Can Fractal Dimension Be Used In Font Classification

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Abstract

In this work, we present a new tool for the font optical recognition. This tool is based on the use of the fractal geometry. We used two techniques for obtaining two parameters, they allowed the extraction of the global textures characteristics. These characteristics are expressed in a parametric form. The vision aspect is held in consideration, since it makes it possible to differentiate one font of another. Experiments show the importance of the proposed approach.

1. Introduction

The reproduction of a digitized document, requires not only the identification of the characters but also the font used in the origin text. The Identification of a word font, a line font or a text font allows us to characterize the structuring of a document. The recognition of the font, is useful for the definition of logical entities (the title of the document, titles of sections or paragraphs) of a document. The identification of the font can be operated upstream or downstream from the optical recognition of characters (OCR: Optical Character Recognition) [2]. In the two strategies, the OFR (Optical Font Recognition) allows to improve the performances of the OCR and to reduce the complexity of the task while bringing back problems multi fonts to problems mono fonts

In spite of the importance of the OFR in an OCR system, it remains a problem often neglected and the studies in this field are few in particular, in the Arabic case. Font identification in the Arabic case is not commonplace task because of the morphological complexity of this script. This is why, little work in Arab recognition used contexts multi font without proceeding to the font recognition [1] [4]. Optical Font recognition improved the systems performances.

2. On the recognition of the font:

The Font optical recognition aims to identify the font used in the origin edition, of a given text. In the following, we present some works in this field.

In [5], the proposed recognition system deals with a Hidden Markov Models. This system functions in two steps. In the first step, the prevalent font is detected in the present paragraph. In the second step the Modified Viterbi algorithm is applied. The rate of best identification of one font among the ten studied is about 97.9 %

The system developed by Cho [9] is dedicated to the recognition of eight Hangul font of various sizes using multi-layer neurons networks. Zramdini et al [2] proposed a priori font recognition system. For this, they identified the font according to 5 criteria (family, size, weight, slope and width). These characteristics represent total attributes of the text like the image density, the text orientation or the spacing between the characters. Shi [3] used the hybrid approach which combine the priori and the posteriori font recognition approach. According to Shi, the recognition is divided into two steps: recognition of the font and contextual treatments. The approach used by Zramdini in [1] for the font recognition was a statistical approach based on the local typographical characteristics. This approach was applied to 10 different fonts in 4 styles and 7 sizes

In [6] the method is based on the extraction of structural characteristics of the writing such as the horizontal and vertical thickness of the stroke, the middle band width, the black pixels density, the average width of an isolated letters. However this approach is based on the typographical characteristics, which depend on the script and the language. Only five fonts were considered: Kahra, Nedim, Iskandaria, Mehdi and Jiza. The priori font identification allow as possible to position directly on the basis of reference corresponding to the recognized font.

The approach applied by Zhu in [13] was based on global characteristics. The font identification was regarded as a texture identification of an image. In the case of the texture analysis, the blocks of text are standardized to create a uniform text block. The approach used by Zhu can be applied for all scripts and languages.

In [7], the authors announced that the use of architecture RBF (Radial Basic Functions) with only one output unit gives better performances, to classify 9 Arabic fonts.

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3. Proposed method

There are mainly two strategies of OFR combination with the OCR: the posteriori approach and priori approach. The posteriori identification recognizes the font after having recognized the characters [5]. It helps to correct the errors of recognition. In this work we have chosen a priori identification, which recognizes the font without recognizing the characters. It simplifies considerably the post treatments in an OCR system. Moreover, it improves the performances of the system while profiting from various information relating to the font, beforehand available.

The use of only one model of font for character recognition is very easy task. However, in the multi font context, it is necessary to identify initially the font in order to conceive a robust OCR. Indeed the physical characteristics of the characters differ from one font to another. The fractal geometry makes it possible to characterize several natural phenomena, having the self-similarity property. The writing has these properties justified by the reproduction of the same alphabet inside a word, a line or a block of text

Our objective is to carry out a fractal analysis of writing so we choose to study the surface of the traces of the writings (texture). More precisely we look if it is possible to find a powerful relation of the calculated surfaces, either with varied scales of observation, or with measuring units of varied size.

3.1 Box counting method

The box counting dimension (BCM) noted B is applied for any structure in a surface. This method is connected to the dimension of auto similarity, but it allows to determinate fractal dimension for invariant objects and those with invariant scale. By covering an image by boxes of size ' r ' and by determining the number of boxes of size ' r ' necessary to cover the image, BCM is then given. From where the number of boxes ' r ' necessary to cover the image is given by

$$N(r) = \frac{1}{r^D}$$

To estimate the dimension of the box, Euclidean space containing the image can be divided into a grid of boxes of size ' r ', and while counting boxes which are not empty (figure 1). We noted the parameters SIZE_B. We have chosen box size limit equal to 10, 15, 20 and 30, to study the influence of these arguments on the one hand on fractal dimension obtained B, on the other hand their impact in the discrimination of the writings. Within the framework of obtaining a specific measurement which contains the maximum of details, we fixed the initial value of the box size and the step of advance between two boxes of successive measurement, with the value one. In the continuation of our work, we maintained these two variables with the value one. This fractal dimension is characterized finally by the maximum size of box noted SIZE_B(box size).

