuracy Graph for both FD and GFD Features.

7. DISCUSSION

Contrastingly, we have observed that FD is doing better than GFD due to the noise reduction nature of extracting contour. Since small contours are discarded, we could get the correct contour with only few noises, while GFD still suffer from the noises.

We see when FD underperforms GFD in the case where the noises reach a certain level that would prevent a complete contour from being extracted.

The figure below illustrates an input character whose contour cannot be completely extracted due to severe noise.

Fig.4 Input Image and its Contour(incomplete due to noise)

Another case where GFD has the advantage is when the characteristic of the shape hinders the contour process from extracting a complete contour. For instances, complete contour cannot be extracted from shapes in Fig.5.

Fig.5. Shapes without complete Contours. (From Fig.2 in [4])

8. CONCLUSION

FD outperforms GFD in the case of Khmer characters. FD's contour process greatly contributes to the noise reduction while GFD still suffers from the noises. GFD only out performs FD when a meaningful contour cannot be extracted which is not the case in Khmer character.

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