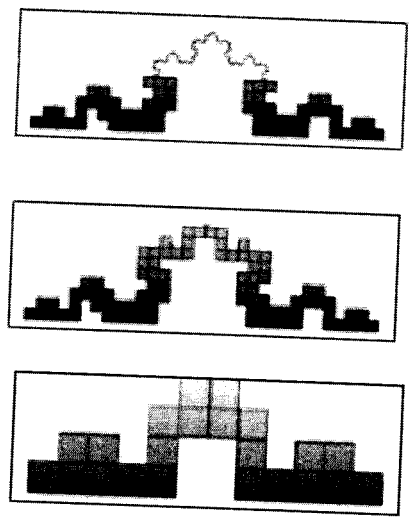


Figure.1. Example of recovery of an image by box

We noticed that the limit of the maximum box size to retain depends on the analysis level (word, line, block). We concluded that fractal dimension of a block is more stable than fractal dimension of a line, and the last is more stable than fractal dimension of a word. This concept of stability depends not only on the limiting size of the box, but also on the image size.

3.2 Elementary Dilation Method of the image

The method of the elementary dilation of the image is based on Minkowski-Boulingand dimension, (Mandelbrot, 1983; Schroeder, 1991). The definition of Minkowski-Boulingand dimension (D_M) for a curve is as follow: to measure the surface obtained for each level of centers dilation, the levels of dilation are obtained by modifying the radius ' r ' of the centers (figure 2). We noted this dimension D, which depends on the radius of dilation. This function is noted SIZE_D(dilation radius).

Dimension D used in this work is obtained by the texture surfaces measurement for each level of dilation. The choice of the maximum dilation level is a function of the dimension values obtained and their discriminating aspects. This dimension depends on both parameters: the maximum dilation radius, and the value of step between two successive dilations. This fractal dimension is characterized finally by a maximum dilation order, noted SIZE_D(radius limit).

Fractal dimension obtained by the approximate linear line of the log uplet (the radius of dilation, corresponding surfaces). We noticed that there is always a threshold of dilation. This enables us to limit ourselves to a level of dilation which keeps the discriminating

aspect of the writing. The work of Nicole Vincent and al [12] limited the number of dilation to 10. We choose to limit ourselves to an order of dilation which is equal to 30, to extract the maximum of detail.

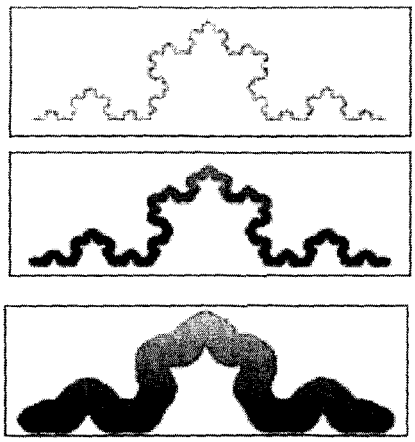


Figure 2. Example of the various dilation levels.

4. Fractal dimension application

The experiments which we present here, were carried out starting from the binary images of Arabic line texts of various font. The images of the written are digitized with a flat scanner at 300 points per inch. The choice of this resolution is well justified by former works [10] [12].

We calculated both dimensions presented before with those alternatives SIZE_B(10), SIZE_B(15), SIZE_B(20), SIZE_B(30), SIZE_D(15) and SIZE_D(20). The image basis constitutes Arabic font of various sizes.

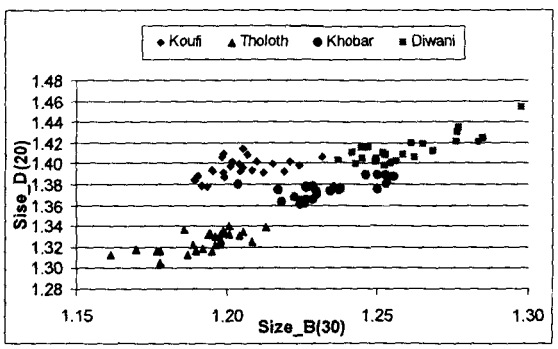


Figure 3. Graphic localization of some font

The basis of different Arabic font is composed of 275 line text images at different font such us: Ahsa, Arabic_transparent, Buryidah, Diwani, El_Kharj, EL_Khobar, Hijaz, Koufi, Naskh, Tholoth. The font line images used in this work having a size, which does not exceed 170 point of height, and a maximum width not exceeding that of a A4 page format.

The graphic study for the font discrimination provides us the distribution of the various types of font. We noticed the existence of the overlapping zones between the fonts. Figure 3 represents a graphic example of distribution of four Arab font, using only the two parameters SIZE_B(30) and SIZE_D(20). The combined use of the other parameters, with two fractal dimension B and D always shows overlapping zones between similar fonts. From where, we used the KPPV classifier to solve this problem of overlapping. We use 90 samples for training and other 185 images for testing. The best rate of discrimination of nine font such as: Ahsa, arabic_transparent, Buryidah, Diwani, El_Kharj, EL_Khobar, Koufi, Naskh, Tholoth is about 94,44 %, for k equal to one.

5. The fractal dimensions study

A study was carried out on two dimensions B and D. We noted a robustness of the two parameters size and skew.

5.1 Size influence:

Several works highlighted the size influence of writing line [1]. In this goal, we studied the influence of the size of the both parameters D and B. We used several prototypes of the same line with different sizes (figure 4). Each image is recorded under a name which specifies its font, the numeral of the image and a writing size on two characters, the sizes selected are: 8, 10, 12, 14, 16, 18, 20 and 24.

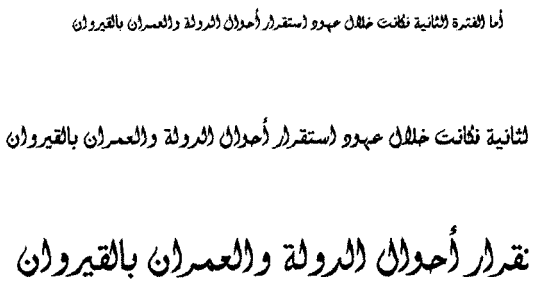


Figure 4. Example of Diwani writing of which size 8, 12 and 18

Table 1. Example of the values of D & B for various sizes of the same font.

Box size	B(15)	B(20)	B(30)
D02508	1.212	1.227	1.259
D02510	1.198	1.237	1.288
D02512	1.194	1.230	1.287
D02514	1.197	1.239	1.271
D02516	1.177	1.226	1.273
D02518	1.178	1.218	1.277
D02520	1.166	1.210	1.265
D02524	1.147	1.192	1.248
Radius Level	D(15)	D(25)	
D02508	1.395	1.362	
D02510	1.421	1.395	
D02512	1.421	1.406	
D02514	1.426	1.416	
D02516	1.422	1.420	
D02518	1.417	1.420	
D02520	1.412	1.419	
D02524	1.396	1.412	

The size values 20 and 24 are generally used in ergonomic aspects, they can be useful in the case of identification of the document structure. The writing size is proportional to the choice of font. Table 1 shows the obtained values for the same line of different sizes. The average deviation between two values of the studied parameters is with the order of 5.3 %

5.2 Skew influence:

Preliminary experiments consist in studying the influence of the slope on our parameters. Figure 5 shows some applied effects on the same writing line. In addition we calculated both dimension, the values obtained for these dimensions are presented in table 2, by respecting the same order as their appearance in figure 5.

We calculated the two dimensions presented before with five alternatives SIZE_B(15), SIZE_B(20), SIZE_B(30), SIZE_D(15) and SIZE_D(20). We noticed that our parameters are not affected by the line skew on the font lines (table 2), nevertheless SIZE_B(30) and SIZE_D(15 and 20). This enabled us to retain the parameter SIZE_B(30) for the BCM. The influence of these effects on the last parameters is about 0.5 %.

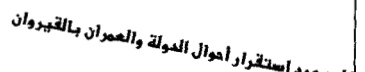
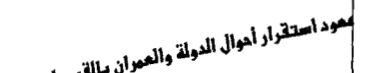
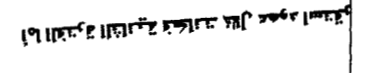
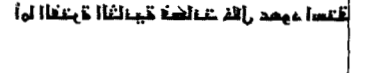
Nature of rotation	Visual effect on the image rotation
10° Est. (Effect 1)	
10° West. (Effect 3)	
5 ° West then 180° West. (Effect 5)	
Mirror. (Effect 6)	

Figure 5: Some skew effects on the writing line.

Table 2. Example of two dimensions obtained after several skew

	B(15)	B(20)	B(30)
Original Image	1.087	1.126	1.208
Effect 1	1.066	1.130	1.209
Effect 2	1.067	1.130	1.208
Effect 3	1.067	1.132	1.209
Effect 4	1.061	1.124	1.204
Effect 5	1.063	1.127	1.204
Effect 6	1.087	1.142	1.214
	D(15)		D(20)
Original Image	1.373		1.395
Effect 1	1.372		1.396
Effect 2	1.372		1.395
Effect 3	1.371		1.395
Effect 4	1.372		1.394
Effect 5	1.372		1.395
Effect 6	1.372		1.395

6. Conclusion and perspectives

We have proposed a new automatic method of font identification. This method is based on global texture analysis it doesn't depend on the language studied. In this method, text lines are not normalized. The method proposed is insensible to the skew effects, in opposition to most statistic and heuristic method, it doesn't require complex treatment, and it can be more efficient in their application, not only for lines but also for text blocks. However it is interesting on the one hand to test our system for other languages, on the other hand to refine parameters to improve their discriminating aspect, in order to restrain the number of the B and D dimensions.

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